VOL. XIII No. 1 MARCH 1983

18/7/83
33 | 59 Ext Jrnl

HARYANA AGRICULTURAL UNIVERSITY

JOURNAL OF RESEARCH

ISSN 0379-4008

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THE DIRECTORATE OF PUBLICATIONS

HARYANA AGRICULTURAL UNIVERSITY
HISSAR
(HARYANA) INDIA

HARYANA AGRICULTURAL UNIVERSITY

JOURNAL OF RESEARCH

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EVALUATION OF ANTIGENIC EFFICACY OF IRRADIATED INFECTIVE LARVAE OF *HAEMONCHUS CONTORTUS* IN GOATS

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(Received : July 23, 1981; Revised : January 15, 1982)

ABSTRACT

The immune response of goats to double dose vaccination with 60 Kr irradiated *H. contortus* larvae showed 82, 60 and 39.74 per cent protection in parasite native, worm free and raised worm free goats, respectively, after challenge. Packed cell volume (PCV) and Hb showed no appreciable alterations in goats of parasite native, worm free and raised worm free groups after vaccination. Weight loss of the animals of all the vaccinated groups after challenge was insignificant as compared to control. There was a marked increase of TSP values in parasite native goats after 30 days of challenge in comparison to worm free and raised worm free animals.

Irradiated larvae have been used successfully in immunization of calves against the cattle lungworm *Dictyocaulus viviparus* (Jarrett *et al.*, 1959 a). Promising results under experimental conditions have also been reported for *H. contortus* infection of sheep (Jarrett *et al.*, 1959 b, 1961; Bitakeramire, 1966; Smith and Christie, 1979). In India, a little or no work has been so far taken on irradiated larval vaccine of *H. contortus*. In view of the above facts, the present study was undertaken to evaluate the antigenic efficacy of irradiated infective larvae of *H. contortus* in goats.

MATERIAL AND METHODS

During culture, female worms were cut on slide in small pieces then triturated gently in glass pestle and mortar after adding little quantity of 0.1% sodium carbonate solution. This material was put to charcoal faecal culture media (Roberts and O' Sullivan, 1950) to obtain the third stage infective larvae.

The cleaned larvae were suspended in suitable volume of cold isotonic saline solution and number of larvae in 0.1 ml suspension were counted. After this, the volume was adjusted for 1000 to 1500 larvae/ml. The larvae were preserved in separate glass vials at the rate of 2000, 5000, 10,000 larvae for future use. No antibacterial or antifungal agent was added. These vials were stored between 5 and 10°C for vaccination, challenge/infection of the experimental goats.

Irradiation of larvae was done as per method of Mulligan *et al.* (1961) with little modification. The irradiation was carried out in gamma chamber 900 with

cobalt 60 source (Bhabha Atomic Research Centre, Bombay). The irradiated larvae were maintained at 20-25°C. The irradiation was done at the dose of 500 r/min for two hours to achieve 60 Kr dose (the instrument was running in half life). The irradiation and vaccination were performed within 25 days of harvest of the larvae from the culture. The required number of irradiated/unirradiated larvae in the vials were suspended in suitable volume of cold physiological saline solution and given orally to each goat/kid with a plastic syringe. All the animals were housed in disease free environment and were maintained on wholesome and nutritious diet. Details of goats are given in the Tables 1-5.

These experimental goats were weighed and faecal and blood examinations were carried out at an interval of 10 days during the experiment. The faecal examination and quantitative evaluation of worm burden (epg) were conducted by the methods of Singh and Srivastava (1977) and Anon. (1977), respectively. The values of haemoglobin (Hb) and packed cell volume (PCV) were determined by techniques of Schalm *et al.* (1975). Total serum protein (TSP) was determined by biuret reaction method of Gornall *et al.* (1949).

RESULTS AND DISCUSSION

No change in gm per cent of Hb was observed in vaccinated parasite native animals, whereas in the vaccinated worm free and raised worm free groups the per cent fall of Hb was 0.9 and 33.6, respectively. In the control animals of parasite native, worm free and raised worm free groups the per cent fall of Hb was 5.7, 29.7 and 30.2, respectively, whereas in vaccinated control parasite native and worm free was nil and 2.6, respectively (Table 1).

On the 30th day after challenge the fall of PCV values recorded in parasite native, worm free and raised worm free was 5.5, 5.6 and 20.5 per cent, respectively. The per cent fall in PCV values in same sequence in the control groups was 6.6, 22.5 and 23.1. In the vaccinated control of parasite native and worm free groups, the per cent fall in PCV was nil and 11.3, respectively (Table 2).

In vaccinated groups of parasite native, worm free and raised worm free the fall in weight after challenge was 10.9, 9.9 and 11.6 per cent, respectively. The fall in body weight recorded in the same sequence for controls was 14.4, 13.7 and 10.8, respectively, whereas vaccinated control of parasite native and worm free groups showed slight increase in body weight (Table 3).

On 30th day post-challenge, the mean epg was lowest (120) in vaccinated group of parasite native animals, whereas the epg was found to be highest (1330) in the raised worm free animals. The mean values of epg in control group of parasite native, worm free and raised worm free were 2000, 2250 and 2250, respectively (Table 4).

There was a marked increase of TSP values in the parasite native animals after 30 days post challenge in comparison to the worm free and raised worm free animals. The maximum fall of TSP values recorded in raised worm free vaccinated as well as in control groups after chal-

TABLE 1

Mean haemoglobin values of goats before and after vaccination with 60 Kr irradiated (IR) infective larvae of *H. contortus*

Group	No. of goats	Haemoglobin (Hb)										% fall
		Pre-vaccination (days)	Post 1st vaccination* (days)			Post 2nd vaccination** (days)			Post challenge*** (days)			
		0	10	20	30	10	20	30	10	20	30	
I. Parasite native	4	11.7	12.1	11.6	12.6	12.2	12.1	12.2	12.1	13.7	12.2	No
Vaccine control	3	11.5	11.0	11.2	12.6	11.5	11.7	11.4	(11.5)	(11.6)	(11.7)	No
Control	3	12.2	(12.1)	(12.0)	(12.3)	(12.1)	(12.2)	(12.1)	12.3	11.8	11.5	5.7
II. Worm free	3	10.4	12.0	10.4	11.5	11.7	11.8	11.7	12.6	11.0	10.3	0.9
Vaccine control	2	11.3	11.7	11.0	11.9	11.1	11.1	10.3	(10.4)	(10.6)	(11.0)	2.6
Control	2	13.1	(13.1)	(13.3)	(13.2)	(13.1)	(13.0)	(13.4)	12.4	11.8	9.2	29.7
III. Raised worm free	3	12.2	11.4	12.6	12.8	11.5	11.8	11.8	12.0	10.9	8.1	33.6
Control	2	11.9	(12.0)	(12.1)	(12.0)	(12.1)	(12.2)	(12.2)	11.5	10.5	8.3	30.2

*1st vaccination 2000 (IR) larvae on day 0.

**2nd vaccination 5000 (IR) larvae on day 35.

***Challenged on day 70 with 10,000 infective larvae.

Figures in parentheses indicate not vaccinated/not challenged.

% fall calculated from normal value on 0 day and at 30 days post challenge.

TABLE 2

Mean packed cell volume (PCV) of goats before and after vaccination with 60 Kr irradiated infective larvae of *H. contortus*

Group	No. of goats	Packed cell volume (PCV %)										% fall
		Pre-vaccination (days)	Post 1st vaccination* (days)			Post 2nd vaccination** (days)			Post challenge*** (days)			
		0	10	20	30	10	20	30	10	20	30	
I. Parasite native	4	25.4	25.7	24.7	24.3	23.9	24.6	24.1	23.1	24.5	24.0	5.5
Vaccine control	3	23.2	22.3	22.1	23.3	22.1	22.6	22.5	(23.0)	(23.2)	(23.2)	No
Control	3	25.5	(25.6)	(25.4)	(25.7)	(25.6)	(25.7)	(25.7)	25.1	24.4	23.8	6.6
II. Worm free	3	25.0	24.1	22.8	24.6	23.8	25.9	24.0	26.1	24.6	23.6	5.6
Vaccine control	2	26.5	27.9	26.2	27.4	25.6	25.8	23.6	(23.6)	(23.8)	(23.5)	11.3
Control	2	27.9	(28.0)	(28.2)	(28.1)	(28.0)	(27.8)	(28.2)	25.9	24.5	21.6	22.5
III. Raised worm free	3	27.2	27.7	28.8	27.1	27.2	26.6	26.8	27.3	24.5	21.6	20.5
Control	2	24.2	(24.4)	(24.5)	(24.0)	(24.1)	(24.3)	(24.5)	24.4	21.5	18.6	23.1

*1st vaccination 2000 (IR) larvae on day 0.

**2nd vaccination 5000 (IR) larvae on day 35.

***Challenged on day 70 with 10,000 infective larvae.

Figures in parentheses indicate not vaccinated/not challenged.

% fall calculated from normal value on 0 day and at 30 days post challenge.

TABLE 3

Mean weight loss/gain of goats before and after vaccination with 60 Kr irradiated infective larvae of *H. contortus*

Group	No. of goats	Live body weight (kg)										% fall
		Pre-vaccination (days)	Post 1st vaccination* (days)			Post 2nd vaccination** (days)			Post challenge*** (days)			
		0	10	20	30	10	20	30	10	20	30	
I. Parasite native	4	16.5	16.7	16.0	15.2	15.7	15.7	15.0	15.7	15.4	14.7	10.9
Vaccine control	3	13.6	13.3	13.8	14.1	14.3	14.2	14.5	(14.8)	(14.5)	(14.8)	No
Control	3	15.3	(15.2)	(15.0)	(15.4)	(15.5)	(15.6)	(15.7)	15.5	15.3	13.1	14.4
II. Worm free	3	13.1	13.1	12.9	12.9	13.4	12.9	12.6	13.0	12.8	11.8	9.9
Vaccine control	2	14.7	15.0	14.6	15.2	14.7	15.0	14.7	(14.8)	(14.5)	(14.9)	No
Control	2	18.2	(17.9)	(18.0)	(18.1)	(18.0)	(18.3)	(18.6)	18.7	18.7	15.7	13.7
III. Raised worm free	3	12.0	12.0	11.8	11.8	11.6	11.8	11.6	11.1	11.1	10.6	11.6
Control	2	12.0	(12.1)	(12.4)	(12.0)	(12.1)	(12.3)	(12.4)	11.5	11.5	10.7	10.8

*1st vaccination 2000 (IR) larvae on day 0.

**2nd vaccination 5000 (IR) larvae on day 35.

***Challenged on day 70 with 10,000 infective larvae.

Figures in parentheses indicate not vaccinated/not challenged.

% fall calculated from normal value on 0 day and at 30 days post challenge.

TABLE 4

Mean values of eggs per gram of faeces (epg) in goats before and after vaccination with 60 Kr irradiated infective larvae of *H. contortus*

Group	No. of goats	EPG										
		Pre-vaccination (days)	Post 1st vaccination* (days)			Post 2nd vaccination** (days)			Post challenge*** (days)			
		0	10	20	30	10	20	30	10	20	30	35
I. +Parasite native	4	0	0	0	0	0	0	12	0	0	25	120
Control	3	0	(0)	(0)	(0)	(0)	(0)	(0)	0	0	225	2000
II. Worm free	3	0	0	0	0	0	33	66	0	0	233	200
Control	2	0	(0)	(0)	(0)	(0)	(0)	(0)	0	0	300	2250
III. Raised worm free	3	0	0	0	16	0	0	133	0	0	120	1330
Control	2	0	(0)	(0)	(0)	(0)	(0)	(0)	0	0	150	2250

*1st vaccination 2000 (IR) larvae on day 0.

**2nd vaccination 5000 (IR) larvae on day 35.

***Challenged on day 70 with 10,000 infective larvae.

+Group showed the presence of egg but epg was less than one.

Figures in parentheses indicate not vaccinated.

TABLE 5

Mean total serum protein (TSP) value of goats before and after vaccination with 60 Kr irradiated infective larvae of *H. contortus*

Group	No. of goats	TSP (g/100 ml)									
		Pre-vaccination (days)	Post 1st vaccination* (days)			Post 2nd vaccination** (days)			Post challenge*** (days)		
		0	10	20	30	10	20	30	10	20	30
I. Parasite native	4	6.0	6 6	6.9	6.4	6.4	6.3	6.1	6.6	6.8	7.2
Control	3	6.2	(6.1)	(6.2)	(6.2)	(6.1)	(6.2)	(6.2)	6.7	6.7	6.9
II. Worm free	3	5.8	7.0	6.7	6.0	6.6	6.2	5.6	6.5	6.4	5.9
Control	2	6.0	(6.1)	(6.0)	(6.1)	(6.0)	(6.1)	(6.4)	7.1	6.9	6.4
III. Raised worm free	3	5.8	6.0	6.3	6.4	6.0	6.3	6.5	6.1	5.9	4.9
Control	2	5.9	(6.0)	(6.1)	(6.1)	(5.9)	(6.0)	(6.1)	6.0	5.9	4.5

* 1st vaccination 2000 (IR) larvae on day 0.

** 2nd vaccination 5000 (IR) larvae on day 35.

*** Challenged on day 70 with 10,000 infective larvae.

Figures in parentheses indicate not vaccinated.

lenge was 0.9 and 1.4 g/100 ml, respectively. The parasite native vaccinated, worm free vaccinated and their control groups did not show any fall of TSP values (Table 5).

Packed cell volume (PCV) and Hb showed no appreciable alterations in any of the animal of the parasite native, worm free and raised worm free groups after vaccination. But there was rather very mild improvement in Hb and PCV values in all the animals under different groups after both the doses of vaccination in comparison to respective controls. The improvement appeared superior in parasite native animals in comparison to the animals of other groups. This showed that radiation dose of 60 Kr was optimum. This confirms the work of Mulligan *et al.* (1961). The Hb and PCV showed mild improvement after first dose of vaccination. This could be due to very little blood sucking by a few worms developed from the irradiated larvae which have stimulated the haemopoietic system.

In parasite native group, Hb did not fall even after 30 days of challenge, whereas in other groups, worm free and raised worm free, it fell. The control animals of all the groups showed fall of 5.7, 29.7 and 30.2 per cent, respectively. This is due to establishment of only a few worms in vaccinated group in comparison to their control, after challenge. All such worms may be unable to produce eggs, as immune response of the vaccinated host had deleterious effects on the reproductive potential of the worms, leading to suppressed egg production. Read (1977) mentioned that the blood loss in haemonchosis was directly correlated with the egg production of the worms. However, in control animals of parasite native group, the per cent fall in blood values after challenge was nominal as they had already experienced the mild infection of haemonchosis. Moreover, goats are less susceptible to *H. contortus* in comparison to sheep and cattle (Blood and Henderson, 1974) and might be responsible for present findings.

The parasite native vaccinated animals withstood the challenge well indicating the immunogenic efficacy of the vaccine. On the basis of blood loss it appeared that worm free animals could adopt protection of lesser intensity. But insignificant protection was seen in raised worm free group with appreciable loss of Hb after challenge. Such Hb loss was due to development of many worms free challenge larvae.

The reasons for fall of Hb also held true for fall in PCV. The resistance provided by the irradiated larvae prevented the challenge larvae from developing their haematophagous potential and thereby reducing their pathogenicity leading to insignificant fall in PCV in immune animals. Crofton *et al.* (1965) stated that significant erythrocyte loss did not occur until the parasites were mature enough to deposit shelled embryos. In the present study most of the challenged worms were expelled out in vaccinated animals, the remaining showed stunted growth resulting into less loss of host's blood.

Weight loss of the animals of all the vaccinated groups after challenge was insignificant as compared to respective control. This could be due to less susceptibility of (adult) goats to *H. contortus*

and at times there may be a loss of body weight which may not be noticeable (Blood and Henderson, 1974). Chronic disease showed extreme weight loss in dry season when larval uptake was negligible. In the present investigation all the experimental animals received nutritious diet which might have accounted for no significant weight loss in any of them.

Vaccinated goats showed eggs in the faeces occasionally as also reported by Mulligan *et al.* (1961). A few worms could develop from the irradiated larvae and that too all of them might not be fertile—caused fall in egg production.

After first dose of vaccination, eggs appeared only in raised worm free animals indicating that some of the irradiated larvae could develop in susceptible animals only but produced infertile eggs (on the basis of culture). But, after 20th day of second vaccination all the animals of three groups passed eggs, though very less in number and no ill health and haematological alterations occurred. Mulligan *et al.* (1961) also observed eggs in lambs immunized with attenuated *H. contortus* larvae after 21 days of vaccination with 5,000 larvae irradiated at 60 Kr. In present study the dose of 2,000 irradiated larvae appeared to be optimum as the egg output was rare.

The increase in total serum protein (TSP) in vaccinated animals of parasite native group after 30 days of challenge in comparison to animals of other two groups indicated groupwise some difference. As all the animals in different groups were maintained on same diet and management procedures, the circumstantial evidences indicated that the increase in TSP value in parasite native group may not be due to other protein fractions than immunoglobulins. When a few per cent of the *H. contortus* of challenge infection reached the abomasa of vaccinated goats and started taking the restricted amount of blood, the vaccinated goats were in a state of erythropoietic preparedness to compensate immediately for this little blood loss without leading to any fall in haematological values. Moreover, antibody produced in the vaccinated goats of parasite native group could have reduced the blood sucking activity of the challenge worms. The other two vaccinated groups which showed resistance in decreasing order had low TSP values after challenge as probably development of many adult worms led to more blood loss. The erythropoietic hyper-responsiveness, therefore, was not manifested in these goats specially of raised worm free group.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 11—18 (March 1983)

HISTOMORPHOLOGICAL STUDIES OF TIBIAL FRACTURE HEALING FOLLOWING INTERNAL AND EXTERNAL IMMOBILIZATION IN SHEEP

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(Received : September 22, 1981; Revised : February 10, 1982)

ABSTRACT

Histomorphological studies were conducted to compare the process of healing of tibial fractures following external and internal immobilization in 36 adult sheep. Results demonstrated an early and better healing of fractures under rigid stabilization achieved either by intramedullary pinning or stainless steel plating. Microscopically, new cartilagenous and osseous tissue bridging the fracture gap was demonstrated earlier in these groups as compared to fractures immobilized only by simple coaptation, where the callus was predominantly of fibrocartilagenous in nature even up to sixth week.

Occurrence of tibial fractures has been rated high among all the fractures in sheep and goat (Singh *et al.*, 1979). A search of literature, however, revealed only sporadic reports on the treatment of tibial fractures in these species (Ferguson *et al.*, 1978), though such studies are available in bovine and canine (Gill and Tyagi, 1972; Singh *et al.*, 1976). This report is concerned to study histomorphologically the process of healing of experimental tibial fractures following internal and external methods of immobilization in sheep.

MATERIAL AND METHODS

The study was conducted on 36 adult sheep, divided equally into three groups as per the technique of repair, i. e., simple coaptation (group A), intramedullary pinning (group B) and stainless steel plating (group C). The experimental fractures were created with wire saw after exposing the bone under general anaesthesia, induced and maintained by intravenous administration of 5% thiopental sodium*. After reduction and alignment of fracture ends, the immobilization was achieved with either of aforementioned techniques.

The sheep were maintained for varying intervals upto ninth week. Four animals of each group were euthanized at third, sixth and ninth weeks and healed bones were collected and fixed in 10% formalin. The formalin fixed bone pieces, including newly formed bone at the fracture site, were decalcified as per the method described by Culling (1963). After complete decalcification (confirmed by radiography),

*May and Baker Ltd., Bombay, India.

the bone pieces were processed in routine manner. The paraffin embedded sections of 6-7 micron thickness were cut and stained with Mayer's haemotoxylin-eosin stain (Luna, 1968) for detailed histomorphological study.

RESULTS

Group A—Simple Coaptation

The tissue reaction at third week revealed marked proliferation of granulation tissue, consisting of abundant fibroblasts (Fig. 1). It resulted in formation of soft fibrous callus adherent to bony fragments. Blood clots were also demonstrated at some places.

Fibrovascular and cartilagenous tissue reaction was observed at sixth week. Appearance of osteoblastic cells, resulting in formation of bony spicules and initiation of trabeculae formation was also discernible (Fig. 2).

At ninth week areas of fibrovascular tissue, chondroblasts and osteoblastic activity were visible. Calcium deposition was noticed. There was evidence of formation of cancellous bone from endosteum (Fig. 3).

Group B—Intramedullary Pinning

Tissue reaction in this group, apart from fibrovascular callus and blood clot, revealed increased activity of osteogenic cells. Clusters of osteoblasts were evident. Periosteal activity was more marked as compared to endosteal activity. Trabeculae formation had started.

At sixth week both the periosteal and endosteal activities were well demonstrated. Cartilagenous areas of callus were marked by the proliferation of chondroblasts. Degeneration of cartilagenous cells and appearance of osteoblasts were also evident at some places. Deposition of calcium salts in intercellular areas of osteoblasts, resulting in trabeculae formation appeared as dark blue in colouration (Fig. 4). Bone fragments were put together with the help of granulation tissue, periosteal and endosteal trabeculae.

At ninth week compact bone was found to be entirely fused with old bony fragments. The cementing line between old bony fragments and newly formed bone was discernible The vascular system was being regenerated (Fig. 5).

Group C—Bone Plating

Histopathological observations at third week interval were almost similar to the group B. Presence of cartilagenous cells, trabeculae and calcification, at some places, were visible (Fig. 6).

Repair process at sixth week revealed similar changes as at third week. The deposition of calcium was marked at this interval as compared to previous interval of this group. Bony spicules were visible. Numerous osteoclasts were also present (Fig. 7).

Areas of granulation tissue and cartilagenous growth were still observed in a few cases at ninth week. Deposition of calcium was well marked. The cementing line was clearly distinguishable (Fig. 8).

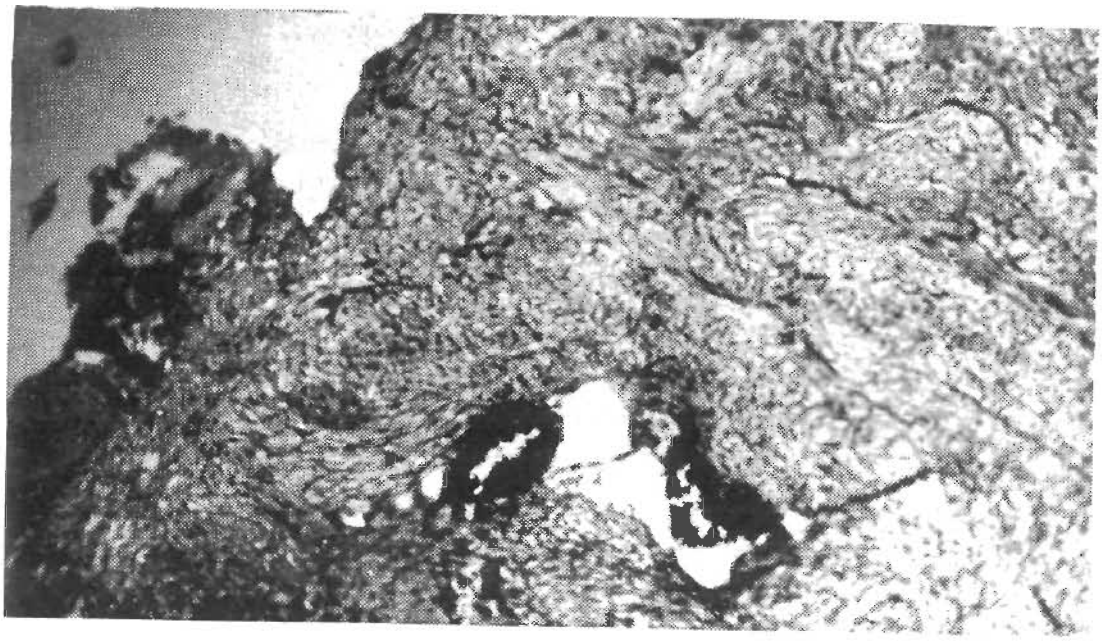


Fig. 1. Microphotograph showing fibrovascular callus at the fracture site in group A at 3rd week (L. S., H. & E., 70x).

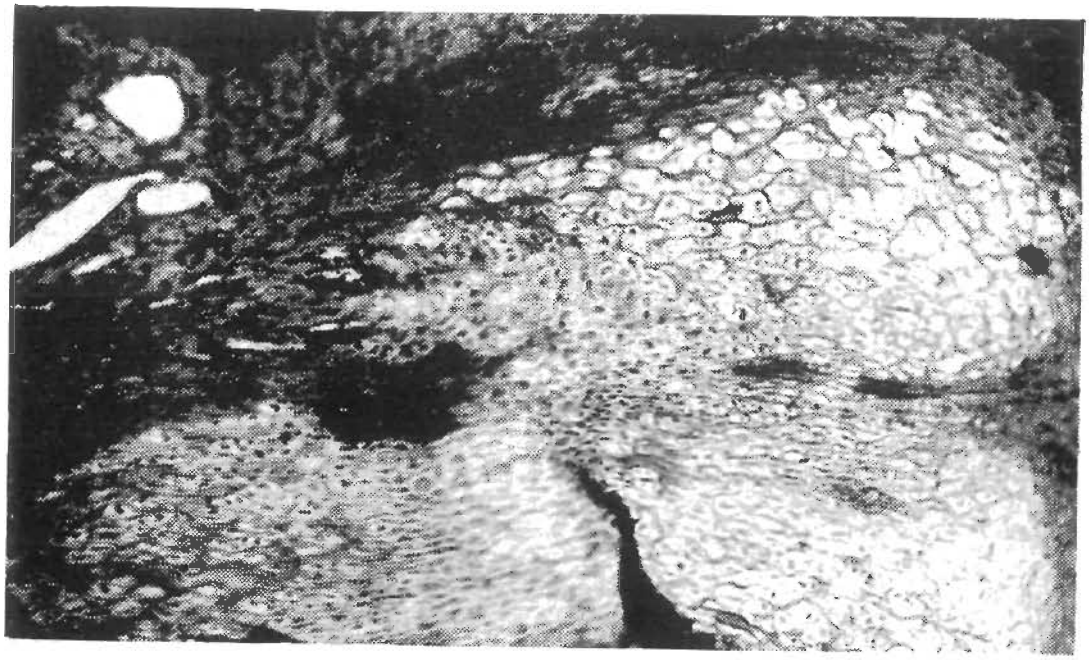


Fig. 2. Microphotograph showing cartilagenous callus with islands of fibrovascular tissue in group A at 6th week (L. S., H. & E., 70x).

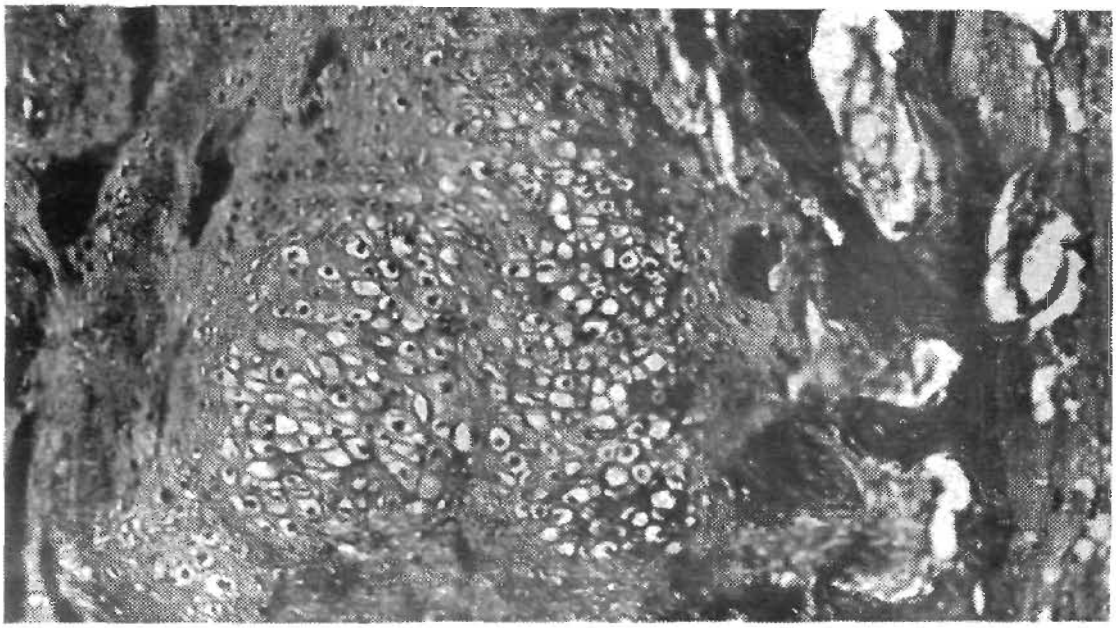


Fig. 3. Microphotograph demonstrating cartilagenous and osseous callus at fracture site in group A at 9th week (L. S., H. & E., 70x).

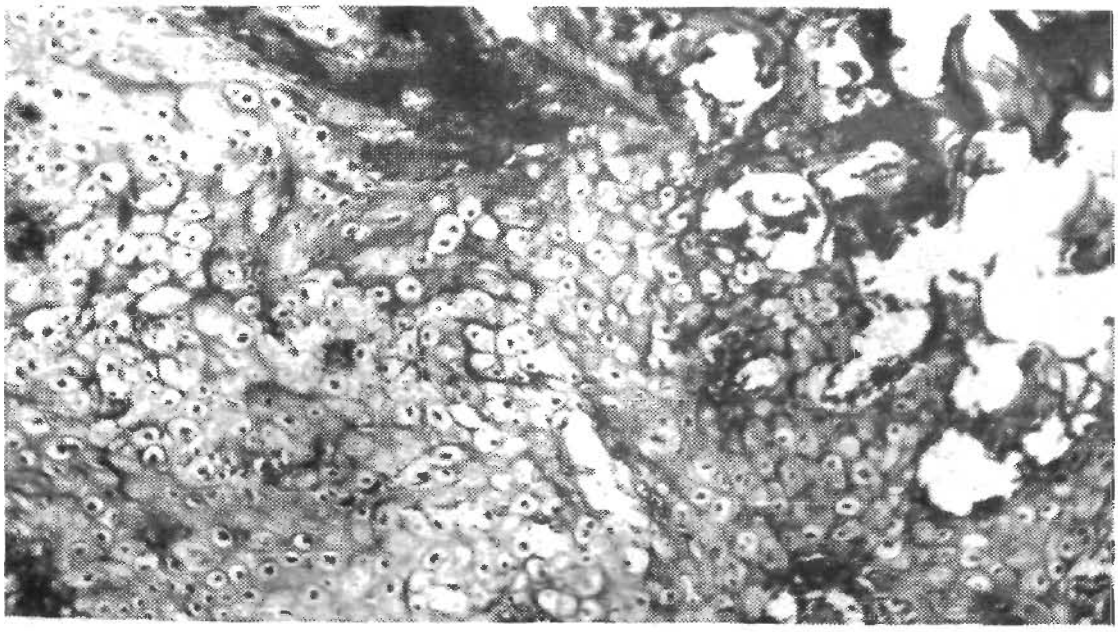


Fig. 4. Microphotograph showing cartilagenous and osseous callus with evidence of calcification in group B at 6th week (L. S., H. & E., 70x).

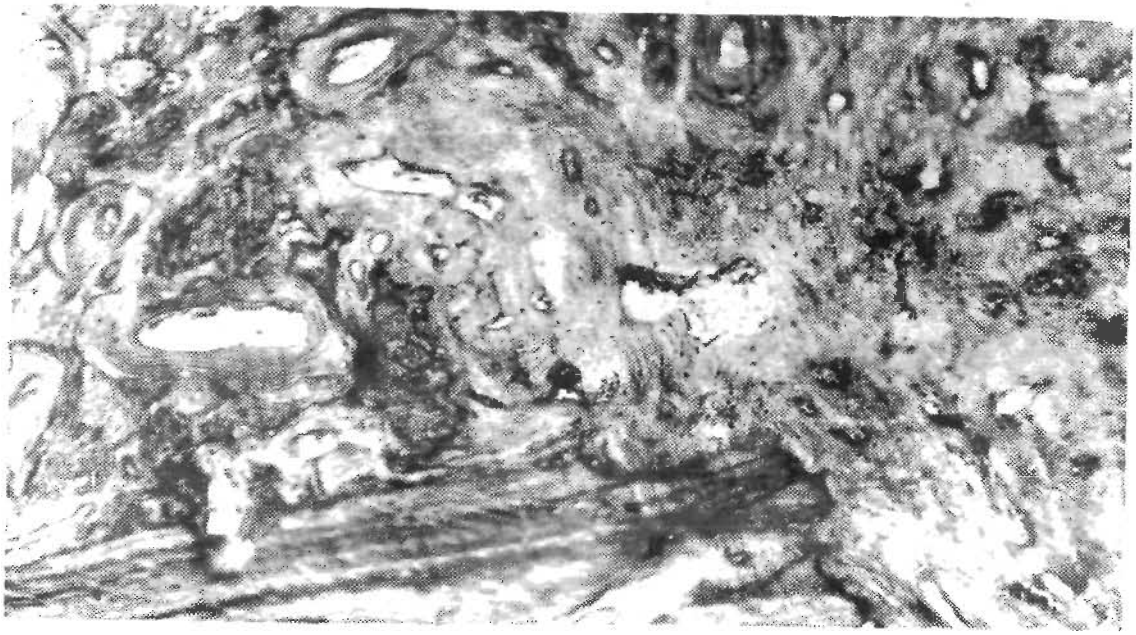


Fig. 5. Microphotograph demonstrating osseous callus, obliterating the fracture gap, in group B at 9th week. Note the development of Haversian system (L. S., H. & E., 70x).

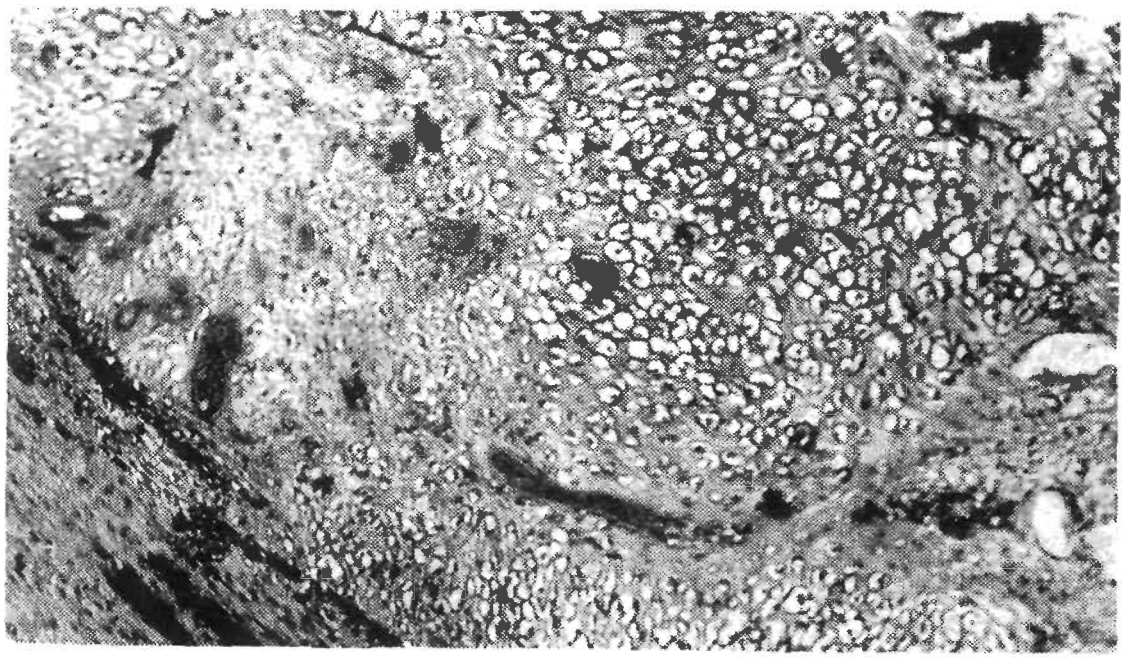


Fig. 6. Microphotograph showing cartilagenous callus in group C at 3rd week (L. S., H. & E., 70x).

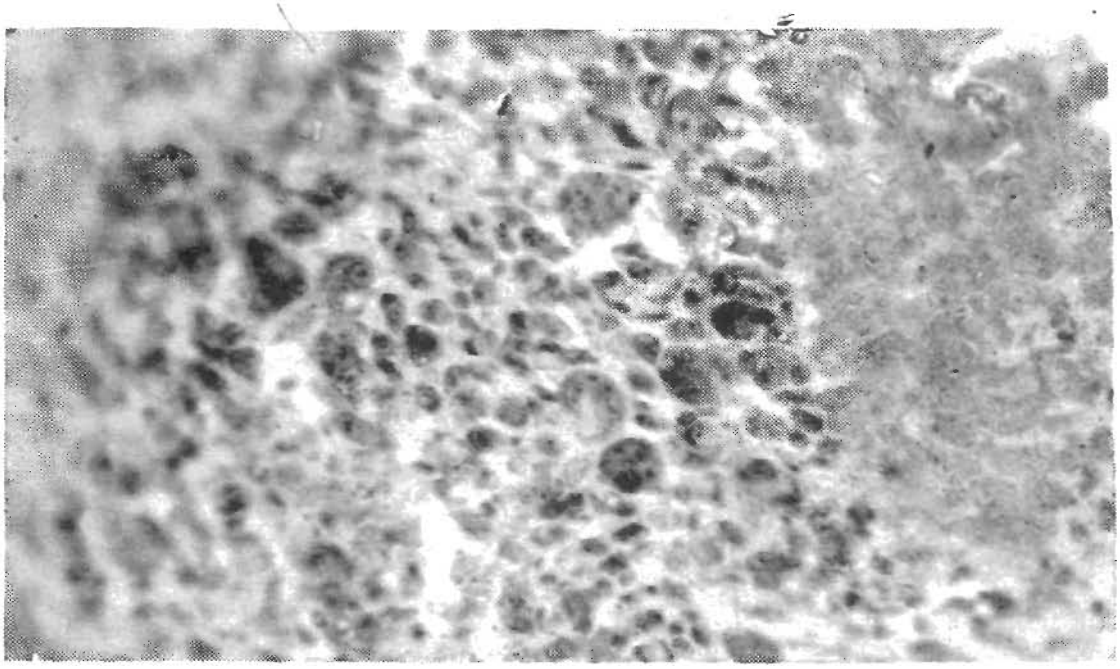


Fig 7. Microphotograph demonstrating multinucleated osteoclastic cells proliferation at the fracture site in group C at 6th week (L. S., H. & E., 280x).



Fig. 8. Microphotograph showing osseous callus bridging the fracture gap in group C at 9th week (L. S., H. & E., 70x).

DISCUSSION

Endosteal and periosteal proliferations are the indirect guidelines for evaluation of pathophysiology of bone. Periosteum is a connective tissue membrane covering the surface of the bone and connecting it with the surrounding tissue. In resting stage, endosteum consists of a single layer of flattened cells which does not form a well defined layer like periosteum. Under the influence of appropriate stimuli, it can develop osteoblastic activity. Periosteum reacts sharply to any stress condition on bone as well as from adjacent tissues (Bhargava, 1979).

Histopathological studies demonstrate the fracture healing process better. In the present study, the most noticeable histological feature in early stages of fracture healing was the presence of abundant fibroblasts in calluses. This fibrous callus was derived from the osteogenic cells of the periosteum and provided stability to fractured ends.

Differentiation of soft fibrous callus into osteogenic cells and periosteal cartilage indicated the process of accelerated healing. Microscopically, the stages of endochondral ossification were evident at the periosteal side in the calluses of both B and C groups at third week.

Intramembranous ossification was not observed in any group at this stage. Contrary to these observations, Kumar (1977) observed healing to be intramembranous in nature during healing in buffalo calves. Cartilage was not observed at any stage of healing and bone formation was directly from the fibrous callus.

At sixth week histomorphologic observations demonstrated endochondral and intramembranous ossification in groups B and C, while only stage of endochondral ossification was evident in group A. Cartilage formation occurs whenever cellular proliferation outpaces the vascular regeneration (Ham and Leeson, 1961; Braden and Brinker, 1976). Further, cartilage formation also depends upon the degree of rigidity of immobilization, being more in unstable fractures (Braden and Brinker, 1976). The cartilagenous nature of bridging callus in group A could have been due to any of the above mentioned factors. Although angiographic observations, in this study, almost excluded the possibility of lack of vascularization it is possible that the growth of the callus might have outpaced the vascularization.

Degree of difference in terms of acceleration of the healing process, in three groups, was much evident at third and sixth week, especially in groups B and C. The more amount of cartilage in the callus in group A indicated a slow rate of healing in these animals.

Ninth week observations revealed that compactness of the osteoid tissue was maximum in group B followed by group C and minimum in group A. The regeneration of Haversian system was also well marked in group B. So it was evident that the healing process in group B was fastest, intermediate in group C and had lagged behind in group A.

The histological findings confirmed that union of the bony fragments occurred rapidly if fixation was rigid. If fixation was relatively unstable, as observed in group A, it took considerably longer time

for the fractures to unite. Braden and Brinker (1976) have also reported that some motion always persisted at the site of fracture in externally immobilized fractures. This lack of immobilization resulted in large haematoma and a large cartilagenous bridge. Newton and Zeitlin (1977) also observed such findings in avian fracture healing.

Remodelling of the callus and the fracture site was still continuing even during ninth week in all the groups. Radiographic studies have shown that remodelling process in the fractured bone continues for many months (Cruess and Dumont, 1975).

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 19—26 (March 1983)

CLINICAL, RADIOGRAPHIC AND ANGIOGRAPHIC STUDIES FOLLOWING AMPUTATION OF THE DIGIT IN BOVINE

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ABSTRACT

Clinical, radiographic and angiographic studies were conducted following amputation of the digit either by resection through middle phalanx or by disarticulation at pastern joint. Results showed resection through middle phalanx to be a better technique for the amputation of the claw as it resulted in less post-operative complications, early wound healing and regain of satisfactory limb function. Angiography revealed early and better vascularization of the amputed stump of the middle phalanx in contrast to poor vascular supply of disarticulated stump.

Amputation of claw either by resection through phalanx or disarticulation at the interphalangeal joint, remains the most widely used surgical intervention for the treatment of septic condition of the bovine foot (Greenough, 1962). Practical experiences showed a great variation in the rate, at which animals regain satisfactory limb function with these techniques. A search of literature, however, did not reveal any available study either to explore the possible cause for such variations or about the normal healing of amputed digit. This investigation is intended to study the healing process following resection through middle phalanx and disarticulation at pastern joint on the basis of clinical, radiographic and angiographic observations in young calves.

MATERIAL AND METHODS

Amputation of the claw was performed in 18 male buffalo calves ($1\frac{1}{2}$-2 years old). The amputation was accomplished either by resection through the middle phalanx or disarticulation at pastern joint of lateral claw in equal number of animals. All the surgical procedures were carried out in lateral recumbency with the limb to be operated, uppermost. Anaesthesia of lower pelvic limb was achieved by the technique of intravenous retrograde regional analgesia with 2% lignocaine hydrochloride at a dose rate of 4 mg per kg body weight after application of a rubber torniquet above the hock joint.

A circular skin incision slightly above the coronary band of digit of lateral claw, was made. Two vertical incisions on axial and abaxial surfaces of the claw, were then made extending cranially from the coronary band upto the pastern joint. The skin flap was undermined with blunt dissection and reflected back, exposing completely the middle phalanx. The resection of the middle phalanx was then performed with wire saw about 2 cm

below the pastern joint. The operative procedure for the disarticulation was the same except that the middle phalanx was resected at the pastern joint without damaging the articular surface. Thereafter, the torniquet was released and bleeding vessels, were ligated. The skin flap was trimmed to the level of the amputed stump and closed with interrupted mattress sutures using black braided silk No. 3.

All the animals received post-operative coverage of broad spectrum antibiotic for 5 days and the skin sutures were removed between 8 to 10 days of surgery. The animals were maintained for varying intervals upto 6th post-operative week, to observe the clinical behaviour and any post-operative complications. Plain and contrast radiographic procedures were performed at 2nd, 4th and 6th week using three animals of both the groups at each interval. Angiography was done as per the technique described earlier (Manohar *et al.*, 1973) using either sodium iothalmate 70% (W/V)* or lead suspension as contrast medium.

RESULTS AND DISCUSSION

The intravenous retrograde regional analgesia was found satisfactory for the amputation of the claw. Similar observations were also made by Manohar *et al.* (1971), Weaver (1972) and Tyagi *et al.* (1973).

All the animals tolerated the surgery. The skin wound healed satisfactorily in 3 to 4 weeks, in cases where resection of the claw was performed through the middle phalanx. However, sepsis at the operative site was noticed in 4 animals of disarticulation group. Local antiseptic dressing and drainage of pus proved beneficial in these cases. Inflammatory oedematous swelling of the amputed stump was a general observation in both the groups, which disappeared by the first week of surgery except in cases of sepsis. Lameness was observed in both the groups but its severity was more in animals, where the claw was removed by disarticulation at the pastern joint. Majority of the animals regained near normal function of the operated limb by the 4th week in the cases of resection of claw through the middle phalanx. Whereas, delay in restoration of functional ability of operated limb upto 5 to 6 weeks was observed in cases of disarticulation.

Radiography showed no evidence of bone necrosis or joint involvement from second through sixth week. Mild to moderate bone reaction was observed at the amputed end of the middle phalanx (Fig. 1). In two cases, sequestrum of the amputated middle phalanx was noticed. In three animals, where disarticulation at the pastern joint was done, radiography showed osteolytic changes at the distal end of proximal phalanx (Fig. 2). In rest of the animals, articular surface appeared smooth with no evidence of bony reaction.

Angiographic studies demonstrated increased vascular supply of the amputated stump as compared to the normal angiogram (Fig. 3.) The amputated stump at second week presented a bush of fine arterial network, which was derived mainly from the corresponding severed digital artery (Fig. 4). From fourth to

*Conray 420, M & B. Pvt. Ltd., India.

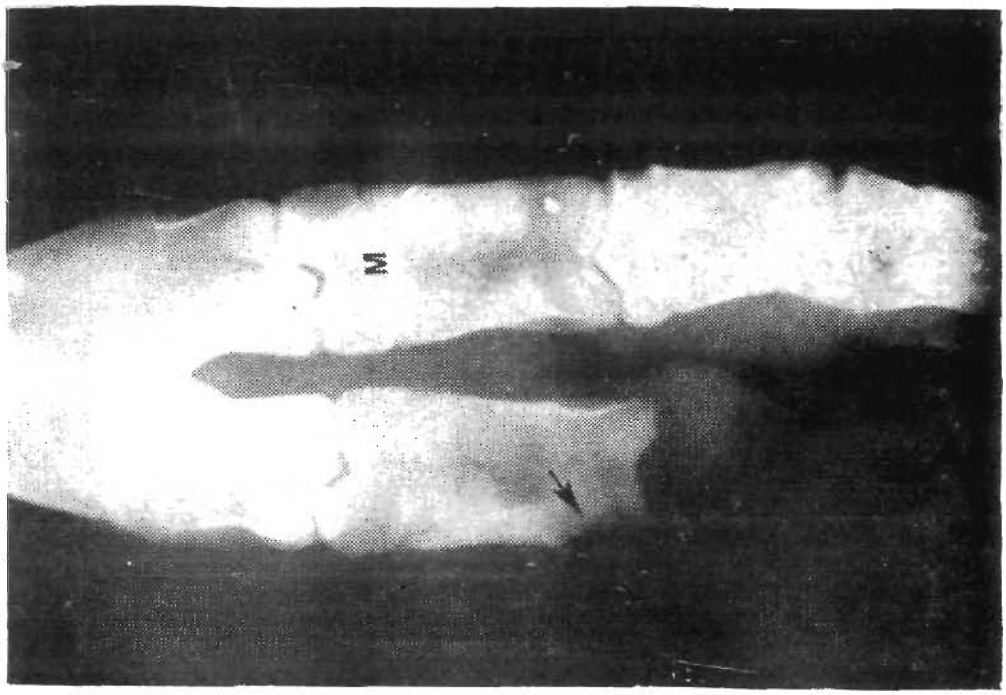


Fig. 2. AP radiograph of bovine foot after 6 weeks of disarticulation at pastern joint showing osteolytic changes at the abaxial surface of distal end of proximal phalanx (arrow). M=Medial digit.

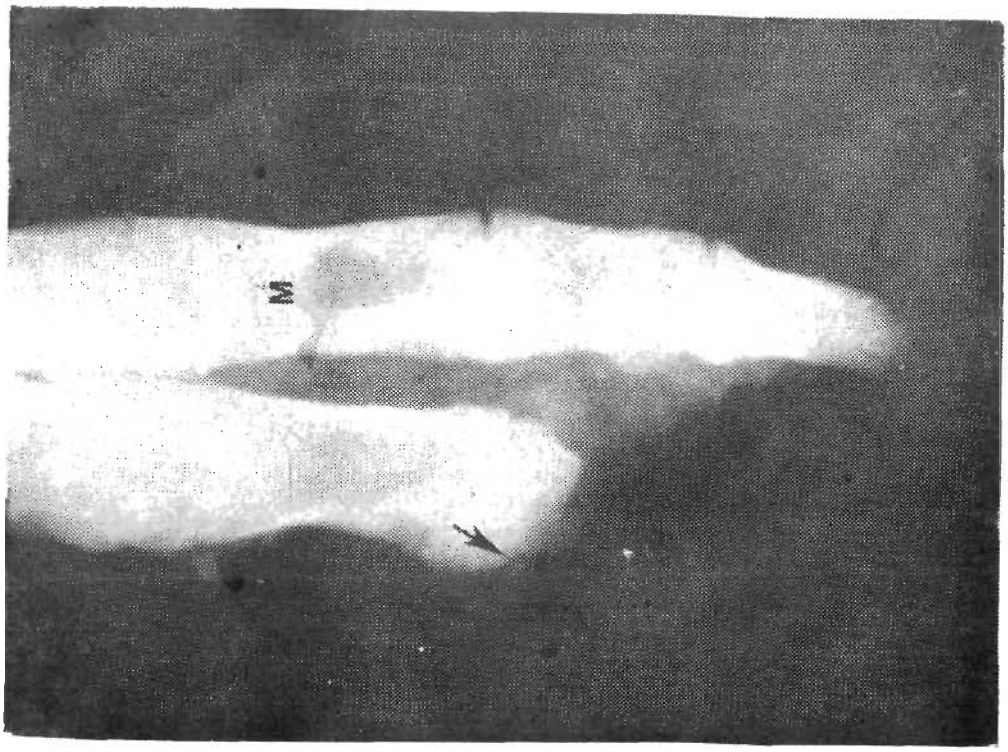


Fig. 1. Anterioposterior (AP) radiograph of bovine foot after 4 weeks of amputation through middle phalanx demonstrating mild bony reaction at the amputed stump (arrow). M=Medial digit.

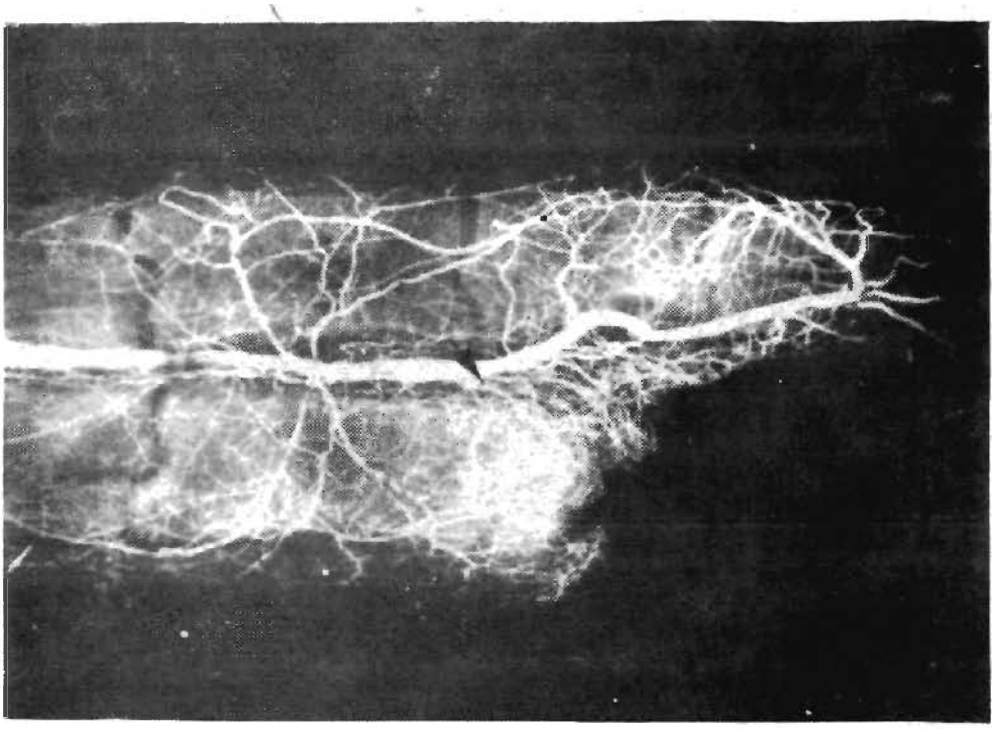


Fig. 4. Angiogram (AP view) of bovine foot at second week of amputation through the middle phalanx depicting increased vascular supply with evidence arterial network at the amputed end. Note the complete damage of corresponding digital artery (arrow).

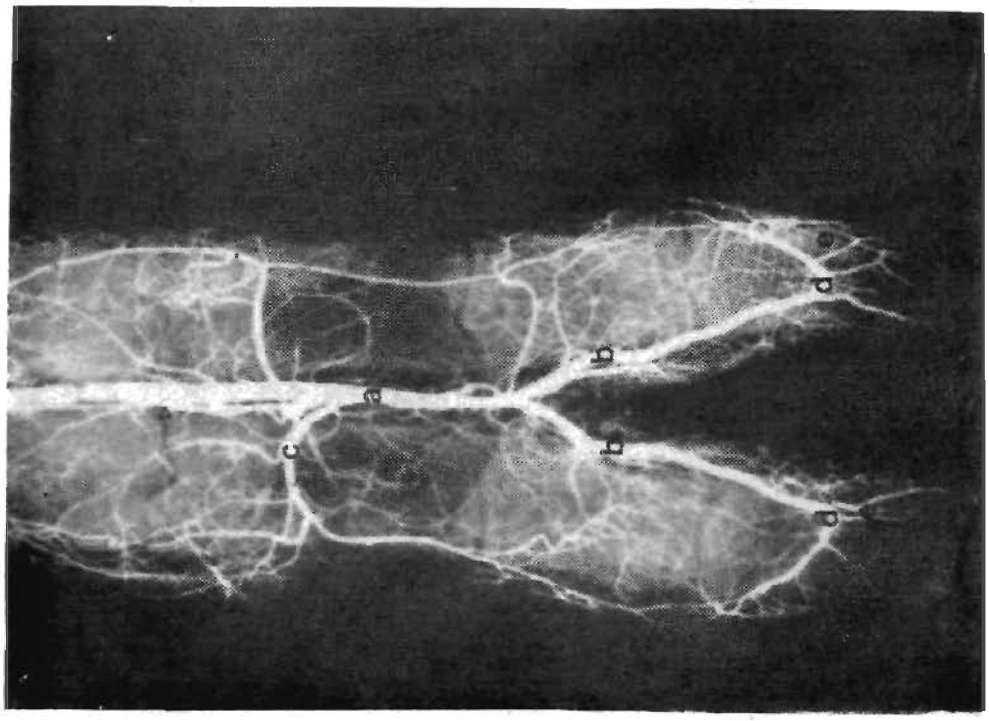


Fig. 3. Normal angiogram of the bovine foot with aqueous lead-soap suspension.
A—common digital artery, b—proper digital arteries, c—distal arch, d—semilunar arches, e—laminar vessels.

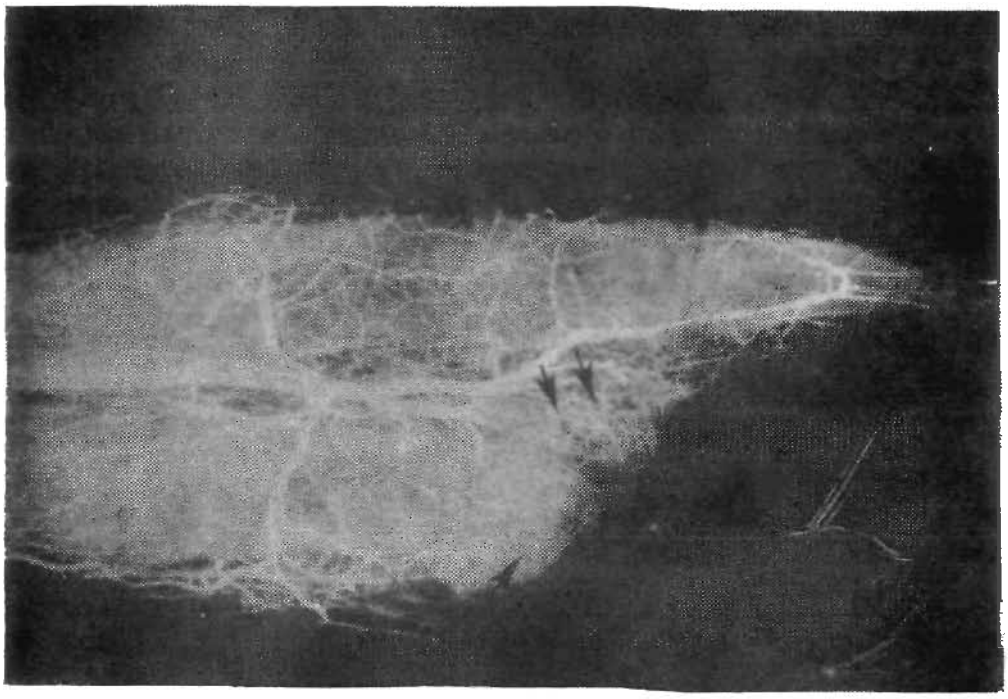


Fig. 6. Angiogram (AP view) of bovine foot at sixth week of amputation through the middle phalanx showing complete vascularization of amputed stump. Note the persistent increased vascular supply at the operated site (arrow).

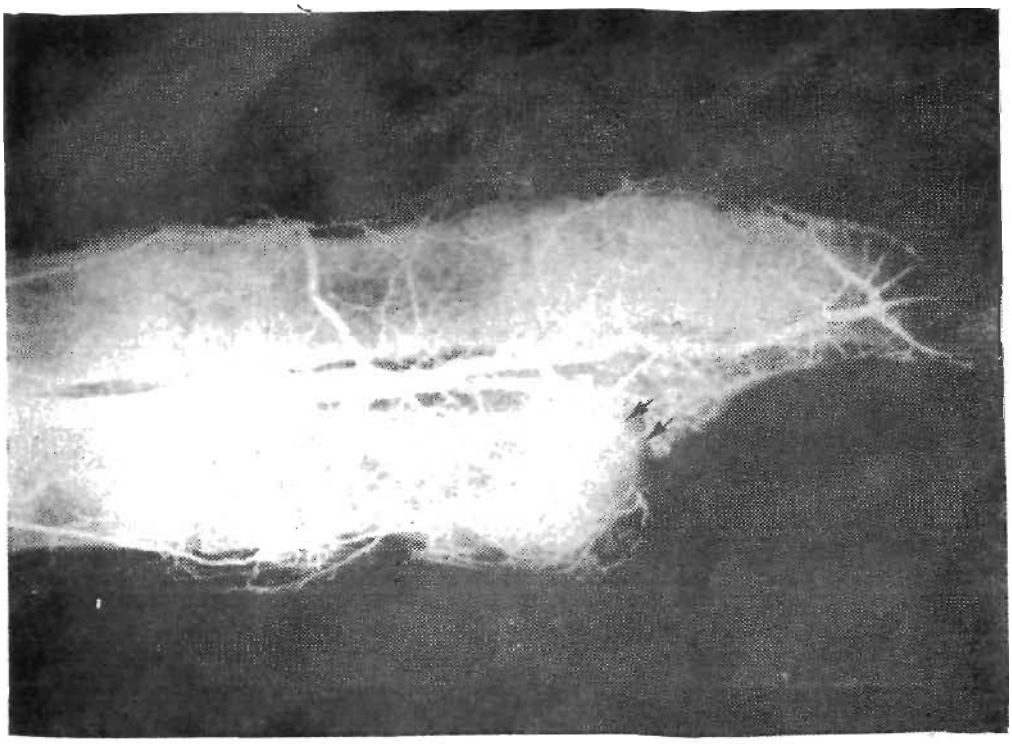


Fig. 5. Angiogram (AP view) of bovine foot at fourth week of amputation through the middle phalanx showing evidence of clear-cut revascularization of amputed stump (arrow).

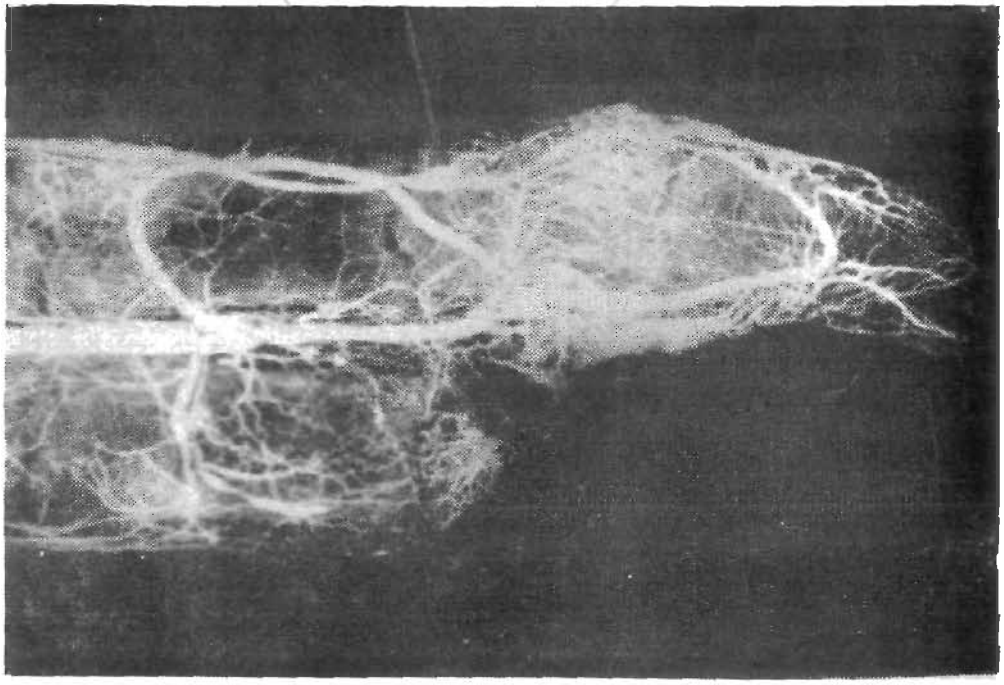


Fig. 8. Angiogram (AP view) of bovine foot at sixth week after disarticulation at pastern joint showing well vascularized stump.

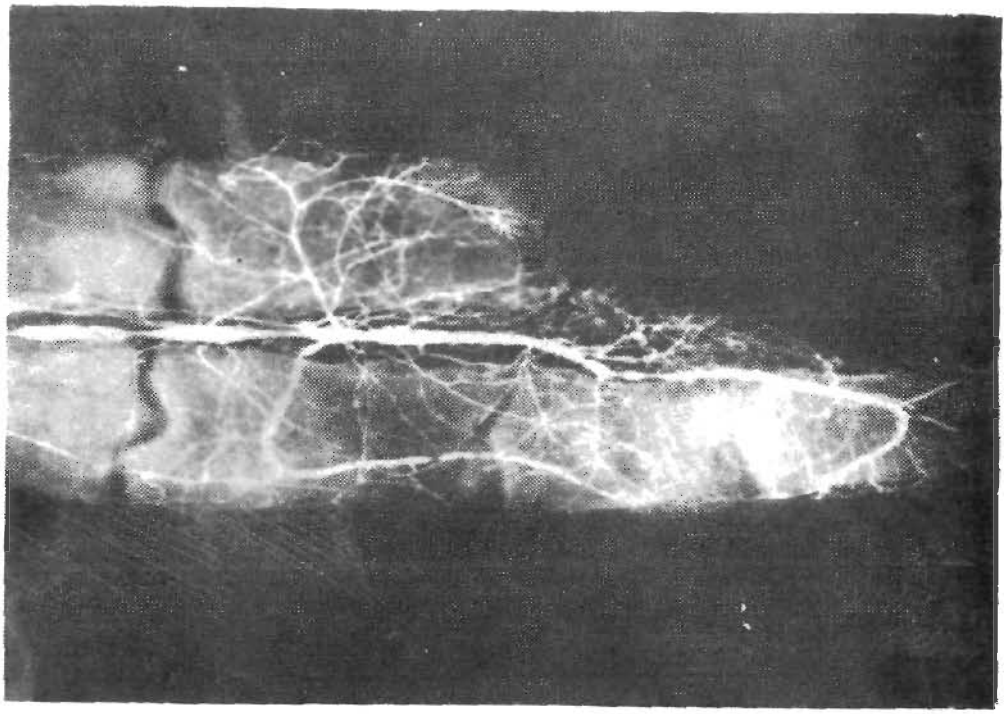


Fig. 7. Angiogram (AP view) of bovine foot at second week after disarticulation at pastern joint showing the damage of corresponding digital artery with evidence of poor vascularity at the stump.

sixth weeks, the amputated end of digit was almost completely vascularized with more prominent and well defined vessels (Fig. 5). However, hypervascularity persisted even upto sixth post-operative week (Fig. 6).

In cases of disarticulation, moderate increase in the vascularization of the disarticulated stump were demonstrated on the angiograms at the second week. The fine arterial network supplying to the disarticulated stump was comparatively less than in the animals where resection through the second phalanx was performed (Fig. 7). The corresponding digital artery was invariably severed off. At 4th and 6th weeks of surgery, the disarticulated stump appeared to be almost vascularized, however, the overall vascularity was comparatively poor leaving an avascular zone at the healing stump (Fig. 8).

Amputation of the claw is now a well established interference that can be carried out routinely without special preparation. The most widely used amputation techniques are variations of two methods namely removal of the digit through proximal or middle phalanx and disarticulation at the pastern joint (Greenough, 1962; Osman, 1970). Disarticulation of the pastern joint, despite its obvious simplicity seems to meet with little favour. Observations of the present study showed that the amputation through the middle phalanx was better technique than the disarticulation, as it invited less post-operative complications, early wound healing and restoration of satisfactory limb function. The only post-operative complication observed radiographically, was the sequestrum of the amputed middle phalanx. In disagreement with the present finding, Osman (1970) reported higher occurrence of septic arthritis following amputation through the second phalanx. This difference could be attributed to the fact that the investigation of Osman (1970) was based on clinical septic condition of foot, whereas the present study was entirely experimental in nature.

In cases, where amputation by disarticulation at the pastern joint was attempted, apart from the sequestrum formation, sepsis of the operative wound and osteolytic changes of the proximal phalanx were the common post-operative complications with subsequent delay in regain of satisfactory limb function. This is in agreement with the report of Osman (1970). The sequestrum formation might be attributed to avascular necrosis due to rapid sawing. However, in the present study, clinical, radiographic and angiographic findings tend to indicate that circulatory disturbances associated with the amputation is a more feasible explanation. Moreover, the sepsis of the wound following disarticulation, leading to osteolytic changes in the adjacent bone further complicated the cases. Greenough *et al.* (1972) also reported retardation of granulation tissue at the distal end of the proximal phalanx in cases of the disarticulation.

The delay in granulation tissue formation in cases of disarticulation was correlated to poor vascular supply at the articular surface as compared to the amputated stump through the middle phalanx. Similar observations were also made by Osman (1970). The author reported that nutrient artery was invariably damaged following amputation and the blood supply to the stump was

derived mainly from hypertrophied epiphyseal vessels. In this study, though the nutrient artery and epiphyseal vessels were not clearly demonstrated, but angiographic observations supported the previous report.

ACKNOWLEDGEMENT

Authors wish to thank Mr. J. R. Jindal, Senior Radiographer for his skilled technical assistance.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 27—32 (March 1983)

TOTAL URINARY OUTPUT AND DIURNAL CHANGES IN RESPONSE TO CLIMATIC VARIATIONS IN BUFFALO CALVES

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(Received : October 16, 1981; Revised : July 30, 1982)

ABSTRACT

The data on 24 h urine output in buffalo calves revealed the excretion of decreased volume of concentrated urine during the hotter months having higher atmospheric temperature, whereas large amount of dilute urine was voided during the months, with low ambient temperature. There was more excretion of urine (ml/min) during 1 p.m. to 7 p.m. as compared to other two periods (7 a.m. to 1 p.m. and 7 p.m. to 7 a.m.).

Water comprises 60 to 70% of the total body weight and is so fundamentally important in sustaining life that ancient Greeks believed water to be the actual source of life. All land dwelling species absolutely depend on water. The loss of 10% body water results in serious metabolic disturbances and a loss of 25% almost inevitably means death (Singh and Taneja, 1978). Among the regulatory organs of particular importance in the control of body water, the kidney holds the key position. The kidneys obviously have the function of excretion, but the excretory function is incidental to the main job of maintaining constant internal environment. The present investigations aimed at to study diurnal variations and total urine output at monthly intervals throughout the calendar year in response to climatic variations.

MATERIAL AND METHODS

Six apparently healthy Murrah male buffalo calves of approximately one year of age having body weight in the range of 80 to 135 kg were included for these studies. These animals were fed according to the standard feeding schedule recommended for buffalo calves (Arora, 1976). They had a free assess to water. The animals were maintained in the departmental animal shed. The shed consisted of an open varrandah having roof above, brick wall on either side and front open. The animals were taken out of the shed for 2 h in summer during late evening and in winter during early part of the evening. Thus, the animals were protected from direct solar radiations in summer and direct cold during extreme winter.

Twenty four hour urine was collected at monthly intervals from each experimental animal with the help of urine collection bags. The urine was collected continuously for 24 h at different time intervals such as 7 a.m. to 1 p.m., 1 p.m. to 7 p.m. and 7 p.m. to 7 a.m. and the volumes excreted during these intervals

were measured separately. The specific gravity of urine was determined with the urinometer. A correction of 0.001 for every 3°C above the calibrated temperature of the urinometer was added or substracted below the calibration of the observed specific gravity value. The climatic elements recorded throughout the year of study have been presented in Table 1.

RESULTS AND DISCUSSION

The data recorded have been presented in Tables 2 and 3. The overall average value of the urine voided during the entire experimental period was 3.94±0.49 l/24 h (range 2.05 to 9.16 litres) and 2.74±0.39 ml/min, respectively. The overall average specific gravity of urine excreted was 1.026 (1.000 to 1.033). Pandey and Roy (1969) reported the mean volume of urine voided in 24 h as 5.38±0.14 litres in adult buffalo cows. Manston and Vagg (1970) reported specific gravity of cow's urine as 1.023.

The results revealed that animals were excreting less urine with higher specific gravity during the months having higher ambient temperature (25.40 to 31.15°C) which may be due to higher insensible water loss in these months, while during winter having lower ambient temperature (12.5 to 19.15°C) large amount of urine having lower specific gravity was excreted. Since specific gravity is the index of urine concentration, studies indicated that urine was concentrated during hotter months as compared to cooler months. The rate of insensible water loss had been reported to be much lower during winter months in cattle (Tomer *et al.*, 1969; Krishna *et al.*, 1975). The increased rate of insensible water loss during summer may have resulted in a moderate dehydration leading to hyperosmolarity of body fluids or reduction in blood volume (both of which tend to occur in dehydration). These changes exert effects upon central osmoreceptors and volume receptors. Further, through the release of antidiuretic hormone (ADH), as a result of hyperosmolarity reabsorption of water from kidney tubules is enhanced thereby reducing water loss in urine (Hafez, 1968). During hot weather, catecholamines are secreted which produce renal vasoconstriction leading to reduced renal blood flow (Whittow, 1969). The increased aldosterone release may have also been caused by renal ischemia by means of renin angiotensive mechanism. In response to aldosterone there is greater reabsorption of water (Hafez, 1968). This mechanism may have been in action to reduce the volume of urine excreted during hot weather. During cooler months water intake is comparatively low and metabolic water production is higher (Krishna *et al.*, 1975) which may have led to decrease in aldosterone secretion. Thus, decrease in ADH secretion may have resulted in lesser absorption of water and its greater excretion through urine.

At higher temperature, Goverdhan (1955) and Kamal *et al.* (1962) observed that cattle excrete urine of low specific gravity which they attributed to the urea recycling in these animals due to reduced feed intake, induced by hot environments. These changes are clearly indicative of the lack of adaptation of the temperate breeds of cattle to high temperature. It may be concluded that the buffalo calves, maintained under the present set of management, were capable to adjust

TABLE 1

Climatic elements at Hissar during 1976-77**

Months	Parameters					
	Ambient temperature (°C)			Relative humidity (%)	Wind velocity (km/h)	Total rainfall (mm)
	Maximum	Minimum	Average			
Jan.	19.9 (13.9-25.5)	3.8 (—1.1-11.5)	12.50	67.5 (33-96)	5.8 (1.5-16.6)	15.7
Feb.	22.6 (16.7-26.3)	8.6 (2.6-13.7)	15.60	78.5 (32-94)	6.2 (1.9-13.0)	18.8
Mar.	27.8 (21.7-31.5)	10.5 (5.6-16.6)	19.15	68.5 (26-98)	6.3 (3.0-11.3)	3.6
Apr.	34.9 (21.4-41.8)	15.9 (7.6-22.5)	25.40	50.5 (10-94)	7.2 (3.3-11.3)	3.6
May	39.4 (28.4-43.3)	22.1 (16.4-26.7)	30.75	46.5 (6-83)	12.0 (5.1-19.9)	38.2
Jun.	38.0 (27.6-45.2)	25.2 (20.7-31.6)	31.60	56.0 (13-80)	12.7 (4.3-33.8)	58.0
Jul.	36.0 (30.3-42.3)	26.3 (24.1-28.0)	31.15	75.0 (45-87)	12.1 (3.2-22.0)	365.8
Aug.	32.5 (25.0-36.3)	24.6 (22.6-26.1)	28.55	84.0 (72-92)	8.8 (3.9-28.6)	77.7
Sep	33.8 (26.3-35.6)	22.2 (19.1-25.5)	28.00	77.8 (46-92)	6.7 (2.0-11.2)	—
Oct.	34.4 (31.9-36.9)	16.1 (11.0-20.0)	25.10	62.0 (30-84)	3.9 (1.9-7.4)	—
Nov.	28.9 (22.4-33.4)	9.4 (3.7-13.6)	19.15	62.5 (28-91)	2.8 (1.1-5.3)	2.8
Dec.	29.0 (19.4-28.0)	4.0 (1.1-12.0)	16.50	60.0 (19-96)	3.3 (1.0-9.6)	2.5

**Source : Department of Agronomy, HAU, Hissar.

TABLE 2

Diurnal variation in urine output

Months	Parameters								
	7 a.m.–1 p.m. (6 h)		1 p.m.–7 p.m. (6 h)		7 p.m.–7 a.m. (12 h)		7 a.m.–7 a.m. (24 h)		Specific gravity
	Amount voided (l)	Urine (ml/min)	Amount voided (l)	Urine (ml/min)	Amount voided (l)	Urine (ml/min)	Amount voided (l)	Urine (ml/min)	
Jan.	1.07±0.08	2.99±0.22	2.05±0.08	5.69±0.22	2.98±0.17	3.71±0.22	3.80±0.22	4.03±0.14	1.020±0.0002
Feb.	1.21±0.30	3.68±0.82	2.54±0.58	7.06±0.62	2.18±0.14	3.03±0.20	5.94±0.55	4.13±0.39	1.018±0.0023
Mar.	1.02±0.18	2.84±0.49	0.90±0.31	2.71±0.77	2.24±0.33	3.12±0.46	4.16±0.55	2.89±0.39	1.026±0.0011
Apr.	0.78±0.12	2.18±0.35	0.78±0.15	2.18±0.42	1.66±0.14	2.31±0.20	3.40±0.22	2.36±0.17	1.030±0.0002
May	0.81±0.06	2.24±0.17	0.95±0.06	2.63±0.07	0.95±0.14	1.32±0.17	2.71±0.06	1.88±0.04	1.031±0.0061
Jun.	0.68±0.10	1.90±0.28	0.50±0.10	1.40±0.26	0.86±0.06	1.19±0.07	2.05±2.05	1.42±0.05	1.033±0.0013
Jul.	0.54±0.10	1.50±0.78	0.71±0.20	1.96±0.56	1.35±0.28	1.88±0.39	2.59±0.30	1.76±0.20	1.029±0.0022
Aug.	0.64±0.05	1.79±0.14	0.81±0.04	2.24±0.67	1.31±0.10	1.82±0.14	2.76±0.15	1.92±0.10	1.030±0.0017
Sep.	0.72±0.07	2.01±0.20	0.83±0.03	2.31±0.10	0.94±0.10	1.31±0.14	2.58±0.13	1.76±0.10	1.032±0.0012
Oct.	0.95±0.05	2.63±0.17	0.92±0.09	2.57±0.27	0.50±0.22	2.09±0.32	3.37±0.28	2.34±0.20	1.029±0.0022
Nov.	0.62±0.10	1.17±0.28	1.97±0.21	5.46±0.59	2.27±0.20	3.15±0.28	4.85±0.47	3.37±0.33	1.023±0.0016
Dec.	1.55±0.15	4.31±0.22	2.00±0.26	5.56±0.71	3.61±0.54	5.01±0.75	7.16±0.73	4.97±0.51	1.010±0.0002
Overall average	0.88±0.09	2.41±0.26	1.25±0.21	3.48±0.57	1.48±0.24	2.50±0.35	3.94±0.49	2.74±0.35	1.026±0.000

TABLE 3

Analysis of variance of urine output

Source of variation	Degree of freedom	Parameters								Specific gravity
		7 a.m.-1 p.m.		1 p.m.-7 p.m.		7 p.m.-7 a.m.		7 a.m.-7 a.m.		
		(l)	(ml/min)	(l)	(ml/min)	(l)	(ml/min)	(l)	(ml/min)	
Between months	11	0.035	0.27	0.21	1.61	0.36	0.70	1.17*	0.55*	0.00008741**
Between animals	5	1.08**	8.82**	6.18**	47.22**	8.98**	17.34**	35.52**	17.23**	0.00043134**
Error	55	0.09	0.68	0.25	1.87	0.23	0.45	0.58	0.26	0.00003
Total	71									

*,**Significant at 5 and 1 per cent level, respectively.

themselves in hot conditions by voiding reduced quantities of concentrated urine, thus, conserving water for proper maintenance of body fluid homeostasis in summer months. Moreover, anorexia was not evident in buffaloes during hotter months. Similar observations in respect of urine volume and its concentration were reported by Pandey and Roy (1969).

The data on diurnal variations indicated that there was more excretion of urine (ml/min) during 1 p.m. to 7 p.m. as compared to other two periods studied. It was observed that in normal individuals there was an increase in plasma aldosterone concentration during the portion of the day when the individual is carrying activities. This increase is due to decrease in the rate of removal of aldosterone from the circulation by the liver. On the other hand, aldosterone and renin secretion are low during the hours of sleep (Ganong, 1977).

Our results may be explained on the basis of above statements. The decreased urine flow (ml/min) during 7 a. m. to 1 p. m. may be due to the increased activity of the animal during these hours and hence, increased aldosterone secretion which may have caused retention of sodium and water, thus, leading to decreased flow of urine excretion, as compared to higher quantity of urine voided in the other two periods where the aldosterone secretion might be comparatively lower.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 33—36 (March 1983)

STUDIES ON THE CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF NEWLY DEVELOPING VARIETIES OF OATS *(AVENA SATIVA)*

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(Received : October 21, 1981; Revised : July 16, 1982)

ABSTRACT

The nutritive value of two newly developed varieties (OS-6 and OS-7) was determined and compared with the check variety HFO-114. The OS-7 variety of oat contained the higher amount of crude protein (7.30%) followed by HFO-114 and OS-6 varieties. The average daily dry matter intake was 2.17, 2.31 and 2.17 kg per 100 kg body weight for HFO-114, OS-7 and OS-6 varieties and the differences were statistically non-significant. The average digestibility coefficient of DM, DCP and TDN (%) were 55.30, 59.89 and 56.77, 3.58, 4.45 and 2.69 and 54.42, 57.22 and 55.30 in HFO-114, OS-7 and OS-6, respectively. The OS-7 variety was found to yield highest amount of digestible nutrients per unit area followed by HFO-114 and OS-6. However, the differences were only significant in case of DCP values.

Oat is an important cereal fodder crop grown during **rabi** season. The chemical composition and nutritive value of oats grown in different parts of the country have been reported by various workers (Cannell and Jobson, 1968; Riewe and Lippke, 1969; Gill and Negi, 1970; Dua *et al.*, 1973; Gupta, 1973; Singh *et al.*, 1973; Gupta and Pradhan, 1974; Gupta *et al.*, 1978; Verma *et al.*, 1980). However, it is essential to know the nutritive value of newly developing varieties of oat. The present investigation was, therefore, undertaken to compare the chemical composition, nutritive value and digestible nutrients yield per unit area of two developing varieties of oat (OS-6 and OS-7) against the check variety HFO-114 grown under similar conditions.

MATERIAL AND METHODS

Three varieties of oat, viz. HFO-114, OS-6 and OS-7 were grown in the experimental field under uniform conditions to assess their nutritive value. Twelve cross-bred adult male cattle (1/2 Jersey × 1/2 Hariana) of 3 to 4 years of age were randomly distributed into three groups of four animals each on the basis of their body weights and age. Each group of animals was then allotted one of the varieties of oat at random. The animals were fed chaffed fodder **ad lib** and no concentrate was given. They were subjected to a preliminary feeding period of 10 days followed by a 5-day collection period. The forages were at 50% flowering stage during collection period. The records of

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feed, left over and dung were maintained. Drinking water was provided **ad lib.**

The proximate analyses of feed, left over and faeces were conducted by the methods laid down in AOAC (1970). The data were subjected to statistical analysis (Snedecor and Cochran, 1967).

RESULTS AND DISCUSSION

The chemical composition of different varieties of oat has been presented in Table 1. The OS-7 variety of oat contained highest amount of crude protein (7.30%) followed by HFO-114 and OS-6 varieties. The nitrogen free extract and ether extract were higher in OS-6 and HFO-114 varieties than OS-7 variety.

The voluntary dry matter intake, digestibility coefficients of various nutrients and the nutritive value of the varieties have been reported in Table 2. The average daily dry matter intake was 2.17, 2.31 and 2.17 kg per 100 kg body weight for HFO-114, OS-7 and OS-6 varieties, respectively. Although the fodder of OS-7 variety was consumed more but the differences in voluntary intake values amongst the varieties were statistically non-significant.

The average digestibility coefficient of dry matter in HFO-114, OS-7 and OS-6 were 55.30, 59.89 and 56.77, respectively. The respective DCP and TDN contents were 3.58, 4.45 and 2.69 and 54.42, 57.22 and 55.30 in these varieties. The difference in TDN content amongst the varieties was non-significant. However, DCP values were significantly ($P<0.01$) different amongst them and were highest in OS-7 variety followed by HFO-114. The information regarding the nutritive value of these developing varieties has not been reported earlier. However, Gupta *et al.* (1978) reported the chemical composition and nutritive value of check variety HFO-114. The proximate composition for this variety obtained in present study is comparable to that reported by Gupta *et al.* (1978). However, their reported values for DCP content were comparatively lower and that of TDN were higher.

The dry matter yield at 50% flowering stage (q/ha) has been reported to be 98.95, 93.98 and 99.10 for OS-6, OS-7 and HFO-114, respectively (Anonymous,

TABLE 1

Chemical composition (% of DM) of three varieties of oat

Chemical constituents	Oat varieties		
	HFO-114	OS-6	OS-7
Dry matter	25.70	25.40	19.40
Crude fibre	31.65	33.65	39.10
Crude protein	6.30	5.07	7.35
Ether extract	2.17	1.56	1.20
Nitrogen free extract	52.77	53.12	44.64
Ash	7.01	6.60	7.71

TABLE 2

Voluntary dry matter intake and nutrient digestibility of three varieties of oat

Particulars	HFO-114	OS-6	OS-7	C. D.
Number of animals	4	4	4	—
Average body weight (kg)	236	235	235	—
Feed consumption				
Average daily DM intake per 100 kg body weight (kg)	2.17±0.24	2.17±0.16	2.31±0.50	NS
Digestibility coefficients				
Dry matter	55.30±1.03	56.77±4.50	39.89±1.36	NS
Crude protein	56.78±1.53	52.71±4.83	56.39±3.22	NS
Crude fibre	49.64±1.32	52.99±5.73	60.47±1.55	NS
Ether extract	57.95±2.81	61.50±6.41	39.88±4.03	16.59
Nitrogen free extract	61.21±1.19	61.41±4.57	62.06±1.70	NS
Digestible nutrients				
Digestible crude protein (%)	3.58±0.09	2.69±0.29	4.45±0.11	0.50
Total digestible nutrients (%)	54.42±1.02	55.20±4.77	57.22±1.19	NS

TABLE 3

Yields of dry matter and digestible nutrients (q/ha) of three varieties of oat

Particulars	HFO-114	OS-6	OS-7	C. D.
Dry matter	99.10	93.98	98.95	—
Digestible dry matter	54.80±1.02	53.35±4.32	59.26±1.35	NS
Digestible crude protein	3.55±0.09	2.53±0.27	4.39±0.11	0.67
Total digestible nutrients	53.93±1.01	51.97±4.48	56.62±1.18	NS

TABLE 4

ANOVA for DCP yield (q/ha)

Variables	DF	SS	MSS	F. cal.	F. tab. at 1%
Treatment	2	7.0312	3.5156	27.3341**	8.02
Error	9	1.1575	0.1286		

**Significant at 1 per cent level.

1978-79). Keeping these as standard values, the yield of digestible nutrients has been calculated (Table 3). It is evident from the data that the variety OS-7 contained higher amount of digestible dry matter. DCP and TDN per unit area followed by HFO-114; OS-6 had the lowest amount of these digestible nutrients. However, the differences were only significant ($P<0.01$) in case of DCP output per unit area which was significantly higher (Table 4), in OS-7 followed by HFO-114.

It is, therefore, inferred from this study that newly developing variety OS-7 had better overall performance than the check variety HFO-114. The other developing variety OS-6 trailed behind the check variety.

ACKNOWLEDGEMENTS

The authors are thankful to Sarvshri Fateh Singh, U. S. Hooda, R. N. Chaturvedi and O. P. Dawla for their help in conducting this study.

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 37—39 (March 1983)

PERFORMANCE OF PIGS FED TOTAL AND LIMITED GRAINS IN COMPLETE MIXED FEEDS

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(Received : October 6, 1981; Revised : October 19, 1982)

Most of the work in swine nutrition has been done in advanced countries with cereal grains (maize/barley) constituting a major component of the diet. In many of the subtropical and tropical countries cereal grains are a luxury that cannot be afforded for swine feeding. The success of any swine enterprise will, thus, depend upon feeding unconventional sources of energy. Ranjhan *et al.* (1971) reported that 40% wheat bran could be incorporated in swine diet. Sharda *et al.* (1977) reported that rice polish could be added to swine diet upto the extent of 15 per cent. Sharda *et al.* (1979) recommended the incorporation of 5 and 37.5 per cent wheat bran in the diet of pigs during the growing and finishing periods, respectively.

A study with 10 Middle White Yorkshire weaned gilts and barrows was conducted to find the effect of total versus limited grains in swine diets on their performance and carcass quality. The pigs were fed 16% C. P. diets during the growing period followed by 14% during the finishing one. The control diet contained maize as the only source of energy while in the experimental diet maize was replaced by 25% of wheat bran and 15% rice polish on weight basis. Groundnut cake and fish meal provided the protein source. The diets were adequately fortified with vitamins and minerals.

The pigs were fed the grower diets till the pigs reached a body weight of 50 kg or 6 month body weight whichever was earlier when these were switched over to finisher diets. Each pig was slaughtered, when approximately 70 kg in body weight, for getting cut-out-data according to procedures described by Satya Parkash *et al.* (1976). The data were analysed by variance method as recommended by Steele and Torrie (1960).

The results of the study have been presented in Tables 1 and 2. The average daily gain, the feed efficiency, and protein efficiency ratio of pigs fed total grains were 466 g, 0.267 and 1.72, respectively, while for pigs fed limited grains the values were 427 g, 0.226 and 1.48, respectively. The performance of pigs in terms of the above traits was found to be similar since the treatment means were not found statistically significant. These results agree with those reported earlier by

TABLE 1

Growth response during different periods

	Control diet	Experimental diet	CD (P<.05)
Av. initial wt. (kg)	14.00	14.02	
Av. final wt. (kg)	71.80	73.00	
Growing Period			
Av. daily gain (g)	420	403	99
Gain/feed ratio	.285	.248	.09
Protein efficiency ratio	1.76	1.56	.60
Finishing Period			
Av. daily gain (g)	589	618	140
Gain/feed ratio	.239	.242	.06
Protein efficiency ratio	1.69	1.70	.75
Combined Period			
Av. daily gain (g)	466	427	66
Gain/feed ratio	.267	.226	.04
Protein efficiency ratio	1.72	1.48	.24

TABLE 2

Carcass traits with organ weights

	Control diet	Experimental diet	CD (P<.05)
Hot carcass weight (kg)	48.3	46.0	5.16
Dressing per cent	68.0	66.3	2.79
Length (cm)	68.1	66.6	3.50
Back fat thickness (cm)	4.0	3.6	0.58
Lean cut (%)	65.0	66.6	5.64
Primal cut (%)	72.0	73.6	3.07
Ham+Loin (%)	49.8	50.5	6.13
G. I. Tract (% HCW)	9.0	12.0	0.40
Liver (% HCW)	1.9	1.9	0.42
Heart (% HCW)	0.2	0.2	0.08
Kidneys (% HCW)	0.2	0.2	0.07

HCW : Hot Carcass Weight.

Sharda *et al.* (1979). The carcass traits (hot carcass weight, dressing per cent, carcass length, average back fat thickness, lean cut per cent, primal cut per cent, ham and loin per cent) were similar for the pigs fed total and limited grains. The same was the case with weight of body organs expressed as a per cent of the kill weight.

The study revealed that maize could be replaced by wheat bran and rice polish to the extent of 25 and 15 per cent, respectively.

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 40—42 (March 1983)

EFFECT OF SOLAR ECLIPSE ON BIOCHEMICAL CONSTITUENTS OF BLOOD IN BUFFALOES

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(Received : July 2, 1981; Revised : April 29, 1982)

The total solar eclipse, a celestial event of rare occurrence, occurred on February 16, 1980. An investigation to study the effect of solar eclipse on biochemical constituents of blood was undertaken on 12 male buffaloes of 4 to 6 years age. The animals were housed in the experimental sheds and were offered 8 kg of wheat straw with 2 kg concentrate mixture and 10 kg of greens per animal. All the animals had free access to drinking water. During the experimental period, the managemental conditions were kept identical as far as possible. Blood samples were drawn in morning hours (9 to 9.30 a. m.), afternoon (4.30 to 5.00 p. m.) and late evening (8 to 8.30 p. m.) on three days viz. one week preceding eclipse, on day of eclipse and one week after eclipse. On each of these three days, the animals were exposed to sun at a time corresponding to solar eclipse to discriminate the effect of eclipse from normal temporal variations, if any. The bio-chemical constituents in blood samples estimated by the methods given by Hawk *et al.* (1954) and Henry *et al.* (1974) and analysed according to Snedecor and Cochran (1967), are presented in Table 1.

Glucose concentration in blood showed a diurnal variation which invariably increased during evening, except on eclipse day when significant increase in the afternoon was followed by a decline in the evening. The pyruvic acid level showed a trend similar to glucose except on post-eclipse day when lower level with no diurnal variation were observed. Total protein and magnesium concentration recorded a significant increase on day of eclipse and on post-eclipse day. The differences between periods within a day were not significant except for pre-eclipse day when the total protein level was significantly higher in the evening and magnesium level significantly lower in afternoon. Non-esterified fatty acids (NEFA) values showed a fall in the afternoon of pre-eclipse and eclipse days, and an increase in the afternoon values on post-eclipse day. Cholesterol content showed no periodic changes on different days, it was almost equal on pre-eclipse and eclipse days, but lower on post-eclipse day. Ascorbic acid, bicarbonate and phosphorus levels were significantly higher on day of eclipse as compared to pre-and post-eclipse days. The periodic differences were not significant except on pre-eclipse

TABLE 1

Mean values of certain biochemical constituents of buffalo in relation to solar eclipse

Constituents	Pre-eclipse (one week)				Eclipse				Post-eclipse (one week)			
	M	AN	E	Av.	M	AN	E	Av.	M	AN	E	Av.
Glucose (mg %)	50.90 ±1.26	55.10 ±2.84	68.20 ±3.99	58.00 ±2.06	67.30 ±1.81	78.90 ±3.65	68.60 ±1.33	71.60 ±1.64	71.10 ±4.58	68.70 ±5.23	86.60 ±3.12	75.50 ±2.81
Pyruvic acid (mg %)	1.55 ±0.06	1.84 ±0.07	2.12 ±0.07	1.84 ±0.06	1.39 ±0.06	1.80 ±0.10	1.52 ±0.08	1.57 ±0.05	0.90 ±0.02	0.98 ±0.06	0.91 ±0.04	0.93 ±0.02
Protein (g %)	7.08 ±0.14	7.27 ±0.16	7.74 ±0.20	7.37 ±0.10	8.53 ±0.18	8.41 ±0.18	8.65 ±0.14	8.53 ±0.10	8.63 ±0.22	8.95 ±0.19	9.04 ±0.16	8.87 ±0.11
NEFA (mEq/L)	1.52 ±0.044	0.84 ±0.042	0.90 ±0.041	1.09 ±0.057	1.19 ±0.052	0.82 ±0.076	1.05 ±0.019	1.02 ±0.028	0.68 ±0.039	0.95 ±0.026	1.25 ±0.050	0.96 ±0.045
Cholesterol (mg %)	143.20 ±7.33	148.50 ±8.76	162.50 ±6.81	151.40 ±4.52	146.70 ±7.40	159.20 ±7.50	154.60 ±4.63	153.5 ±3.83	137.80 ±5.17	128.60 ±5.19	125.30 ±3.78	130.60 ±2.82
Ascorbic acid (mg %)	0.81 ±0.05	1.35 ±0.07	1.31 ±0.09	1.16 ±0.06	1.46 ±0.23	1.38 ±0.11	1.57 ±0.14	1.47 ±0.09	1.19 ±0.09	1.30 ±0.06	1.21 ±0.11	1.23 ±0.05
Creatinine (mg %)	0.535 ±0.034	0.385 ±0.031	0.334 ±0.031	0.418 ±0.023	0.765 ±0.094	1.012 ±0.041	0.992 ±0.123	0.923 ±0.043	0.926 ±0.025	1.081 ±0.028	1.118 ±0.036	1.041 ±0.020
Bicarbonate (mEq/L)	25.60 ±0.86	22.90 ±0.92	27.00 ±0.49	25.20 ±0.52	27.70 ±0.68	28.50 ±0.52	26.20 ±0.58	27.40 ±0.37	24.00 ±0.78	24.30 ±0.40	25.90 ±0.56	24.70 ±0.36
Phosphorus (mg %)	3.63 ±0.22	3.80 ±0.20	3.43 ±0.22	3.62 ±0.14	3.37 ±0.17	4.17 ±0.24	3.71 ±0.20	3.75 ±0.14	2.97 ±0.24	3.56 ±0.24	3.27 ±0.14	3.27 ±0.14
Magnesium (mg %)	2.27 ±0.10	1.59 ±0.02	1.91 ±0.04	1.92 ±0.05	2.12 ±0.03	2.06 ±0.02	2.07 ±0.03	2.08 ±0.02	2.01 ±0.10	2.08 ±0.13	2.12 ±0.03	2.07 ±0.05

Figures are average of 12 observations.

M—Morning (9 to 9.30 a. m.) ; AN—Afternoon (4.30 to 5 p. m.) ; E—Late Evening (8 to 8.30 p. m.).

day when the afternoon values were higher for ascorbic acid and lower for bicarbonate. The phosphorus concentration, however, showed a clear peak at the time of eclipse. Creatinine values showed a significant fall in the afternoon of pre-eclipse day but a progressive increase on eclipse and post-eclipse days. The values on eclipse and post-eclipse days increased significantly ($P<0.05$) in the afternoon samples.

From the results it is evident that the fluctuations observed in various blood constituents after exposure of buffaloes to solar eclipse were either non-significant or similar to those observed on pre- and post-eclipse days except for glucose pyruvic acid and phosphorus. Such changes were not observed on pre-and post-eclipse days. A significant rise in glucose level in the post-eclipse samples corresponded to the levels generally observed in the evening of pre-and post-eclipse days. Probably this reflected an effect of light or solar radiations in glucose *haemostasis*. In any case, the levels did not cross the physiological limits. The studies conducted at IVRI, Izatnagar revealed an increase in white cell counts (WBC) in guinea pigs and rabbits exposed to solar eclipse but no effect on pregnancy of buffaloes (Hindustan Times, 1980).

A number of reports compiled by Livestock Adviser (1980) indicated no ill effect of solar eclipse on physiological attributes in a number of species of animals except some behavioural changes in few laboratory animals and birds. Thus, in the absence of any spectacular changes in blood constituents of buffaloes, it is inferred that exposure to solar eclipse did not inflict any drastic and unphysiological changes in biochemical constituents of blood.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 43—44 (March 1983)

CHEMOTHERAPEUTIC VALUES OF BERENIL AGAINST EXPERIMENTAL *BABESIA CANIS* INFECTION IN DOGS

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(Received : July 14, 1981; Revised : May 29, 1982).

Early diagnosis and treatment of *Babesia canis* infection are necessary since this causes rise in temperature, anaemia, prostration and death in dogs especially in the exotic breeds. Berenil is a very potent drug and has been used against *B. canis* infection in dogs by various workers (Ryley, 1957; Botha, 1964; Joyner and Brocklesby, 1973). No report from India seems to be available on the chemotherapy of *B. canis* with Berenil in dogs. The present paper is the first systematic trial of Berenil in experimental babesiosis of dogs.

Chemotherapeutic study was made on seven experimentally *B. canis* infected indigenous dogs. The dogs were divided into two groups of three dogs each while one was kept as untreated infected control. Dogs of group I were treated with Berenil @ 8 mg per kg body weight while dogs of group II were treated @ 12 mg per kg body weight deep i/m as a single dose. Dogs of group I were given Decadron (Dexamethasone sodium phosphate) @ 8 mg i/m daily as an immunosuppressant on the 30th, 31st and 32nd days of infection and their blood examined

FIG. 1.

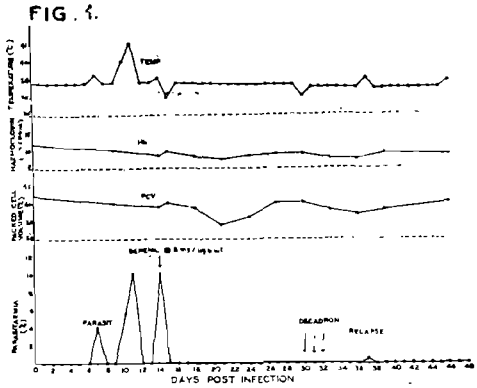
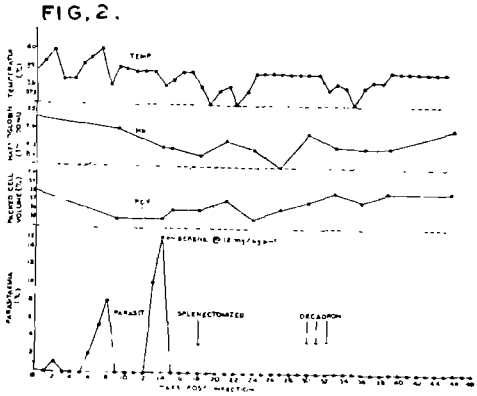


FIG. 2.



Figs. 1-2. Effect of Berenil @ 8 mg per kg body weight (Fig. 1) and 12 mg per kg body weight (Fig. 2) on parasitaemia, packed cell volume, haemoglobin and temperature in experimental *Babesia canis* infection in dogs.

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for two weeks. Dogs of group II were splenectomized after two days of treatment and their blood examined for the presence of parasite. In order to further break the immunity, each dog was given three injections of Decadron @ 8 mg i/m daily and followed as above.

One of the three dogs of group I treated with Berenil @ 8 mg per kg body weight died after 11 days of treatment due to fever, fall in haemoglobin and packed cell volume. The remaining two dogs of this group showed clinical recovery as temperature, haemoglobin and packed cell volume returned to almost normal but after immunosuppression with Decadron there were relapses (Fig. 1).

In the dogs of group II treated with Berenil @ 12 mg per kg body weight, there was complete clinical recovery and no relapses even after immunosuppression through splenectomy and Decadron while rectal temperature, haemoglobin and packed cell volume became normal (Fig. 2), whereas the untreated infected control dog died on the 17th day of infection.

In the present study it has been observed that Berenil @ 12 mg per kg body weight completely sterilized the dogs as there were no parasites in the blood even after splenectomy and Decadron administration. In dogs treated with Berenil @ 8 mg per kg body weight there were relapses of parasitaemia and one of them even died of disease. Berenil @ 3-6 mg per kg body weight has been reported to be effective in *B. canis* infection in dogs by Ryley (1975) and Botha (1964) but our findings are contrary to there observations.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 45—48 (March, 1983)

CHROMOSOMAL STUDIES ON SOME SPECIES OF THE SUB-FAMILY OTIORRHYNCHINAE (CURCULIONIDAE : COLEOPTERA)

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(Received : August 28, 1981; Revised : December 20, 1981)

ABSTRACT

Chromosomal studies on five species viz., *Hemerus* sp., *Myllocerus sabulosus, M. discolor, M.*11-*pustulatus* var. *maculosus* and *Lepropus lateralis* were conducted. *Hemerus* sp. showed the phenomenon of polymorphism so far as the autosomes were concerned.

Inspite of the immense economic importance of the Curculionids and extensive cytological investigations carried out on them in foreign countries, they have so far remained unexplored in India. Since for establishing the evolutionary trends in the family Curculionidae to which the above sub-family belongs, the chromosomal studies on a large number of Curculionids are required, the present work was taken up. The chromosomal observations on as many as five species have been presented in this report.

MATERIAL AND METHODS

The male and female specimens were tried for the chromosomal preparations, but only the males gave satisfactory results. The tests were first left in the hypotonic solution and then fixed in Carnoy's fixative. They were teased in 60% acetic acid and stained in Carbolfuchsin (Carr and Walker, 1961). The chromosomes were classified on the basis of the system of nomenclature proposed by Leven *et al.* (1964).

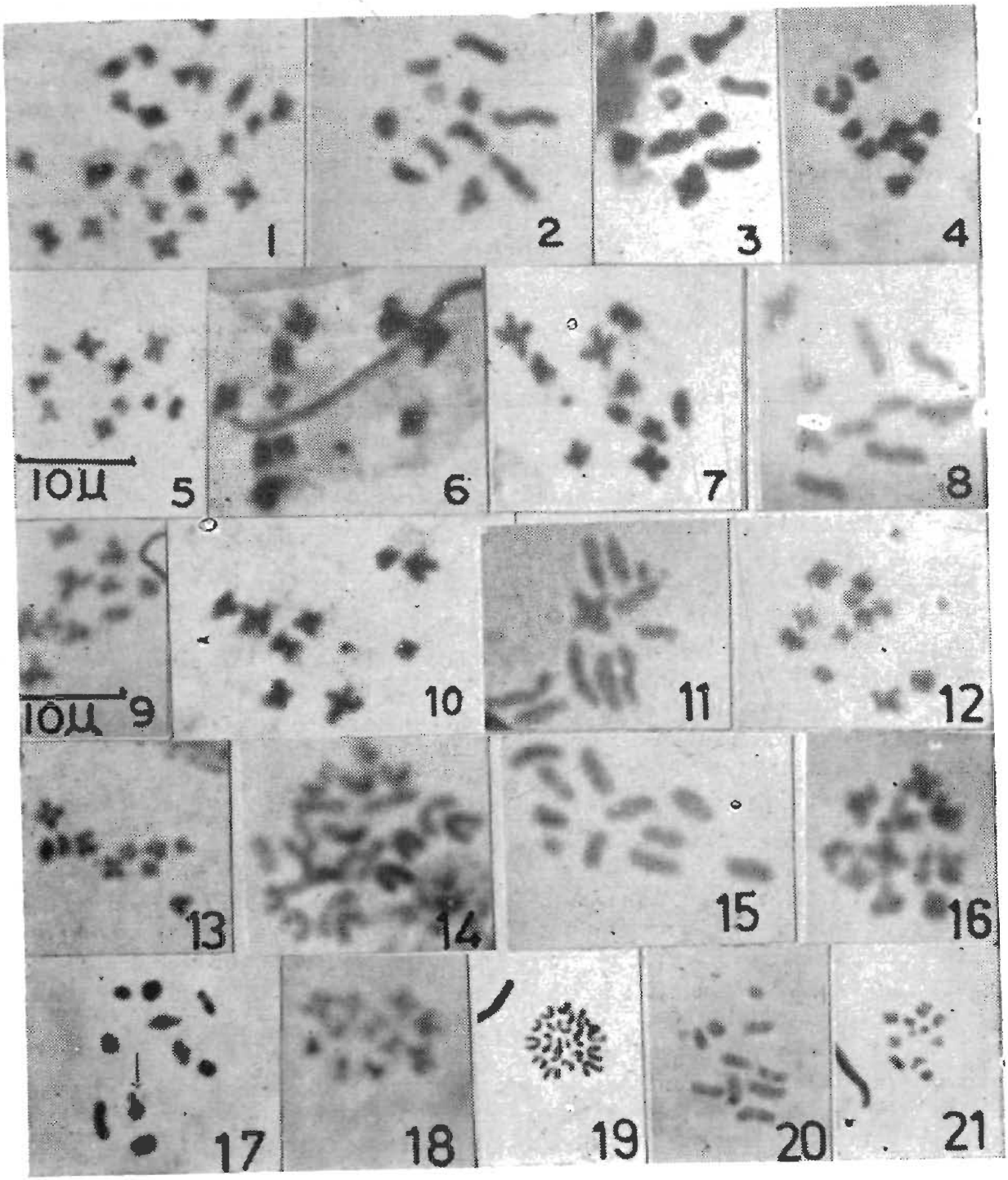
RESULTS AND DISCUSSION

Hemerus sp.

The diploid number of chromosomes, as represented by the spermatogonial metaphase, is 22 (Fig. 1). At metaphase-1, there are 11 bivalents in the form of crosses, rods and dumb-bells. The sex-bivalent is of the typical parachute type (Figs. 2 and 3). The two types of metaphase-II plates encountered are—one with the X chromosome (Fig. 4) and the other with y chromosome (Figs. 5, 6 and 7).

This species also revealed an intraspecific autosomal polymorphism as two types of metaphase-I and metaphase-II plates were observed. Whereas in the normal metaphase-I (Figs. 2 and 3), there are 11 bivalents, the polymorphic plate reveals only 10 bivalents (Fig. 8). Similarly the normal metaphase-II plates have either 10 autosomes and the sex-chromosome X (Fig. 4) or 10 autosomes and the dot-shaped y chromosome (Figs. 5, 6 and 7). The polymorphic form is, on the other

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hand, represented by two types of metaphase-II plates—one with 9 autosomes and the sex-chromosome X (Fig. 9) and the other with 9 autosomes and the dot-shaped y chromosome (Fig. 10).

Myllocerus sabulosus

The spermatogonial metaphase plate is not very clear. However, the metaphase-I (Fig. 11) reveals 11 bivalents out of which 10 are autosomal, and the remaining one, being the sex-bivalent, is in the form of a parachute. Two types of metaphase-II plates are either with X chromosome (Fig. 12) or with the y chromosome (Fig. 13) in addition to 10 autosomes.

Myllocerus discolor

The spermatogonial metaphase plate, though not very clear, reveals 22 chromosomes (Fig. 14). Metaphase-I clearly represents 11 bivalents (Fig. 15). But the sex chromosomes could not be identified. Metaphase-II with the X chromosome is quite clear (Fig. 16) but that with the y chromosome is not so.

Myllocerus-11-*pustulatus* var. *maculosus*

A clear spermatogonial metaphase could not be obtained. However, metaphase-I represents 11 bivalents. Whereas the 10 autosomal bivalents are in the form of a typical parachute where a small dot-shaped y chromosome is attached to a large X chromosome (Fig. 17). Metaphase-II plate with X chromosome and 10 autosomes is quite clear (Fig. 18) while that with y chromosome is not so.

Hemerus sp.

Fig. 1. Spermatogonial metaphase × 2500 X.
Figs. 2 & 3. Metaphase-I Normal with 11 bivalents × 2500 X.
Fig. 4. Metaphase-II Normal with X chromosome × 2500 X.
Figs. 5, 6 & 7. Metaphase-II Normal with y chromosome × 2500 X.
Fig. 8. Metaphase-I Polymorphic with 10 bivalents × 2500 X.
Fig. 9. Metaphase-II Polymorphic with X chromosome and 9 autosomes × 2500 X.
Fig. 10. Metaphase-II Polymorphic with y chromosome and 9 autosomes × 2500 X.

Myllocerus sabulosus

Fig. 11. Metaphase-I × 2500 X.
Fig. 12. Metaphase-II with X chromosome × 2500 X.
Fig. 13. Metaphase-II with y chromosome × 2500 X.

Myllocerus discolor

Fig. 14. Spermatogonial metaphase × 2500 X.
Fig. 15. Metaphase-I × 2500 X.
Fig. 16. Metaphase-II with X chromosome × 2500 X.

Myllocerus-11-*pustulatus* var. *maculosus*

Fig. 17. Metaphase-I × 2500 X.
Fig. 18. Metaphase-II with X chromosome × 2500 X.

Lepropus lateralis

Fig. 19. Spermatogonial metaphase × 2500 X.
Fig. 20. Metaphase-I × 2500 X.
Fig. 21. Metaphase-II with X chromosome × 2500 X.

Lepropus lateralis

The spermatogonial metaphase (Fig. 19) reveals 22 as the diploid number of chromosomes. The metaphase-I clearly shows 11 bivalents out of which 10 are autosomal being in the form of spheres, rods and dumb-bells while the remaining one represents the parachute type of sex-bivalent (Fig. 20). Consequently the sex-mechanism is said to be of the Xyp type.

Metaphase-II plate with the X chromosome (Fig. 21) clearly suggests the morphology of the chromosomes which can be of the acrometa- or sub-metacentric type.

The earlier observations on about 150 species of the sub-family Otiorrhynchinae reveal 22 as the common diploid number in almost all the species excepting a few which show either a diploid number of 20 or an abnormally high number of 32 chromosomes. The present studies also confirm the compact nature of the group and, thereby, do not support the previous sub-division of this group (Marshall, 1916) into three sub-families.

Some of the species e.g. *Lepidospyris demissus* (Sharma *et al.*, 1978) and *Scepticus insularis* (Takenouchi, 1969) show polymorphism regarding their sex-chromosomes. *Hemerus* sp., in the present studies, also shows a case of polymorphism, but it is of the autosomal type as there is a decrease in the haploid chromosome number. Takenouchi (1972) is of the view that the autosomal polymorphism may be due to the dissociation and unification of certain chromosomal arms in the early embryos and secondly due to several Robertsonian changes. The present studies also suggest that the evolution may be due to fusion where the autosomes either fuse with the autosomes or sometimes the autosomes fuse with the sex-chromosomes and thus result in a decrease in the number of chromosomes.

ACKNOWLEDGEMENT

This research was financed in part by a grant made by the USDA, Agricultural Research Service, authorized by the PL 480, which is gratefully acknowledged.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 49—54 (March 1983)

COMBINING ABILITY STUDIES IN WHEAT (*TRITICUM AESTIVUM* L.)

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(Received : June 20, 1980; Revised : October 12, 1982)

ABSTRACT

Studies on combining ability were conducted in wheat using 8 × 8 diallel set in two environments. Yield and its component characters were studied. Grain yield was found to be governed by the non-additive gene effects, whereas other characters were predominantly governed by the additive gene effects. Agra Local was the best combining parent for grain yield and tillers per plant. Kalyan Sona was better combiner for grains per ear and grain weight per ear, whereas Sonalika was good combiner for 100-grain weight. Among all the crosses, UP 301 × Agra Local was the most promising one. Array mean appeared to be closely related with the GCA effects of the parents. *Per se* performance was found to be a suitable measure in place of SCA effects of the crosses and could, therefore, be used to avoid the computation of the latter.

Combining ability studies furnish useful information regarding the selection of suitable parents and at the same time indicate the nature and magnitude of gene action involved. Moreover, gene action is known to vary under different environments and, therefore, it is necessary to evaluate each time parents for their combining ability. Such information is generally required in order to frame an effective breeding programme. The object of the present study was to estimate the general and specific combining ability effects by using an 8 × 8 diallel set in wheat under two fertility levels.

MATERIAL AND METHODS

An 8 × 8 diallel set of wheat, excluding reciprocals, was grown under high (120:60:40 kg of NPK/ha) and low (60:30:20 kg of NPK/ha) fertility levels at the Haryana Agricultural University Research Farm Hissar during **rabi**, 1972. The planting system adopted was randomized block design with three replications. Sowing was done by dibbling the seeds at a distance of 15 cm in 3 m long rows placed at 30 cm apart. At maturity, five plants were selected at random from each single-row plots and were evaluated for effective tillers per plant, grains per ear, weight of grains per ear (g), grain yield per plant (g) and 100-grain weight (g). Combining ability analysis was carried out according to Griffing (1956) method 2, model 1.

RESULTS AND DISCUSSION

The genetic variability was present for all the characters investigated. GCA and

TABLE 1

Mean squares for GCA, SCA and error under high (H) and low (L) fertility conditions in wheat

Source	d. f.		Tillers per plant	Grains per ear	Grain weight per ear	Grain yield per plant	100-grain weight
General combining ability	7	H	32.767**	184.826**	0.079**	72.009**	0.872**
		L	18.227**	181.986**	0.262**	38.136**	0.185**
Specific combining ability	28	H	17.013**	6.425*	0.038*	123.009**	0.083**
		L	2.739**	12.410**	0.036	17.576**	0.093**
Error	70	H	4.773	5.914	0.019	16.910	0.023
		L	0.955	4.159	0.028	4.796	0.015

*, **Significant at 5 and 1 per cent, respectively.

SCA variances have been presented in Table 1. GCA variances were highly significant for all the characters in both the environments. The variances due to GCA were also significant for all the characters except grains per ear in high fertility and grain weight per ear in low fertility environments. The significance of GCA and SCA variances revealed that both additive and non-additive type of gene effects were involved in the inheritance of these attributes. Singh *et al.* (1969), Bhat (1971) and Gill *et al.* (1972) have also reported similar results in wheat.

The GCA estimates have been presented in Table 2. The best general combiner for grain yield was PV 18 followed by Agra Local in high fertility and Agra Local followed by Kalyan Sona under low fertility conditions. It was interesting to note that Agra Local was also best general combiner for tillering under both fertility levels. Earlier, Paroda and Joshi (1970) had also found Agra Local to be a good combiner for ears per plant. Kalyan Sona and PV 18 were found to be good general combiners for grains per ear as well as grain weight per ear in both the environments. Sonalika, a variety with highest kernel weight, produced desirable hybrids with respect to this trait. Sonalika was also good general combiner for grain weight per ear. It may be pointed out that Sonalika, a poor general combiner for grains per ear, was good general combiner for grain weight per ear primarily because of its very high test weight coupled with high GCA effect for this attribute.

Hybrids involving atleast one parent as good general combiner, in general, gave high specific effects. UP 310 × Agra Local was best specific combination for grain yield when studied under high fertility conditions. Under low fertility conditions, on the other hand, PV 18 × UP 301 showed highest SCA effect for yield, although PV 18 × Lerma Rojo gave the highest yield. The crosses selected on the basis of *per se* performance and SCA effects were not the same (Table 3). Taking *per se* perfor-

TABLE 2

GCA effects for yield and its components under high (H) and low (L) fertility conditions in wheat

		Hira	Sonora 64	Sonalika	Kalyan Sona	PV 18	Lerma Rojo	UP 301	Agra Local	CD (gi-gj)
Tillers per plant	H	0.22	−0.44	−2.31	−2.45	0.83	−0.20	14.02	2.94	1.145
	L	0.19	−1.64	−0.12	−0.25	−0.47	0.20	−0.88	2.98	0.512
Grains per ear	H	−2.23	−0.03	−5.17	6.39	6.05	1.02	−2.31	−3.73	1.275
	L	−1.05	0.56	−2.37	7.40	5.01	−1.51	−2.31	−5.71	1.196
Grain weight per ear	H	−0.10	0.04	0.05	0.10	0.07	0.04	−0.15	−0.96	0.072
	L	−0.08	0.04	0.06	0.28	0.14	−0.08	−0.11	−0.24	0.190
Grain yield per plant	H	−1.84	1.16	−0.33	−5.59	4.53	−1.15	−1.64	2.86	2.155
	L	−0.87	−2.74	0.73	1.55	0.25	0.08	−2.24	3.23	1.148
100-grain weight	H	−0.11	0.05	0.61	−0.23	−0.25	−0.05	−0.24	0.22	0.080
	L	−0.01	−0.01	0.33	−0.07	−0.07	−0.06	−0.05	−0.06	0.064

TABLE 3

Best crosses and parents selected on the basis of *per se* performance, array means, GCA and SCA effects in wheat

		Parents						Hybrids			
		Per se performance		Array mean		GCA effect		*Per se* performance		SCA effect	
		H	L	H	L	H	L	H	L	H	L
Tillers per plant	I	8	8	8	8	8	8	7×8	7×8	7×8	2×3
	II	5	1	7	6	7	6	2×8	1×8	1×6	5×6
	III	4	4	1	1	1	1	1×6	5×6	2×8	7×8
Grains per ear	I	5	4	4	4	4	4	4×5	2×4	4×7	3×7
	II	4	5	4	5	5	5	4×7	1×4	3×6	2×4
	III										
Grain weight per ear	I	4	4	4	4	4	4	2×4	2×4	3×5	2×4
	II	6	5	5	5	5	5	3×5	2×5	6×8	2×8
	III	2	3	3	3	3	3	3×6	1×4	3×6	3×6
Grain yield per plant	I	3	8	8	8	8	8	7×8	5×6	7×8	5×7
	II	5	4	5	3	5	3	3×5	3×8	3×5	2×3
	III	2	1	2	5	2	5	2×8	3×6	1×8	4×8
100-grain weight	I	3	3	3	3	3	3	3×3	3×7	1×8	3×8
	II	8	7	8	2	8	2	2×3	3×6	3×5	5×6
	III	1	4	2	1	2	1	3×5	2×3	2×6	3×7

1. Hira
2. Sonora 64
3. Sonalika
4. Kalyan Sona
5. PV 18
6. Lerma Rojo
7. UP 301
8. Agra Local

TABLE 4

Ranking pattern of 8 wheat varieties based on array means and GCA effects under high (H) and low (L) fertility environments

Parents	Tillers per plant				Grains per ear				Grain weight per ear				Yield per plant				100-grain weight			
	GCA effect		Array mean		GCA effect		Array mean		GCA effect		Array mean		GCA effect		Array mean		GCA effect		Array mean	
	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L
Hira	4	3	4	3	5	4	6	4	7	6	7	6	7	6	4	6	5	2	5	2
Sonora 64	6	8	6	8	4	3	4	3	4	4	4	4	3	8	3	8	3	3	3	3
Sonalika	7	4	8	4	8	7	8	7	3	3	3	3	4	3	7	3	1	1	1	1
Kalyan Sona	8	5	7	6	1	1	1	1	1	1	1	1	8	2	8	2	6	8	6	7
PV 18	3	6	3	5	2	2	2	2	2	2	2	2	1	4	1	4	8	7	7	6
Lerma Rojo	5	2	5	2	3	5	3	4	5	5	5	5	5	5	6	5	4	5	4	4
UP 301	2	7	2	7	6	6	5	6	8	7	8	7	6	7	5	7	7	4	8	8
Agra Local	1	1	1	1	7	8	7	8	6	8	6	8	2	1	2	1	2	6	2	5
r H	0.9761**				0.9761**				1.000**				0.7619**				0.9761**			
r L	0.9761**				1.000**				1.000**				1.000**				0.7619**			

*, **Significant at 5 and 1 per cent, respectively.

r = Correlation between array means and GCA effect.

mance into account crosses UP 301 × Agra Local, Kalyan Sona × PV 18, Sonora 64 × Kalyan Sona, UP 301 × Agra Local and Sonalika × Agra Local were found to be the best for tillering, grains per ear, grain weight per ear, yield and 100-grain weight, respectively. UP 301 × Agra Local and PV 18 × Lerma Rojo were consistantly higher yielders under both the fertility levels indicating their superiority in a wide range of environmental conditions. It may be pointed out that Hira × UP 301 was poor specific combination for tillering irrespective of the fact that the parents involved had high general combining ability for this attribute.

Ranks were given to the varieties based on their GCA effects and array means separately; the variety with rank 1 being best general combiner as well as high in array mean. The almost identical ranking pattern supported by highly significant correlation coefficient (Table 4) revealed that the combining ability of genotypes could also be judged effectively from their array means in a diallel table. Jatasra and Paroda (1979) have also made similar observations in wheat.

Results have revealed that Agra Local was best combiner for tillers per plant and grain yield, Kalyan Sona for grains per ear and weight per ear, and Sonalika for 100-grain weight. As such, these parents should effectively be used in wheat breeding programmes aiming at further genetic improvement in these attributes. Also exploitation of cross like UP 301 × Agra Local would be desirable through *inter se* mating for getting the transgressive segregants having the desirable yield contributing characters. Since the variety Agra Local is highly susceptible to rust, care must be exercised to select only the rust resistant segregants. Use of *per se* performance of hybrids for SCA effects and array means for GCA effects appeared to be a useful and time saving approach for the breeders having a large number of hybrids to be evaluated in each season.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 55—60 (March 1983)

STUDIES WITH FODDER OAT ON RESIDUAL P AFTER CEREAL-CEREAL AND CEREAL-LEGUME SEQUENCE

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(Received : January 13, 1981; Revised : April 7, 1981)

ABSTRACT

Phosphorus applied to wheat only in wheat-maize, wheat-sorghum, wheat-cowpea and wheat-moong sequences where **kharif** crops were grown unfertilized showed marked residual effect of phosphorus even on subsequent unfertilized fodder oat after above sequences for two consecutive years. The yield of fodder, P content and its uptake increased proportionately as the level of phosphorus increased ranging from 0 to 51 kg P/ha. P status of soil also increased at each stage of plant growth, but available N gave a reverse trend. Legume following wheat, by and large proved superior to cereal following wheat in producing fodder oat as well as in increasing soil fertility.

Suitable choice of crops in any cropping sequence necessitates proper selection both from the point of productivity and maintenance of soil fertility. Introduction of legumes in rotation increases the availability of nutrients to the succeeding crop which not only results in higher yield but removes more nutrients. In the cereal-cereal rotation there is progressive decline in grain yield of various crops while it is maintained at much higher level in the legume-cereal rotation because of enrichment of soil nitrogen and residual phosphorus. Hence, it is not only essential to study the residual effect of applied phosphorus to the following one crop, but also to investigate the nature and magnitude of residual effect to the succeeding second crop. In the present studies, fodder oat was grown unfertilized after the sequences wheat-maize, wheat-sorghum, wheat-cowpea and wheat-moong where **kharif** crops preceding fodder oat were also unfertilized. The work on fodder oat is detailed in this paper alongwith NP status of soil after crops in above sequences.

MATERIAL AND METHODS

Field experiments were carried out during 1977-78 and 1978-79 at the farm of Agronomy Division, Indian Agricultural Research Institute, New Delhi, using split-plot design with four replications in which the cropping sequences viz., wheat-maize, wheat-sorgum, wheat-cowpea and wheat-moong were allocated in main plots and levels of P applied to wheat only (0, 17, 34 and 51 kg P/ha) in sub-plots. The plot size was 9 m × 3 m. Wheat crop received a basal application of 120 kg N/ha in two splits (half at sowing and half at tillering) and

50 kg K/ha at sowing. The results obtained in the above trial have already been reported in a separate paper (Prasad *et al.*, 1980)

In 1979-80, fodder oat variety 'Kent' was grown unfertilized to study the residual effect of P on this crop after the above sequences for two years. Fodder oat was harvested at jointing, panicle and milk stages after 12, 14 and 17 weeks, respectively for yield and P uptake studies at three stages of growth The net harvest area was 2 m×2 m at each date of sampling. The yield of fodder was recorded soon after harvest. A handful sample was drawn from the produce for chemical analysis which was first sun dried and then oven dried at 65°C and grounded to pass through 20 mesh sieve. All the samples were analysed for P content using Vanadomolybdo-phosphoric yellow colour method (Jackson, 1958) Similarly, soil samples were taken from 0-30 cm layer from each plot and composit soil was analysed for available P (Watnable and Olsen, 1965) and available N (Jackson, 1958).

RESULTS AND DISCUSSION

Yield of Fodder Oat

There was a clear trend of increase in fodder oat yield with the subsequent increase in the level of P ranging from 0 to 51 kg P/ha (Table 1) Seventeen kg P/ha gave significantly higher yield over no phosphorus application at jointing and panicle, while at milk, the difference was not significant Thirtyfour kg P/ha proved significantly superior to 17 kg P/ha at panicle and milk, while at jointing, the increase was marginal Similarly, 51 kg P/ha gave significantly higher yield of fodder oat over both 17 and 34 kg P/ha at jointing and panicle, but at milk,

TABLE 1

Yield of fodder oat (q/ha) at different stages of growth as influenced by phosphorus applied to wheat and cropping sequence

Treatments	Different stages of plant growth		
	Tillering	Panicle	Milk
Doses of P (kg/ha)			
0	122	174	250
17	149	203	268
34	156	239	297
51	183	272	303
S Em±	9 9	10 0	11 6
C. D at 5%	19 5	19 7	22 6
Cropping sequence			
Wheat-maize	140	197	265
Wheat-sorghum	93	143	204
Wheat-cowpea	205	277	343
Wheat-moong	173	271	306
S Em±	17 9	6.8	15 2
C D at 5%	40 7	15 3	34 5

the difference between 34 and 51 kg P/ha was just marginal. The residual P became more and more available to the succeeding oat crop and the availability was proportional to the dose of phosphorus applied to wheat crop There is a general belief that phosphorus applied to one crop is gradually mineralized and only a fraction of it is utilized by the first crop so that the later crops are also benefitted to a great extent (Goswami and Singh, 1976).

Various cropping sequences showed tremendous differences on the yield of fodder oat at each stage of plant growth. Wheat-cowpea sequence resulted in the maximum yield of fodder oat followed by wheat-moong and wheat-maize. By and large wheat followed by legumes gave much higher yield of fodder oat compared with wheat following cereals. At jointing and panicle, wheat-cowpea sequence did not differ significantly, but at milk, the former proved significantly superior to the latter. These results are in agreement with those of other workers (Sen and Sundararao, 1951; Carlson *et al*, 1963; Sen and Dhillon, 1963, Rao and Sharma, 1978, Yadav and Saxena, 1978) who advocated that legume-cereal rotations always favour cereal due to available nitrogen contributed by the legume.

P Content

P content of fodder oat increased progressively at each stage of plant growth as the level of phosphorus increased from 0 to 51 kg P/ha (Table 2). There was significant difference in P content between two consecutive levels of phosphorus at jointing and panicle, but at milk, 34 and 51 kg P/ha proved significantly superior to 0 kg P/ha. Similarly, the difference between 17 and 51 kg P/ha reached the significance level at milk stage. Higher

TABLE 2

P content (%) in fodder oat at different stages of growth as influenced by phosphorus applied to wheat and cropping sequence

Treatments	Different stages of plant growth		
	Tillering	Panicle	Milk
Doses of P (kg/ha)			
0	0 105	0 099	0 102
17	0 119	0 111	0 112
34	0.130	0 126	0 120
51	0 142	0 137	0 129
S Em±	0 004	0 003	0 005
C D at 5%	0 008	0.006	0 010
Cropping sequence			
Wheat *maize*	0 121	0 114	0 112
Wheat-sorghum	0 136	0 136	0 123
Wheat-cowpea	0 117	0 110	0 113
Wheat-moong	0 122	0 113	0 113
S Em±	0 025	0 005	0 004
C D at 5%	0.056	0 012	0 009

P content at high rate of phosphorus application to the previous crop was solely due to increased phosphorus concentration in soil media from where the plant was continuously absorbing the nutrient for its growth and development.

Wheat-sorghum sequence showed the maximum P content in fodder oat at each stage of growth and, at panicle and milk, the difference in favour of this sequence reached the significance level. High P content in this case may be attributed to low yield of fodder oat resulting higher P concentration in the plant system.

P Uptake

Since P uptake is largely a function of yield of a crop and its nutrient content, the P uptake increased markedly with the subsequent increase in the level of phosphorus applied to wheat resulting significant differences among the treatments at each stage of plant growth (Table 3).

Wheat-cowpea sequence gave the maximum P uptake by fodder oat at each stage of growth mainly due to increased fodder yield as discussed earlier and this treatment proved significantly superior to either wheat-maize or wheat-sorghum, but the differences between the two sequences involving legumes did not reach the significance level.

NP Status of Soil

The data on available N and P prior to sowing of test crop, i. e., fodder oat and at different stages of oat plant growth have been presented in Table 4. It may be seen that increase in dose of P applied to wheat crop only during 1977-78 and 1978-79 gave an increas-

TABLE 3

P uptake (kg/ha) in fodder oat at different stages of growth as influenced by phosphorus applied to wheat and cropping sequence

Treatments	Different stages of plant growth		
	Tillering	Panicle	Milk
Doses of P (kg/ha)			
0	2.7	5.4	8.1
17	3.9	7.1	9.5
34	4.4	9.4	11.5
51	5.7	11.7	12.5
S. Em±	0.3	0.5	0.9
C. D. at 5%	0.6	0.9	1.8
Cropping sequence			
Wheat-maize	3.7	7.3	9.6
Wheat-sorghum	2.8	6.4	8.1
Wheat-cowpea	5.4	9.9	12.6
Wheat-moong	4.7	10.0	11.3
S. Em±	0.6	0.5	0.7
C. D. at 5%	1.3	1.1	1.6

TABLE 4

NP status of soil after harvest of crops in sequence as influenced by phosphorus applied to wheat

Treatments	After wheat	After kharif	After wheat	After kharif	Different stages of oat plant growth		
	1977-78	1978	1978-79	1979	Tillering	Panicle	Milk
			Available N (kg/ha)				
Doses of P (kg/ha)							
0	200	183	201	180	170	139	134
17	203	183	190	179	157	140	133
34	213	174	205	175	149	133	122
51	219	176	220	166	150	132	123
Cropping sequence							
Wheat-maize	201	179	181	156	146	125	110
Wheat-sorghum	213	180	210	169	147	130	128
Wheat-cowpea	213	212	210	216	161	140	135
Wheat-moong	215	214	212	222	163	148	148
			Available P (kg/ha)				
Doses of P (kg/ha)							
0	12.2	11.8	11.4	11.0	10.8	10.6	10.2
17	14.8	13.3	14.6	13.2	13.3	13.2	13.1
34	15.2	14.9	16.3	15.9	15.8	15.8	15.6
51	17.2	17.1	18.2	17.8	17.9	17.8	17.8
Cropping sequence							
Wheat-maize	16.2	13.7	16.2	15.7	14.6	13.1	14.6
Wheat-sorghum	15.2	15.6	16.2	15 0	14.2	15.5	14.1
Wheat-cowpea	14.1	14.2	15.5	14.2	13.4	14.1	13.9
Wheat-moong	14.9	14.9	14.4	13.2	13.5	14.0	13.7

ing trend of available N after the harvest of wheat crop, but the trend appeared to reverse when unfertilized **kharif** crops were grown. This was true in case of unfertilized test crop of fodder oat which also gave a trend of increased available N at jointing, panicle and at milk stages of growth. Increased available N at lower dose of phosphorus application was mainly due to less utilization of soil N due to comparatively less supply of phosphorus. Legume crops by and large showed higher available N in soil where moong proved slightly superior to cowpea. This was owing to contribution of N through its fixation by bacteria. Similarly, there was slightly higher available N in soil after wheat-sorghum sequence compared with wheat-maize.

There was a continuous increase in trend of available P as the dose of phosphorus increased from 0 to 51 kg P/ha. It may be noted that available P in soil was comparatively lower in favour of wheat-legume sequence compared with wheat-cereal at each stage of oat plant growth. This is just possible because legume enriched soil with more nitrogen resulting more utilization of phosphorus by the crop plant and hence relatively less phosphorus was left in soil.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 61—69 (March 1983)

EFFECT OF PROTECTION MATERIALS AND GROWTH REGULATORS ON THE PRODUCTION OF AN EARLY CROP OF TOMATO (*LYCOPERSICON ESCULENTUM* MILL.)

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(Received : January 14, 1981; Revised : May 12, 1981)

ABSTRACT

Experiments were conducted during 1976-77 and 1977-78 to raise an early summer crop of tomato by use of protection materials and growth regulators. Maximum survival percentage of plants, number of fruits per plant and early and total yields were recorded from plants protected by polythene bags followed by paddy straw and sugarcane trash. Spray of plants at flowering with 50 ppm PCPA resulted in better fruit set, higher number of fruits and increased early and total yields. Boric acid and NAA also improved the early and total yields to some extent. The protection of tomato plants by polythene bags followed by spray of 50 ppm PCPA helped in raising a sizeable early crop of tomato during spring season.

Due to heavy frost during winter in the north-western plains of India comprising Haryana, Punjab, Rajasthan and Western U. P., the spring crop cannot be transplanted before the first week of February. Protection of plants from frost certainly helps in raising an early crop (Thompson and Kelly, 1957). There is low fruit set during cold weather or unfavourable weather conditions at the time of blossoming. Growth regulators have been tried successfully in tomato to enhance fruit set, ripening, early and total yields (Randhawa and Thompson, 1947; Singletary, 1951; Rakitin and Alimova, 1976; Pandita *et al.*, 1979). Protection materials and growth regulators have been reported to increase fruit set and ultimately the yield (Thompson and Kelly, 1957; Mehta and Mathai, 1975). The present studies were, therefore, conducted to study the performance of different protection materials and plant growth regulators for raising an early crop of tomato variety HS-102 under Hissar conditions.

MATERIAL AND METHODS

The present investigation was conducted during 1976-77 and 1977-78 on tomato variety HS-102. The experiment was laid out in a split plot design in three replications with five main plot treatments comprising of four protection materials namely paper bags, sugarcane trash, paddy straw and polythene bags alongwith an uncovered control. The four subplot treatments included three growth regulators—50 ppm PCPA, 50 ppm NAA and

5 ppm boric acid alongwith unsprayed control. Each experimental plot measured 3.60×1.20 m net with 16 plants in two rows. Seeds were sown in the nursery during middle of October and crop was transplanted in the field during the end of November in both the years. Seedlings were transplanted on the raised beds with a spacing of 60 and 45 cm between rows and plants, respectively. The plants were covered with different protection materials in the month of December-January during both the years while control plots were kept uncovered. The covering materials were removed in the middle of February when the danger of frost was over. The whole plants were sprayed with growth regulators using Tween-20 as surfactant in the third week of February in both the years. The control plots were sprayed with canal water in all the replications. The monthly mean maximum and minimum temperature during the period of investigation were recorded (Table 1).

The observations were recorded on the survival percentage, number of fruits set after 20 days of spraying, number of fruits per plant for early and total pickings and early and total yield. The survival percentage was calculated on the basis of survival out of the total number of plants transplanted, at the time of final harvest. Yield from the pickings made upto 30th April was considered as an early yield, whereas total yield was regarded as the sum of all the pickings made upto 10th June, during both the years.

RESULTS AND DISCUSSION

Survival Percentage

It is apparent from Table 2 that differences in the survival percentage between different protection materials and control were significant during both the years. The survival percentage was highest (64.9 and 87.5 per cent) when the plants were covered with polythene bags followed by paper bags (56.0 and 76.8 per cent) and paddy straw (47.7 and 76.4 per cent), whereas uncovered control plots showed least survival (39.9 and 64.2 per cent) during both the years. The growth regulator treatments did not have any significant effect on the survival of plants during both the years. Maximum

TABLE 1

The average maximum and minimum temperature (°C) during the experimental period of 1976-78

Month	Maximum temp. (°C)		Minimum temp. (°C)	
	1976-77	1977-78	1976-77	1977-78
November	26.4	30.1	10.4	11.9
December	20.3	23.6	5.7	6.3
January	19.9	20.5	3.8	2.9
February	24.1	21.1	5.2	6.4
March	34.2	26.3	10.9	11.0
April	36.4	35.9	18.6	20.8
May	38.7	40.8	21.5	35.3

TABLE 2

Effect of protection materials and growth regulators on the survival percentage and number of fruits per plant 20 days after the spray of tomato variety HS-102 raised as an early spring crop

Treatments	Paper bags		Sugarcane trash		Paddy straw		Polythene bags		Unprotected (control)		Average	
	76-77	77-78	76-77	77-78	76-77	77-78	76-77	77-78	76-77	77-78	76-77	77-78
A. Survival percentage												
NAA 50 ppm	56.3	75.0	45.8	73.6	48.0	72.2	60.4	80.6	44.7	63.9	51.0	73.1
PCPA 50 ppm	66.3	80.6	43.8	72.2	52.2	80.6	71.6	96.1	56.1	59.7	58.0	77.8
Boric acid 5 ppm	43.0	83.3	44.0	79.2	44.5	79.2	68.2	86.7	31.0	72.2	46.1	80.1
Control (unsprayed)	58.4	68.1	49.6	79.2	45.9	73.6	59.5	86.4	27.9	61.1	48.3	73.7
Average	56.0	76.8	45.8	76.1	47.7	76.4	64.9	87.5	39.9	64.2		
B. Number of fruits set per plant (20 days after the spray)												
NAA 50 ppm	4.2	8.9	4.5	9.7	5.3	10.9	9.2	14.0	3.7	5.8	5.4	9.9
PCPA 50 ppm	7.3	12.1	10.1	17.0	11.6	18.3	15.4	19.9	7.5	9.6	10.4	15.4
Boric acid 5 ppm	6.1	9.3	7.8	12.2	7.3	9.4	9.8	16.6	4.5	5.4	7.1	10.6
Control (unsprayed)	3.4	4.7	4.3	5.0	4.0	6.2	6.0	7.6	2.9	3.7	4.1	5.4
Average	5.3	8.8	6.7	11.0	7.1	11.2	10.1	14.5	4.7	6.1		

C. D. at 5% level	A. Survival percentage		B. Fruit set/plant 20 days after spray	
	1976-77	1977-78	1976-77	1977-78
Protection materials (P)	4.7	8.8	1.5	1.9
Growth regulators (G)	NS	NS	1.2	2.6
Interaction (P × G)	NS	NS	3.1	5.8

survival of plants under polythene cover was due to maintenance of higher and better temperature and environment surrounding the plants including better exposure of plants to sunlight for photosynthesis which maintained better growth of plants (Thompson and Kelly, 1957). Uncovered control plants showed higher mortality during 1976-77 because of prevailing low temperature than 1977-78 (Table 1).

Fruit Set

The differences in the number of fruits set per plant were significant for protection materials, growth regulator treatments and their interaction (Table 2). Polythene bags had significantly higher earlier fruit set per plant (10.1 and 14.5, respectively) during both the years as compared to other protection materials and the uncovered control plants. During both the years, maximum fruits set (10.4 and 15.4) 20 days after spray was recorded with 50 ppm PCPA followed by 5 ppm boric acid (7.1 and 10.6) while least fruit set (4.1 and 5.4) was obtained in unsprayed plants. The interaction between protection materials and growth regulators was significant. Covering plants with polythene bags followed by foliar spray with 50 ppm PCPA resulted in maximum fruit set (15.4 and 19.9) during both the years. The least fruit set (2.9 and 3.7) was recorded in uncovered control plants sprayed with canal water. The increase in fruit set under polythene bags was due to better growth of plants as a result of higher temperature and better exposure to light which helped in profuse flowering at the time of spray of growth regulators. Poor fruit set under paper bags was due to lanky and poor growth of plants as a result of non-exposure of plants to direct sunlight. Under other protection materials light was available partially to the plants. Abdelhafeez and Verkerk (1969) and Mehta and Mathai (1975) reported early fruiting in tomato crop when plants were grown at temperature regime of 35°C day and 18°C night as compared to temperature regime of 20°C day and 15°C night. The increase in the fruit set at lower temperature by PCPA has also been reported by Krishnamurthi and Subramanian (1955) and Mehta and Mathai (1975). The most probable reason for increased fruit set with PCPA application was that the external application of this auxin increased the endogenous auxin content of flowers which improved fruit set and development (Randhawa and Thompson, 1947; Verzilov and Mihteleva, 1968). Another possible reason for increased fruit set with PCPA application may be increased translocation of organic material (Shindy and Weaver, 1967).

Increased fruit set by boric acid was related with increased level of sugar (Jurkevic, 1963) which promoted pollen germination and pollen tube growth. Poor fruit set in control treatment may be due to flower drop at low temperature as reported by Smith (1932).

Number of Fruits per Plant from Early and Total Yield

The data presented in Table 3 show significant differences in number of fruits per plant from early yield due to protection materials, growth regulators sprays and their interaction in both the years. Number of fruits per plant

TABLE 3

Effect of protection materials and growth regulators on the number of fruits per plant for early and total yield of tomato variety HS-102 raised as an early spring crop

Treatments	Paper bags		Sugarcane trash		Paddy straw		Polythene bags		Unprotected (control)		Average	
	76-77	77-78	76-77	77-78	76-77	77-78	76-77	77-78	76-77	77-78	76-77	77-78
A. Number of fruits per plant for early yield												
NAA 50 ppm	3.4	4.1	3.3	7.2	2.9	5.5	4.9	6.8	1.9	2.6	3.3	5.2
PCPA 50 ppm	5.1	8.5	5.9	7.3	8.5	12.1	12.6	15.3	5.0	6.2	7.4	9.9
Boric acid 5 ppm	3.4	4.4	3.6	6.4	3.4	4.8	4.2	6.9	2.7	3.5	3.5	5.2
Control (unsprayed)	1.0	1.9	1.5	2.6	1.9	2.6	2.4	3.8	1.3	2.0	1.6	2.6
Average	3.2	4.7	3.6	5.9	4.2	6.3	6.0	8.2	2.7	3.6		
B. Total number of fruits per plant												
NAA 50 ppm	14.8	19.2	16.1	20.8	11.7	14.3	13.4	21.2	5.8	11.5	12.4	17.4
PCPA 50 ppm	15.5	21.4	17.1	19.9	22.3	26.2	24.1	30.0	12.8	17.6	18.4	23.0
Boric acid 5 ppm	10.4	14.6	14.7	18.4	11.1	14.1	16.3	21.5	10.6	15.6	12.6	16.8
Control (unsprayed)	8.3	11.0	9.3	13.1	10.3	12.0	9.9	12.1	4.4	10.4	8.4	11.7
Average	12.3	16.6	14.3	18.1	13.9	16.7	15.9	21.2	8.4	13.8		

C. D. at 5% level	A. Number of fruits per plant for early yield		B. Total number of fruits per plant	
	1976-77	1977-78	1976-77	1977-78
Protection materials (P)	0.8	0.5	1.6	4.9
Growth regulators (G)	1.2	1.0	2.1	3.4
Interaction (P × G)	1.8	0.9	4.7	5.7

harvested upto 30th April was significantly higher in plants covered with polythene bags (6.0 and 8.2) followed by paddy straw (4.2 and 6.3) during both the years. Uncovered control plants exhibited least number of fruits per plant (2.7 and 3.6). PCPA 50 ppm was significantly better in increasing the number of fruits per plant (7.4 and 9.9) as compared to water sprayed plants (1.6 and 2.6) in both the years. These results confirm the results of Rakitin and Alimova (1976) who reported reduced flower drop and improved fruit set with sodium salt of PCPA. The interaction between protection materials and growth regulator was significant. Covering the plants with polythene bags followed by 50 ppm PCPA spray gave the highest number of fruits (12.6 and 15.3) per plant, whereas least number was obtained from unsprayed plants covered with paper bags (1.0 and 1.9) during both the years.

Polythene bags performed better in giving the maximum number of fruits (15.9 and 21.2) per plant as compared to uncovered control plants (8.4 and 13.8) during both the years. Among the growth regulators 50 ppm PCPA spray resulted in maximum fruits per plant (18.4 and 23.0). Water sprayed control plants yielded least number of fruits (8.4 and 11.7) in both the years. The interaction between protection materials and growth regulators was significant. The covering of plants with polythene bags in combination with foliar spray with 50 ppm PCPA resulted in maximum number of fruits per plant (24.1 and 30.0) while uncovered control plants sprayed with canal water yielded least number of fruits (4.4 and 10.4) during both the years.

Early and Total Yield

Data on the early yield taken upto 30th April presented in Table 4 show significant differences among the protection materials and growth regulators during both the years. Highest early yield was obtained from plants covered with polythene bags (0.71 and 0.95 kg/plot) in both the years, whereas uncovered plots gave poorest yield (0.23 and 0.26 kg/plot). Among the growth regulators highest early yield was obtained with foliar application of 50 ppm PCPA (0.76 and 0.95 kg/plot) during both the years, whereas unsprayed plants gave the lowest yield (0.17 and 0.22 kg/plot). The interaction between protection materials and growth regulator spray was significant in both the years. The covering of plants with polythene bags in combination with 50 ppm PCPA spray gave the highest early yield (1.26 and 1.54 kg/plot), whereas least early yield (0.05 and 0.08 kg/plot) was recorded in water sprayed control plants protected by paddy straw. These results are in conformity with the previous findings of Pandita *et al.* (1979) who obtained maximum early yield with 50 ppm PCPA in tomato variety HS-101. Similar results were also obtained by Rakitin and Alimova (1976). The increased early yield with 50 ppm PCPA was mainly due to early and better fruit set under unfavourable weather condition (Table 2).

Protection materials and growth regulators improved total yield significantly during both the years (Table 4). Best performance for total yield was recorded with polythene bags (4.22 and 6.35 kg/plot), whereas uncovered control plots gave significantly lower fruit yield (1.88

TABLE 4

Effect of protection materials and growth regulators on early and total yield of tomato variety HS-102 raised as an early spring crop

Treatments	Paper bags		Sugarcane trash		Paddy straw		Polythene bags		Unprotected (control)		Average	
	76-77	77-78	76-77	77-78	76-77	77-78	76-77	77-78	76-77	77-78	76-77	77-78
A. Early yield (kg/plot)												
NAA 50 ppm	0.23	0.35	0.28	0.37	0.49	0.48	0.45	0.61	0.12	0.14	0.31	0.39
PCPA 50 ppm	0.72	1.07	0.78	0.66	0.74	1.14	1.26	1.54	0.30	0.32	0.76	0.95
Boric acid 5 ppm	0.56	0.76	0.39	0.40	0.61	0.80	0.99	1.34	0.22	0.26	0.55	0.71
Control (unsprayed)	0.23	0.20	0.20	0.21	0.05	0.08	0.12	0.30	0.26	0.31	0.17	0.22
Average	0.44	0.60	0.41	0.41	0.47	0.63	0.71	0.95	0.23	0.26		
B. Total yield (kg/plot)												
NAA 50 ppm	2.15	3.64	2.96	4.67	2.45	3.18	4.12	5.60	1.64	2.38	2.66	3.89
PCPA 50 ppm	2.91	4.45	5.71	7.65	3.84	5.12	6.46	8.33	2.17	2.64	4.22	5.64
Boric acid 5 ppm	2.55	4.26	2.94	4.90	2.56	3.50	3.95	7.10	2.13	3.28	2.83	4.61
Control (unsprayed)	1.10	2.49	2.72	3.68	2.78	2.79	2.35	4.38	1.59	1.81	2.11	3.03
Average	2.18	3.71	3.58	5.23	2.91	3.65	4.22	6.35	1.88	2.53		

C. D. at 5% level	A. Early yield (kg/plot)		B. Total yield (kg/plot)	
	1976-77	1977-78	1976-77	1977-78
Protection materials (P)	0.10	0.25	0.24	1.08
Growth regulators (G)	0.18	0.30	0.36	1.14
Interaction (P × G)	0.39	0.66	0.82	2.95

and 2.53 kg/plot). PCPA 50 ppm was superior in increasing the total yield (4.22 and 5.64 kg/plot) to other treatments. The lowest total yield was recorded in control (2.11 and 3.03 kg/plot) during both the years. The interaction effects were significant. The protection of plants by polythene bags followed by 50 ppm PCPA spray gave the highest total yield (6.46 and 8.33 kg/plot). The unsprayed plants protected by paper bags during 1976-77 and uncovered plants sprayed with 50 ppm NAA during 1977-78 exhibited the lowest yields of 1.10 and 2.38 kg/plot, respectively. Arora (1974) also obtained highest fruit set with foliar application of 50 ppm PCPA during summer season. In 1976-77 there was poor yield from plants due to hailstorm during fruiting period.

The maximum early and total yield recorded with polythene bags followed by 50 ppm PCPA spray combination was primarily because of increased fruit set. Another possible reason may be the auxin directed mobilization of nutrients into flowers and fruits by external application of auxins (Weaver, 1973). Coulombe and Rogers (1959) observed that tomato plants when sprayed with growth regulators showed a rapid increase in respiration, photosynthesis and transpiration; there may be thus a greater accumulation of carbohydrates owing to greater photosynthesis which caused the fruits to increase in size, weight and ultimately the yield.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 70—78 (March 1983)

CRITICAL LIMIT OF AVAILABLE PHOSPHORUS FOR WHEAT (*TRITICUM AESTIVUM*) AND EVALUATION OF SOIL TESTS IN SIEROZEM SOILS OF HARYANA

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(Received : February 2, 1981)

ABSTRACT

Nine rapid soil tests were evaluated for sierozem soils for wheat crop on the basis of their correlation coefficients with different yield parameters, i. e. dry matter yield of control, per cent dry matter yield, and per cent P uptake at two stages of growth. 0.5 N sodium bicarbonate (pH 8.5), colour developed by ascorbic acid and stannous chloride were found to be the best as both these methods gave highest correlation coefficient than other methods with different yield parameters at both stages of growth. The highly significant response to P application was obtained in 18 of the 20 soils at both the stages of growth. The per cent dry matter yield response with the application of 50 and 100 ppm P was 128 and 156, respectively, at first stage and 3 and 31, respectively, at second stage of growth.

First stage, i.e. 4 weeks after germination was found to be the best stage of taking sampling as compared to second stage, i. e., maturity for such type of study. The per cent P uptake gave higher correlation coefficient values with different extractant to closely followed by per cent dry matter yield. Two methods, i. e., graphical procedure and mathematical two-mean discontinuous model have been tried for establishing critical limit. About 12.42 kg P/ha was found to be the critical limit by mathematical model which is the best and precise method of determining critical limit in soil. Organic carbon gave highly positively significant value and pH gave negatively significant 'r' value with different soil tests.

A correct interpretation of soil test data is necessary in order to get maximum return per rupee spent on fertilizers. The establishment of critical limit for particular crop and soil is pre-requisite for accurate and precise fertilizer recommendation based on soil test. The selection and standardisation of available soil P methods are very important for right assessment of soil P. Different growth parameters for testing the suitability of a soil-test have been used by various workers, i. e., per cent yield (Bray, 1948), control plots (Robertson, 1962) and nutrient uptake (Fitts and Nelson, 1956). An attempt was made in this study to evaluate different extractants for available P determination, to establish critical limit for soil P in sierozem soils for wheat crop and to find out the effect of different soil characteristics on the extractability.

MATERIAL AND METHODS

Twenty bulk soil samples having different physico-chemical characteristics were collected from areas representing sierozem soils in Haryana. Physico-chemical characteristics were determined by the routine laboratory procedures as described by Jackson (1958). In the greenhouse study, earthen pots of 25 cm diameter lined with polythene were filled with 4 kg soil. Treatments consisted of 0, 25 and 100 ppm P applied as potassium dihydrogen phosphate to the soil alongwith 100, 50 and 10 ppm of N, K and Zn, respectively, in the form of urea, potassium chloride and zinc sulphate, and replicated thrice.

Six plants of wheat (Kalyan Sona) were raised in each pot using deionized water for irrigation. Wheat plants were harvested at two stages of growth, i. e., 4 weeks after germination and at maturity; washed immediately with distilled water, acidified distilled water and distilled water in that sequence; dried at 60–70°C and dry matter and grain weight were recorded. After grinding, plant samples were analysed for total P uptake by using the procedure described by Jackson (1958).

In order to evaluate different chemical extractions for their suitability in predicting available P status, the same 20 soils were extracted with six extractants, viz. Olsen *et al.* (1954), Morgan (1935), Bray and Kurtz (1945), M/2 ammonium acetate + M/2 acetic acid with soil-solution ratio 1 : 5 and 30 min shaking, 1 N NH_4F+0.05 N EDTA with soil solution rates 1 : 5 and 30 min shaking, 1 N $NaHCO_3$+0.05 N EDTA with soil solution ratio 1 : 5 and 30 min shaking. The colour was developed by using stanous chloride and ascorbic acid method as prescribed by John (1970). The available-P extracted by Olsen-P, Bray's-P and colour developed by ascorbic acid method are termed as modified Olsen-P and modified Bray's-P.

For evaluation of the different extractants tried, the coefficient of correlation between the amount extracted and the yield of control, Bray per cent yield, control uptake and Bray's per cent uptake were worked out. The per cent yield was calculated as $\frac{\text{Yield of control}}{\text{Maximum yield}} \times 100$

For the establishment of critical limit of available-P, two procedures, i. e. graphical (Cate and Nelson, 1965) and mathematical (Cate and Nelson, 1971) were used.

RESULTS AND DISCUSSION

The different soils used for this study were analysed for physico-chemical properties (Table 1). Most of the soils were alkaline in reaction and texture varied from sand to silt clay loam. A perusal of dry matter yield data (Table 2) shows that highly significant response to P application was obtained in all but two soils at both the stages of growth. The two soils which did not respond to the P application contained very high amount of available-P (155.8 and 42.40 kg P/ha). The per cent dry matter yield response with the application of 50 and 100 ppm P was 128 and 156, respectively, over control at first stage of growth. The corresponding figures for second stage of growth were 3 and 31, respectively. The lesser magnitude of P response at second

TABLE 1

Physico-chemical properties of different soils

S. No. (soils)	pH (1 : 2)	E. C. (1 : 2)	O. C. (%)	$CaCO_3$ (%)	C. E. C. (meq/ 100 g)	Clay (%)	Texture
1	7.2	0.67	0.18	Absent	4.20	8	Silty loam
2	7.5	0.73	0.22	Absent	4.50	16	Silty loam
3	7.7	1.31	0.21	Absent	4.30	16	Silty loam
4	7.2	1.73	0.32	Absent	8.40	28	Silty clay loam
5	7.8	2.13	0.28	1.0	7.60	28	Silty clay loam
6	7.8	1.81	0.35	Absent	6.26	24	Silty loam
7	7.9	1.60	0.15	Absent	4.20	10	Silty loam
8	7.8	1.80	0.19	Absent	7.65	28	Loamy sand
9	8.0	3.13	0.56	Absent	4.80	16	Silty loam
10	7.8	1.00	0.11	Absent	3.60	6	Loamy sand
11	8.1	1.80	0.34	Absent	4.00	16	Silty loam
12	8.0	2.14	0.22	Absent	3.90	14	Silty loam
13	7.8	0.87	0.24	Absent	8.10	28	Silty clay loam
14	7.2	2.67	0.59	Absent	4.40	10	Silty loam
15	7.7	0.46	0.55	Absent	4.60	18	Silty loam
16	8.0	0.20	0.13	Absent	2.10	8	Silty loam
17	7.9	0.43	0.19	Absent	3.70	14	Silty loam
18	7.8	0.13	0.37	Absent	4.70	20	Silty loam
19	7.4	0.61	0.32	Absent	3.90	12	Silty loam
20	8.4	0.07	0.14	Absent	0.80	2	Sand
Average	7.76	1.088	0.28	—	4.78	16.1	—

stage in comparison to first stage may be attributed to root proliferation and high temperature resulting into higher solubilization of P.

The available P by different extractants is given in Table 3. A perusal of available P data clearly indicates a wide range of soils from critically poor to very high in available P. In general, the highest amount of P was extracted with M/2 acetic acid+M/2 ammonium acetate (89.4) followed by Bray's-P (83.9), Morgan (75.6), 1 N $NaHCO_3$+0.05 EDTA (74.4), 1 N NH_4F+0.05 N EDTA (59.9) and N/2 $NaHCO_3$-PH 8.5 (18.80). The amounts extracted in different extractants were in accordance with their chemical properties. The N/2 $NaHCO_3$ (pH 8.5) colour developed by ascorbic acid method extracted smallest amount of P and gave highest correlation coefficient values with all the yield parameters at both the stages of growth. Such observations were also recorded by Alban (1972). According to him, the method that extract smaller quantities of P results in better estimation of site index than the methods that extract larger amount of P.

TABLE 2

Dry matter yield of control, per cent dry matter yield and per cent uptake of P at first and second stages of growth

S. No. (soils)	Dry matter yield (control)		Per cent dry matter yield		Per cent P uptake
	First	Second	First	Second	First
1	0.665	7.20	22.7	54.96	3.4
2	1.958	8.35	68.1	72.60	5.6
3	0.662	9.15	18.2	75.30	4.7
4	1.712	10.05	89.6	90.13	45.4
5	0.409	5.90	19.7	68.60	14.1
6	0.475	10.30	21.4	72.79	8.4
7	1.124	10.80	38.9	96.00	7.9
8	1.374	7.95	45.3	79.84	14.1
9	1.125	10.80	56.6	97.20	15.0
10	1.321	8.35	58.8	84.77	21.8
11	0.143	4.75	5.9	61.68	1.2
12	0.406	4.90	15.4	42.24	5.9
13	0.555	3.80	16.9	50.00	4.9
14	2.485	16.15	100.0	99.08	97.1
15	0.679	5.45	33.7	39.35	10.7
16	1.022	11.80	39.0	129.60	13.8
17	0.472	7.05	19.4	68.61	6.2
18	1.186	6.80	62.5	58.36	18.2
19	0.584	7.50	23.7	89.28	5.0
20	0.793	4.63	26.2	57.40	5.4
Average	0.956	8.08	39.1	75.37	15.4

Out of nine methods tried for their suitability to predict correctly and precisely available P from sierozem soils of Haryana, Olsen's-P and N/2 $NaHCO_3$ (pH 8.5) colour developed by ascorbic acid gave highest correlation with all the yield parameters at both stages of growth. The probable reason of best suitability of N/2 $NaHCO_3$ (pH 8.5) extractant under these soils which are alkaline in reaction is that it controls the ionic activity of calcium through solubility product of calcium carbonate during extraction and thereby extracting a fraction of Ca-P, Fe-P and Al-P. Whereas the Bray's-P method is suitable for acidic and slightly neutral soils only as flouride forms complexes with Fe and Al and solubilizes P held by them. The colour developed by using stanous chloride as reducing agent remains stable only for 10 min, whereas the colour remains stable for even 24 h in case of ascorbic acid method. Moreover, the ascorbic acid method is not affected by moderate variation in acidity, temperature, time, reducing

ters clearly indicate the superiority of first stage of growth and second stage of growth sampling. Meaning thereby the first stage of growth sampling is the best stage for predicting the suitability of test methods for the determination of available-P. The probable reason may be attributed to the very high amount of P per unit time required at early stages of growth and in the later stages only redistribution and translocation processes are pre-dominant.

Attempts were made to establish critical limit by two procedures, i.e., Cate and Nelson (1965) graphical procedure and Cate and Nelson (1971) mathematical two means discontinuous model (Figs. 1 and 2). This is quite apparent that the graphical procedure is a raw method and gives only approximation of critical limit, whereas the mathematical two-means discontinuous model establishes critical limit precisely and accurately as the peak indicates the critical limit on the graph when average available-P is plotted against coefficient of determination (R^2) values.

The critical limit by mathematical model and graphical procedure have been established as 12.42 and 13.3 kg P/ha

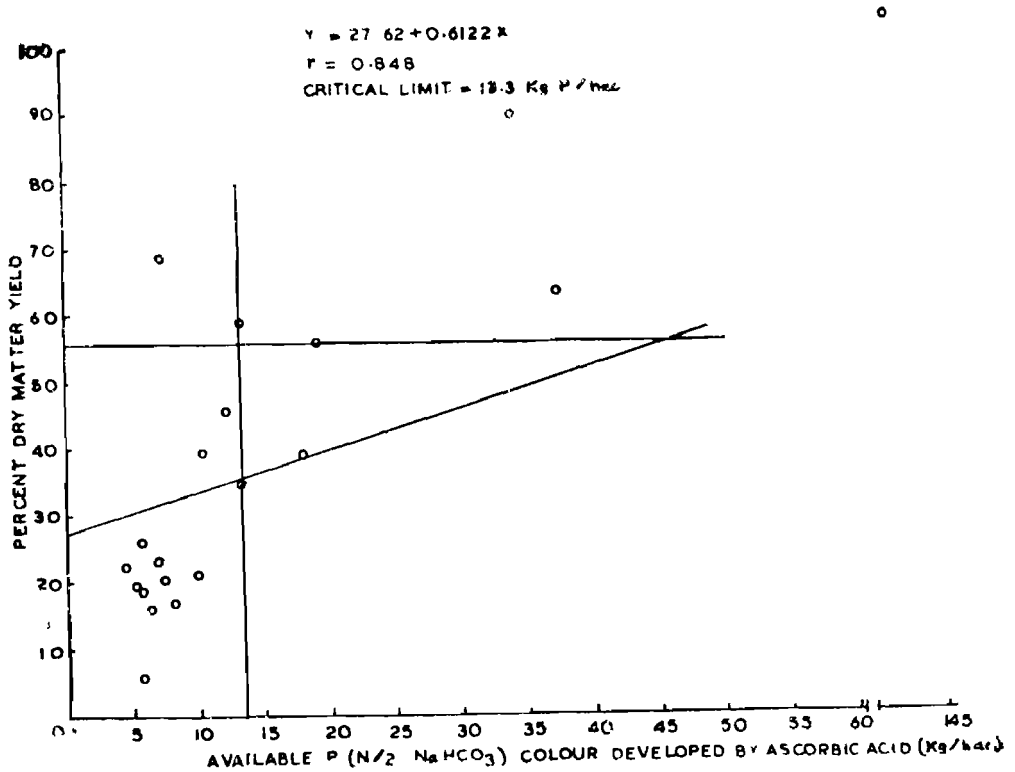


Fig. 1. Relationship between N/2 $NaHCO_3$ extractable P (colour developed by ascorbic acid) and per cent dry matter yield at first stage of growth.

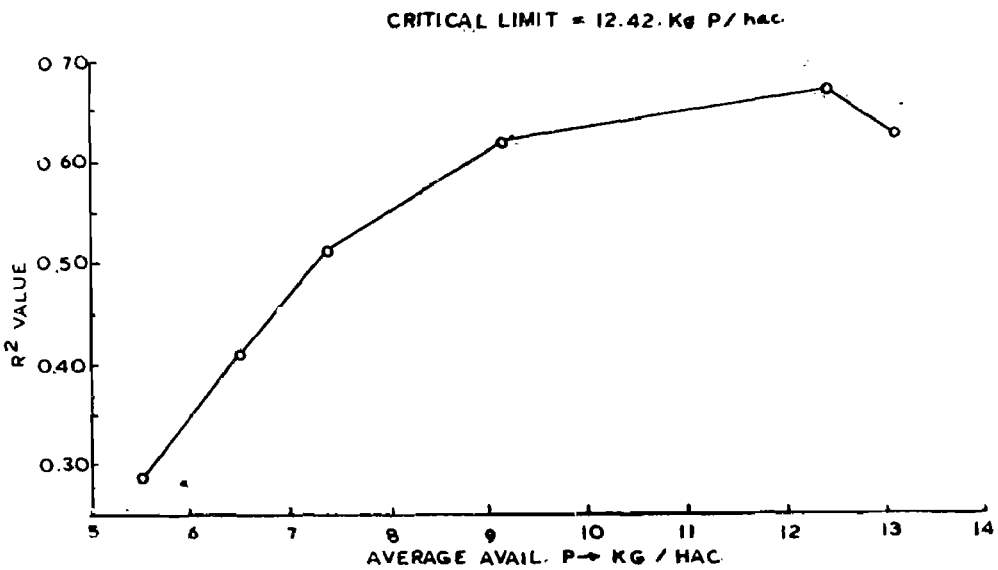


Fig. 2. Relationship between average available P of two groups and coefficient of determination (R^2— value) for the mean discontinuous model (mathematical model).

for sierozem soils of Haryana in wheat (K-227) crop. Khera and Datta (1969) found different critical limits of available-P for Delhi soils for different wheat varieties, i.e., 11.00 kg P/ha for MP wheat 823, 824 and between 30-45 kg P/ha for Sonora-64.

Attempts were also made to find out relationship between physico-chemical properties and soil test values by best methods (Table 5). The organic carbon gave highest correlation coefficient values with soil test values by different methods. The negative significant correlations bet-

TABLE 5

Correlation coefficient of soil test values by different methods with physico-chemical properties

Soil test values	O. C. (%)	pH (1 : 2)	E. C. (1 : 2)	C. E. C. (meq/100 gm)	Clay (%)
Colour developed by stanous chloride					
Olsen-P	0.735**	—0.656**	0.643**	—0.150**	—0.375
Bray-P	0.687**	—0.526*	0.492*	—0.574	—0.502
Colour developed by ascorbic acid					
$\frac{N}{2}$ $NaHCO_3$	0.758**	—0.445*	0.648**	0.333	0.574**
Bray-P	0.689**	—0.660**	0.481*	—0.729**	0.503*

*,**Significant at 1 and 5 per cent level, respectively.

ween pH and soil test values are well understood.

The above results conclude that N/2 $NaHCO_3$ (pH 8.5) colour developed by ascorbic acid (modified Olsen's P method) and Olsen's method are the best and most suitable for estimation of available-P in sierozem soils of Haryana. The four weeks old wheat crop is the best stage of sampling for predicting best method and 12.42-13.30 kg P/ha is the critical limit of available-P for wheat crop.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 79—86 (March 1983)

CROPPING PATTERNS IN AMBALA DISTRICT UNDER IRRIGATED AND RAINFED CONDITIONS

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(Received : March 7, 1981; Revised : January 11, 1982)

ABSTRACT

Existing cropping patterns in different assessment circles of Ambala district under irrigated and rainfed conditions were studied. Wheat was the first ranking crop in all the assessment circles and paddy, sugarcane and rabi fodder were second ranking crops in 5, 2 and 1 assessment circles, respectively, under irrigated conditions. Maize got first position in the cropping pattern of eight assessment circles and sugarcane, kharif fodder, wheat and gram appeared as a first rank crop in 1 assessment circle each under the rainfed conditions. Wheat was also an important crop under rainfed conditions as it achieved second position in 7 assessment circles.

The study of existing cropping patterns under irrigated and rainfed conditions is the outcome of prevailing physical, social and economic conditions. Land being a limited natural resource, there is a need for good land use planning and adoption of suitable cropping patterns with the available resources to increase the food production. The study of existing cropping patterns is of great significance to enable the efficient utilization of land, water and benefit from the natural resources. This study was carried out to know the existing cropping patterns of Ambala district (30°-3'-30" to 30°-37' N Lat. and 76°-31' to 77°-35' E Long.) at village level under irrigated and rainfed conditions.

MATERIAL AND METHODS

The study is based on the analysis of 116 villages, randomly selected, over the entire district of Ambala (Table 1) confining to the boundaries of 13 (Fig. 1) assessment circles (Jasbir Singh, 1976). Statistics of land use for two years, i. e., 1976-77 and 1977-78 were taken from the revenue record of the district and an average was made of two years after converting the statistics into percentage term.

RESULTS AND DISCUSSION

Land Utilization

The irrigated cultivated area is more in the assessment circles of Jagadhari and Ambala tehsils in comparison to the assessment circles of Kalka and Naraingarh tehsil. The regional variations in cultivated area under irrigated and rainfed conditions are presented in Table 2. All the land in Naili area of Kalka is under forest and is barren. This type of regional variations in the cultivated area

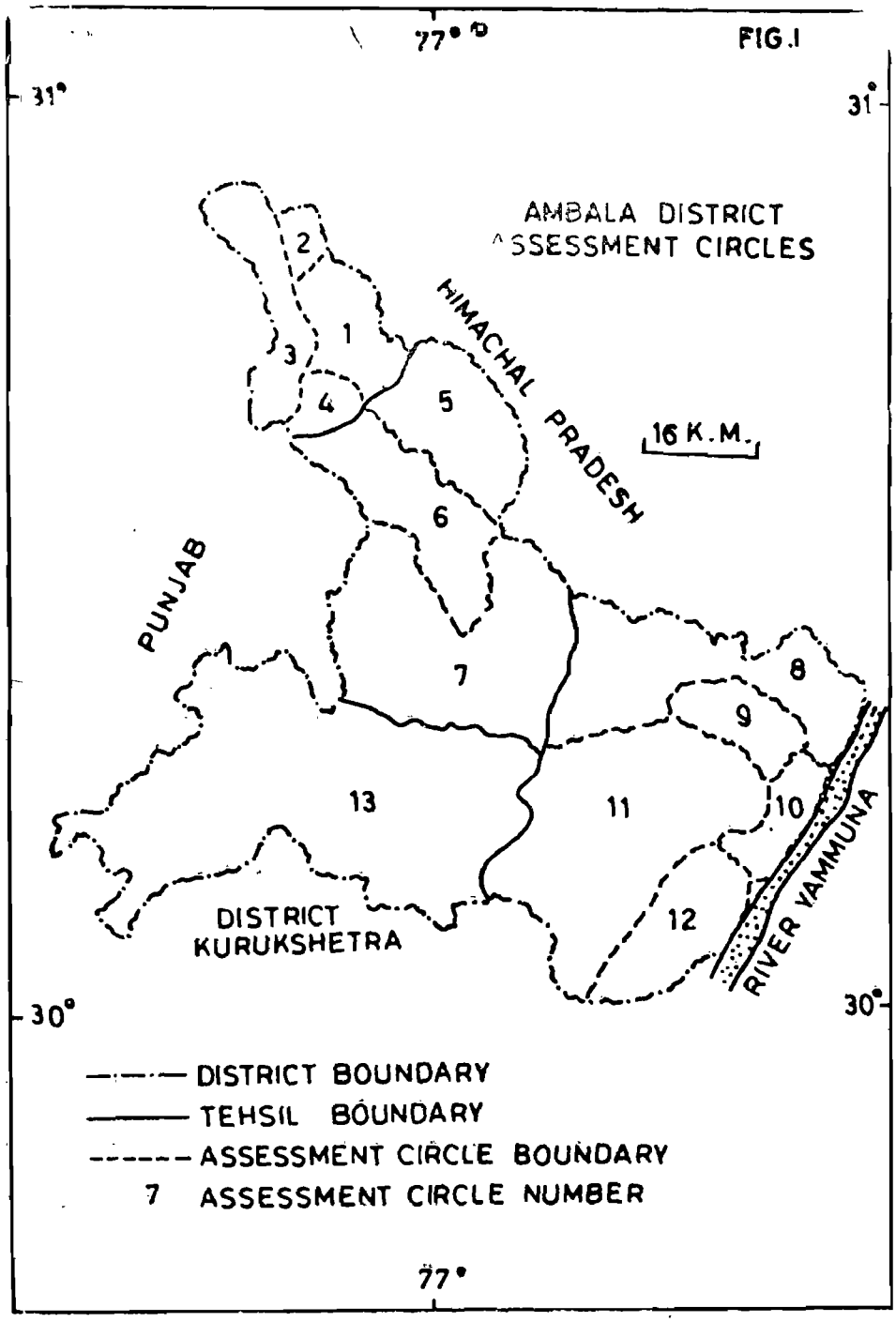

FIG.I
77°
31°
31°
AMBALA DISTRICT
ASSESSMENT CIRCLES
HIMACHAL PRADESH
16 K.M.
PUNJAB
1
2
3
4
5
6
7
8
9
10
11
12
13
DISTRICT
KURUKSHETRA
RIVER YAMMUNA
30°
30°
DISTRICT BOUNDARY
TEHSIL BOUNDARY
ASSESSMENT CIRCLE BOUNDARY
7 ASSESSMENT CIRCLE NUMBER
77°

TABLE 1

Selection of villages

Name of tehsil	Identification No.	Name of assessment circle	No. of total villages	No. of selected villages
Kalka	1	Pahar	9	1
	2	Naili[1]	20	2
	3	Seoty[2]	60	6
	4	Ghar[3]	65	7
Naraingarh	5	Pahar	13	1
	6	Ghar	109	11
	7	Seoty	212	21
Jagadhari	8	Kandi	67	6
	9	Khaddar Som[4]	93	7
	10	Khaddar Som Jamuna North	60	5
	11	Bhangar[5]	232	14
	12	Khaddar Jamuna South	41	3
	13	Ambala	325	32
Ambala district as a whole			1306	116

[1]Channel of the Ghaggar river, [2]Light loam, [3]Alluvial fan or the Piedmont plain, [4]New Alluvium, [5]Old Alluvium.

may be due to relief of the area which exercises a direct influence on land use, soil erosion and occurrence of floods in seasonal streams on low lands.

Cropping Pattern under Irrigated Conditions

Wheat was the dominating and first ranking crop followed by paddy in all the assessment circles* (Table 3) except in Bhangar and Khaddar Jamuna South where the area under sugarcane crop was more.

Wheat. It occupied 80% of the total cropped area in Ghar areas of Naraingarh tehsil and 70% in Seoty. Khaddar Som, Bhangar, Khaddar Jamuna North and Khaddar Jamuna South covered 57.2, 46.1, 38.0 and 47.0 per cent of the total cropped area, respectively. This crop accounts 52% of the total cropped area in Ambala tehsil and 60% in Seoty areas of Kalka tehsil.

Paddy. The second important crop was paddy as it covered 30.2% of the total cropped area in Ambala tehsil followed by 30.1% in Khaddar Jamuna North circle. Khaddar Som, Bhangar and Khaddar Jamuna South of Jagadhari tehsil and Seoty areas of Kalka and Naraingarh tehsils are other areas where paddy was grown.

Sugarcane. In Khaddar Jamuna South and Bhangar areas, it was second ranking crop in the cropping pattern as it covered 28.2 and 20.4 per cent of the total cropped area, respectively. Khaddar Jamuna North and Khaddar Som areas were also important for growing sugarcane crop.

*An assessment circle is a sub-division of a tehsil including the villages having the same land capability.

Other crops. **Rabi** fodder, **rabi** oilseeds and maize crops were also grown with some low percentage under irrigated conditions. **Rabi** oilseeds occupied 12.7% of the total cropped area in Khaddar Jamuna North, whereas maize crop covered 11.0% in Bhangar areas of Jagadhari tehsil.

Intensity of Cropping under Irrigated Conditions

Sugarcane cultivation that remains standing in a field during the whole year is one of the most important factor for influencing the intensity of cropping in the district. It is clear from Table 3 that in Khaddar Jamuna South area under sugarcane cultivation is more but on the other hand, the intensity of cropping is very low. Seoty circle of Kalka tehsil had 169.6% intensity of cropping followed by Khaddar Som (162.7%).

Cropping Patterns under Rainfed Conditions

Maize, paddy, **kharif** fodder, wheat and gram crops are important under rainfed conditions (Table 4).

Maize. This crop requires the annual rainfall over 750 mm with an optimum of about 750 mm during the period July to October and such favourable rains occur in Ambala district. Maize is the most important crop of Pahar areas of Kalka and Naraingarh tehsils where about 35% area was sown under this crop.

Paddy. The rainfall between 1250 and 1500 mm during the growing season is favourable for paddy crop. It occupied more than 10% of the total cropland in Seoty areas of Kalka, Pahar areas of Naraingarh, Khaddar Som and Bhangar of Jagadhari tehsil. In Ambala tehsil 9% of the total cropped area was devoted to paddy crop.

Kharif fodder. **Kharif** fodder accounted for more than 10% acreage in Pahar, Seoty and Ghar areas of Kalka, Khaddar Jamuna North and Bhangar areas of Jagadhari and Seoty of Naraingarh tehsil.

Wheat. It occupied more than 20% of the total cropped area in Pahar and Seoty areas of Kalka and also Pahar areas of Naraingarh tehsil. It covered 10 to 20% in Ghar areas of Kalka and Naraingarh tehsils, Seoty of Naraingarh, Kandi, Khaddar Som and Khaddar Jamuna South of Jagadhari tehsil and Ambala tehsil.

Gram. More than 20% of the total cropland was devoted to this crop in Ambala tehsil and Kandi areas of Jagadhari tehsil. The cropped area between 10 to 20% under gram crop was covered in Ghar and Seoty areas of Kalka and Naraingarh tehsil and Khaddar Som and Jagadhari tehsil.

Sugarcane. It is an important crop only in Jagadhari tehsil where 39.8, 15.5, 14.4 and 9.0 per cent of the total cropland was occupied in Khaddar Jamuna North, Khaddar Jumuna South, Bhangar and Khaddar Som, respectively.

Other crops. There are some crops such as bajra, **kharif** pulses, cotton, groundnut, **rabi** pulses and **rabi** fodder which may be considered as an important crop in one and two assessment circles.

TABLE 4

Cropping pattern (percentage of total cropped area) and intensity of cropping (per cent) under rainfed conditions

Tehsil	Assessment circle	Paddy	Bajra	Maize	Kharif pulses	Sugar-cane	Kharif vege-tables	Cotton	Gro-und nut	Kharif fodder	Wheat	Barley	Gram	Rabi pulses	Rabi vege-tables	Rabi oil-seeds	Rabi fodder	Intensi-ty of cropping
Kalka	Pahar	2.5	—	34.1	3.7	—	3.9	—	1.4	14.5	30.2	—	0.4	—	1.7	3.5	4.1	189.8
	Naili	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Seoty	10.3	—	16.0	1.2	1.5	0.5	1.0	8.5	11.0	20.0	10.8	14.7	4.7	3.4	4.1	2.3	145.6
	Ghar	5.3	—	27.5	10.4	1.2	1.1	—	2.8	10.2	18.8	1.3	17.2	1.4	0.4	1.4	—	130.5
Naraingarh	Pahar	13.7	—	35.1	6 7	1.1	1.0	—	—	—	32.7	4.1	0.8	1.8	—	2.7	0.1	129.6
	Ghar	6.8	4.5	20.4	1.2	2.4	—	0.2	8.8	9.8	16.0	0.1	18.8	7.4	—	2.8	0.2	138.9
	Seoty	8.3	1.6	19.4	2.3	3.6	0.5	1.2	7.1	15.3	16.0	1.1	14.7	4.0	0.5	1.9	2.0	148.2
Jagadhari	Kandi	9.4	12.2	14.5	2.3	—	—	0.5	2.7	7.4	19.9	0.5	22.3	2.4	—	2.0	2.1	134.4
	Khaddar Som	10.5	2.9	26.4	—	9.0	—	4.8	—	9.5	14.0	1.9	10.0	2.6	—	2.0	6.5	148.3
	Khaddar Jamuna (N)	6.4	0.4	16.2	—	39.8	—	—	—	11.5	9.3	0.7	4.0	1.4	1.0	4.2	5.1	136.6
	Bhangar	15.6	1.0	11.4	2.5	14.4	—	1.4	—	20.0	8.0	2.3	6.5	2.4	—	2.1	12.4	154.0
	Khaddar Jamuna (S)	7.4	3.9	20.0	0.4	15.5	—	4.4	1.8	9.0	16.5	2.1	6.7	2.4	2.3	2.0	4.4	149.4
Ambala	Ambala	9.0	1.3	22.6	0.5	2.8	0.4	0.6	0.2	8.8	13.7	1.7	21.3	10.8	0.2	4.6	1.2	145.2

Intensity of Cropping under Rainfed Conditions

The intensity of cropping was low in Ghar area of Kalka tehsil, Pahar and Ghar areas of Naraingarh tehsil and Khaddar Jamuna North of Jagadhari tehsil in comparison to district average, i. e., 144.2% under rainfed conditions. The intensity of cropping was highest (189.8%) in Pahar area of Kalka tehsil. The remaining assessment circles of the district may be grouped into the category comprising the areas of medium intensity.

CONCLUSIONS

Under irrigated conditions, wheat among **rabi** and paddy among **kharif** season crops were the predominate crops. Wheat covered more than 50% of the total cropped area in 5 assessment circles out of 8 circles in which this crop was grown (Table 3). Paddy crop accounted for more than 25% of the total cropland in Seoty, Khaddar Som, Khaddar Jamuna North and Ambala assessment circles under irrigated conditions. Maize, paddy and **kharif** fodder crops were important among **kharif** season and wheat and gram among **rabi** season crops with some regional variations in the district under rainfed conditions. Sugarcane was also significant crop under rainfed conditions particularly in the assessment circles of Jagadhari tehsil.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 87—97 (March 1983)

MINERALOGY OF FINE SAND FRACTION OF SOILS OF HARYANA

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(Received : March 12, 1981; Revised : July 30, 1981)

ABSTRACT

Mineralogical investigations on the fine sand fraction of the soils confirm the view that these are mainly derived from alluvium together with massifs of aeolian material on the top.

Quartz and muscovite constituted the main bulk of light minerals and the predominance of quartz was as high as 80% in soils from hot and semi-arid areas. Crenulated muscovite was next to quartz in abundance, because of its weathering resistance to the prevailing conditions. In soils of hot and humid areas there was a preponderance of plagioclase feldspars over the alkali feldspars.

Among heavy minerals which were around 2% of the total mineral content; biotite, epidote, chlorite, garnet, zircon, hornblende, tourmaline, kyanite, apatite, limonite and rutile were present. Chlorite was the dominant one but most of it seemed to be of detrital origin. The high percentage of muscovite accounted for the rich status of potash in these soils. Iron minerals were found well distributed in the form of hematite and limonite as coatings, cracks filling, globules and stains on various mineral grains.

In recent years, mineralogical investigations in soil science have been undertaken with increasing frequency, in most countries. In India alone, such a study has been made by several workers, like Raychaudhuri and Mukherjee (1942), Tamhane and Namjoshi (1959), Sinha and Mandal (1963), Roonwal *et al.* (1967) Singh and Gangwar (1971) and Pundeer *et al.* (1974) on different soils. This is because mineralogical investigations have proved of immense help in the practical exploration of soils of an area. Mineralogical analysis is of great use in characterizing the parent material, tracing the mode of soil formation, soil genesis and in evaluating both the soil potential fertility and present fertility status.

Both qualitative and still more the quantitative analysis of mineralogical composition of the fine sand fractions of the soils of Haryana have not received the proper attention. Hence, this study deals with the mineralogical investigations of the fine sand fraction of the soils of Haryana.

MATERIAL AND METHODS

General Description of the Area

Extent and location. The State of Haryana (Lat. 27°39′ to 30°5′N and Long.

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74°27.8' to 77°36.5'E) comprises a part of Indo-Gangetic plains. It has a total area of 44044 sq km.

Geology. The State mainly occupies the Indo-Gangetic water divide, formed by tectonic uplift during the Pleistocene which was a very important period in the geology of India. The main geological systems represented in the State of Haryana are : (i) Siwalik system—rocks are mainly sandstones, clays and boulders, ranging in age from middle Eocene to lower Pleistocene; (ii) Indo-Gangetic plain—these are formed by the deposition of alluvial sediments transported by the Himalayan rivers into the trough between the Himalaya in the North and the Deccan plateau in the south (Wadia, 1961). The alluvial deposits, ranging in age from Pleistocene to the recent times are of variable thickness, consists of silts and clays with occasional gravel beds; and (iii) Aravalli hills in the south-western parts of the State where geological elements of Aravalli Synclinorium are also exposed. The lithological units are mainly precambrian, quartzites, quartzitic sandstone, phyllites, micashists and crystalline limestone. The rocks are also traversed by basic dykes, intrusive pegmatites and quartz veins (Krishnan, 1968).

Physiography. Except some hills of the Siwalik system in the north and those of the Aravalli system in the south, Haryana State is a plain area having a height of 200 to 300 meters above mean sea level. Physiographically, the State is divided into six regions, viz. (i) the Siwalik hill tract, (ii) the dissected rolling plains in the foothills, (iii) the upland plains, (iv) the flood plains, (v) the plains with sand dunes, and (vi) plains with Aravalli hills (Fig. 1).

Climate. The State experiences a sub-tropical, semi-dry continental monsoonic climate with very hot summers and markedly cool winters. Normal annual rainfall varies from less than 300 mm in the south-western parts of the State to over 1250 mm in the hilly tract of the north-east. Duggal (1970) demarcated six different bio-climatic zones in Haryana, viz. (i) hot and semi-arid zone along the Rajasthan border with mean annual rainfall less than 300 mm, (ii) hot and dry zone in the south-west with mean annual rainfall between 300 to 500 mm, (iii) hot and semi-dry zone in the south-east with mean annual rainfall between 500 to 700 mm, (iv) hot and semi-dry east-central, (v) hot and sub-humid zone adjoining the hill with mean annual rainfall between 700 and 1000 mm, and (vi) hot and humid Siwalik with mean annual rainfall more than 1000 mm.

Collection and Preparation of Soil Samples

In all 14 soil profiles were exposed and sampled horizon-wise, representing various physiographic units under different rainfall zones in the State (Fig. 1).

The following six steps were involved in the preparation of a specimen, crushing, disaggregation, sizing, cleaning, separation and mounting. Crushing and disaggregation were achieved through mechanical analysis of soils by International pipette method (Piper, 1966) and fine sand fractions were separated from the bulk sand by the decantation process. Sizing was achieved by retaining grains

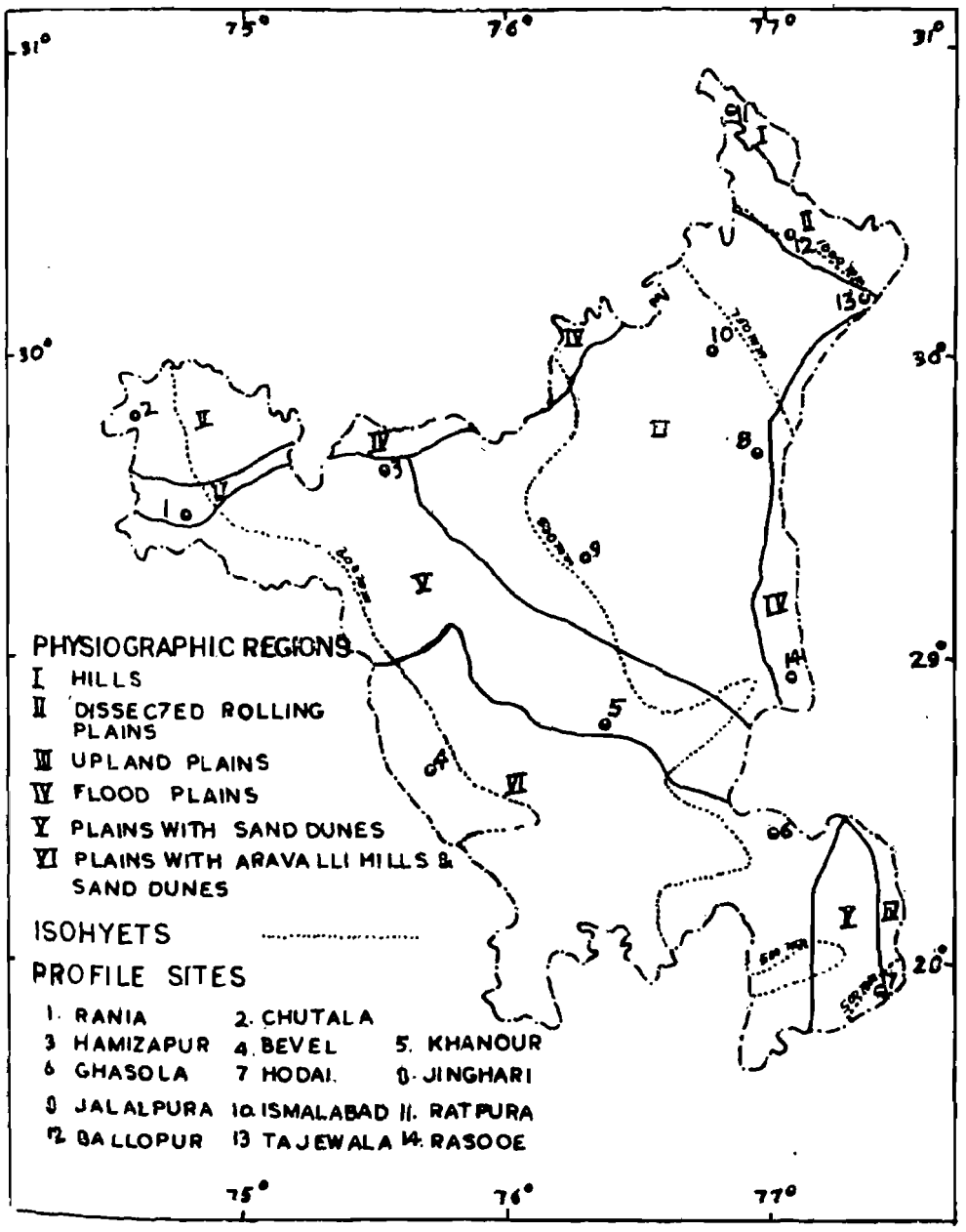


Fig. 1. Haryana State

only between 100 and 160 mesh. Any coating of ferruginous or other material from grains was removed by boiling them in 50% hydrochloric acid with added stanous chloride (Towenhofel and Taylor, 1941). Separation of grains into light and heavy minerals fractions was achieved through mineral concentration, using bromoform of specific gravity 2.85. The two fractions were washed separately in filter cones with acetone and then dried on hot plate. Permanent slides, in duplicate, were prepared using Canada Balsam and were studied under a polarizing microscope fitted with a mechanical stage for identification and counting of mineral grains (Tickell, 1965). As far as possible, the iron minerals were separated with the help of a powerful magnet.

RESULTS AND DISCUSSION

Description of Minerals

The character and properties of the different mineral population were strikingly akin in nature all over the State for they were laid down mainly by the fluviatile agency of Indo-Gangetic river system. Heterogenity was also noted as is very true with the whole of the alluvial plains, but in the western fringe of Haryana along Rajasthan border minerals showed marked wind abrasion and subsequent aeolian depositional effects. Minerals identified in these soils are described below with their important characteristics :

A. Light Minerals

(a) Quartz

Three different types were identified based upon angularity, types of inclusions and strain effects.

(i) Grains which were mostly subsequent, xenomorphic and of non-composite type, exhibiting generally straight extinction. These were either free from inclusions or showed irregular type of inclusions of sericite and apatite. It is obvious that these grains were derived from plutonic sources and might have been from granitic terrain.

(ii) Grains which were coarse, displaying undulose extinction as strain shadows. Some of these also exhibited crenellated borders and a large percentage of such grains were elongate. These were derived from dominantly metamorphic terrain (gneisses and schists).

(iii) Some of the quartz grains exhibited outgrowths and were better sorted. These are suggestive of a reworked cycle and a sedimentary provenance is evident.

However, all the three types of quartz grains showed recent irregular striations and displayed broken overgrowth edges. In addition, bigger grains were much better sorted and smaller ones were angular showing the latter to be of recent deposition. Pundeer *et al.* (1974) also observed three different types of quartz grains in flood plains soils of Punjab and related their inheritance to reworked deposits.

(b) Muscovite

Muscovite of different sizes with crenellated borders was noteworthy and indicated aqueous conditions prevailing in the past. However, because of its

recent movement by wind it showed some mechanical weathering. Muscovite occurred in colourless, thin parallel cleavage flakes.

(c) **Feldspars**

Among the light minerals identified, feldspars occupied an important place. The general scarcity of feldspars was due to their proneness to chemical weathering. However, because of low rainfall and dry conditions, chemical weathering may not be very significant in causing feldspars to undergo alteration to sericite through saussuritisation. This alteration was noticed more in samples from hot and sub-humid zone (Ballopur).

A dominance of potash feldspars over soda feldspar was also evident. Fine sand mineralogy revealed a predominance of orthoclase, microcline and perthite with only a low proportion of albite-oliogoclase. Moreover, microcline seemed to be fresher in comparison to orthoclase. In addition to this, the composition of samples from the hot and semi-arid zone (Rania, Chutala and Bevel) suggests that the source and parentage of most of the minerals is from a granite-gneiss terrain (on Rajasthan side) brought in through wind blown sand loss.

B. **Heavy Minerals**

The proportion of heavy mineral fraction was roughly about 2% of the bulk. A large part of the heavy mineral fraction was made up of opaque minerals. Heavy minerals observed are described below:

(a) **Amphiboles**

Hornblende was the predominant mineral and pleochroism was marked from palegreen to darkgreen. Tremolite and actinolite were also present in minor amounts. All of them exhibited alteration into chlorite, showing different stages of weathering.

(b) **Epidote**

Grains were of irregular and variable shapes. Some of the grains showed distinct lines of scar marks, these were not cleavages but marks seemed to be produced by abrasion and attrition during movement by wind.

(c) **Tourmaline**

Three different varieties were recognised, viz. (i) Blue, which occurred commonly as irregular, large fragments. This displayed weak pleochroism with shades of lavender or violet to grey. This variety pointed to pegmatite parentage. (ii) Straw yellow variety strongly pleochroic straw yellow to dark brown. Many grains were riddled with inclusions of bubbles and cavities indicating that they were derived from granite rocks. (iii) Dark greyish brown to black, non-pleochroic variety occurring as big irregular grains.

(d) **Zircon**

Two different types were identified, viz. (i) Doubly pyramidal, terminated, prismatic in outline and relatively small in size. Their embaded nature suggests that they were derived from acid igneous rocks. (ii) Very well rounded, large in size, some stumpy and globular. These seemed to be slightly frosted due to harsh abrasion and indicated more than one cycle of erosion, deposition first by fluvial action and then by wind.

(e) **Garnet**

Two types of garnet were observed. One was a colourless variety, generally riddled with inclusion in the central parts of the grain, and many of them were well rounded. The other was pinkish in colour and was by far the most preponderant type. A majority of grains was irregularly bounded by conchoidal fractures surfaces and slightly modified by abrasion suggesting aeolian origin. These grains indicated derivation from crystalline rocks, such as gneisses, schists and granulites.

(f) **Apatite**

These occurred commonly as very well rounded grains. The interference colours (under crosnicols) were first order grey or sometimes light blue.

(g) **Iron minerals**

Magnetite and limonite grains were sub-rounded to irregular in shape and were black and opaque with limonite altering into leucoxene. Limonite occurred as irregular grains and powdery aggregates. Hematite was observed as irregular earthy grains of a reddish brown shade under reflected light.

(h) **Sphene**

Grains were generally sub-rounded in shape and occurred sparingly. Its grains exhibited peculiar yellow, brown and ultra-blue interference colours, and strong dispression.

(i) **Kyanite**

Cleavage controlled rectangular grains, exhibiting two sets of cleavages. These grains were only slightly affected by abrasion and consequently were larger in size.

(j) **Staurolite**

Short prismatic grains, yellow in colour. Pleochroism from colourless to yellowish brown. Irregularly arranged inclusions of quartz were abundant. It was a common detrited mineral and its presence proved that the original rock was a sedimentary one.

Distribution of Minerals

In all the soil profiles, under investigations, quartz grains were most abundant constituting 50% or more of the bulk. With aridity and less precipitation its amount increased, as much as 80% of the bulk as shown in Table 1. Pundeer *et al.* (1974) also reported quartz as the most abundant constituent of all the profiles in the flood plain areas of Punjab. Muscovite was next to quartz in abundance because of its resistance to weathering under prevailing conditions. If there was any effect of weathering on these two minerals (quartz, muscovite), it was predominantly physical weathering. The high percentage of muscovite accounted for the high status of potash in these soils and for the abundance of imperfect hydrous mica or pedogenic illite type of clay a mineral which is invariably present in these soils (Sehgal, 1974).

Next in abundance were feldspars, but usually these decreased in percentage with depth in different soil profiles giving rise to sericite after saussuritization in variable degrees depending upon the bioclimatic zones. In most areas of the hot and semi-dry west central zone, which

TABLE 1

Mineralogical composition of the fine sand fraction expressed as per cent distribution of grains of various minerals

	Light minerals with specific gravity <2.85					Heavy minerals with specific gravity >2.85														
Depth (cm)	Quartz	Muscovite	Feldspars (Alkali)	Plagioclase feldspar	Saussuritised	Biotite	Tremolite+Actinolite	Hornblende	Chlorite	Zircon	Tourmaline	Apatite	Garnet	Hemalite+Limonite	Magnetite	Staurolite	Kyanite	Rutile	Epidote	Augite
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Hot and Semi-Arid Zone																				
Profile-1, Rania																				
0-9	68	18	2	3	T*	1	1	2	2	T	T	—	—	3	—	—	—	—	1	—
9-25	70	5	1	1	3	2	—	3	5	1	1	—	4	—	1	1	—	3	3	—
25-94	64	5	1	—	5	1	—	4	7	1	1	1	T	3	1	1	—	—	5	—
Profile-2, Chautala																				
0-10	65	20	1	11	T	1	—	2	3	T	T	—	2	—	1	—	—	2	2	—
10-76	58	16	3	2	2	2	1	4	4	T	T	T	1	3	—	1	—	—	3	—
76-110	69	10	2	1	4	—	—	—	5	T	T	T	1	2	—	—	—	—	5	—
110-160	62	8	1	—	6	—	—	3	9	T	T	T	1	3	1	—	—	—	5	—
Profile-4, Bevel																				
0-18	70	20	2	—	1	11	1	1	—	T	T	T	—	1	1	1	—	—	1	—
18-74	68	9	2	1	2	1	2	3	3	T	1	1	—	2	1	1	1	—	2	—
74-110	65	10	—	—	4	—	—	—	4	1	2	1	—	3	1	—	—	—	3	—
110-180	67	8	1	5	5	2	—	3	6	1	2	1	1	—	2	—	—	T	4	—

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Hot and Dry South-Western Zone																				
Profile-3, Hamizapur																				
0-15	60	25	1	1	—	—	1	2	1	1	1	—	—	2	1	—	—	—	1	—
15-35	62	17	2	—	3	1	1	1	3	1	1	1	1	3	1	—	—	—	2	—
35-98	70	10	—	—	4	1	—	2	5	1	1	1	1	4	—	—	—	—	—	—
Profile-5, Khanpur																				
0-14	60	12	3	2	4	2	3	2	3	—	—	—	—	2	—	—	—	—	1	—
14-32	60	5	3	6	3	4	4	5	T	T	T	T	3	—	1	1	1	—	2	—
32-70	61	T	2	1	8	1	—	3	8	1	2	1	1	4	1	1	1	T	3	1
70-120	62	T	1	—	9	—	—	3	10	2	2	1	1	5	—	—	—	—	5	—
120-170	61	T	—	—	10	—	—	2	10	3	3	1	—	6	—	—	—	—	5	—
Hot and Semi-dry South-Eastern Zone																				
Profile-6, Ghasola																				
0-15	75	10	2	3	2	—	1	1	1	—	—	1	—	1	1	1	—	—	—	—
15-33	72	10	2	2	4	1	1	2	1	T	1	1	—	2	1	—	—	—	—	—
33-80	75	6	1	—	6	1	—	1	3	1	2	1	1	3	1	—	—	—	—	—
80-170	68	5	1	—	8	1	—	1	3	2	2	1	1	4	1	—	—	T	2	—
Profile-7, Hodel																				
0-18	80	10	3	2	1	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—
18-50	76	10	2	1	2	1	1	1	2	—	1	1	—	2	—	—	—	—	—	—
50-76	75	5	1	—	4	1	—	2	3	1	1	1	1	3	1	—	—	—	1	—
76-100	73	4	1	—	6	1	—	—	2	1	1	1	1	4	2	1	—	—	2	—
Profile-14, Rasooe																				
0-20	54	8	8	6	3	—	5	4	3	2	1	1	—	—	2	—	1	—	1	1
20-90	53	8	8	7	3	—	7	3	2	2	1	2	—	—	2	—	—	—	2	—
90-135	55	4	4	2	8	—	6	—	6	2	1	2	1	1	3	—	—	—	3	—

Hot and Semi-dry West-Central Zone																				
Profile-8, Jinghari																				
0-15	50	21	2	9	5	—	—	1	2	—	—	—	—	1	1	—	—	—	—	2
15-27	50	18	6	6	8	1	1	2	2	—	1	1	—	2	1	—	—	—	—	—
27-68	53	15	—	—	18	1	—	3	3	—	1	1	—	2	1	—	—	—	—	—
68-153	55	13	1	—	20	—	—	2	4	1	1	—	—	2	1	—	—	—	—	—
Profile-9, Jalalpura																				
0-20	50	20	4	13	3	2	1	1	—	—	—	—	—	2	1	1	—	—	2	—
20-42	50	12	2	3	16	3	—	1	3	1	1	1	—	2	1	—	—	—	3	—
42-110	50	10	1	—	18	—	—	2	5	1	2	1	1	3	2	—	—	—	4	—
Profile-10, Ismalabad																				
0-22	55	15	4	12	4	2	1	1	1	—	—	—	2	1	—	—	—	—	—	2
22-85	53	12	1	3	15	2	2	2	2	—	1	—	3	1	—	—	—	—	3	—
85-110	50	7	1	—	18	1	—	2	3	1	2	—	3	1	—	—	—	—	5	—
Hot and Sub-humid Zone Adjoining Hills																				
Profile-12, Ballopur																				
0-15	69	15	2	3	12	1	—	—	1	—	—	—	—	2	1	—	—	—	—	—
15-60	61	12	1	1	15	1	—	—	3	1	1	—	—	3	1	—	—	—	—	—
60-105	64	13	1	2	10	1	—	—	3	1	—	—	—	3	2	—	—	—	—	—
Profile-13, Tajewala																				
0-58	49	18	3	10	14	1	1	1	1	—	—	—	—	2	1	—	—	—	—	—
Hot and Humid Siwalik Zone																				
Profile-11, Ratpura																				
0-22	50	19	12	4	11	1	1	1	—	—	—	—	—	1	—	—	—	—	—	—
22-85	52	15	7	2	13	2	—	—	3	T	T	T	—	2	1	1	1	1	—	—
85-156	50	7	1	1	15	3	—	—	5	1	1	1	—	3	2	—	2	2	4	—

*T = Traces.

lie in a depressed basin type of physiographic area, with poor drainage conditions, are places whose Na^+ and Ca^{++} ions are brought in solution to the surface and develop salinity and alkalinity of harmful concentrations to the plants.

Most of the ferro-magnesian minerals like tremolite, actinolite, hornblende, etc., have altered to give rise to chlorite and epidote. But chloritization and epidotization were noticed to be variable in degree depending upon the availability of Ca^{++} from anorthite molecules. The present study showed that the preponderance of these minerals is not to be attributed to their formation **in situ** except to a very small degree for these minerals are present in quite high amount in the Siwaliks (Wadia, 1961) and have been transported and deposited in the plains through fluviatile agencies. With the distance from the source area the mineral grains disintegrated into smaller and smaller pieces, ultimately into clay size. For that reason minerals in the clay are primary chlorite and illite, a hydrous mica (Kanwar, 1959; Sehgal and Coninck, 1971).

The more resistant heavy minerals like tourmaline, zircon and garnet were mostly authigenic in nature. Tourmaline, especially, was in sufficient amount to give rise to boron toxicity in most of these soils. Grewal *et al.* (1959) reported high amounts of boron in these soils.

Apatite was found selectively distributed especially in the hot and semi-arid areas which have a granite terrain with pegmatite vein as their provenance. In hot sub-humid and hot humid areas of the State, a few of the stress minerals like kyanite, staurolite, etc., were found and were derived from a metamorphic terrain subjected to tectonic disturbances.

The differences in percentage of various minerals found are mainly due to two reasons :

I. Because of different climatic conditions (variation of temperature and rainfall).

II. In recent times, considerable aeolian deposition has taken place through the stormy winds originating from the adjoining Thar deserts especially in the western fringe of Haryana. It has been observed that wherever these drift soils are found impregnated with the Indo-Gangetic alluvium, these are minerals belonging to a granite or parametamorphic terrain. If these are not present, the Indo-Gangetic alluvium is found to contain minerals of a second cycle of sedimentation having in its composition abundance of secondary minerals.

The Siwaliks are the main provenance for the alluvium of this State as the mineralogical investigations of the fine sand fractions of these soils confirm the view that they are mainly derived from alluvium with additional masses of aeolian material typified by abrasion effects on various mineral grains.

The relative low status of these soils in easily weatherable minerals accounts for their poor inherent fertility status.

ACKNOWLEDGEMENT

The first author (MSK) is thankful to the Indian Council of Agricultural Res

earch, New Delhi, for providing financial assistance in the form of a Senior Research Fellowship to conduct this piece of research work.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 98—102 (March 1983)

EFFECT OF YELLOW MOSAIC ON GROWTH COMPONENTS AND YIELD OF MUNGBEAN AND URDBEAN

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(Received : April 10, 1981; Revised : April 5, 1982)

ABSTRACT

Screening of varieties of mungbean and urdbean against yellow mosaic disease under natural conditions of infection in the field and after artificial inoculation in the glasshouse was done at Hissar. Yellow mosaic disease reduced height upto 38.2%, fresh weight of shoot upto 28.5%, loss in yield per plant upto 66.6%, loss in 1000-seed weight upto 25.7 per cent. Shape, size and appearance of pods and seeds of diseased plants were also considerably distorted. However, the germinability of seeds was apparently unaffected due to yellow mosaic.

Mungbean yellow mosaic is a major disease limiting the exploitation of mungbean and urdbean yield potential in India. Ever since its occurrence was first reported (Nariani, 1960), this disease has been found wide spread in Northern India (Williams *et al.*, 1968; Nene, 1972; Varma *et al.*, 1973; Raychaudhari, 1977; Raychaudhari *et al.*, 1977; Singh *et al.*, 1979). The loss in yields is reported to vary from 10 to 100% (Nair and Nene, 1974). Viewing the seriousness of the problem some selected varieties/germplasm lines were screened under natural condition of infection in the field and after artificial inoculation in the glasshouse at Hissar (Haryana), and the effect of the disease on growth components and yield of plants was investigated.

MATERIAL AND METHODS

Based on earlier investigations (Varma, 1976), 29 varieties of mungbean and 33 varieties of urdbean were grown in the field and in the glasshouse in **Kharif** season of 1977-78 at Haryana Agricultural University, Hissar. Field sowing was done according to package and practice recommendation for mung/urd cultivation in Haryana. Glasshouse sowing was done in 1×1 m beds covered on all sides with one meter high muslin cloth. In each bed a couple of yellow mosaic infected young plants were transplanted from the field at the time of sowing. About 20 days after sowing when trifoliate leaves emerged, 10 plants were left in each bed. At the same time about 200 viruliferous (fed for 24 hours on infected plants) whiteflies were released in each bed. For each observation the beds were replicated three times.

Resistance/susceptibility of a given variety was determined as described earlier (Varma *et al.*, 1980). For determination of height of plants, fresh and

dry weight of shoot and root, 10 plants were selected at random. Yields per healthy and deseased plant were determined by picking all pods of each plant under observation. Weight of 1000-grains from the produce of each selected variety of healthy and yellow mosaic infected plants was taken. The shape, size and appearance of pods and seeds were recorded. To determine the effect of yellow mosaic on germinability of seeds, 100 seeds separately from healthy and yellow mosaic infected plants were kept for germination on moist filter paper in petriplates at 30°C in an incubator. Same number of seeds of each variety were also sown in 12" diameter clay pots keeping 10 seeds per pot, in the greenhouse. Ten days after sowing, the germinated seedlings were counted and per cent germination was calculated.

RESULTS AND DISCUSSION

Field and glasshouse screening of 29 varieties of mungbean and 33 varieties of urdbean to yellow mosaic indicated that two varieties of urdbean (UPU-1 and H76-14) and none of mungbean were highly resistant. One variety of urdbean (Pant U-30) and two varieties of mungbean (ML-9, L-24-2) were resistant. Rest of the varieties were found moderately resistant, moderately susceptible and susceptible.

Growth components, i.e., height, fresh weight and dry weight of shoots and roots, shape, size and colour of pods and seeds and yield per plant were determined using 2 varieties from each of five categories (Tables 1 and 2). There was reduction 9.6 to 38.2% in height, 7 to 28.5% in fresh weight of shoot and 4.3 to 22.1% in dry weight of shoot in diseased plants when determined at 50 days after sowing in moderately resistant, moderately susceptible and susceptible varieties of both mungbean and urdbean. There was significant loss in yield per plant in moderately susceptible and susceptible varieties and no loss was found in highly resistant varieties since the disease did not appear in them during the years under observation till 50 days after sowing (Tables 1 and 2).

Remarkable differences were found in shape and appearance of pods and seeds of resistant and susceptible varieties of mungbean and urdbean due to yellow mosaic disease. In susceptible varieties, the pods malformed, reduced in size and curved. Seeds shrivelled, reduced in size and became dull/yellowish. There was no significant difference in germinability of seeds collected from healthy and yellow mosaic infected plants of both mungbean and urdbean varieties/germplasm lines.

Earlier, at Pantnagar (Nene, 1972) UPU-1, UPU-2 and DG-7 varieties of urdbean were identified as resistant to yellow mosaic virus. Ahmad and Harwood (1973) from Pakistan reported partial resistance to yellow mosaic virus in some urdbean lines. Dharam Singh and Patel (1974) reported that yellow mosaic tolerance in variety L-24-2 was governed by a single recessive gene. The gene controlling disease reaction, seed colour and maturity were independently inherited and freely combined. Pandya *et al.* (1977) screened 248 lines of mungbean under natural infection of yellow mosaic virus in field and only one (Tarai local) was resistant, 21 were

TABLE 1

Effect of yellow mosaic on growth components of some field resistant and susceptible varieties of mungbean

Varieties	Per cent reduction in height (cm)	Per cent loss in fresh wt. of shoot (g)	Per cent loss in dry wt. of shoot (g)	Per cent loss in fresh wt. of root (g)	Per cent loss in dry wt. of root (g)	Per cent loss in yield/plant (g)	Per cent loss in 1000-seed wt. (g)
Highly resistant							
ML-9	Nil	Nil	Nil	Nil	Nil	Nil	Nil
T-51	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Resistant							
L-24-2	Nil	Nil	Nil	Nil	Nil	Nil	Nil
LM-87	Nil	Nil	Nil	Nil	Nil	4.7	2.2
Moderately resistant							
SSM-1	15.6	8.6	5.7	3.5	2.2	9.7	5.9
Mung-Russian	13.8	7.9	4.3	2.7	1.6	8.9	6.5
Moderately susceptible							
J-45	26.1	14.8	16.9	4.8	4.7	22.2	21.9
G-65	31.6	13.1	14.6	2.1	2.3	15.1	18.3
Susceptible							
Varsha	34.8	17.0	14.8	9.0	5.8	39.4	25.6
J-781	36.0	15.7	18.3	5.8	7.1	36.7	23.8

TABLE 2

Effect of yellow mosaic on growth components of some field resistant and susceptible varieties of urdbean

Varieties	Per cent reduction in height (cm)	Per cent loss in fresh wt. of shoot (g)	Per cent loss in dry wt. of shoot (g)	Per cent loss in fresh wt. of root (g)	Per cent loss in dry wt. of root (g)	Per cent loss in yield/plant (g)	Per cent loss in 1000-seed wt. (g)
Highly resistant							
H 76-14	Nil	Nil	Nil	Nil	Nil	Nil	Nil
UPU-1	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Resistant							
Pant U-26	Nil	Nil	Nil	Nil	Nil	1.5	Nil
K-10	Nil	Nil	Nil	Nil	Nil	2.4	1.3
Moderately resistant							
Pant U-19	10.5	8.5	6.8	2.4	4 3	12.6	8.7
Pusa-1	9.6	7.0	4.7	2.2	3.8	10.7	6.8
Moderately susceptible							
H 76-16	27.2	23.0	11.6	2.5	8.6	19.6	11.60
T-9	31.3	24.2	9.0	3.5	12.5	19.3	13.40
Susceptible							
Krishna	36.3	26.5	19.0	10.5	17.6	66.6	25.70
PLS-364	38.2	28.5	22.1	13.0	13.2	42.83	28.8

moderately resistant and the rest were susceptible.

There was much reduction in height, fresh and dry weights of shoots of susceptible varieties after yellow mosaic infection, but there was practically no effect on fresh and dry weight of roots. Nene (1972) reported that yellow mosaic infected plants drastically reduced in size if they were infected at young age. Suteri and Srivastava (1979) reported that in soybean, disease (bean yellow mosaic virus ?) reduced the height from 12 to 45 per cent. They also reported that total weight was reduced because of restricted growth, fewer branches and smaller leaves.

Maximum loss in yield (66.6%) per plant was in highly susceptible urdbean variety 'Krishna' when the plants got infected after 22 days of sowing. Loss in yield might be more if the plant got infected earlier than 22 days after sowing. Nair (1971) reported that yield losses varied from 10-100 per cent. Variation in yield in different varieties after virus infection and due to infection at different stages of growth at different locations is known in many cases. For example, Thongmeerakom *et al.* (1978) found significant reduction in yield when soybean plants were mechanically inoculated with cowpea mosaic virus at primary leaf stage than at mid bloom stage. The yield of *Trigonella coerulea* was reduced by 31% when the plants were inoculated with bean yellow mosaic virus (BYMV) at the beginning of flowering stage (Balszczak and Weber, 1978).

Remarkable differences were found in shape and size of pods and seeds in diseased plants of susceptible varieties/ germplasm lines of mungbean and urdbean. Nene (1972) also observed that the pods of PLS-364 variety of urdbean and J-781 variety of mungbean reduced in size and curled and seeds shrivelled, reduced in size and became yellowish. There was no effect of yellow mosaic on germinability of seeds of any variety of mungbean and urdbean. Yellow mosaic virus is not transmitted through seed (Nariani, 1960; Nair and Nene, 1973) and this may be a reason that there is no effect on germinability of seeds due to yellow mosaic disease.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 103—111 (March 1983)

GURGAON CANAL PROJECT AREA, GURGAON, HARYANA : I. IMPORTANT SOILS, THEIR NATURE, DISTRIBUTION AND EXTENT

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(Received : April 16, 1981; Revised : November 10, 1981)

ABSTRACT

From a reconnaissance soil survey conducted in the Gurgaon Canal Project Area, five important soil series representing brown to yellowish brown coarse textured (sandy to loamy sand) soils on dune tops and slopes of Mandkola series (834.70 sq km, i.e. 58.60% of the total area); dark yellowish brown to brown sandy loam, very deep soils on old higher alluvial plains of Gulha series (160.32 sq km, i.e. 11.35% of the total area); strongly saline-alkali sandy loam soils of brown to yellowish brown and light brownish gray colour distributed along the banks of main canal and its distributaries of Bidhwaka series (26.28 sq km, i.e. 1.85% of the total area); medium to heavy-textured (loam to clay loam) poorly drained soils characterized by the presence of mottles, and Fe and Mn concretions in the sub-soil, formed on lower alluvial plains of Piproli series (287.96 sq km, i.e. 20.21% of the total area); and dark grayish brown to dark gray heavy-textured (clay loam) very poorly drained soils in depressions and basins of Ujina series (105.56 sq km, i.e. 7.41% of the total area) have been identified, described and mapped.

Soil surveys are of great use in planning agricultural development and other related projects of land reclamation, as they are the only source of basic information on soils and other natural resources in a project area. From one such survey conducted in the project area of Gurgaon canal, it has been possible first to identify, describe and map important soils in the area and then to make recommendations in respect of their proper management and land use.

MATERIAL AND METHODS

Description of the Project Area

Location and extent. Gurgaon Canal Project Area located in the south-eastern part of the erstwhile district of Gurgaon in Haryana State, between the parallel of N latitudes 27° 49' 25" and 28° 20' 50" and E longitudes 77° 00' 25" and 77° 32' 25", had a land area of 1424.54 sq km. The total gross command area of the canal is spread over 376 villages in five tehsils of Gurgaon, Palwal, Ballabgarh, Ferozpur Jhirka and Nuh (Fig. 1).

Geology and physiography. The eastern most margin of the area is bordered by Yamuna river's flood plain. On the western side, the Aravalli hills are extended from SSW to NNE direction into Delhi region. The Aravalli hills are composed of Delhi quartzites, slates, phyllites, etc.

Phyllites are occupying the lower grounds covered by the Indo-Gangetic alluvium. Between the eastern Yamuna flood plains and western quartzite ridges, a vast stretch of land, more or less plain with few depressions, is covered by aeolian sand, giving rise to sheet cover underlain by alluvium. Isolated sand dunes extensions from SW to NE direction are there, but at present the area is more or less a monotonous undulating plain.

Slope and drainage. The general slope of the area is from north-west to north-east. Due to these reverse slopes and poor surface drainage the run-off water accumulates into natural depressions which assume the shape of lakes. There are four such main lakes viz., Ujina, Khalipur, Chandri and Kotla. The drainage in the area is of complex nature due to peculiar characteristics of topography.

Rainfall and temperature. The area comes under hot and semi-arid zone where about 280 days in a year are dry. The mean annual rainfall in the area is 576.4 mm out of which 57.5% is received during the two months of July and August. Some rain is also received during winter from north-westernly winds and make vital contribution to the success of rabi crops. Hot dry dusty winds are also common during summer months. The average annual evaporation is of the order of 2540 mm.

Natural vegetation and land-use. The natural vegetation in the area consists of trees like Janti (*Prosopis spicigera*), Kikar (*Acacia arabica*), Beri (*Zizyphus nummularia*) and Jaal (*Salvadora oleoides*); Bhang (*Cannabis sativa*), Sarkanda (*Saccharum ravennae*) and Kair (*Capparis decidua*) are some of the important shrubs while Bathu (*Chenopodium album*), Satyanasi (*Argemone mexicana*), Pholi (*Carthamus oxycantha*) and Dub (*Cynodon dactylon*) are some of the weeds and grass in the area.

At present, out of 1.42 lacs hectares of the project area, 1.10 lacs hactares are under plow. **Bajra** is the main **kharif** crop with an area of 26270 hectares, whereas wheat, gram, barley and sarson are the major **rabi** crops.

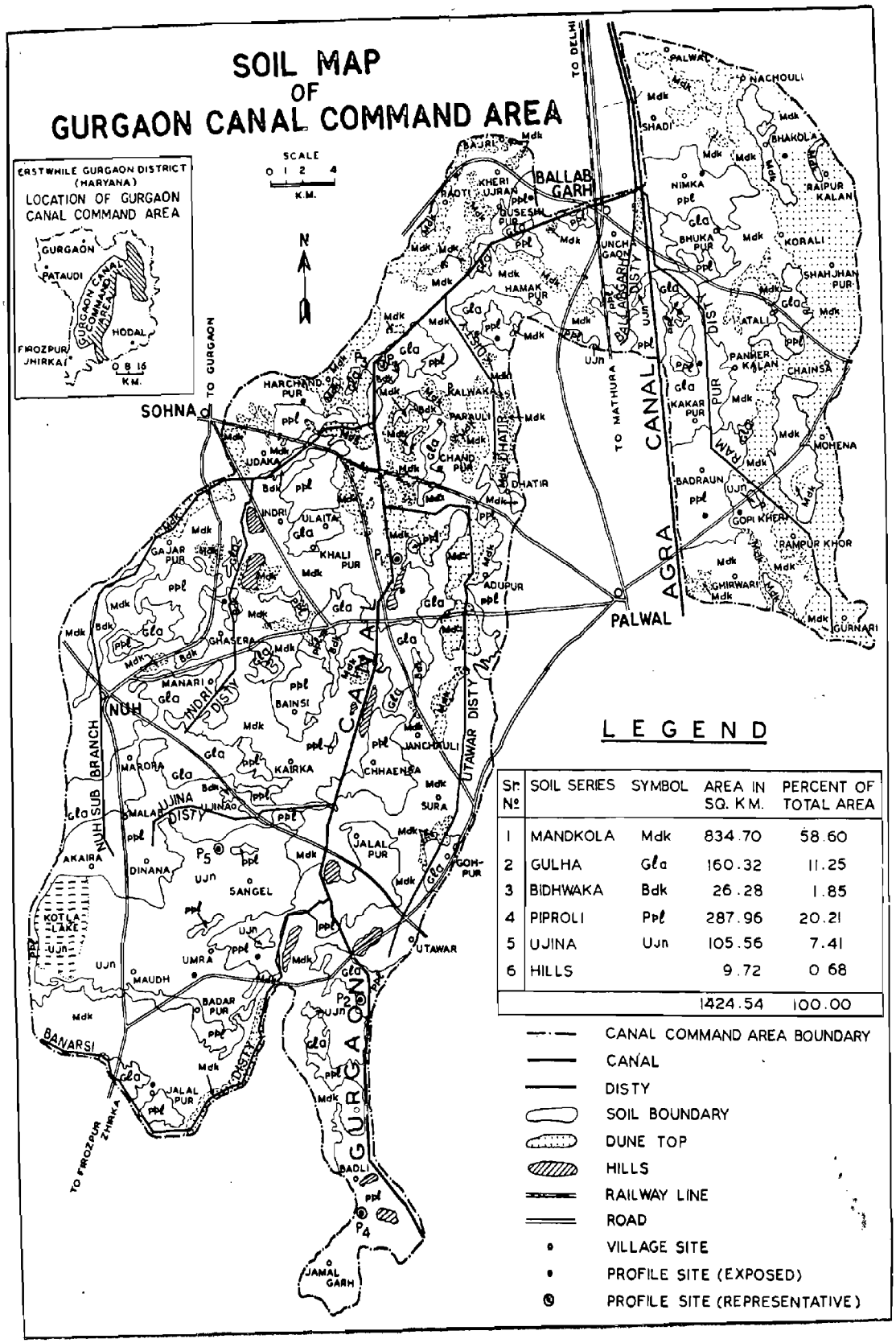
Reconnaissance soil survey, using contour sheets 4" to 1 mile as base maps, was conducted. Soil boundaries were delineated on the basis of systematic traversing over the area, taking auger observations at regular intervals of 1 km and making profiles examination at 8 to 10 km apart. The relationship found to be existing between physiography and soil type in the area was also used for delineating the soil boundaries.

Representative air dry fine earth samples from five most typical one pedons of the soil series were employed for analysis of particle size distribution by international pipette method as described by Piper (1950), pH by using Beckman glass electrode pH meter (Jackson, 1967), organic carbon (Walkley and Black wet digestion-Jackson, 1967), available P (Olsen *et al.*, 1954) and available K by turbidimetric method (Datta *et al.*, 1966). The method described in USDA (1951) Soil Survey Manual was followed for describing soil profile morphology.

RESULTS AND DISCUSSION

Description of the Soils Identified

During the course of reconnaissance soil survey of Gurgaon Canal Project Area



LEGEND

Sr. No	SOIL SERIES	SYMBOL	AREA IN SQ. K.M.	PERCENT OF TOTAL AREA
1	MANDKOLA	Mdk	834.70	58.60
2	GULHA	Gla	160.32	11.25
3	BIDHWAKA	Bdk	26.28	1.85
4	PIPROLI	Ppl	287.96	20.21
5	UJINA	Ujn	105.56	7.41
6	HILLS		9.72	0.68
			1424.54	100.00

- CANAL COMMAND AREA BOUNDARY
- CANAL
- DISTY
- SOIL BOUNDARY
- DUNE TOP
- HILLS
- RAILWAY LINE
- ROAD
- VILLAGE SITE
- PROFILE SITE (EXPOSED)
- PROFILE SITE (REPRESENTATIVE)

TABLE 1

Analytical data of the soil series identified in the Gurgaon Canal Project Area

Series	Depth (cm)	pH (1 : 2)	E. C (1 : 2) (mmhos/cm)	Mechanical composition (%)			CEC me/100 g soil	ESP	O. C. (%)	$CaCO_3$ (%)	Av. P_2O_5 lbs./acre	Av. K_2O lbs /acre	Hydraulic conductivity (cm/h)
				Clay	Silt	Sand							
Mandkola	0-20	8.5	0.36	6.8	4.2	89.0	5.02	11.16	0.15	Nil	20.76	187.60	1.00
	20-52	8.4	0.31	6 6	6.4	87.0	4.54	10.13	0.16	Nil	20.70	168.91	1.54
	52-76	8.4	0.26	8.0	6.1	85.9	5.74	15.73	0.04	Nil	19.31	131.38	1.61
	76-125	8.5	0.28	7.1	5.7	87.2	5.02	16.30	0.13	Nil	10.48	131.38	1.50
Gulha	0-20	8.3	0.14	12.2	13.6	72.2	6.09	3.28	0.20	Nil	22.98	197.06	0.39
	20-60	7 1	0.13	15.0	19.4	65.6	7.72	3.27	0.10	Nil	25.80	180.17	0.37
	60-98	7.1	0.12	13.1	18.0	68.9	8.83	2.27	0.15	Nil	15.65	152.02	0.38
	98-124	7.3	0.12	15.8	17 6	66.6	8.29	2.41	0.13	Nil	22.31	152.02	0.52
	124-180	8.0	0 21	14.8	17.4	67.8	7.09	2.12	0.09	Nil	22.98	164.22	0.45
Bidhwaka	0-29	10.6	9 72	13.6	5.4	79.8	7.24	44.20	0.16	1.2	35.26	281.45	0.32
	29-84	10.5	0.85	18.6	8.8	66.4	9.77	12.69	0.05	1.0	14.96	187.60	0.20
	84-103	10 5	0.92	16.0	16.0	71.5	9.17	39.80	0.09	1.5	22.98	281.52	0.22
	103-150	10.2	0.75	15.2	8 3	63.1	9.52	9.80	0.07	12.9	18.32	225.21	0.25
Piproli	0-18	7.7	0.26	13 8	40.4	45.8	7.78	3.24	0.30	Nil	36.64	316.24	0.72
	18-55	8.2	0.27	21.8	39.8	38.4	10.54	7.96	0.17	Nil	32.98	354.33	0.65
	55-85	8.3	0.26	24.0	41.0	35.0	11.64	6.94	0.14	Nil	38.62	288.09	0.51
	85-100	8.5	0.26	25.4	43.4	31.2	11.31	5 78	0.14	Nil	32.98	290.00	0.58
	100-158	8 1	0.26	28.0	43.4	28.6	13.78	5.09	0.13	Nil	32.98	275.95	0.50
Ujina	0-22	9.2	0.67	42.5	26.4	30.0	20.77	16.71	0.45	Nil	32.98	638.11	0.11
	22-53	9.1	0.75	52.2	25.6	20.5	24.57	17.38	0.37	Nil	24.68	807.02	0.27
	53-104	9.1	0.75	56 6	21 0	20 9	25.94	20.70	0.36	Nil	21.98	788.25	0.18
	104-126	9.1	0 97	56.9	22.6	16.8	24.84	18.00	0.24	Nil	21.98	788.25	0.18
	126-165	9 0	0.81	28.3	31.7	17.9	12.74	15.41	0.18	Nil	32.98	281.52	0.20

26 profiles were examined and five important soil series recognised, described and mapped (Fig. 1). Each series differed from other in certain morphological and other physico-chemical characteristics. These characteristics also control the suitability of the soils for different crops and management requirements. The profile descriptions which distinguish each soil series and the problems connected with each are given below. The analytical data for these soils are mentioned in Table 1.

I. Mandkola series : Mdk

Mandkola series consists of brown to yellowish brown coarse textured (sandy to loamy sand) soils occurring on dunal tops and slopes. The soils are very deep, being coarse textured, and are excessively drained. They are susceptible to both wind and water erosion, low in available water holding capacity and poor in organic carbon, available K_2O and P_2O_5.

Mandkola series is a member of non-acid, mixed, hyperthermic family of Typic Ustipsamments.

Mandkola sandy—A typical profile near R. D. 108 of Gurgaon canal between the villages of Mandkola and Sarauli is described below :

Horizon	Depth (cm)	Description
Ap	0–20	Brown (7.5 YR 4.5/4) sand; single grain; loose; common fine roots; many very fine interstitial pores; diffuse smooth boundary; pH 8.5.
A 12	20–52	Brown (7.5 YR 4.5/4) loamy sand; single grain; very friable moist; non-sticky and non-plastic (wet); few fine, common medium interstitial pores; common fine roots; diffuse smooth boundary; pH 8.4.
A 13	52–76	Brown (7.5 YR 4.5/4) loamy sand; single grain; soft dry, very friable (moist) non-sticky and non-plastic, few fine and few medium roots; pH 8.4.
C	76–125	Yellowish brown to dark brown (10 YR 4.5/4) loamy sand; friable (moist), non-sticky and non-plastic (wet); no roots; pH 8.5.

II. Gulha series : Gla

Gulha series consists of dark yellowish brown to brown medium textured (sandy loam) soils formed on old alluvium in plain areas. The soils are very deep, moderately well drained with weakly developed sub-angular blocky structure. They are mostly non-calcareous. The sub-soil is characterized by the presence of few, fine concretions of Fe and Mn alongwith few reduction mottles. These soils are well distributed over almost level old surfaces and occupy large area in the project area. The soils are low in organic carbon and are poor in fertility. Gulha series is a member of coarse loamy, non-acid, mixed, hyperthermic family of Typic Ustorthents.

Gulha sandy loam—A typical profile between village of Gulha and Rospur, about 250 meters away from Rajasthan link on Shirkrawa-Punhana road is described below :

Horizon	Depth (cm)	Description
Ap	0-20	Brown (10 YR 5/3) sandy loam; weak sub-angular blocky structure; soft (dry), friable, (moist) and slightly sticky and slightly plastic (wet); common fine; few medium tubular and interstitial pores; many medium to coarse and common fine roots; gradual smooth boundary; pH 8.3.
A 12	20-60	Dark brown (10 YR 4/4) sandy loam; fine weak sub-angular blocky structure; soft (dry), friable (moist) and slight sticky and slight plastic (wet); few fine dark brown (7.5 YR 4/2) mottles and few fine Fe and Mn concretions; pH 7.1.
A 13	60-98	Dark brown (10 YR 4/4) sandy loam; weak sub-angular blocky; few fine Fe and Mn concretions; pH 7.1.
G_1	98-124	Dark yellowish brown (10 YR 4/4) sandy loam; fine weak sub-angular blocky; no mottles; few fine concretions of Fe and Mn; pH 7.3.
G_2	124-180	Dark brown to dark yellowish brown (10 YR 4/3.5) sandy loam; few fine hard concretions; few fine yellowish brown (10 YR 5/6) mottles; pH 8.0.

III. Bidhwaka series : Bdk

Bidhwaka series consists of deep, poor to moderately drained, brown to yellowish brown and light brownish gray sandy loam soils which are saline-alkali with pH 10.2 to 10.6 and E. C. (1 : 2) 0.72 to 0.92 mmhos/cm. The sub-soil is characterised by mottlings of yellowish brown (10 YR 5/6) colour and a hard layer of $CaCO_3$ concretions at greater depths. Soils of Bidhwaka series are mainly distributed along the sides of main canal and its distributaries, where ground water table is high. Members of this series are distinguished by the presence of white salts encrustation on the surface and as such are uncultivated.

Low permeability, poor fertility and high soil pH are some of the major soil problems.

Bidhwaka series is a member of coarse loamy, calcareous, mixed hyperthermic family of Typic Camborthids.

Bidhwaka sandy loam—A typic profile, about 100 meters east of left bank of Gurgaon canal at R. D. 66, in uncultivated waste land is described below :

Horizon	Depth (cm)	Description
Ap	0-29	Yellowish brown (YR 5/4) sandy loam; fine weak sub-angular blocky; slight sticky and slight plastic (wet); slight effervescence with dil. HCl; pH 10.6.
(B)	29-84	Brown (10 YR 5/4) sandy loam; medium strong sub-angular to angular blocky; firm (moist); slightly sticky and plastic (wet); slight effervescence with dil. HCl; gradual smooth boundary; pH 10.5.

Horizon	Depth	Description
BC	84–103	Grayish brown to light brownish gray (10 YR 5/2) sandy loam; slightly sticky and plastic; few fine faint yellowish brown (10 YR 5/6) mottles; no concretions but moderate effervescence with dil. HCl; clear smooth boundary; pH 10.5.
C	103–150	Light brownish gray (10 YR 6/2) sandy loam; few fine faint yellowish brown (10 YR 5/6) mottles; violent effervescence with dil. HCl; hard $CaCO_3$ concretionary layer; pH 10.2.

IV. Piproli series : Ppl

Piproli series consists of brown to palebrown, medium to heavy textured (loam to clay loam) soils developed on old alluvium in plains. They are very deep and poorly drained soils. The soil is characterized by the presence of few, fine, faint yellowish brown (10 YR 5/6) mottles and few fine concretions of Fe and Mn. Piproli series is a member of fine loamy, non-acid mixed, hyperthermic, Typic Ustochrepts.

Piproli loam—A typical profile near R. D. 64 of Ferozpur Jhirka distributory, near village Piproli is described below :

Horizon	Depth (cm)	Description
Ap	0-18	Brown to pale brown (10 YR 5/3) loam; sub-angular to angular blocky; hard (dry); very firm (moist), sticky and plastic (wet); many fine; common medium and few coarse roots; common fine distinct dark-brown (7.5 YR 4/2) mottles; diffuse smooth boundary; pH 7.7.
B_{21}	18-55	Brown (10 YR 5/3) loam; medium strong sub-angular to angular blocky; hard dry; sticky and plastic (wet); many fine, common medium, few coarse roots; distinct dark-brown (7.5 YR 4/2) mottles; patchy, thin dark-gray (10 YR 4/1) flood coatings; no effervescence; few Fe and Mn concretions; pH 8.2.
B_{22}	55–85	Dark brown (10 YR 4/3) moist; loam; strongly developed irregular, subangular and angular blocky structure; hard when dry, slightly firm when moist, sticky and plastic; common fine; common medium, tubular and interstitial pores; many fine, common medium and few coarse roots; common, fine, distinct dark-brown (7.5 YR 4/2) mottles; patchy and thin, dark gray (10 YR 4/1) flood coatings; no reaction with HCl; pH 8.2; few Fe, Mn, concretions; gradual and diffused boundary.
B_{23}	85–100	Dark grayish brown (10 YR 4/3) loam; strong sub-angular to angular blocky structure; hard (dry); very firm (moist) and sticky and plastic (wet); few fine roots; fine distinct dark-brown (7.5 YR 4/2) mottles; broken, thin dark-gray (10 YR 4/1) flood coatings; few Fe and Mn concretions; pH 8.5.
C	100–158	Dark brown (10 YR 4/3) clayl oam; strong angular blocky structure; no roots; pH 8.1.

V. Ujina series : Ujn

Ujina series consists of dark-grayish brown to dark gray heavy-textured (clay loam) soils of depressional areas. The soils are calcareous and have a high pH values; cracks are also found to develop in these soils, from surface to a depth of about 90 cm, during dry period. Their heavy-texture, low water permeability and susceptibility to flooding are some of the major problems. Ujina series occupies significant area and are important soils from agriculture point of view. Ujina series is a member of fine (clayey) calcareous, mixed, hyperthermic Aquic Camborthids.

Ujina clay—A typic profile about 1 km east of Ujina village is described below :

Horizon	Depth (cm)	Description
Ap	0–22	Dark-gray (10 YR 4/1) clay; medium strong angular blocky; hard (dry), firm (moist) and sticky and plastic (wet); Cracks wider than 1 cm exist; many fine and medium, few coarse roots; strong effervescence with dil. HCl; few soft lime concretions; pH 9.2.
B_{21}	22–53	Dark gray (10 YR 4/1) clay; strong angular blocky; hard (dry); very firm (moist) and sticky and plastic (wet); many fine, many medium and few tubular and interstitial pores; cracks more than 1 cm wide; few soft lime concretions; pH 9.1.
B_{22}	53–104	Dark gray to very dark gray (10 YR 3.5/1) clay; no mottles; strong effervescence with dil. HCl; few soft lime concretions; gradual, smooth boundary; pH 9.1.
B_{23}	104–126	Light gray to light brownish gray (10 YR 6/1.5) and dark gray (10 YR 4/1) clay; strong angular blocky; no roots; many fine distinct yellowish brown (10 YR 5/6) mottles; strong effervescence with dil. HCl; few soft lime concretions; pH 9.1.
C	126–165	Yellowish brown (10 YR 5/4) clay loam; moderate to strong sub-angular blocky; fine yellow (10 YR 7/8) mottle; violent effervescence with dil. HCl; soft few lime concretions; pH 9.0.

Soils of Mandkola series are most extensive one, they cover about 834.7 sq km, i. e. about 58.60% of the total area (Table 2). In the landscape they occupy a high position mainly dune tops (287.40 sq km) and dune slopes and stabilized dunes on higher plains (547.30 sq km). Surface soil has pH value of 8.5, EC 0.36 and ESP 11.16. The soils are free from $CaCO_3$ and are very low in organic carbon. C.E.C. is 5.02 m. e./ 100 g of soil (Table 1).

Gulha series comprises dark yellowish brown to brown sandy loam soils non-calcareous in nature. Gulha series extends over an area of 160.32 sq km which is about 11.35% of the total project area.

TABLE 2

Area coverage under each soil series, their taxonomy and physiography

Series	Symbol	Physiographic unit	Soil taxonomy	Area (sq km)	% of total area
Mandkola	Mdk	Dune tops and slopes	Typic Ustipsamments	834.70	58.60
Gulha	Gla	Old Alluvial plains mostly level to gently sloping (higher)	Typic Ustorthents	60.32	11.35
Bidhwaka	Bdk	Alluvial plains along either banks of main canal and other minor distributories	Typic Camborthids	26.28	1.85
Piproli	Ppl	Alluvial plains (lower)	Typic Ustochrepts	287 96	20.21
Ujina	Ujn	Basinal areas	Aquic Camborthids	105.56	7.41

The surface soil is moderately well drained but sub-soil is characterized by the presence of fine cencretions of Fe and Mn alongwith some reduction mottles. pH of the surface soil is 8.3, EC 0.15 mmhos/cm and ESP 3.28. Surface soil has a clay percentage of 12.2 which increases with depth to a maximum of 15.8% at 154 cm. The content of organic carbon in the surface soil is 0.20%, which decreases regularly with depth in the sub-soil.

Bidhwaka series occurs along either bank of the main canal and other minor distributories and drains where natural surface drainage is impeded, covering an area of about 26.28 sq km which is about 1.85% of the total area. The soils are highly saline-alkali, pH of surface soil is 10.6, EC (1 : 2) 9.72 mmhos/cm and ESP 44.2. The soils are very low in O.C. as its content in surface soil is only 0.16%, cation exchange capacity is 7.24 m.e./100 g of soil in the upper soil which increases with depth in the sub-soil. Rise of ground water table seems to be the possible cause of their salinisation.

Piproli series is mapped over large areas covering about 287.96 sq km, i.e. nearly 20.21% of total area. Surface soils have pH 7.7, EC 0.26 and ESP 3.24. Clay content in the surface soil is 13.8% which increases with depth in the sub-soil. The content of available P and available K is high, which is 36.64 and 316 lbs/acre, respectively, in the surface soil. From agricultural point of view, these are very important soils.

Ujina series occurs in depressions and basins in the project area. It covers about 105.56 sq km which is about 7.41% of the total area. During rainy season the soils are over-flooded and during hot dry summer wide cracks are developed. They are calcareous and have high pH. They are of fine texture and, thus, have high cation exchange capacity, i.e. 20.77 m.e./

100 g soil in the surface. The clay content at the surface is 42.5%, which increases with depth to a maximum of 56.9 between 104 and 126 cm. The soils are very poorly permeable. They have high amounts of available P and available K.

On the basis of agro-climatic conditions the soils in the project area can be classified into arid brown, sierozem and desert soils. The pH of the surface soils varies from 7.7 to 10.6; while organic carbon varies from 0.15 to 0.40% and calcium carbonate content varies from nil to 1.2 per cent. The cation exchange capacity varies from 5.02 to 20.77 m.e./ 100 g soil. The soils are very poor to medium in N and medium to high in available P and K.

The soils are very light in texture in Sohna, Ballabgarh and Palwal and in the remaining areas of the project it varies from sandy loam to loam. In certain low lying parts of Palwal, Ferozpur Jhirka and Nuh tehsils, the soils are clayey and have the problem of salinity.

ACKNOWLEDGEMENTS

The authors wish to express their sincere thanks to Dr. Mahendra Singh, Professor and Head, Department of Soils for providing necessary facilities and guidance during the course of the survey work. Assistance rendered by various State and University departments is fully acknowledged.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 112—114 (March 1983)

FLOWERING AND FRUITING BEHAVIOUR OF **BER** (*ZIZYPHUS MAURITIANA* LAMK.) UNDER GURGAON CONDITIONS

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(Received : April 21, 1981; Revised : November 12, 1981)

ABSTRACT

Studies on physico-chemical characters of five **ber** cultivars viz., Gola, Kaithli, Chhuhara, Umran and Muria were conducted during 1979-80 at Horticultural Research Station, Gurgaon. Umran was the late ripening cultivar and Gola was the earliest. Umran had maximum fruit weight (28.20 g). Maximum total sugars (8.10%) were also recorded in Umran, closely followed by Gola, Chhuhara and Muria cultivars; Kaithli had the minimum sugars (7.87%). Kaithli and Umran cultivars had maximum ascorbic acid being 88.76 and 87.36 mg/100 g of pulp, respectively. Chhuhara had minimum values for acidity (0.243) and ascorbic acid (75.53), whereas Kaithli had minimum values for T. S. S. (17.06) and total sugars (7.89). Maximum yield was obtained in Umran followed by Kaithli, Muria and Gola.

Umran, Kaithli and Gola are recommended as the most suitable late, mid and early season cultivars, respectively, for this region.

The **ber** can thrive well under conditions of salinity, drought and water logging, whereas other fruits fail to grow successfully. It is resistant to hot dry winds during summer and frost during winter. Some of the most promising cultivars of **ber** were introduced at this Research Station in the year 1970. This experiment was conducted with a view to recommend most suitable cultivars for this region and adjacent areas.

MATERIAL AND METHODS

Studies were conducted on five cultivars of **ber** viz., Gola, Kaithli, Umran, Muria and Chhuhara. The trees were eight years old, growing under similar cultural practices.

Time of bud initiation, flowering, fruit set and fruit ripening were recorded by visual observations. Fruit size, weight, pulp and stone weight were recorded on a random sample of 100 fruits from each tree. For estimation of T. S. S. a hand refractometer was used. For determination of acidity 5 g of fruit pulp was macerated in hot distilled water and this extract was titrated against 2, 6-dichlorophenol indophenol dye. For estimation of total sugars, 5 g of fruit pulp was macerated in water and a known volume was made after extraction on water bath. Sugars were estimated by AOAC (1970) method.

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TABLE 1

Physico-chemical characters of **ber** cultivars

Characters	Cultivars				
	Gola	Muria	Kaithli	Chhuhara	Umran
Time of bud initiation	14.9.1979	11.9.79	17.9.79	15.9.79	8.9.79
No. of days for flowering	7	7	8	7	7
No. of days for fruit set	8	7	6	7	7
No. of days for fruit ripening	108	119	142	137	147
Fruit size (cm)					
Length	3.56	4.85	4.90	5.48	4.81
Diameter	3.36	3.22	3.10	2.91	3.61
Fruit weight (g)	23.40	28.00	25.70	21.80	28.20
Fruit pulp weight (g)	21.89	26.56	24.56	20.73	26.70
Stone weight (g)	1.51	1.44	1.44	1.07	1.50
Yield/tree (kg)	85.05	125.04	132.01	65.03	142.02
Total soluble solids (%)	18.05	18.04	17.06	20.04	18.03
Acidity (%)	0.266	0.275	0.324	0.243	0.302
Ascorbic acid (mg/100 g fruit pulp)	80.34	84.11	88.76	75.53	87.36
Total sugars (%)	8.05	7.92	7.89	7.97	8.10

RESULTS AND DISCUSSION

The data on flowering, fruiting and physico-chemical characters of fruits have been presented in Table 1. It is evident from the data that cultivar Gola was the earliest and Umran late in ripening among the five cultivars under study. The number of days taken from bud initiation to flowering was the same in all cultivars. Maximum fruit length was observed in Chhuhara cultivar and diameter in Umran cultivar. Maximum fruit weight (28.20 g/fruit) was recorded in Umran and minimum in Gola (23.40 g/fruit). The stone weight was minimum in Chhuhara cultivar and maximum in Gola and Umran. The stone weight for Gola and Umran culivars was 1.51 and 1.50 g, respectively. Similar findings have been reported by Dhingra *et al.* (1973).

The total soluble solids were highest in Chhuhara (20.4%) followed by Gola, Muria, Umran and Kaithli. Maximum acidity and ascorbic acid contents were observed in variety Kaithli being 0.324% and 88.76 mg/100 g of pulp, respectively, followed by Umran variety. Similar values were recorded by Randhawa and Biswas (1966), Dhingra *et al.* (1973) and Khera and Singh (1976). An evaluation of sugar content of various **ber** cultivars showed that the total sugars were maximum in Umran (8.10%) and minimum in Kaithli (7.89%). Khera and Singh (1976) also observed similar results. Umran variety yielded maximum (145.2 kg/tree) followed by Kaithli, Muria, Gola and Chhuhara cultivars.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 115—120 (March 1983)

EFFECT OF CULTURAL PRACTICES AND APHID INFESTATION ON SEED YIELD AND ITS COMPONENT TRAITS IN *BRASSICA JUNCEA* (L.) CZERN AND COSS

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(Received : April 21, 1981; Revised : June 7, 1982)

ABSTRACT

An experiment on Indian mustard was conducted to observe the effect of cultural practices and aphid infestation on the seed yield and its component traits. During **rabi**, 1976-77, three levels of irrigation (0, 1 and 2), three levels of nitrogen (0, 30 and 60 kg N/ha) and three spacings between lines (30, 45 and 60 cm) were tried in split plot design. In the succeeding year, i. e., 1977-78, irrigation levels were reduced to two (0 and 1), since there was no significant difference in yield and other yield contributing factors between once and twice irrigated crops. The spacing between lines had no marked effect on aphid infestation and yield contributing factors, therefore, this factor was replaced by two levels of insecticidal sprays with phosphamidon 0.03 per cent. The levels of nitrogen application were retained as such. Irrigation increased the aphid attack but still it provided higher yield, however, number of siliquae/plant and number of seeds/siliqua were not affected. Due to heavy fertilization with nitrogen, aphid attack, seed weight and number of siliquae/plant and yield increased without affecting the number of seeds/ siliqua. Insecticidal sprays did not affect the number of siliquae and seeds produced per plant and siliqua. However, it did reduce the aphid population and increased the seed weight and yield.

Indian mustard, *Brassica juncea* (L.) Czern and Coss is an important **rabi** oilseed, but the crop often fails to express its full potential as it is prone to the attack of a number of serious insect pests, of which mustard aphid, *Lipaphis erysimi* (Kalt) robs away the lion's share. This pest has been assigned to cause as high as 87% damage to mustard (Pradhan *et al.*, 1960). As of today the accepted practice to control mustard aphid is the use of insecticides. Problems associated with the use of chemicals have, however, come to light and, therefore, integrated control is now gaining momentum. This method includes cultural practices as one of the important factors (Bhattacharjee, 1961; Jayaraj and Venugopal, 1964; Wearing, 1967; Wearing and van Emden, 1967; Rawat *et al.*, 1968; Pal *et al.*, 1976). Some practices (Bhola *et al.*, 1973; Rathi and Tripathi, 1973) and aphid infestation are liable to mar yield potential of the crop by affecting the number of siliquae/plant, number of seeds/ siliqua, seed weight, etc. (Sirohi *et al.*, 1966;

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Nath and Saha, 1974). An experiment to study the effect of cultural practices and aphid infestation on mustard (var. Prakash) was, therefore, conducted during the years 1976-77 and 1977-78.

MATERIAL AND METHODS

The thrice replicated experiment was conducted in split plot design during 1976-77 and 1977-78 at the farm of Haryana Agricultural University, Hissar. During the **rabi** season of 1976-77, three levels of irrigation (0, first at flowering and second at pod formation), three levels of nitrogen application (0, 30 and 60 kg N/ha) and three spacings between lines (30, 45 and 60 cm) were tried. Levels of irrigation were randomized in the main plots, and combinations of nitrogen were randomized in sub-plots. The plant to plant distance was 15 cm.

In the light of the first year's results, the experiment in the second year was modified keeping three levels of nitrogen (0,30 and 60 kg N/ha), two levels of irrigation (0 and one) and substituting spacing with insecticidal sprays (0 and three sprays with phosphamidon when aphid population reached 500 plant). Here the levels of insecticidal sprays were randomized in main plots, irrigation in sub-plots and nitrogen in sub sub-plots. Data on five randomly selected plants from each plot, were recorded and were subjected to statistical analysis.

The aphid population was recorded, at weekly intervals, with the help of indices standardized by actually counting the number of aphids present on five twigs of equal size as described by Kalra and Gupta (1981).

RESULTS AND DISCUSSION

Irrigation

Number of siliquae/plant and seeds/siliqua. The crop irrigated once, harboured significantly higher aphid population, i. e., 1772 and 3745 aphids/plant than the unirrigated one, 1318 and 3288 aphids/plant in 1976-77 and 1977-78, respectively (Tables 1 and 2). On the other hand, the twice irrigated crop during 1976-77 harboured similar number of aphids as the once irrigated crop and aphid infestation had no effect on the number of siliquae/plant and number of seeds/siliqua.

Seed weight. Irrigation significantly affected the seed weight. In the unirrigated crop one thousand seeds weighed 3.49 g as against 3.36 g in the once irrigated crop (Table 1). However, the twice irrigated crop produced seeds of the same weight as those of the once irrigated crop. In the following year, when the aphid infestation was too heavy, the seeds produced by both the irrigated and unirrigated crops were statistically of the same weight.

Yield. Although irrigation and aphid infestation had no significant effect on the yield contributing characters but the yield obtained from unirrigated crop, 19.06 and 18.16 q/ha was significantly lower than from the once irrigated crop, 21.20 and 20.34 q/ha in 1976-77 and 1977-78, respectively. This might be due to the independent effect of irrigation which is in agreement with Singh *et al.* (1970). The yields obtained from the once and twice irrigated crops in 1976-77 were statistically at par (Table 1). This can

TABLE 1

Effect of cultural practices and aphid infestation on the seed yield and its component traits in *Brassica juncea* during 1976-77

Treatments	Highest no. of aphids/plant	No. of siliquae/ plant	No. of seeds/ siliqua	1000-seed weight (g)	Yield (q/ha)
Irrigation					
No irrigation	1318	381.8	13 00	3.49	19.06
One irrigation	1772	393.4	13.02	3.36	21.20
Two irrigations	1648	364.8	12.90	3.36	21.11
C. D. at 5%	—	NS	NS	0.12	1.71
Nitrogen/ha (kg)					
0	1212	349.9	12.45	3.09	17.20
30	1688	365.8	12.66	3.27	20.98
60	2095	405.6	12.20	3.41	21.74
C D. at 5%	—	30.51	0.28	0.10	1.20
Spacing between lines (cm)					
30	1656	313.7	12.78	3.39	20.68
45	1670	381.5	13.08	3.37	20.91
60	1610	426.2	13.05	3.40	20.66
C. D. at 5%	—	30.51	0.28	NS	NS

—=The aphid population is from different observations, therefore no C. D. value has been given.

TABLE 2

Effect of cultural practices and aphid infestation on the seed yield and its component traits in *Brassica juncea* during 1977-78

Treatments	Highest no. of aphids/plant	No. of siliquae/ plant	No. of seeds/ siliqua	1000-seed weight (g)	Yield (q/ha)
Insecticidal sprays					
No	6011	265.6	11.94	2.11	17.91
Three	2546	261.3	12.15	3.14	20.59
C. D. at 5%	—	NS	NS	0.01	0.50
Irrigation					
No irrigation	3288	275.4	12.13	3.12	18.16
One irrigation	3745	251.6	11.95	3.14	20.34
C. D. at 5%	—	NS	NS	NS	0.36
Nitrogen/ha (kg)					
0	3167	256.4	12.42	3.15	18.50
30	3728	250.7	11.74	3.15	19.29
60	4217	283.4	11.97	3.09	19.95
C D. at 5%	—	26.71	0.44	NS	0.48

=The aphid population is from different observations, therefore no C. D. value has been given.

possibly be due to the secondary flowering and lodging of the crop after second irrigation.

Nitrogen

Number of siliquae/plant. The data in Table 1 reveal that the aphid population increased with increase in the application of nitrogen. A maximum of 1212, 1688 and 2095 aphids/plant during 1976-77 and 3167, 3728 and 4217 aphids/plant (Table 2) during 1977-78 were recorded when the crops were fertilized with 0, 30 and 60 kg N/ha, respectively. Both these factors, i. e. nitrogen application and aphid infestation ultimately affected the number of siliquae formed on the plant. The crops receiving 0 and 30 kg N/ha formed 349.9 and 365.8 siliquae/plant during 1976-77 and 256.4 and 250.7 siliquae/plant during 1977-78, respectively, which were statistically at par. However, with the application of 60 kg N/ha, although the crop harboured higher aphid population, yet significantly higher number of siliquae, 405.6 and 283.4 siliquae/plant, respectively, were formed in the two successive years. It is, thus, clear that the damage caused by aphids was, to some extent, compensated by the higher dose of nitrogen. Similar results have been reported by Jayaraj and Venugopal (1964).

Number of seeds/siliqua. During 1976-77, the number of seeds/siliqua was maximum (12.6) in the crop fertilized with 30 kg N/ha followed by 12.45/siliqua in the unfertilized crop, both of these being statistically at par (Table 1). On the other hand, the number of seeds/siliqua was maximum (12.42) in the unfertilized crop, during 1977-78, which was significantly higher than the crop with 30 kg N/ha (11.74/siliqua) and 60 kg N/ha (11.97/siliqua) (Table 2). However, it is clear that the nitrogenous fertilizer helped in increasing the number of siliquae formed on a plant, yet the number of seeds formed in a siliqua was checked by the higher aphid population which resulted mainly due to the higher doses of nitrogen.

Seed weight. Seed weight was significantly affected by the nitrogen application during the year 1976-77 when thousand seed weight of 3.09, 3.27 and 3.41 g was recorded in the plots receiving 0, 30 and 60 kg N/ha, respectively. However, in the year 1977-78, seed weight showed no significant differences in the plots receiving 0,30 and 60 kg N/ha. A possible explanation for this can be that with more number of aphids attacking the crop, lighter seeds were formed during 1977-78. However, some of the weight loss due to aphid attack could be compensated by higher fertilizer dose.

Yield. Significantly higher yield was obtained from the crops which were fertilized with 60 kg N/ha (21.74 and 19.95 q/ha) than the unfertilized crops (17.20 and 18.50 q/ha) in 1976-77 and 1977-78, respectively (Tables 1 and 2). It was also accompanied with heavier seeds and more number of siliquae formed in the fertilized treatments.

Spacing Between Lines

Number of siliquae/plant and seeds/siliqua. The number of aphids harboured by the plants were statistically similar when the crops were sown at 30, 45 and 60 cm distance between lines

(Table 1). However, significantly higher number of siliquae/plant were formed in crops sown at a distance of 60 cm (426.2 /plant) followed by 381.5 siliquae/plant at a distance of 45 cm and 313.7 siliquae /plant at a distance of 30 cm. The number of seeds/siliqua formed in the crops sown 45 cm apart was significantly higher (13.08/siliqua) than the crops at 30 cm apart (12.78/siliqua). The former being statistically at par with the crop sown at a distance of 60 cm (13.05/ siliqua).

Seed weight and yield. There was no significant difference in the seed weight and yield of the crops sown at different distances between lines. The differences in the yield might have been reduced by the more number of siliquae formed on a plant in the crops having wider spacing.

Insecticidal Sprays

Number of siliquae/plant and seeds/siliqua. The results given in Table 2 reveal that there was no significant effect of sprays on the number of siliquae/ plant and seeds/siliqua. The unsprayed crop recorded 265.6 siliquae/plant and 11.94 seeds/siliqua as against 261.3 and 12.15, respectively, in the sprayed crops. However, significantly higher aphid population (6011 aphids/plant) was recorded in the unsprayed crop as compared to 2546 aphids/plant in the sprayed one.

Seed weight and yield. The weight of 1000 seeds obtained from the unsprayed crop, weighing 2.11 g was significantly lower than that of sprayed crop which weighed 3.14 g. This may be due to the fact that aphids sucked the plant sap because of which the seeds remained undeveloped. The number of siliquae/plant and seeds/siliqua was least affected. The higher seed weight resulted in significantly higher yield in the sprayed crop, 20.59 q/ha, as compared to the 17.91 q/ha in the unsprayed crop. These results are in conformity with those of Nath and Saha (1974), Hameed *et al.* (1976) and Prasad (1978).

Therefore, it is inferred that irrigation increased the aphid population on the crop but still it helped in obtaining higher yield. However, to some extent, the yield in the irrigated crop could be compensated by heavier seeds produced in such crops. But irrigation had no effect on the number of siliquae/plant and number of seeds/siliqua. Nitrogen fertilization increased the aphid attack. Simultaneously, it resulted in the production of heavier seeds and more number of siliquae/plant which in turn contributed towards higher yields in the fertilized treatments. However, the number of seeds/siliqua was not affected. Spacing between lines did not affect the number of aphids attacking the crop, seed weight and yield. However, the number of siliquae/plant and seeds/ siliqua was affected in such a way that the yield obtained became statistically at par. Insecticidal sprays significantly reduced the aphid population and increased the seed weight and yield. However, there was no difference in the number of siliquae/plant and number of seeds/ siliqua.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 121—126 (March 1983)

OCCURRENCE AND INCIDENCE OF LEAF CRINKLE DISEASE ON URDBEAN AND MUNGBEAN IN HARYANA

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(Received : April 25, 1981; Revised : August 22, 1981)

ABSTRACT

A survey of different districts of Haryana during summer and **kharif** seasons of 1975, 1976 and 1979 revealed that the leaf crinkle disease on urdbean and mungbean was less in summer than in **kharif**. The disease increased year after year throughout the State. The disease was more in the northern region than in the southern region of the State.

Among pulses, mungbean and urdbean are adversely affected by the virus diseases in India (Raychaudhuri *et al.*, 1977). In Haryana, the occurrence of virus diseases on these crops during 1973 and 1975 fluctuated (Singh *et al.*, 1979). Among virus diseases, till 1974, the leaf crinkle was regarded as a disease of minor importance. During 1974-75 **kharif**, it was observed in severe form in various cultivars of mungbean and urdbean in different districts of the State. A brief account of occurrence and incidence of this disease on different cultivars of mungbean and urdbean during summer and **kharif** seasons of 1975, 1976 and 1979 is presented in this paper.

MATERIAL AND METHODS

Survey in Haryana was done during summer and **kharif** seasons of 1975, 1976 and 1979. Occurrence and incidence of the disease were determined by counting healthy and diseased plants in approximately 5×5 sq m area of different fields and then calculating the per cent diseased plants referred to as 'per cent disease'. In each district 4-5 villages were randomly visited, and in each village 3-5 fields covering 2-3 hectares for each cultivar were surveyed. Mungbean cultivars Varsha, J-45 and Pusa Baisakhi and urdbean cultivars T-9, Mash 1-1 and H 70-3 were commonly grown during **kharif**. During summer mungbean cultivar Pusa Baisakhi alone was under cultivation and urdbean crop was not found cultivated during the year under survey.

RESULTS AND DISCUSSION

During summer, the maximum disease incidence in mungbean was in Kurukshetra district (Table 1) being 3.48, 3.81 and 4.65 per cent during 1975, 1976 and 1979, respectively, followed by Sonepat, Ambala, Karnal, Jind, Rohtak, Sirsa and Gurgaon. There was no disease in summer season during the year under survey in Mohindergarh, Bhiwani and Hissar districts.

TABLE 1

Occurrence of leaf crinkle disease on mungbean cv. Pusa Baisakhi in different districts of Haryana during summer of 1975, 1976 and 1979

District	Per cent disease		
	1975	1976	1979
Ambala	2.36	3.24	4.62
Bhiwani	0.00	0.00	—
Gurgaon	1.39	2.23	0.00
Hissar	0.00	0.00	0.00
Jind	2.08	3.05	2.90
Karnal	2.29	3.13	2.80
Kurukshetra	3.48	3.81	4.65
Mohindergarh	0.00	0.00	—
Rohtak	1.54	2.68	2.87
Sirsa	1.07	2.45	—
Sonepat	2.61	3.47	4.56

—=Crop/variety was not found cultivated.

The disease incidence during **kharif** was maximum in Rohtak district being 34.63% in mungbean (Table 2) and upto 37.13% in urdbean (Table 3), followed by Jind, Sonepat, Karnal, Kurukshetra, Ambala, Sirsa, Hissar, Gurgaon, Bhiwani and Mohindergarh districts.

A perusal of data presented in Tables 1 and 2 revealed that the disease incidence was less in summer than in **kharif**. The low or no disease incidence during summer was due to masking of disease symptoms probably due to prevailing high temperature. Kadian (1980) observed that the symptom expression of leaf crinkle was masked in the month of May and June when the field temperature was more than 40°C. However, symptoms on **kharif** crop appeared when temperature came down to 37°C and intensified as the temperature further decreased to 35°C in the month of July/August. During summer in Mohindergarh, Bhiwani and Hissar districts absence of disease symptoms was probably due to prevailing high field temperature (>40°C). The differential reactions in the same cultivar (Pusa Baisakhi) in different parts of Haryana State were obviously due to fluctuation in environmental conditions particularly temperature (Anonymous, 1979; Kadian, 1980).

Nene (1972) reported mungbean cultivar Pusa Baisakhi as disease-free under artificially inoculated conditions in the greenhouse at Pantnagar (U.P.). Differential behaviour of Pusa Baisakhi in Haryana could be due to the presence of more virulent strain of the virus which might have broken down the resistance in this State. This cultivar was also recorded as susceptible to leaf crinkle in field as well as artificially inoculated (sap) conditions in the screen house in Haryana by Singh (1974, 1980).

TABLE 2

Occurrence of leaf crinkle disease on mungbean cvs. Pusa Baisakhi, J-45 and Varsha in different districts of Haryana during **kharif** of 1975, 1976 and 1979

District	Per cent disease								
	1975			1976			1979		
	Pusa Baisakhi	J-45	Varsha	Pusa Baisakhi	J-45	Varsha	Pusa Baisakhi	J-45	Varsha
Ambala	4.35	13.12	18.35	6.66	17.20	18.16	6.95	—	19.35
Bhiwani	1.91	4.15	8.45	2.18	5.72	9.76	—	—	9.60
Gurgaon	3.89	8.47	11.95	3.94	11.85	14.88	—	11.00	16.43
Hissar	2.65	9.47	12.62	4.33	12.96	14.67	4.28	18.93	17.50
Jind	8.13	21.39	27.75	8.10	25.51	29.30	10.23	18.93	29.00
Karnal	7.15	17.64	22.97	7.91	23.46	24.69	8.82	25.25	—
Kurukshetra	5.88	11.72	16.66	6.14	18.00	19.81	—	20.00	22.70
Mohindergarh	1.12	3.78	6.23	1.43	5.80	8.67	—	—	6.50
Rohtak	8.84	22.95	29.01	9.43	25.44	31.67	10.18	26.88	34.63
Sirsa	3.17	6.33	13.18	4.45	13.62	13.56	5.00	20.00	16.00
Sonepat	6.76	8.27	23.18	8.20	18.10	24.18	10.15	22.56	26.24

—=Variety was not found cultivated.

TABLE 3

Occurrence of leaf crinkle disease on urdbean cvs. H 70-3, Mash 1-1 and T-9 in different districts of Haryana during kharif of 1975, 1976 and 1979

District	Per cent disease								
	1975			1976			1979		
	H 70-3	Mash 1-1	T-9	H 70-3	Mash 1-1	T-9	H 70-3	Mash 1-1	T-9
Ambala	1.31	12.38	17.95	1.82	17.42	19.70	—	—	20.25
Bhiwani	—	4.45	8.85	—	5.15	9.95	—	—	10.18
Gurgaon	0.68	7.65	11.46	1.38	9.83	14.90	—	—	16.50
Hissar	0.85	9.29	13.50	1.16	9.14	14.80	2.00	14.66	18.00
Jind	2.18	21.13	29.53	2.59	26.19	30.91	—	—	30.00
Karnal	1.87	17.87	22.63	1.84	21.17	24.42	2.02	24.73	26.25
Kurukshetra	1.41	13.77	18.44	1.40	16.20	19.22	3.50	—	23.50
Mohindergarh	—	3.40	7.66	—	4.87	8.82	—	—	8.00
Rohtak	2.31	21.56	34.05	2.94	27.42	37.13	3.26	26.35	35 78
Sirsa	0.72	6.14	12.15	1.35	6.00	13.66	—	—	18.00
Sonepat	1.64	16.77	23.68	2.36	22.47	24.21	4.21	22.25	25.95

—=Variety was not found cultivated.

The disease incidence was more in urdbean (Table 3) than in mungbean (Table 2) in all districts of Haryana under study which was due to comparative resistance/susceptibility at species level (Kadian, 1980). Among mungbean cultivars commonly grown in Haryana, Pusa Baisakhi had least disease incidence followed by J-45 and Varsha (Table 2), and among urdbean cultivars H 70-3 had least disease incidence followed by Mash 1-1 and T-9 (Table 3). This was due to comparative resistance/susceptibility at varietal level (Kadian, 1980).

It is clear from Tables 1, 2 and 3 that the disease incidence was less in 1975. It slightly increased in 1976 and still more in 1979. The increase in disease incidence from year to year in different cultivars was due to spread of virus through infected seeds (Singh, 1974; Kadian, 1980) and further spread through vectors (Kadian, 1980). These findings on the nature of seed-borne disease and spread through vectors were in confirmity with those of Kolte and Nene (1972), Dhingra (1975) and Beniwal *et al* (1980).

It was interesting to note that Haryana State has two different regions, i.e., north region and south region where incidence of leaf crinkle disease was different in the same cultivar. The northern districts Ambala, Kurukshetra, Karnal, Sonepat, Jind and Rohtak showed more disease incidence than the southern districts Mohindergarh, Bhiwani, Hissar, Sirsa and Gurgaon. The high incidence of the disease in the north region could be attributed to low temperature and high humidity prevailing during summer and **kharif** than in the south region (Anonymous, 1979).

ACKNOWLEDGEMENT

The author is grateful to Dr. J. P. Varma, Associate Professor of Plant Pathology, H.A.U. Hissar for guidance during the study and also for going through the manuscript and giving useful suggestions.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 127—134 (March 1983)

EFFECT OF SOIL MOISTURE STATUS ON CONSUMPTIVE USE AND WATER USE EFFICIENCY OF SOME CROPS

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(Received : April 27, 1981; Revised : October 14, 1981)

ABSTRACT

An experiment comprising three initial soil moisture levels (125, 160 and 200 mm) in 100 cm soil profile, two irrigation treatments (no additional irrigation and one additional irrigation of 50 mm depth after 60-65 days of sowing) and four levels of fertilizer (0, 20, 40 and 60 kg N/ha in case of *Hordeum vulgare* (L.), *Brassica juncea* (L. Czern & Coss) and *Eruca sativa* (Lam.) and same doses of P_2O_5 in *Cicer arietinum* (L.) was conducted during winter seasons of 1975-76 and 1976-77. Consumptive use of water at different stages of growth and total consumptive use increased with the increase in initial soil moisture level or with application of additional irrigation in all the crops during both the seasons. The water use efficiency decreased with the increase in initial soil moisture level or with additional irrigation, except in case of gram where it was increased at 160 mm over 125 mm initial soil moisture level. At lowest soil moisture level water use efficiency was highest in *Hordeum vulgare* followed by *Cicer arietinum*, whereas at highest moisture level *Cicer arietinum* attained the highest water use efficiency.

Barley (*Hordeum vulgare* L.), raya (*Brassica juncea* L. Czern & Coss), taramira (*Eruca sativa* Lam.) and gram (*Cicer arietinum* L.) are the most important winter season crops of dry land areas in north India. The yield of these crops are low because they are mostly grown on stored soil moisture in the profile under poor level of management. The crops generally exhaust the stored soil moisture of profile during vegetative stage of growth and experience moisture stress during reproductive phase of crop growth. The increasing facilities of irrigation could be utilized for life saving irrigation in these crops to exploit their yield potential.

Studies on limited irrigation aspect of winter crops are few and fragmentary. Singh and Moolani (1969) found one irrigation at flowering (60 days after sowing) in raya to be adequate for obtaining high yield. Sharma and Singh (1971) reported that by increasing consumptive use of water from 10.8 cm under unirrigated plot to 27.6 cm by two supplemental irrigations, barley yield increased from 23.5 to 30.2 q/ha. For gram crop, Sharma *et al.* (1974) reported the values of potential evapotranspiration as 204 mm and 280 mm during 1970-71 and 1971-72, respectively. Virmani *et al.* (1975) found only a limited response of raya

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(RL-18) with the increase in the level of pre-sowing irrigation at Hissar, whereas the increase in yield was quite high (3.6 q/ha) with the one supplemental irrigation of 50 mm over no post-sowing irrigation treatment. Singh *et al.* (1977) observed no significant increase in yield of raya/sarson due to increase in profile soil moisture level. However, one supplemental irrigation (25 mm) given at flowering stage increased the yield significantly. Bishnoi (1977) reported that the total consumptive use varied from 20.5 to 24.2 cm under different dates of sowing in raya crop. Gupta and Agarwal (1977) reported the consumptive use of water as 24.7, 25.7 and 29.0 cm for gram with no irrigation, one irrigation and two irrigations, respectively.

Most of the work reported so far has not shown the relative performance and consumptive use of water of more than one crop under same agro-climatic conditions and, therefore, for taking a decision in crop suitability in relation to moisture availability, it was considered desirable to try four important crops of dry land agriculture under varying levels of profile soil moisture with and without supplemental irrigation.

MATERIAL AND METHODS

Field experiments with four important rainfed winter season crops viz., barley, raya, taramira and gram were conducted for two consecutive seasons of 1975-76 and 1976-77. The soil was moderately deep sandy loam, low in nitrogen (150 kg N/ha), medium in available phosphorus (13 kg P_2O_5/ha) and high in potash (580 kg K_2O/ha). The field capacity and permanent wilting point values for 0-15, 15-30, 30-60 and 60-100 cm soil layers were 17.80, 19.87, 25.40, 26.80 and 4.68, 5.40, 6.30, 7.00 per cent moisture on volume basis, respectively. The experiment was laid out in split plot design with three replications. The treatments in the experiment included all the combinations of three initial soil moisture levels (125, 160 and 200 mm soil moisture in 100 cm soil profile), two irrigation treatments (no water applied and 50 mm water applied after 60 to 65 days of sowing of crops) in main plots and four fertilizer doses (0, 20, 40 and 60 kg N/ha to barley, raya and taramira and same doses of P_2O_5/ha to gram) to each crop in sub-plots.

For moisture studies soil samples were taken from all the plots having variable soil moisture treatments and one fertility (40 kg N or P_2O_5/ha) level only. The crops were sown on 30th October, 1975 and 10th November, 1976, respectively, during two seasons. Barley, raya, taramira and gram were harvested during 1976 on 20th March, 20th March, 31st March, and 3rd April and during 1977 on 23rd March, 26th March, 3rd April and 1st April, respectively. Soil moisture determinations were made by gravimetric method from sowing to harvest at 15 days interval and consumptive use was later on calculated stage-wise for different crops.

RESULTS AND DISCUSSION

Changes in soil moisture status with age and water use efficiency under different irrigation treatments for each of the crops during both the seasons have been shown in Tables 1 to 4. Data in Tables clearly show that with the increase in soil

TABLE 1

Effect of different profile soil moisture on consumptive use of water and water use efficiency of barley

Moisture content in 100 cm profile initial+ protective irrigation (mm)	Consumptive use of water (mm)								Yield (kg/ha)		Water use efficiency kg/mm/ha	
	Sowing to late tillering		Late tillering to ear emergence		Ear emergence to harvest		Total					
	1975-76	76-77	75-76	76-77	75-76	76-77	75-76	76-77	75-76	76-77	75-76	76-77
125+0	27.0	30.0	40.6	37.7	36 8	15.0	104.4	82.7	1153.6	1217.6	11.05	14.72
160+0	46.3	46.0	39.1	37.7	56.8	35.0	142.2	118.7	1357.5	1602.9	9.55	13.50
200+0	69.3	70.0	41.5	39.7	64.8	43.0	175.6	152.7	1434.6	1687.6	8.17	11.05
125+50	31.7	27.0	62.5	59.7	56.7	41.0	150.9	127.7	1457.8	1763.0	9.66	13.81
160+50	50.0	48.0	61.8	63.7	74.8	54.0	186.6	165.7	1659.2	1983.9	8.89	11.97
200+50	66.0	68.0	69.3	73.7	88.4	65.0	224.3	206.7	1699.2	2074.0	7.58	10.03

TABLE 2

Effect of different profile soil moisture on consumptive use of water and water use efficiency of raya

Moisture content in 100 cm profile initial+ protective irrigation (mm)	Consumptive use of water (mm)								Yield (kg/ha)		Water use efficiency kg/mm/ha	
	Sowing to flowering		Flowering to pod formation		Pod formation to harvest		Total					
	1975-76	76-77	75-76	76-77	75-76	76-77	75-76	76-77	75-76	76-77	75-76	76-77
125+0	29.4	29.4	42.8	40.3	33.8	10.0	105.0	79.7	884.3	1033.3	8.42	12.96
160+0	37.8	37.5	65.1	35.2	37.3	42.0	140.2	114.7	989.6	1141.5	7.06	9.95
200+0	47.0	64.4	70.7	35.3	48.4	48.0	176.1	147.7	1101.8	1221.0	6.26	8.27
125+50	30.3	28.1	54.1	57.7	65.3	39.0	149.7	124.8	1112.0	1250.0	7.43	10.02
160+50	36.5	33.3	75.4	68.0	75.0	58.3	186.9	159.6	1243.5	1290.4	6.65	8.09
200+50	43.1	67.1	86.1	67.5	96.3	62.0	225.5	196.6	1347.2	1367.6	5.97	6.96

TABLE 3

Effect of different profile soil moisture on consumptive use of water and water use efficiency of taramira

Moisture content in 100 cm profile initial+ protective irrigation (mm)	Consumptive use of water (mm)								Yield (kg/ha)		Water use efficiency kg/mm/ha	
	Sowing to flowering		Flowering to pod formation		Pod formation to harvest		Total					
	1975-76	76-77	75-76	76-77	75-76	76-77	75-76	76-77	75-76	76-77	75-76	76-77
125+0	23.6	26.0	48.1	34.7	35.3	29.4	107.0	90.1	795.8	880.7	7.44	9.77
160+0	33.4	32.0	51.3	42.7	57.6	42.4	142.3	117.1	867.3	973.2	6.09	8.31
200+0	44.0	45.0	65.5	39.7	59.4	61.4	168.9	148.1	963.9	1106.5	5.71	7.47
125+50	22.6	29.0	51.5	53.7	81.4	63.4	155.5	146.1	893.0	1026.8	5.74	7.03
160+50	33.4	27.0	72.4	69.0	78.8	74.1	184.6	170.1	936.3	1134.2	5.22	6.67
200+50	43.9	44.7	76.8	69.4	101.1	89.4	221.8	202.8	1006.6	1163.8	4.54	5.74

TABLE 4

Effect of different profile soil moisture on consumptive use of water and water use efficiency of gram

Moisture content in 100 cm profile initial+ protective irrigation (mm)	Consumptive use of water (mm)								Yield (kg/ha)		Water use efficiency kg/mm/ha	
	Sowing to flowering		Flowering to pod formation		Pod formation to harvest		Total					
	1975-76	76-77	75-76	76-77	75-76	76-77	75-76	76-77	75-76	76-77	75-76	76-77
125+0	26.0	29.0	33.1	30.7	44.8	23.4	103.9	83.1	819.7	1215.3	7.89	14.62
160+0	44.6	44.0	42.1	42.7	65.3	31.4	142.0	118.1	1279.3	1770.4	9.01	14.99
200+0	49.7	52.0	49.1	47.7	76.8	51.4	175.6	151.1	1280.7	1753.1	7.29	11.60
125+50	25.4	26.0	52.1	52.7	72.8	47.4	150.3	126.1	1138.9	1676.0	7.58	13.29
160+50	35.5	44.0	64.1	57.7	84.8	66.4	184.4	168.1	1453.8	2046.3	7.88	12.17
200+50	48.6	49.0	73.1	73.7	90.8	77.4	212.5	200.1	1748.8	2046.7	8.23	10.23

moisture content in the profile the moisture use by all the four crops increased. The water use by the barley crop under 200 mm initial soil moisture level was increased by 42.3 and 19.3 mm over 125 and 160 mm, respectively from sowing to late tillering stage during 1975-76 and 40.0 and 16.0 mm during 1976-77. The water use by other three crops (raya, taramira and gram) during the early stage of growth sowing to flowering was less as compared to barley crop when the initial profile soil moisture was 200 mm, however, these values were low in case of raya and taramira only when the profile soil moisture was 160 mm.

Application of 50 mm post-sowing irrigation applied to all the crops during the next stage of growth made an appreciable change in water use from the profile among the no additional irrigation and additional irrigation treatments. It is evident from the data in Tables 1 and 4 that there was very little difference in water use of barley and gram during two different seasons. In case of raya and taramira there was great variation from season to season except in the treatment of lowest level of moisture (125 mm) with additional irrigation.

During the last stage of growth the variation in consumptive use in all the crops was high. It is interesting to note that the moisture in the profile was below the wilting point in all the crops at the time of harvest. With the additional irrigation there was difference in the consumptive use for different crops under no additional and additional irrigation treatments and the sum of the difference between the two treatments under two different stages (stage II late tillering/flowering to heading/pod formation and stage III heading/pod formation to maturity) was almost 50 mm which was equal to the additional irrigation applied to the crops indicating the best utilization of applied water. The total consumptive use in all the crops was almost same during the same year of investigation which differed from year to year depending on the availability of water in the profile and effective rainfall received during crop season. These results support the views of Penman (1948) and indicated that consumptive use of water is mainly governed by the weather factors rather than by crop, provided similar soil moisture conditions are provided to different crops.

Highest moisture use efficiency was obtained under minimum profile soil moisture present at the time of sowing (125 mm) without additional irrigation, except gram where the water use efficiency was decreased with the increase in the profile soil moisture. Highest water use efficiency was observed in case of barley during 1975-76 and in case of gram during 1976-77. Singh *et al.* (1977) also observed high moisture use and low water use efficiency with the increase in initial soil moisture or with additional irrigation in case of raya/sarson. Taramira which is otherwise considered to be a sure crop under low profile soil moisture (below 100 mm) (Bishnoi, 1975). This crop had the lowest water use efficiency because of the low yield potential of the crop during both the years. The highest yield of all the crops was obtained under the highest profile soil moisture (200 mm) alongwith 50 mm additional irrigation, where the water

use efficiency was lowest in all the crops during both the years except for gram during 1975-76.

It was interesting to note that in gram the water use efficiency increased with the increasing profile soil moisture from 125 to 160 mm during both the years and during 1975-76 even with the application of supplemental irrigation in 200 mm initial profile soil moisture treatment. This clearly indicates that the gram crop responded very well to additional irrigation as compared to other three crops (barley, raya and taramira). The supplemental irrigation of 50 mm given to all the crops at late tillering/ flowering stage, avoided the moisture stress conditions at the critical stages and thereby the initial favourable effect of higher pre-sowing moisture level was carried out to grain development phenomena, which otherwise had reduced to a considerable extent specially in case of barley and gram.

ACKNOWLEDGEMENT

Authors are thankful to the Director of Research, Haryana Agricultural University, Hissar for execution of work.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 135—139 (March 1983)

COMPONENTS OF VARIABILITY, HERITABILITY AND GENETIC ADVANCE STUDIES IN TOMATO (*LYCOPERSICON ESCULENTUM* MILL.)

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(Received : April 27, 1981; Revised : October 7, 1981)

ABSTRACT

Forty diverse genotypes of tomato were evaluated for components of variability, heritability and genetic advance for eight characters. Weight per fruit, early yield per plant and number of fruits per plant showed high degree of coefficients of variation, heritability and genetic advance suggesting their importance in selection programme of tomato improvement.

The success of an effective breeding programme depends upon the amount of genetic variability present in the material. Studies of genetic variability in tomato have earlier been made by Nandpuri *et al.* (1973, 1974, 1977), Peter and Rai (1976) and Srivastava and Sachan (1973). The present experiment was undertaken with the objective to study the extent of genetic variability, heritability and genetic advance in tomato.

MATERIAL AND METHODS

Forty varieties of diverse genetic stock of tomato were planted in a randomized block design with three replications in February, 1979, at the Vegetable Research Farm of Haryana Agricultural University, Hissar. Randomly five plants were selected from each treatment and observations were recorded on total yield per plant, early yield per plant, number of fruits per plant, weight of fruit, pericarp thickness, locule number per fruit, plant height and green plant weight. Genotypic and phenotypic coefficients of variation were calculated according to the method suggested by Burton and DeVane (1953). Heritability and genetic advance were estimated as per the method of Hanson *et al.* (1956).

RESULTS AND DISCUSSION

Mean performance of 40 varieties for different characters has been given in Table 1. Significant differences were recorded among varieties for all the characters studied suggesting that the population was amendable to selection for these characters. Maximum total yield per plant was recorded in EC 32099 and Columbia, and the highest early yield was given by HS 102 and HS 107. Maximum number of fruits per plant were found in HS 107 and Gamed. Variety Columbia had the maximum weight per fruit followed by HS 110. Tall plant habit corresponded almost to the green plant weight in many genotypes.

TABLE 1

Mean performance of varieties for different characters

	Varieties	Plant height (m)	Green plant weight (kg)	Number of fruits per plant	Fruit weight (g)	Total yield per plant (kg)	Early yield per plant (kg)	Pericarp thickness (mm)	Locule number per fruit
		1	2	3	4	5	6	7	8
1.	Chamboli Red	1.06	0.82	34.66	23.48	0.82	0.38	4.40	2.93
2.	Superbag	0.96	0.79	33.00	60.28	1.95	0.62	5.13	3.40
3.	Hybrid Pink	0.75	0.60	32.33	29.87	1.52	0.80	3.80	3.66
4.	Red Top	0.63	0.34	33.33	11.88	0.96	0.66	4.40	3.33
5.	Traveller	0.93	0.70	49.66	43.27	0.56	0.23	5.86	4.06
6.	Pusa Ruby	0.90	0.50	32.66	21.50	1.40	0.62	3.73	4.33
7.	Gamed	0.74	0.45	63.33	42.53	1.30	0.62	4.53	2.53
8.	Pusa Early Dwarf	0.83	0.44	30.00	46.48	1.21	0.46	3.73	2.86
9.	E C 32099	0.56	0.31	53.66	42.53	2.14	0.69	4.28	4.00
10.	Sabour Prabha	0.61	0.33	54.66	25.75	1.28	0.33	2.20	2.53
11.	New Yorker	0.68	0.68	45.00	11.65	1.08	0.37	3.46	3.26
12.	63-VF	0.67	0.48	38.66	35.93	1.35	0.56	4.20	3.33
13.	Fire-ball Early	0.35	0.14	19.00	39.72	0.75	0.41	3.60	3.20
14.	H S 108	0.72	0.63	38.33	24.39	0.95	0.44	3.93	2.93
15.	No-140	1.02	0.72	32.00	32.62	1.03	0.34	4.86	3.93
16.	E C 58062	0.76	0.66	49.66	35.59	1.82	0.28	3.80	4.40
17.	VL-11-1	0.88	0.50	26.33	41.36	1.09	0.47	3.86	4.60
18.	E C 3239-1	1.27	0.77	46.66	28.50	1.28	0.68	4.13	3.20
19.	SL-152	0.63	0.56	33.66	31.12	1.24	0.29	4.26	2.00
20.	Columbia	0.56	0 31	19.33	98.69	2.00	0.38	4.93	4.93
21.	Monarch	1.08	1.15	21.66	41.54	0.91	0.26	4.00	4.73
22.	Mikado Pink	0.99	0.75	49.00	30.75	1.51	0.73	4.33	3.60
23.	KT-1	1.12	0.83	17.66	35.55	0.64	0.18	3.53	3.93
24.	VFN-45-3	0.99	0.94	21.00	30.23	0.61	0.14	3.73	5.66
25.	Nematode Resistant	0.66	0.66	22.66	45.10	1.05	0.43	4.53	3.33
26.	Traverer	1.15	0.93	28.66	37.29	1.03	0.22	4.26	4.46
27.	E C 16278	0.81	0.87	37.33	31.89	1.14	0.48	3.66	3.33

28.	Nematex-3	0 88	0.73	41.66	31.63	1.32	0.52	4.06	4 20
29.	H S 110	0.71	0.57	28.33	70.98	1.95	0.65	5.40	5.20
30.	Ultrabag	0.63	0.54	22.66	47.10	1.03	0.38	3.86	3.80
31.	H S 102	0.78	0.47	51.00	35.81	1.80	1.05	4.26	3.66
32.	Druzba Bulgaria	0 89	0.50	51.00	28.47	1.45	0.73	3.53	2.93
33.	G-2	0.69	0.50	43.00	27.12	1.17	0.75	4.13	3 66
34.	R-039	0.59	0.44	18 66	68.63	1.30	0.34	5 26	5.40
35.	Big size tomato	0.68	0.00	43 00	32.78	1.45	0.48	3.33	2 80
36.	H S 104	0.62	0.35	46.00	33.50	1.54	0.80	2.86	3.46
37.	S-12	0.83	0 56	40.66	27.39	1.01	0.46	3.26	3.13
38.	B-17	1.00	0.62	30.33	38.48	1.16	0.40	4.86	4.13
39.	C S Tomato	0.48	0.26	33.66	35.86	1.25	0.48	3.80	5.15
40.	H S 107	0.63	0.38	73.66	21.15	1.56	0.90	2.13	4.33
	General mean	0.7976	0.5823	37.1917	37.4619	1.2682	0.5034	4.0500	3.7600
	C. D. at 5%	0.20	0.32	15.97	13.99	0.63	0.24	0.96	1.07

TABLE 2

Components of variation, range, heritability and genetic advance for various characters

Characters	Range	Variances due to			Coefficients of variation		Heritability (%) in broad sense	Genetic advance	Genetic advance as % of mean
		Treatments	Genotypic	Phenotypic	Genotypic (%)	Phenotypic (%)			
1. Total yield/ plant (kg)	0.56-2.14	0.4386	0.0949	0.2487	24.30	39.33	38.16	0.39	30.75
2. Early yield/ plant (kg)	0.14-1.05	0.1288	0.0357	0.0573	37.55	47.58	62.27	0.31	61.61
3. Total number of fruits/plant	17.66-73.66	504.3058	134.8780	234.5498	31.23	41.18	57.51	18.14	48.77
4. Weight per fruit (g)	11.65-98.69	702.6346	208.6920	285.2504	38.56	45.08	73.16	25.45	67.94
5. Pericarp thickness (mm)	2.13-5.86	1.7174	0.4675	0.7823	16.88	21 84	59.76	1.09	26.91
6. Locule number/ fruit	2.00-5.66	2.1202	0.5585	1.0031	19.88	26.64	55.68	1.15	30.59
7. Plant height (m)	0.35-1.27	0.1199	0.0349	0.0501	23.43	28.07	69.70	0.32	40.12
8. Green plant weight (kg)	0.14-1.15	0.1361	0.0319	0.0721	30.71	46.14	44.29	0.25	42.93

Range, phenotypic and genotypic variances and coefficients of variation, heritability and genetic advance estimates have been presented in Table 2. Maximum range was exhibited by weight per fruit followed by number of fruits per plant which was further supported by their high treatment variances. Early and total yield per plant also exhibited wide range. Genotypic and phenotypic variances of these characters also followed the same trend.

The estimates of coefficients of variation, which provide the degree of variation in relation to a particular character mean, revealed that the early yield per plant, green plant weight, weight per fruit and number of fruits per plant showed high degree of phenotypic coefficient of variation in order. Highest genotypic coefficient of variation was recorded for early yield followed by green plant weight, weight per fruit and number of fruits per plant. Similar results were also reported by Peter and Rai (1976) and Nandpuri *et al.* (1973) for number of fruits and early yield per plant.

Heritability which indicates the extent of transmissibility of a character in future generations is important in selecting out characters for improvement to execute selection. Weight per fruit had high heritability closely followed by plant height, early yield per plant, pericarp thickness and number of fruits per plant. Nandpuri *et al.* (1973, 1977) also recorded high heritability values for these characters. Genetic advance and genetic advance as a per cent of mean were high for weight per fruit and number of fruits per plant. However, the genetic advance as a per cent of mean for early yield per plant was also high. Heritability and genetic advance should be considered together for making an effective selection. Weight per fruit, early yield per plant and number of fruits per plant exhibited high coefficients of variation, heritability and genetic advance probably due to additive genetic effects (Panse, 1957). These characters should be given due importance for selection breeding programme.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 140—145 (March 1983)

ZINC-POTASSIUM RELATIONSHIP IN WHEAT

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(Received : May 16, 1981; Revised : November 27, 1981)

ABSTRACT

A pot experiment conducted in screen house with all possible combinations of 0, 5, 10 and 20 ppm Zn and 0, 25, 50 and 100 ppm K revealed that *application of K in the absence of Zn reduced grain yield of wheat against* control. Application of higher levels of K supplemented with Zn enhanced the grain yield significantly. Straw yield improved with Zn and K application. Application of Zn enhanced Zn concentration in grain and straw, while addition of K increased it in grain and depressed in the straw. Accumulation of Zn was higher in grain than straw. K concentration in straw improved with Zn and K fertilization. Application of K enhanced the effectiveness of applied Zn and vice versa.

Zinc-potassium relationship in wheat is not well understood and has been little explored. Divergent views have been expressed on Zn-K relationship in crops by various investigators. Shukla and Mukhi (1980) observed an increase in Zn concentration with K application in maize, while Terman and Allen (1974) reported a decrease in Zn concentration of young corn plants. Application of Zn augmented K concentration in maize (Shukla and Mukhi, 1980) while a reduction was recorded by Seatz *et al.* (1959).

Thus, keeping in view the conflicting reports and limited information on Zn-K relationship, the present investigation was carried out to study Zn-K nutrition relationship in wheat.

MATERIAL AND METHODS

A pot experiment was conducted in screen house using a typic-Torripsamment sandy soil having pH, EC, OC, available P, available K and DTPA extractable Zn, 8.0, 0.15 mmhos/cm, 0.04%, 8 kg/ha, 50 kg/ha and 0.48 ppm, respectively. Laboratory procedures as described by Kanwar and Chopra (1967) were followed for the determination of various soil properties. Available Zn was extracted with DTPA (Lindsay and Norvell, 1978). Polyethylene lined earthen pots were filled with 4 kg of well air dried soil. The treatments consisted of all possible combinations of four levels of K viz., 0, 25, 50 and 100 ppm through KCl and four levels of Zn viz., 0, 5, 10 and 20 ppm through $ZnSO_4.7H_2O$. Each treatment was replicated thrice in a completely randomised design. A basal application of 100 ppm N and 50 ppm P was applied as urea and $(HN_4)_2.HPO_4$, respectively. Four plants of wheat variety WH-147 were grown till maturity. After harvest the plants were washed in acidified deionized water and finally rinsed with deionized water. Samples were dried in

a forced air circulation oven at 70°C. Shoot dry matter and grain yields were recorded. Samples were ground in a wiley mill with stainless steel blades. Plant and grain samples were digested in diacid mixture of HNO_3 and $HClO_4$ (5 : 1). Potassium in plant and grain digest was determined on flame-photometer and Zn by atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

Grain yield of wheat was significantly influenced with Zn and K applications (Table 1). In the absence of added Zn, application of K reduced the grain yield when compared with control. The results are contrary to the findings of Shukla and Mukhi (1980) who reported an increase in corn straw yield with K, when Zn was not added. Application of K in the presence of Zn had an additive effect on the yield, but the differences were significant only at 50 and 100 ppm K application. The increase in grain yield with higher doses of K in the presence of added Zn clearly shows that application of K makes the soil more responsive to Zn fertilization and vice versa.

Application of 5 ppm Zn enhanced the grain yield by 30% over control in the absence of added K. It is interesting to note that 5 ppm Zn enhanced the grain yield by 60% when supplemented with 100 ppm K in comparison to K alone. Mean values indicated that there was a significant increase in yield with K and Zn application.

TABLE 1

Effect of K and Zn application on grain and straw yields of wheat

K levels (ppm)	Zn levels (ppm)				
	0	5	10	20	Mean
	Grain yield (g/pot)				
0	13.40	17.43	17.80	18.53	16.79
25	12.43	17.50	18.16	18.60	16.70
50	12.96	17.86	16.26	19.80	17.22
100	12 33	19.73	20.20	20.46	18.20
Mean	12.62	18.15	18.70	19.35	
C D. at 5% for K and Zn levels mean=0.57; K×Zn=0.50.					
	Straw yield (g/pot)				
0	16.03	17.43	17.70	18.50	17.41
25	16.63	18.53	18.70	19.43	18.32
50	16.25	18.56	19.43	18.46	18.17
100	15.90	18.83	19.20	19.96	18.47
Mean	16.20	18.34	18.75	19.09	
C. D. at 5% for K and Zn levels mean=0.70; K×Zn=NS.					

Application of 25 and 50 ppm K in the presence of varying levels of Zn, enhanced the yield negligibly, but 100 ppm K boosted the yield by 13% over 0 ppm K in the presence of 5 and 10 ppm Zn. In the absence of applied Zn the yield was reduced by 8% with 100 ppm K against 0 ppm K. A synergistic and significant interaction was exhibited between K and Zn in wheat grain yield.

Mean values indicated (Table 1) that straw yield improved significantly over control with Zn and K application. The interaction effect was non-significant. In the absence of applied Zn, addition of K enhanced the straw yield asymptotically. Shukla and Mukhi (1979) reported an increase in maize yield with increasing rates of K.

The data in Table 2 depicted that Zn concentration in grain improved significantly with increasing rates of Zn at all levels of K. In grain, Zn concentration increased with K fertilization. Shukla and Mukhi (1980) also reported identical results in maize straw. In contrast to 0 ppm K, application of K without adding Zn enhanced the Zn concentration in grain significantly. The differences among various K levels were non-significant. The interaction effect of K and Zn on Zn concentration was also significant. Zinc concentration was augmented significantly with 100 ppm K over lower levels of K in the presence of 5 ppm applied Zn. A similar trend was observed at other levels of Zn.

The Zn concentration increased by 17% with 100 ppm K against 0 ppm K when 5 ppm Zn was applied. The magnitude of increase in Zn concentration and uptake were lower at 20 ppm Zn. An increase in Zn concentration and uptake

TABLE 2

Effect of K and Zn application on Zn concentration (ppm) of grain and straw of wheat

K levels (ppm)	Zn levels (ppm)				
	0	5	10	20	Mean
	Grain				
0	8.40	26.10	31.41	58.48	31.97
25	10.10	26.10	33.98	64.13	33.55
50	11.00	26.73	34.05	64.32	34.02
100	11.72	33.45	37.70	64.28	37.79
Mean	10.30	27.54	34.28	62.80	
C. D. at 5% for K and Zn levels mean=0.87; K×Zn=1.75.					
	Straw				
0	7.56	15.95	33.35	45.93	25.69
25	6.40	16.65	29.48	46.45	24.74
50	4.83	16.43	28.60	48.14	24.50
100	4.78	14.80	28.45	49.30	24.43
Mean	5.89	15.95	29.97	47.45	
C. D. at 5% for Zn levels mean=1.43; K×Zn=NS; K levels mean=NS.					

at 100 ppm K over 0 ppm K in the presence of applied Zn clearly indicated that there was synergistic effect of K on Zn absorption.

Zinc concentration in straw (Table 2) was reduced non significantly with K and increased with Zn application. There was non significant decrease in Zn concentration and uptake as K levels were increased regardless of Zn application.

An increasing trend in Zn concentration in grain wi.h K application and reduction in straw suggested that Zn accumulated during vegetative growth in shoot was translocated to the grain. Zn concentration in grain was higher than the straw, which indicates the role of Zn in grain formation. The percentage distribution of Zn in grain and straw (Table 3) indicated that grain had a higher percentage of Zn distribution than straw and it decreased in straw with K application, while reverse was true in grain.

It is evident from data in Table 4 that K concentration in straw increased significantly with K and Zn applications. Mean values indicated that K concentration in straw improved from 1.47% at 0 ppm Zn to 1.75% at 20 ppm Zn. Application of K enhanced K content from 1.39% at 0 ppm K to 1.96% at 100 ppm K. The interaction between K × Zn was significant and application of Zn significantly enhanced the K content which indicated the synergistic effect of Zn on K concentration in straw.

An increase in K concentration was quite evident when K was applied along-

TABLE 3

Effect of K and Zn application on the percentage distribution of Zn in grain and straw of wheat

K levels (ppm)	Zn levels (ppm)				
	0	5	10	20	Mean
	Grain				
0	48.2	62.1	48 6	56.1	53.7
25	54.1	59.7	53.5	56.9	56.1
50	64.5	61.0	50.6	58.9	58.8
100	74.9	68.3	58.2	57.2	64.7
Mean	60.4	60.3	52.7	57.3	
	Straw				
0	51.8	37.9	51.4	43.9	46.3
25	45.9	40.3	46.5	43.1	43.9
50	35.5	38.9	49.4	41.1	41.2
100	25.1	31.7	41.8	42.8	35.3
Mean	39.6	37.2	47.3	42 7	

TABLE 4

Effect of K and Zn application on K concentration (%) of grain and straw of wheat

K levels (ppm)	Zn levels (ppm)				
	0	5	10	20	Mean
	Grain				
0	0.250	0.250	0.257	0.258	0 254
25	0.263	0.264	0.262	0.262	0.262
50	0.270	0.268	0.267	0.267	0 267
100	0.280	0.276	0.269	0.269	0.273
Mean	0.266	0.264	0.263	0.264	

C. D. at 5% for K and Zn levels mean=0.002; K× Zn=0.004.

	Straw				
0	1.28	1.36	1.48	1.47	1.39
25	1.30	1.36	1.46	1.50	1.41
50	1.48	1.35	1.55	1.88	1.62
100	1.82	1.92	1.96	2.15	1.96
Mean	1.47	1.55	1.60	1.75	

C. D. at 5% for K and Zn levels mean=0.02; K×Zn=0.04.

TABLE 5

Effect of K and Zn application on the percentage distribution of K in grain and straw of wheat

K levels (ppm)	Zn levels (ppm)				
	0	5	10	20	Mean
	Grain				
0	16.3	15.5	15.2	14.9	15.4
25	16.8	16.3	15.2	14.8	15.7
50	15.4	16.6	14.6	12.4	14.7
100	13.3	12.6	12.1	11.2	14.8
Mean	15.4	15.2	14.3	13.3	
	Straw				
0	83 6	84.5	84.7	85.1	84.5
25	83.2	83.7	84.8	85.1	84.2
50	84.6	83.4	85.4	87.6	85.2
100	86.7	87.4	87.9	88.9	85.2
Mean	84.5	84.7	85.7	86.7	

with Zn. The interaction among K and Zn might be physiological in nature and occurs in the root during the process of absorption of nutrients and translocation to the aboveground parts. The results are contrary to the findings of Seatz *et al.* (1959) who reported reduction in K content of plants due to Zn fertilization. However, the results are in conformity with the findings of Shukla and Mukhi (1980) who indicated an increase in K content in maize due to Zn application. The K content in grain improved slightly with K fertilization. Application of Zn reduced the K concentration in grain which was in accordance with the findings of De and Chatterjee (1978). Data in Table 5 indicated that 83.6 to 88.9 per cent of the total K was accumulated by wheat straw and it was five fold than the grain. Application of Zn decreased the percentage distribution of K in grain and increased in straw.

ACKNOWLEDGEMENT

The authors are thankful to Indian Council of Agricultural Research, New Delhi for the financial assistance during this investigation.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 146—149 (March 1983)

VARIABILITY AND CORRELATION STUDIES IN SPONGE GOURD (*LUFFA CYLINDRICA* ROEM)

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(Received : December 20, 1980; Revised : July 5, 1982)

Sponge gourd an extensively used vegetable crop has been given rare attention to improve the yield potential. Limited information on variability and heritability in this crop is available in literature. Present study was, therefore, conducted to provide some information on variability, the nature of heritability and magnitude of correlations in quantitative characters in sponge gourd. In a randomised block design, thirteen lines of sponge gourd each planted in two rows, were evaluated for length of vine and internode, days to first male and female flower opening, node setting first female flower, sex ratio, length and diameter of fruits at marketable stage and number of fruits and yield/plant. Varietal variances and coefficient of variation, heritability in broad sense, genetic advance and simple correlation coefficients were computed for the characters recorded.

Varietal differences were significant for all the characters studied. Genotype HS-4 was poorest (0.021 kg/plant), HS-12 (1.368 kg/plant) and HS-13 (1.392 kg/plant) with good yield performance were comparable almost for all the characters. The genotype HS-3 with maximum vine length (275.1 cm) was early (68.3 days to flowering) having low sex ratio (8.6) and node setting first female flower (8.2); second highest for number of fruits/plant (10.5) and highest for fruit length (25.7), diameter (5.2 cm) at edible stage and fruit yield/plant (3.106 kg). Genotypes HS-1, HS-6 and HS-8 also performed well for most of the characters.

Maximum range of variation and high genotypic and phenotypic coefficients of variation for yield/plant were closely followed for number of fruits/plant and sex ratio (Table 1) revealing large variability and good scope of selection for these characters. Panwar *et al.* (1977) also reported highest gcv and pcv for yield/plant and high pcv for number of fruits/plant in sponge gourd. The heritability estimates for all the characters except vine and internode length and fruit diameter which showed moderate values were high. The genetic advance as a per cent of mean was also highest for yield/plant followed by sex ratio and number of fruits/plant. Panwar *et al.* (1977) found low heritability and genetic advance for fruit diameter and fruit

TABLE 1

Variability and genetic parameters for ten characters in sponge gourd

Parameters/characters	Range	Coefficient of variation		Heritability	Genetic	Genetic advance
		Genotypic (GCV%)	Phenotypic (PCV%)	BS (%)	advance	as per cent of mean
Length of vine (cm)	150.3—386.3	22.10	36.48	36.69	67.32	25.57
Internode length (cm)	7.6—11.3	9.71	16.29	35.55	1.09	11.93
Days to first male flower opening	55.7—117.7	20.78	22.09	88.46	31.05	40.26
Days to first female flower opening	60.8—124.8	20.56	22.86	80.93	31.83	38.12
Node to setting of first female flower	8.2—20.0	28.28	34.06	69.98	5.96	48.39
Sex ratio (male : female)	8.2—55.3	64.98	70.97	83.83	32.78	122.58
Length of fruit (cm) at edible stage	11.0—25 7	16.95	24.16	49.20	4.08	24.46
Diameter of fruit (cm) at edible stage	2.4—5.2	12.67	22.20	32.58	0.63	14.90
Number of fruits/plant	0.3—12.0	58.44	77.92	56.30	4.28	90.29
Fruit yield/plant (kg)	0.021—3.106	82.82	93.39	78.64	1.51	151.79

Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 150—152 (March 1983)

EFFECT OF PRE-SOWING SOIL APPLICATION OF BHC AND ALDRIN ON PLANT STAND IN WHEAT AND MOONG

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(Received : July 2, 1981; Revised : February 2, 1983)

For the control of soil insects such as termites and white grubs, mixing in soil of as high as 10 kg actual per hectare of either BHC (Patel *et al.* 1967) or aldrin (Hetrick, 1952) has been recommended. This is against the normal doses of 2.5 and 1.87 kg actual per hectare of these two insecticides (Anonymous, 1980). Repeated applications of these insecticides, to the same fields, may result in their accumulation to rather undesirable high levels, which may interfere with the germination and plant stand of the crops sown therein. Therefore, a study on plant stand in wheat and **moong**, as affected by high and very high doses of BHC and aldrin dusts, applied to the soil in a single dose before sowing, was undertaken.

The experiment was laid out at the research area of the Department of Entomology. The doses of both BHC and aldrin (used as 10 and 5 per cent dusts, respectively) applied to the soil were : 6.25, 12.5, 25.0, 37.5, 50.0, 62.5, 75.0, 87.5, 100.0, 112.5 and 125.0 kg a. i./ha in case of wheat and 2.5, 12.5, 25.0, 50.0, 75.0, 100.0 and 125.0 kg a. i./ha in case of **moong** crop (Table 1). The treatments were compared in a randomised block design with three replications. The plot size for wheat and **moong** was 1 and 2 sq m, respectively. The soil in the test plots was loam in texture with pH of 8.6 and organic matter of 1.1 per cent.

The insecticidal dusts, after their application to the plots, were thoroughly mixed in the soil. The mixing was done with a spade and this was confined to upper 15 cm soil layer. Three hundred healthy seeds of **moong** (variety 70-16) and 500 of wheat (variety C 306) were sown in each plot during the months of July and November, 1974, respectively. Well established wheat and **moong** plants per plot were counted 21 and 30 days after sowing the seeds. This obviously excluded such seedlings which soon after germination might have died due to scorching. The data were subjected to analysis of variance and the least significant differences for comparison of results were calculated at the 5% level of probability.

The results reported in Table 1 reveal that pre-sowing soil application of aldrin dust, at doses as high as 125.0 kg a.i./ha did not adversely affect the plant stand in wheat crop. On the contrary, considerable reduction in number of **moong**

TABLE 1

Effect of pre-sowing soil application of high and very high doses of BHC and aldrin dusts on plant stand in wheat and **moong** crops

Insecticide a.i./ha (kg)	Mean per cent plant stand*			
	Wheat		**Moong**	
	BHC	Aldrin	BHC	Aldrin
0 (Control)	31.3(33.98)**	31.3(33.98)	73.4(59.19)	68.8(56.05)
2.50	—	—	71.3(57.77)	67.9(55.49)
6.25	28.0(31.60)	42.1(40.35)	—	—
12.50	35.3(36.08)	39.4(38.80)	64.3(53.38)	71.9(57.99)
25.00	34.0(35.53)	37.3(37.53)	74.6(61.05)	65.7(54.15)
37.50	31.4(33.95)	31.2(33.29)	—	—
50.00	23.3(28.40)	35.1(36.31)	44.2(41.64)	57.2(49.16)
62.50	21.4(26.37)	34.9(36.21)	—	—
75.00	28.0(31.19)	37.7(37.63)	32.2(34.53)	61.2(51.48)
87.50	24.0(29.31)	36.3(36.97)	—	—
100.00	13.3(21.06)	44.7(41.67)	24.5(29.34)	51.9(46.09)
112.50	15.7(22.54)	35.3(36.47)	—	—
125.00	5.3(12.75)	44.0(41.54)	23.4(28.07)	52.8(46.58)
'F' test	Sig.	NS	Sig.	Sig.
C. D. at 5%	(11.06)		(13.39)	(4.04)

*Based on the total number of seeds sown and well-established plants counted.

**Angular, transformed values.

plants was observed when the dose of the toxicant exceeded the level of 50 kg a.i./ha.

As compared to the control, the higher doses of soil applied BHC dust resulted in considerable reduction in the number of both wheat and **moong** seedlings. Such adverse effects were evident at doses higher than 50 kg a.i./ha in case of **moong** and 100 kg a. i./ha in case of wheat (Table 1).

Effect of very high doses of soil applied BHC on sugarcane crop has been studied by earlier workers. At doses of 100, 200 and 400 ppm (1 ppm works to about 1 kg actual per hectare), this insecticide resulted in decreased growth followed by drying up of the plants. With 50 ppm dose the adverse effects were, however, less and the plants dried after 24 weeks. In all these treatments the germination was poor and the roots were comparatively short, club shaped and swollen (Agarwala, 1952). Siddiqui and Agarwal (1954) and Rao and Agarwal (1957) also reported retardation of shoot and root development with the increase in level of this toxicant in the soil.

These studies reveal that the application of rather high doses of BHC and aldrin dusts to the soil was deterimental more to germinating/germinated **moong** than to the wheat seedlings. The phytotoxic effect of these toxicants may be crop specific or it may even be related to the soil temperature, the temperature being higher during July (**moong** sowing period) than November (wheat sowing period).

Comparison of the overall performance of the two insecticides showed that BHC was more deleterious than aldrin. Verma (1974), in his studies on the treatment of the water-wetted wheat seeds with aldrin and BHC dusts also obtained somewhat similar results. He observed that aldrin 5% dust, even at 3.75 kg a.i./q seed, did not hamper wheat germination, whereas with BHC 10% dust the adverse effects were seen at doses higher than 0.25 kg/q seeds.

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Haryana agric Univ. J. Res., Vol. XIII, No. 1, pp. 153—159 (March 1983)

A STUDY ON INFANT FEEDING AND WEANING PRACTICES

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(Received : February 26, 1982; Revised : August 13, 1982)

ABSTRACT

A study carried out on 120 children in a village near Hissar indicated wide spread ignorance among mothers about the special nutritional needs of the children. Colostrum was not fed to the infants as it was considered an impure milk. The first feed of sugar water, honey or commercial **janam ghuti** was given 1 to 2 h after birth. Breast feeding was continued until the commencement of next pregnancy. Supplementary foods started between the age of 6 to 12 months in most of the children included tea, **khichari, dalia, chapatis,** etc. No special foods were prepared for the children. Food supplements such as cereals, pulses, fruits and vegetables were not given to infants because of false beliefs.

The nutritional requirement per unit body weight of infants and pre-schoolers is much higher than that of adults due to rapid growth. Breast fed children which grow normally during the first six months of their life show slow growth during the transitional period of weaning because they do not get enough of nutritious foods needed by them.

Ignorance of the special nutritional needs of children and prevalence of food fads make the situation still worse. Most of the mothers do not know that foods prepared for adults are not always suitable for the young ones. Sometimes children get enough energy from starchy foods, such as wheat and rice, but the requirements of protein and other nutrients are not met. Such children develop signs of nutritional deficiencies. Study of the existing pattern of infant feeding and weaning habits is the first important step towards improving their nutritional status.

Breast feeding practices among infants in various parts of the country have been studied by different workers (Gopalan *et al.*, 1974; Bahl, 1979; Gupta *et al.*, 1979; Thimmayamma *et al.*, 1980). However, no information is available on this aspect from Haryana. The present investigation was carried out to study the feeding and weaning practices among children in a selected village of Hissar district.

MATERIAL AND METHODS

The study was conducted on 120 children in the age group of 3 to 36 months belonging to village Mirzapur, situated at a distance of 16 km from Hissar. A pretested structured respondent schedule was used to collect the data on infant feeding and weaning practices. The data were collected by personal interview of mothers or caretakers of children under study.

RESULTS AND DISCUSSION

Socio-Economic Background

Out of the infants surveyed, 50.9% belonged to nuclear families, while 43.1 and 6.0 per cent were from joint and extended families, respectively. Average family size was 6.9 (4.8 Adult Consumption Units).

About 59.5% of the fathers of children had no formal school education, whereas 11.2, 15.5 and 13.8 per cent were educated upto primary, middle and high school, respectively. A few fathers (0.9%) had diploma in Engineering. Educational level of mothers was very low. About 88.c% were illiterate and 8.6 and 2.6 per cent of mothers were educated upto primary and middle school, respectively.

Most of the fathers (64.7%) of surveyed children were agriculturists while 10.3 and 6.0 per cent fathers were engaged in service and business, respectively. About 15.6% of fathers were landless labourers and only 3.4% were engaged in dairying, carpentry and shoe making or working as goldsmith, blacksmith, etc. Families with monthly per capita income below Rs. 60, 60 to 100 and above Rs. 100 were 34.1, 42.6 and 23.3 per cent, respectively.

Out of 120 children surveyed the male were 64 and female were 56. Age-wise distribution of children has been shown in Table 1.

TABLE 1

Age and sex wise distribution of children

Age group (months)	Male	Female	Total
Below 6	8	6	14
6 to 12	25	22	47
13 to 24	24	18	42
Above 24	7	10	17
	64	56	120

Breast Feeding Practices Among Children

The first feeding was given to 23.3, 32.5 and 25.0 per cent of infants within 12 h, between 12 to 24 h and after 24 h of birth, respectively while 19.2% of mothers could not give any specific time for first feed. Bahl (1979) observed that 84% of the children were given their first feed 12 h after birth. Discussion with mothers and caretakers of children revealed that some of them believed that breast feeding given immediately after birth was not good for child's health and others gave the first feed very late due to the traditional beliefs of unknown origin (Table 2).

TABLE 2

Time of giving first feed to children before starting breast feeding

Time (h)	Percentage	Reason	Percentage
Less than 12	23.3(28)	Traditional practice	52.5(63)
Between 12-24	32.5(39)	Colostrum is not good for child's health	20.0(24)
After 24	25.0(30)	Colostrum is difficult to digest	12.5(15)
Not fixed	19.2(23)	Colostrum is impure; child is not able to suck	15.0(18)

Values in parentheses denote number of subjects.

About 47.5% children were given sugar dissolved in warm water within 1 to 2 h of birth, 20% of children received honey and water, 22.5% **janam ghuti**, 6.7% commercial **ghuti** and sugar water and 3.3% of children got sugar and omum **(ajwain)** dissolved in warm water as their first feed. Bansal *et al.* (1973) reported a similar pattern regarding the first feed given to the new born child after birth. Rao *et al.* (1959) reported that breast feeding is usually started 2 to 3 days after delivery. During the interim period babies in South India are usually given water, diluted cow's milk or honey. It is believed that these feeds clear the digestive system of the infant and stimulate suckling reflex. Almost all the mothers did not feed colostrum to their infants because of the belief that it is impure milk or that baby is not able to digest it. Some of them believed that colostrum was harmful for the child's health.

A large percentage (95.8) of mothers fed their children on demand and only 4.2% fed them at fixed time intervals of 3 to 4 h. Yeung *et al.* (1981) reported that in Canada during the first month approximately 68% of the mothers attempted to feed their babies on demand. However, shortly thereafter, a feeding pattern was established and the infants were fed on schedule. Frequency of breast feeding in case of the infants below six months of age was not fixed. About 72% of the children between 6 to 12 months of age were fed more than five times a day. Frequency of breast feeding decreased with increase in the age of the child (Table 3). Rao *et al.* (1959) observed that the mean frequency of breast feeding in India was six times per day, with the frequency decreasing as the baby's age increased. Suckling time at breast ranged between 10 to 15 min in 50.0, 59.6, 88.1 and 58.8 per cent of children in age groups below 6, 6 to 12, 13 to 24 and above 24 months, respectively (Table 4).

Most of the children in age group 0 to 12 months were given night feeding, whereas 40.5 and 76.5 per cent children in the age group 13 to 24 months and above 24 months of age, respectively, received no night feeding. The concerned mothers felt that the children were old enough to skip the night feed.

Data regarding the duration of breast feeding show that 15.8% of mothers breast fed their children for 1 to 2 years,

TABLE 3

Frequency of breast feeding (%)

Frequency of feeds per day	Age groups (months)			
	below 6	6 to 12	13 to 24	Above 24
More than 5 or not fixed	100.0(14)	72.3(34)	35.7(15)	5 9(1)
3 to 5	—	27.7(13)	50.0(21)	35.3(6)
Less than 3	—	—	14.3(6)	58.8(10)

Values in parentheses denote number of subjects

TABLE 4

Length of breast feeding (%)

Length (min)	Age groups (months)			
	below 6	6 to 12	13 to 24	above 24
Less than 10	7.1(1)	4.2(2)	7.1(3)	35.3(6)
10 to 15	50.0(7)	59 6(28)	88.1(37)	58.8(10)
More than 15	42.9(6)	36.2(17)	4.8(2)	5.9(1)

Values in parentheses denote number of subjects.

TABLE 5

Use of galactogogues

Food item	Percentage
Cumin seeds and milk	25.8(31)
Cumin seeds, milk and ghee	23.3(28)
Cumin seeds, milk and omum	9.2(11)
Cumin seeds, milk, ghee and panjiri*	3.3(4)
Cumin seeds, milk and panjiri	2.5(3)
Cumin seeds, ghee, omum and panjiri	0.8(1)
Cumin seeds, milk and nuts**	0.8(1)
Cumin seeds, milk, ghee and nuts	0.8(1)
Milk and ghee	8.3(10)
Milk, ghee and omum	20.0(24)
Milk, ghee, omum and panjiri	2 5(3)
Milk, ghee, omum and halwa	0.8(1)
Milk, ghee, omum and panjiri	1.9(2)

Values in parentheses denote the actual number of subjects.

*Recipe prepared by using wheat flour, ghee, gum acacia, omum and nuts.

**Include almonds, cashew nuts, raisins, etc.

15.0% above two years, 42.5% till the commencement of next pregnancy and 9.2% till the milk dried up. Most of them (42.5%) believed that feeding the infant after next pregnancy was harmful for the child as well as for mother's health. Breast feeding was continued in 1.7% mothers even after the commencement of the next pregnancy. Ten per cent of the mothers believed that prolonged breast feeding prevents conception, whereas 12.5% did not agree with this view and 77.5% of respondents had never heard of any benefit of prolonged breast feeding for prevention of subsequent conception.

Lactating mothers consumed a number of food items to increase their milk secretion (Table 5). Most of the mothers were of the opinion that consumption of cumin seeds, milk, ghee, panjiri (gond) and omum increased the secretion of milk (Table 5). Almost all the women were taking these items after delivery except a few of them who could not afford to purchase these because of

poverty. It was found that with increase in per capita income consumption of these foods increased.

Bottle Feeding Practices

Artificial feeding was started between the age of 6 to 12 months in most of the cases. In the age group below six months, 71.4% of infants were entirely breast fed (Table 6). In the age group 6 to 12 months and 13 to 24 months only 6.4 and 2.4 per cent of the children, respectively were entirely breast fed and no child above 24 months of age was wholly breast fed.

Artificial feed given to the children included cow's or buffalo's milk whichever was available in the house. Children were fed usually from a cup, spoon or **katori** and only 4.2% had a bottle. Milk was diluted before feeding to the children as dilution was considered to make it easily digestible. Proportion of dilution of milk to water varied from 1 : 1 to 3 : 1 and only a small percentage of children were given undiluted milk (Table 7). About 78% of the mothers were adding sugar to the milk to sweeten it and only 9.2% children were given unsweetened milk. More than 60% of mothers did not add any spices to milk, whereas 39.2% of them were adding fennel seeds, cardamom or both. The spices were believed to make the milk more digestible.

TABLE 6

Bottle feeding practices (%)

Type of milk fed	Age groups (months)			
	below 6	6 to 12	13 to 24	Above 24
Buffalo	—	38.6(17)	24.4(10)	52.9(9)
Cow	25.0(1)	13.6(6)	7.3(3)	—
Buffalo and cow (whichever is available)	75.0(3)	47.7(21)	65.8(27)	47.1(8)
Goat	—	—	2.4(1)	—

Values in parentheses denote the actual number of subjects.

TABLE 7

Dilution of animal milk in bottle fed infants (%)

Proportion of Milk : Water	Age groups (months)			
	Below 6	6 to 12	13 to 24	Above 24
No dilution	25.0(1)	18.2(1)	9.8(4)	35.3(6)
75 : 25	50.0(2)	43.2(19)	36.6(15)	35.3(6)
50 : 50	--	9.1(4)	29.3(12)	5.9(1)
No fixed proportion	25.0(1)	29.6(13)	24.4(10)	23.5(4)

Values in parentheses denote the actual number of subjects.

Weaning Practices

Data regarding the age of introduction of first supplementary food in different age groups have been presented in Table 8. Supplementary foods were started in 6.4% of children before six months of age. Thirty four per cent children received supplements between the age of 6 to 9 months and another 34% between 9 to 12 months of age. The results of this study are similar to those reported by Gupta *et al.* (1979), who observed that supplementary feeding was started between 7 to 12 months of age in more than 50% of children. Thimmayamma *et al.* (1980) on the other hand found in a study conducted on urban children of Hyderabad that at 4 months of age almost all babies were receiving cereal and pulse based semi-solid supplements in addition to breast milk. Supplementary foods given included tea, semi-solid foods like **khichari, dalia, kheer** and thin **halwa** and solid foods like **chapati** and biscuits. None of the food supplements given to children supplied ascorbic acid. No child was given tomato juice or vegetable soup as the food supplement. Green leafy vegetables were also not included in the supplements. Bansal *et al.* (1973) and Vijayadurgamba and Geervani (1979) also reported that the highest percentage of the children were given supplementary foods within a year of birth and semi-solid foods included rice dishes, **chapati**, porridge, cooked vegetables, mashed banana, biscuits, etc.

Most of the mothers did not prepare any special foods and the children were given the same foods as prepared for the family. None of the mothers gave commercial baby foods to their children.

It was found that milk, butter, fruits, bengal gram flour & jaggery were some of the foods considered good for the children Pulses were avoided because of the belief that they caused gas formation and lead to digestive troubles. Curd was not given to young children as it was considered to be a cold food.

From the above observations it can be concluded that there was widespread ignorance among the mothers about the nutritive value of colostrum and the special nutritional needs of the children. It is a well known fact that colostrum is very rich in globulins and helps the infant to develop natural immunity against infections. The mothers, therefore, need to be

TABLE 8

Age of introduction of supplementary foods (%)

Age of supplementation (months)	Age groups (months)			
	Below 6	6 to 12	13 to 24	above 24
No supplementation	100.0(14)	25.6(12)	4.8(2)	—
Below 6		6.4(3)	—	—
6 to 9		34.0(16)	47.6(20)	17.6(3)
9 to 12		34.0(16)	42.9(18)	76.5(13)
above 12			4.8(2)	5 9(1)

Values in parentheses denote the actual number of subjects.

educated about the importance of colostrum for new borns. Nutrition education to the mothers is also required for the preparation of the supplementary foods suitable for children with slight modifications in the normal existing diet of the family without spending extra time and money. Nutrition education regarding importance of foods rich in vitamin A and C and minerals—iron and calcium in the diets of the children is also needed so as to improve the overall nutritional status of infants and children.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 160—163 (March 1983)

DYNAMICS OF CHILD LABOUR IN HISSAR TOWN

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(Received : April 30, 1981; Revised : July 16, 1982)

ABSTRACT

India has the largest share of child labour in the world. Present exploratory study pertained to hundred child labourers in Hissar town of Haryana State. Poor economic conditions and other related factors were found to be prominent in compelling the children to work. Social factors like friend's company, father's crude behaviour, lack of affection, illiteracy of their family members, and larger size of their families were also found to influence the phenomenon of child labour.

The real wealth of a country is not the amount of coins or bank-notes that it possesses, but its people and not least of all, its children. Child labour according to section 2(c) of the Indian Factory Act, 1948, means a person who has not completed his/her 15 years of age and is employed in a gainful activity or activities. India has the largest share of child labour in the world. According to 1971 census most of the children are employed as cheap agricultural labourers. Children are also employed in countless numbers in restaurants, hotels, tea-stalls and as ice-creams or sweet vendors in towns. Numerous factors are responsible for forcing the child to work at an early age. Sachdeva (1961) stated that mass illiteracy and meagre income of the labour class are the important factors subjecting children to exploitation. Bhagoliwal (1966) reported that the economic necessity and wage earning to support family, deprive the child of opportunity for education, wholesome play and recreation and stunts his physical growth. Iyer (1968) stated that the continuance of child labour in India which came into practice with the advent of modern industrialization is the low level of earnings of adult workers which necessitates their sending children for any work, on any wage so that they might survive. Daniel (1976) and Chander and Lali (1979) observed that the children work mainly due to poverty. Karlenkar (1980) stated that the children were compelled to join the labour force to supplement the family income.

A review of studies on the subject leads to the conclusion that poverty was the most prominent compelling force to bring children to work at such a tender age. Not much attempts have been made to know the dynamics of child labour in its totality. Moreover, in Haryana the area remains unexplored. However, this problem is taking new dimensions because of increased rural migration to urban areas in search of employment necessitated by increase in population below

poverty line. Therefore, it was considered imperative to investigate the dynamics of child labour in Hissar town at a time when we have just celebrated 1979 as International Child year for relieving them from the clutches of ruthless exploiters.

METHODOLOGY

The study pertained to hundred child labourers in Hissar town of the Haryana State. The respondents were located after visiting and enquiring from a quite larger number of persons spread out to different parts of the town. During preliminary survey it was established that children are employed mainly in domestic activities followed by tea-stalls and hotels/dhabas. So 40 respondents working each in tea-stalls and house-hold activities and 20 working in hotels/dhabas were selected randomly from different localities of the town in the year 1980. The data were collected with the help of pretested and structured schedule personally administered to the respondents. Averages and percentages were calculated for drawing inferences.

RESULTS AND DISCUSSION

Dynamics of child labour is an intricate complex social phenomenon. An appraisal of Table 1 reveals that 55% respondents were forced to join labour force mainly due to acute poverty of their families. Moreover, 12 and 3 per cent respondents had to work at such an early age because of death and continued illness of their fathers, respectively. In other words, it can be stated that around two-third respondents were forced to work mainly due to poor economic conditions of their families. It was noticed that around four-fifth of respondents were coming from families whose average monthly income was less than 300 rupees, whereas only 10% were coming from families whose monthly income ranged between rupees 300-600. The average size of their families was eight which indicates that families whose economic standings were below poverty line had to join labour force, however, this generalization found wider applicability as one goes to the poorest families in the poverty line brackets. Iyer (1968), Daniel (1976), Chander and Lali (1979) and Karlenkar

TABLE 1

Factors responsible for respondents employment

Reason/factor		Frequency
1	Poverty	55
2.	Friend's company	21
3.	Father's death	12
4.	Father's crude behaviour	5
5.	Lack of affection	4
6.	Father's continued illness	3
	Total	100

(1980) reported poverty as the main cause while investigating the causes for child labour. Moreover, 48 and 15 per cent respondents were represented by families possessing land holdings and livestock, respectively. However, the size and quality of their families possession reveal that more than four-fifth of the land owning families possessed small and marginal holdings and livestock of poor breeds. Furthermore, it was observed that 66% respondents had come from labour families, whereas 28% belonged to the farming families that too from the small and marginal categories. It again points out that the respondents were mainly forced to join labour force due to acute poverty of their families, again confirming poor economic conditions of respondents families.

Social circumstances were also found to influence the phenomenon of child labour. Company of friends, crude behaviour of father and lack of affection in the family were the important social situations reported by 21, 5 and 4 per cent respondents, respectively as factors responsible for respondents employment. In addition to these factors, it was observed that caste, family size and literacy levels of family members also contributed substantially in intensifying the evil of child labour. Analysis revealed that around four-fifth respondents had come from scheduled and backward castes, whereas one-fifth were from the upper castes. It may be concluded that the evil of child labour is not confined to any particular caste, however, its proportion is much more amongst scheduled and backward castes. Chander and Lali (1979) also reported similarly. Family size analysis disclosed that 54 and 29 per cent respondents were coming from families comprised of 6 to 8 and above 8 members, respectively, whereas only 17% had come from families whose size ranged between 3 to 5. The average family size was eight indicating a larger size of their families compared to the national average. The probable reason may be the inability of the family head to provide adequate food and other necessities to his family members which in turn pushed children to earn their livelihood and to supplement family income at such an early age. Illiteracy is also an important limitation to attain better socio-economic status in the modern society. It was noticed that around four-fifth members of the respondents families were illiterate, whereas around 12% were educated upto primary and the rest were above primary. Sachdeva (1961) also reported illiteracy as a factor responsible for forcing children to work.

The analysis presented above confirms that poverty continues to be the most important factor compelling children to work as labourers. All the economic dimensions of the respondents families such as income, occupation and moveable property depicted clearly the role of these determinants in forcing children to work. Moreover, the economic structure of the country as elaborated by Shah (1981) highlighting the extent of poverty and income disparities in the country indicates a trend where the problem of child labour would increase over the years. Employing children at such a tender age when they need to be looked after well they are being harshly looked down and exploited upon by their employers which is bound to fall heavily upon them and the general progress of

the Nation. Therefore, there is an urgency to check this evil at the earliest.

Secondly, social factors such as mass illiteracy, larger family size and caste values were closely associated with this social evil. It can be deduced that continued prevalance of mass illiteracy amongst respondents families did not convince them to adopt modern values such as smaller family size. These social situations did not allow families to come out from the vicious circle of social and economic maladies. Therefore, it is imperative to break their ignorance and provide elementary education so that they may come out of the vicious circle of socio-economic poverty and adopt to modern values thereby help children to come out of the serious maladies in which they are being involved increasingly.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 164—168 (March 1983)

EXISTING HEALTH STATUS AND FUTURE NEEDS IN HARYANA

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(Received : March 3, 1981; Revised : November 6, 1981)

ABSTRACT

An attempt was made to measure existing status of health in Haryana State and to project the future needs for providing reasonably fair standards of health. Secondary sources of data have been extensively used for computation of health status indicators. Existing status of health in the State was poor and efforts being made to improve general level of health status would not meet the requirements for 1990-91. Some suggestions to ameliorate the problem have also been given.

Health planning in India, since independence has been guided by the Bhore Committee of 1946 and Mudaliar Committee of 1961.

The broad objectives of health care and service programmes in first three Five Year Plans were to control or eradicate major communicable diseases; to provide curative, preventive and promotional services through Primary Health Centres; and augmentation of training programmes of medical and paramedical personnel. During Fourth Plan emphasis was laid on strengthening the Primary Health Centre complexes and preventive health services. Whereas in Fifth Five Year Plan concerted efforts were made to provide minimum public health facilities integrated with family welfare and nutrition for vulnerable groups (children, pregnant women and nursing mothers).

Achievements during the plan period fell short of the targets, especially in the minimum needs programme where objective was to create adequate infra structure and health care services in rural areas (Planning Commission, 1978). Therefore, it is essential at this stage to look at the present status of health in the State for appropriate planning and effective implementation of health programmes to achieve the goal of providing 'Health for all by 2000 AD' (Alma Ata Declaration).

METHODOLOGY

Status of health is measured in terms of birth and death rates, diseases prevalence, nutritional level, health institutions, medical and paramedical personnel and bed facilities (Dutt, 1962; Raman and Gupta, 1973; Pathak and Kataraki, 1978) Data on aforesaid aspects were computed

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and complemented with the help of secondary sources. Health status computed in this manner was compared with health standards defined by different authorities (Appendix I) for future projections.

RESULTS AND DISCUSSION

Health Status

Mortality. In Haryana death rate in rural areas has decreased from 11 to 9, whereas it is constant (8) in urban areas over the decade (1966-77). Of the total deaths in 1966, 42.28% were of infants below the age of 4 years and 50% of the children below age of 14 years. Among adult females 6.76% deaths were in the age group of 20–29. Infant deaths constituted about 40% of the total deaths and maternal deaths about 7% in 1977. Expectation of life (1979–80) at birth is 54.4 for male and 53.4 for female which is slightly higher than national level of 52.6 and 51.6, respectively.

Diseases. In 1966, out of total deaths, 85.54% were from cholera (0.04%), small pox (0.22%), fever (73.81%), dysentary and diarrhoea (1.32%), and respiratory diseases (10.15%). As many as 1.40 and 10.07 per cent deaths were from injuries and other causes, respectively. Deaths from cholera and small pox did not take place in 1977, whereas fevers, dysentary and diarrhoea, and respiratory diseases caused 52.06, 1.22 and 13.54 per cent of the total deaths, respectively.

Nutritional level. Malnutrition is a well recognised problem in the State and this problem was more acute among children, pregnant women and nursing mothers. Heavy toll of female deaths in potential age group of 20–29 years was nutritional drain because of repeated pregnancies. A country wide nutrition survey has revealed that 80% of the children in age group 0-4 years were below average in both height and weight (Sukhatme, 1978). Apart from protein-calorie malnutrition, vitamin A deficiency was much prevalent in this region which was generally responsible for blindness. Though no nutritional survey of this region is available yet, it is obvious that 37% of population of the State was suffering from under nutrition. They were below poverty line and were unable to provide 2033 calories. Similarly 77.29% of the total expenditure on food by small cultivators and labourers shows under nutrition in 50% of population (NSS 1977). The main food stuff of this group was cereals which constitute 37.6% of food expenditure of small cultivators and 47.5% of non-cultivating wage earners. Protein-calorie malnutrition was mild in this region.

Medical facilities. In the State there were 409 hospitals and dispensaries. Population served by each institution was 27,795 and patients treated (visited) per institution were 23,114. Trained medical officers were 733 (excluding teaching staff) who treated 113.69 lakh people. Thus, one medical officer was on 15,210 persons. Number of doctors (allopathic) registered were 107 who did private practice. Population per nurse or matron sister-incharge, midwife or ANMs, nurse orderly, dispenser or pharmacist and dai or nurse dai was 16,149, 22,647, 22,647, 21,370 and 63,161, respectively. Population per bed was 1,368. Population served by each ayurvedic and unani insti-

tution was 47,174, but it treated only 8984 patients. When all types of institutions were taken into account each institution served 17,490 persons and treated 17,875 patients taking mid-year 1977 population as 113.69 lakhs.

Each family planning clinic was to provide services to 1,06,252 persons. Under family welfare programmes percentage of eligible couples effectively protected (30.6.79) were 21.6. Out of these 19.9% sterilization, 0.9% IUCD and 0.8% other methods. In para medical staff the ratio of extension educators and health inspectors was 1,33,752 and 23,685, respectively.

Safe drinking water supply. Only 15.54% of the inhabited villages were provided with safe drinking water supply. Whereas 84.46% of villages (5685) were in danger of water borne diseases.

Finance. Annual budget of health department was Rs. 249,032,280 (1979-80) which was 3.2% of the State budget. Per capita expenditure of medical and health was Rs. 14.7 and Rs. 1.1 on medicine which was too less to meet the minimum requirements.

Thus, the health indicators clearly reveal a very poor health status in Haryana. According to per capita income State ranks second but in health status it ranks tenth (Pathak and Kataraki, 1978).

Projections for 1990-91

As the concept of health is vague it is not possible to have rigid yard stick. Therefore, for the present study standards fixed by Health Survey and Development Committee, 1946 (Bhore, 1946) were taken into consideration.

Health facilities in State were too poor to provide minimum medical and health care. Most of the hospitals (92.7%) were located in urban areas. Rural health care and services were being looked after by 77 PHCs and 6 hospitals only. According to health standards (Bhore, 1946) for 40,000 people there should be one PHC. Therefore, the additional number of rural PHCs required were 174 and 224 by 1980-81 and 1990-91, respectively. In urban areas much demand of medical care and services was met by trained private practitioners as almost all (107) of the registered doctors (allopathic), not serving in government departments, practised in urban centres. Rural areas have always been deprived of health services. Additional requirements of health personnel (Table 1) for 1980-81 and 1990-91 based on the standards fixed by Bhore Committee (1946) clearly reveal an acute shortage of trained medical personnels and especially the women personnels. There is no scope of meeting the additional requirement of health personnel by 1980-81 and the future is also bleak because of poor training facilities. Additional requirements are expected to take 40 years instead of ten years, if the present rate of turn over of medical personnels continues.

SUGGESTIONS

There is need of emphasizing both preventive and curative services but more efforts be made along preventive lines. Element of health education should be stressed in schools and already existing

TABLE 1

Health personnel requirements for 1980-81 and 1990-91

Class of personnel	Strength as on 31.12.1978			Requirements by 1980-81 (for estimated population of 123.7 lakhs)		Requirements by 1990-91 (for estimated population of 149 lakhs)	
	Govt. service	Registered	Total	Total	Additional	Total	Additional
Doctors (allopathic)	1081	107	1188	6185	4997	7450	6262
Nurses	1125	—	1125	4123	2998	4966	3841
Midwives (ANMs also)	1369	1536	2905	3092	187	3725	820
Lady Health Visitors	274	138	412	2474	2062	2980	2568
Sanitary Inspectors	480	—	480	492	12	596	116

school health services should be revitalised (Chadha, 1979).

Community participation can be increased by involving people in planning and execution of health programmes. It will also create awareness of health among people without which actions on preventive lines are futile.

Cholera and small pox have been eradicated but no one knows the germs might be present at any place. A comprehensive public health and hygiene act should be framed and implemented with strong political will.

There is need to set up additional hospitals, PHCs, dispensaries, etc. at appropriate places. Community resources may be tapped for providing such facilities.

Trained medical staff is far lesser than optimum requirements. Therefore, single medical college can not meet the demand of doctors and other paramedical staff. Moreover, the trend of setting up private practice is increasing. There is need to create another medical college in the State. Special attention should be given to train more females to fill the wide gap.

At present it may not be feasible to invest much in training of health personnels. Therefore, RMP's already working in rural areas should be given short duration training in modern medicines and extension education. It will also fill up the gap between PHC complexes and community.

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APPENDIX I

Health Standards

Health personnel	Suggested ratio of number to population
Doctors	1 : 2000*; 1 : 5000**; 1 : 3000/3500****
Nurses	1 : 3000*; 1 : 5000 or 1 : 5 beds**; 1 : 2000****
Midwives	1 : 4000 or 1 : 100 births*; 1 : 5000 or 1 : 200 births**; 1 : 100 births***
Lady Health Visitors	1 : 5000*; 1 : 2000 or 1 : 4 midwives**
Sanitary Inspectors	1 : 25000*; 1 : 10000**
Dentists	1 : 4000*; 1 : 10000**

*Health Survey and Development Committee, 1946.

**The Planning Commission (cf. Dutt, 1962).

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 169—174 (March 1983)

IMPACT OF TRACTORIZATION ON LABOUR EMPLOYMENT IN HARYANA AGRICULTURE

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(Received : June 23, 1981; Revised : November 20, 1981)

ABSTRACT

The study revealed that with the increase in tractorization the employment of human labour, in general, declined. Taking into consideration the heavy capital investment in tractors and its accessories; rapidly increasing prices of petroleum products in world markets; under-utilization of available labour force, bullocks and tractor power in the State; and reduction in employment of human as well as bullock labour due to increase in tractorization, the social cost of tractorization considerably exceeds the gains from it.

In contrast to traditional agriculture which mainly depends on muscular power of human beings and draught animals, under the new agricultural technology the use of fertilizers, plant protection measures, mechanical power and assured irrigation facilities are considerably increased. In the State of Haryana, for instance, during the last one decade, the number of tractors, tubewells/pumpsets and use of chemical fertilizers have increased by 240, 310 and 300 per cent, respectively. The increased use of mechanical power has implication with the employment of human labour as well as the shortage of the petroleum products. The capital intensive new agricultural technology has further widened the gap between the rural poor and rich. Among the rich farmers, the tendency to replace the bullocks by tractor power is increasing with a quest to acquire more leisure and higher social status. Although a few scattered studies such as Rao (1975), Misra *et al.* (1976), Singh and Singh (1976) and Rao and Singh (1977) have been conducted in different parts of the country but so far no systematic empirical study has been conducted to estimate the magnitude of reduction in labour employment with increase in tractor power use particularly in the State of Haryana. With these considerations, attempts were made to study the impact of tractorization on employment of human labour on various categories of farms in Haryana.

METHODOLOGY

The primary data for this study for the years 1978-79 and 1979-80 were taken from the farm business records of 300 sample farmers selected from Ambala, Karnal, Kurukshetra, Sonepat, Jind, Hissar and Sirsa districts of Haryana State. The design of study was stratified three-stage random sampling with tehsil as the primary sampling unit, a cluster of three villages as the second stage unit

and operational holding within the cluster as the third and ultimate stage sampling unit. Ten farmers were selected from each cluster.

Based on the source of draught power used to perform various agricultural operations, the sample farms were categorised into (i) farms exclusively depending on bullock power (category I), (ii) farms mainly depending on bullock power but also occasionally using hired tractor power (category II), (iii) farms mainly depending on tractor power but also maintaining bullocks for some specialized works (category III), and (iv) farms exclusively depending on tractor power (category IV). The number of sample farms falling in I, II, III and IV categories was 100, 120, 50 and 30, respectively. Simple statistical tools were used to find out the utilization pattern of human, bullock and tractor power for various categories of the sample farms.

RESULTS AND DISCUSSION

The use pattern per hectare of human, bullock and tractor power on different categories of farms has been given in Table 1. The employment of mandays of human labour per hectare on category I (exclusively bullock power operated farms) was highest in sugarcane (161) followed by paddy (118), cotton (108), wheat (86), maize (57), barley (45), **jowar** (40), **bajra** (39), rapeseed and mustard (37), and gram (31). The per hectare employment of human labour on categories II, III and IV of the sample farms declined by 36, 44 and 45 per cent in wheat; 11, 13, and 36 per cent in paddy; 2, 28 and 31 per cent in cotton; 15, 32 and 49 per cent in gram; 5, 16 and 17 per cent in barley and 4, 0 and 46 per cent in **jowar**, respectively, over the employment of human labour on category I farms. However, per hectare employment of human labour on category III farms was higher by 2, 50 and 3 per cent in case of maize, **bajra** and sugarcane, respectively. This was mainly due to adoption of relatively improved production technology on category III farms.

The per hectare employment of pair-days of bullock labour on category I farms was also highest in sugarcane (29.52) followed by wheat (23 40), paddy (21.05), rapeseed and mustard (12.74), maize (12.73), barley (12.00), cotton (10.91), gram (10.31), **jowar** (10.07) and **bajra** (8.85) (Table 1). The magnitude of reduction in per hectare use of bullock labour on categories II, III and average of all sample farms was 49, 83 and 60 per cent in paddy; 33, 76 and 32 per cent in maize; 25, 47 and 15 per cent in **bajra**; 16.83 and 6 per cent in **jowar** 18, 60 and 4 per cent in cotton; 68, 90 and 63 per cent in wheat; 45, 90 and 27 per cent in gram; 17, 78 and 4 per cent in barley; and 68, 88 and 64 per cent in sugarcane, respectively, as compared to category I farms. In case of bullock power operated farms supplemented with tractor power (category II), the reduction in per hectare use of bullock labour was more pronounced in wheat, sugarcane and paddy and it was relatively low in **jowar**, barley, cotton, and **bajra**. The considerations for timely preparation of field for planting paddy and wheat crops, existence of heavy (clayey) soils, and easy availability of tractor power on custom hiring basis were the main factors leading to increased use of tractor

TABLE 1

The use pattern per hectare of human, bullock and tractor power on different categories of farms

Particulars	Paddy	Maize	Bajra	Jowar	Cotton	Wheat	Gram	Rapeseed and mustard	Barley	Sugarcane
I. Exclusively bullock-power operated Farms										
1. Human labour (mandays)	118 21	56.85	39.07	40.11	107.97	86.12	30.97	36.91	45.20	160.71
2. Bullock labour (pairdays)	21.05	12.75	8.85	10 07	10.91	23.40	10 31	12.74	12.00	29.52
II. Bullock-power operated farms supplemented with tractor power										
1. Human labour (mandays)	105 51	52 66	36 88	38.51	106.00	55.22	26.38	34.51	42.95	140 50
2. Bullock labour (pairdays)	8.35	8.54	6.64	8.48	8.91	7.59	5.71	10.34	10.00	9.33
3. Tractor power (h)	10 70	4.20	2.20	1.60	2.20	12.90	4.60	2 40	2.00	20.20
III. Tractor-power operated farms supplemented with bullock-power										
1. Human labour (mandays)	102.50	58.00	58.60	40 59	78.20	48.10	21.00	26 72	37 88	164.39
2. Bullock labour (pairdays)	3.52	3.01	4.70	1 70	4.33	2.42	1.01	2.10	2.65	3.67
3. Tractor power (h)	12.16	13.43	6.91	10.81	9.35	28.63	14.83	6 67	23.75	32 57
IV. Exclusively tractor-power operated farms										
1. Human labour (mandays)	75.10	50.72	22.14	21 73	75.00	47.15	15 93	—	37.51	150.50
2. Tractor power (h)	15 89	15.56	7 68	12.38	11.25	31.48	14 90		26 60	45.39
V. Average of all the sample farms										
1. Human labour (mandays)	108.13	53.04	37.24	39.27	102.50	53.21	27.13	35.10	43.50	145.00
2. Bullock labour (pairdays)	8.50	8 60	7.50	9 50	9.40	8.65	7.50	11 30	11.50	10.50
3. Tractor power (h)	9.60	3.40	1.80	1.30	1.50	10.50	3 50	1 50	1.50	19.50

power in case of these crops in category II farms.

The average number of tractor hours used per hectare of the crop area in categories II, III, IV and average of all sample farms has been presented in Table 1. In case of the exclusively tractor power operated farms (category IV), the use of tractor hours per hectare was highest in sugarcane (45) followed by wheat (31), barley (27), paddy (16), maize (16), gram (15), **jowar** (12), cotton (11), and **bajra** (8). However, the use of tractor power per hectare was slightly lower on category III farms but it was considerably low on the farms of category II and average of all the sample farms. As it requires huge capital investment for acquiring the specialized accessories for various crops grown on the farms, majority of the tractor owners preferred to maintain draught animals also to perform some specific agricultural operations like sowing, interculture, etc. The use of tractor power has become more prevalent in the sugarcane and paddy growing tract of the State. After the harvest of paddy crop the preparation of land for planting wheat must be completed within a short period. Further, due to existence of relatively heavy soils in this region, the tractor power suits more than bullock power particularly for the first ploughing/harrowing. Due to these reasons even the farms basically operated by bullock power use hired tractor power, quite often.

In the total labour employment, the share of harvesting, threshing, winnowing and transportation operations varied from 45 % in paddy to 73% in **jowar**. The preparation of land and sowing operations accounted for 7 to 30 per cent of total human labour employment in various crops. Similarly, the employment of labour in performing irrigation and interculture operations varied from 7% in **jowar** to 40% of total labour employed in cotton (Table 2).

The preparation of land and sowing operations accounted for 72 to 95% of total bullock power used in case of the important crops except for sugarcane in which case this figure was only 38 per cent. This shows that tillage operations consume bulk of the bullock power in most of the crops. In case of the tractor power also the preparation of land and sowing operations consumed bulk of it ranging from 54% of total tractor hours per hectare used in wheat to 100 per cent in **jowar**. However, harvesting, threshing and transportation consumed the largest share of total tractor hours used per hectare in case of sugarcane and paddy (Table 2).

In 1971, the labour force in Haryana agriculture consisted of 13,03,000 cultivators and 4,30,000 agricultural labourers. Based on the existing cropping pattern and per hectare requirement of human labour for different crops, on an average each agricultural worker in the State got gainful employment in crop raising activities for only 164 days per year. Similarly, each pair of bullocks was used for 176 and 80 days per year on the farms of category I and II, respectively. The average size of the tractor operated farms was 12.28 hectares and the average annual use of tractor worked out to be only 372 h (Pandey and Panghal, 1981). This reflects upon the under utilization of the available human, bullock and tractor power in the State.

TABLE 2

The average yield, amount of fertilizers and irrigation applied and percentage distribution of human, bullock and tractor power used per hectare on major operations on the sample farms

Particulars	Paddy	Maize	Bajra	Jowar	Cotton	Wheat	Gram	Rapeseed and mustard	Barley	Sugarcane
1. Number of observations	126	58	87	141	77	196	144	27	35	114
2. Quantity of fertilizers used (kg of NPK/ha)	120	110	32	10	100	124	3	37	48	108
3. Average number of irrigations	9.5	1.2	0.1	1.1	1.0	4.4	0.2	0.8	3.2	5.8
4. Average yield (q/ha)	38.73	14.00	4.98	244	2 43	25.02	8.85	6 25	15 42	339
5. Percentage of total human labour used in										
(i) Preparation of land and sowing	25	18	15	20	7	17	20	30	20	5
(ii) Harvesting, threshing, transportation, etc.	45	45	64	73	53	53	63	60	54	58
(iii) Irrigation, interculture, etc.	30	37	21	7	40	30	17	10	16	27
6. Percentage of total bullock-power used in										
(i) Preparation of land and sowing	95	95	81	79	72	91	80	88	75	15
(ii) All other operations	5	5	19	21	28	9	20	12	25	85
7. Percentage of total tractor-power used in										
(i) Preparation of land and sowing	43	33	64	100	80	54	63	75	60	11
(ii) Harvesting, threshing, transportation, etc.	57	67	36	0	20	46	37	25	40	89

The data listed in Tables 1 and 2 also reveal the existence of a high degree of association in per hectare value of crop output, quantity of fertilizers (NPK) applied, number of irrigations given and number of mandays of human labour employed. Further, with the expansion in irrigation facilities, there is a shift in area from low value crops like **jowar, bajra**, maize, gram, rapeseed and mustard to relatively high value crops like paddy, wheat and sugarcane which in turn also results in increase in employment. From the above discussion it is evident that the social cost of tractorization is considerably higher than the gains from it.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 1, pp. 175—181 (March 1983)

CHOICE PATTERN OF VILLAGE PANCHAYAT MEMBERS : A SOCIOMETRIC STUDY

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(Received : December 11, 1981; Revised : July 6, 1982)

ABSTRACT

Among different factors, caste was the most dominating factor in determining the interaction pattern among village Panchayat members. Younger or middle age, education, political awareness and contact with government officials were the necessary conditions for emerging as a political leader. In social aspects, advanced age, socio-economic status, experience and maturity were the main guiding forces, whereas in agricultural leadership progressiveness of the individual in the field was most important. The increasing importance of younger age, education, women's participation and diffusing pattern of leadership indicated some changes in rural leadership.

The success of all community development programmes, social reforms and extension work largely depends upon the involvement and cooperation extended by the village Panchayat members and other local leaders. These people reflect the level of group thinking, exert maximum influence on other members of the group in shaping their attitudes, beliefs and values. They also direct and control their behaviour. Thus, they play a vital role in reconstruction of rural society.

Since the beginning of statutory Panchayats there were many hopes and expectations and many claims too, regarding the developmental changes in rural India. But, there is not much evidence that new aspirations and new urges for development have actually started (Sinha, 1969). However, changes in economic status through improved agricultural farming and in attitudes toward certain social issues are evident but the change in the pattern of social interaction which is most crucial, is still in question. For a healthy community life, the social harmony is the pre-requisite, without which the rural India in its true sense, can never develop. Panchayat members are village leaders and represent various strata of the community. The social relationships between them will be an index of knowing the interactional process in the village community at large.

A trend of systematic researches on rural leadership in India started about three decades back (Dhillon, 1955; Barnabas, 1958) and since then a number of attempts have been made to identify the local leaders and their correlates (Roy, 1967; Mehta, 1972; Gangrade, 1974; Shukla, 1976; Misra, 1977; Saran, 1973;

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Ansari, 1980). However, the field of identifying the channels of interpersonal influences among the Panchayat members which is important for extension of rural developmental programmes has remained much neglected.

Keeping these points in view the present investigation was carried out with the following objectives : (i) to trace the pattern of interaction among the members of Panchayat in terms of political, social and occupational activities and (ii) to identify the role of socio-economic variables in the emergence of rural leaders.

METHODOLOGY

The study was conducted on 25 members of village Panchayat elected during 1959-81 of Barani-Fortpura village falling under tehsil Jhajjar, district Rohtak of Haryana State. Village was dominated by Jats (40%) followed by Rajputs (35%), Chamars (12%), Kumhar (8%) and others (5%) like Brahmin, Banwari, Dhanak, Bania, Arora and Chura.

In order to know the pattern of interaction each member was approached separately and rapport was built up. He was asked to name two persons for each stimuli, out of the remaining 24, he would like most to consult (i) for casting vote in M.L.A.'s elections, (ii) in setting marriages of his children, and (iii) on problems regarding farming. Information on personal, social and economic aspects of these members was also recorded.

On the basis of their choices, sociograms prepared for each stimuli are presented in Figs. 1-3 where J=Jat, T=Thakur, C=Chamar, K=Kumhar and △ for women.

RESULTS AND DISCUSSION

Voting Purpose

For voting purposes (Fig. 1) the whole group of 25 Panchayat members was divided into factions completely based on castes. There was no superstar in the group, however, no. 1 enjoyed the maximum support of the members belonging mostly to his own caste. He was a Jat and supported by seven Jats out of nine Jat members and one Kumhar out of two Kumhar members. Thakurs had chosen the member of their own caste for the purpose of consultation on political issues. Chamar and Kumhar had not shown the strong tendency of forming their own groups rather, they preferred being with Jats than with Thakurs. However, among the lower castes one woman member who herself was a Chamar enjoyed the maximum support among the members of low castes. Her supporters were two Chamars and one Jat.

The person who got the maximum choice was a Sarpanch and was 50 years old. He was educated upto 8th class, owned 8 acres of land in the village and was elected twice in the Panchayat. The other person no. 20 was preferred most only by Thakur members. He was educated upto 10th class, owned 30 acres of land and was 40 years old. The second important person among the Thakurs (no. 22) was 65 years old, owned 25 acres of land but illiterate.

The findings clearly show that the group was completely divided into two major factions of dominating castes. They

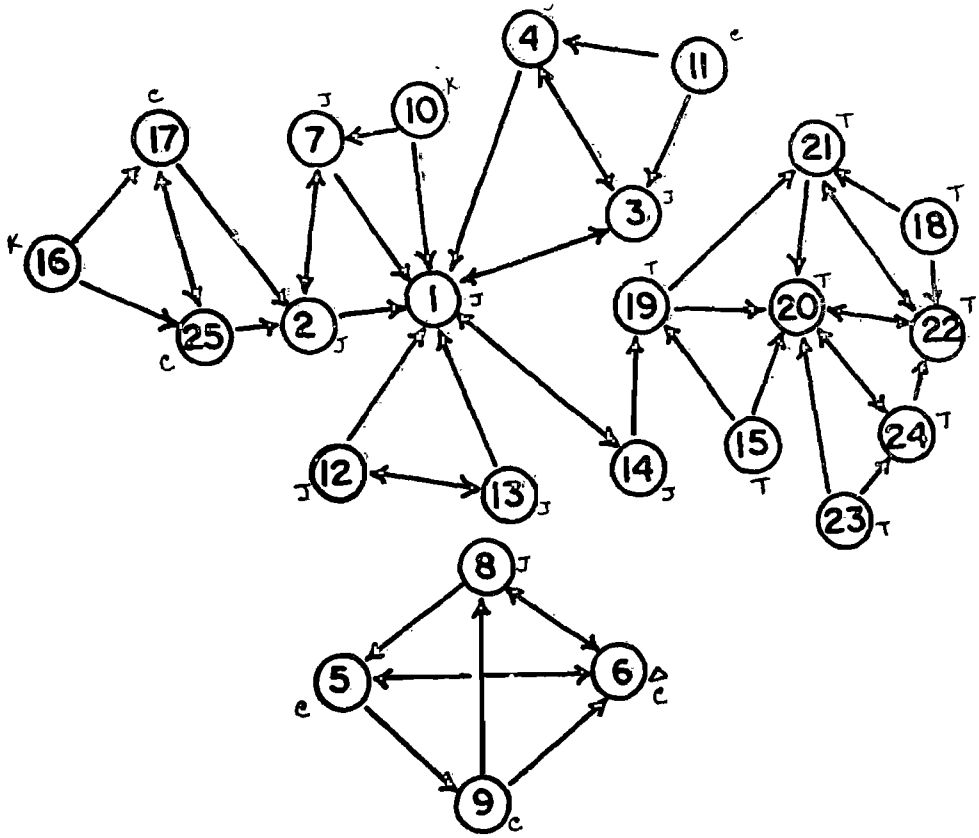


Fig. 1. Like most to consult for voting.

confined their activities within their own caste members and maintained no link with the members of other factions. This was observed in previous studies also (Singh, 1968; Mehta, 1972; Gangrade, 1974; Misra, 1977) and the same is being observed today. The situation has not yet changed significantly.

The study also shows the hold of higher castes in village leadership as all the three persons who had emerged as leaders were from higher castes. Though the lower caste members were not much less than Jats or Thakurs, but instead of forming their own stronger group they preferred to support the member of the dominating castes. The submissive tendency among lower caste members which had made them more dependent in past is still prevailing. The dominance of upper caste in rural leadership as observed by many researchers in past (Srinivas, 1959; Roy, 1967; Mehta, 1972; Gangrade, 1974; Misra, 1977; Saran, 1978) still remains unchanged in our so-called present day democratic and secular society.

The numerical strength of the caste also accounts for the leadership. Jats were in majority, hence their member got maximum choice. The strong urge to power among dominating castes has made them to see the numerical strength of the lower castes. They have now started seeking their support. It is because of Panchayati Raj system that people have to now join hands across caste and socio-economic strata which is primarily due to their needs and not the internal harmony.

All the three factions showed the lack of inter-communications. Thakurs had very tight close-up circle of interactions. They confined their activities within their own community, whereas Jats seemed to be a little more liberal. Their relationship with low caste people was better than with the Thakurs. Thakurs neither supported nor enjoyed the support of low caste people. The better relationship between Jats and low caste members might be primarily due to their competition with Thakurs for the hold of power in the village Panchayats, the traditional work-relations or dependency need of the weaker section. The flow of communication was from lower caste to higher caste which might be due to the economic and social dependency of lower caste on higher castes. This has been interpreted by Punia and Sharma (1982) in terms of inbuilt inequalities in agrarian social structure.

The only woman candidate who belonged to the lower caste had the largest following in her own caste members. Women, generally, do not come forward but their statutory provision bring them forward. In the present study also the only woman member was under the same provision but her popularity among the Panchayat members indicates towards mild change in the traditional pattern of rural leadership which in past was solely with men.

Regarding the socio-economic variables important for leadership the present study reveals that besides caste, literacy, middle or young age with maturity and experience, sufficient landholding, political awareness and contacts with government officials are closely associated with political leaders among Panchayat members. Good socio-economic status, more education and good contacts were also observed by Roy (1967) and in addition middle age (36-46 years) by Mehta (1972), Shukla (1976) and Misra (1977). Old traditional leaders were being replaced by young and educated leaders.

The observations that the social distance between castes is narrowing down (Shukla, 1976), decreasing effect of caste in the selection of leaders (Singh and Sharma, 1980) and more people have started realizing that caste system is a social crime (Ansari, 1980) do not seem true here. However, some changes in the traditional pattern of leadership were observed in the study but the restricted pattern of interaction suggests that the basic structure of rural relationships has not undergone much change. The apparent change seems to be the working adjustment among the elite class and oppressed for their respective needs of dominance and security.

Settling Marriages

For consulting the members regarding settling the marriages (Fig. 2) of their

children, besides no. 1, no. 7 also emerged with equal strength among Jats. Among Thakurs besides no. 22, nos. 20 and 21 emerged as popular leaders for social matters. No. 7 was 80 years old and owned 60 acres of land and educated upto 8th class, whereas no. 20 was middle aged (40 years), owned 30 acres of land and educated upto 10th class. Thus, it is quite evident that for social leaders, age, maturity and experience, higher social status, enough landholding and education are more important factors. It is also obvious from Fig. 2 that for social matters consultation was confined to smaller groups of their own caste members.

Farming Problems

Regarding the problems of farming (Fig. 3) the maximum choice was given to a person (no. 18) who was absolutely isolated in other two pursuits. He was Thakur by caste, educated upto 10th class, owned 20 acres of land and was 40 years old. He was a progressive farmer, using modern techniques of

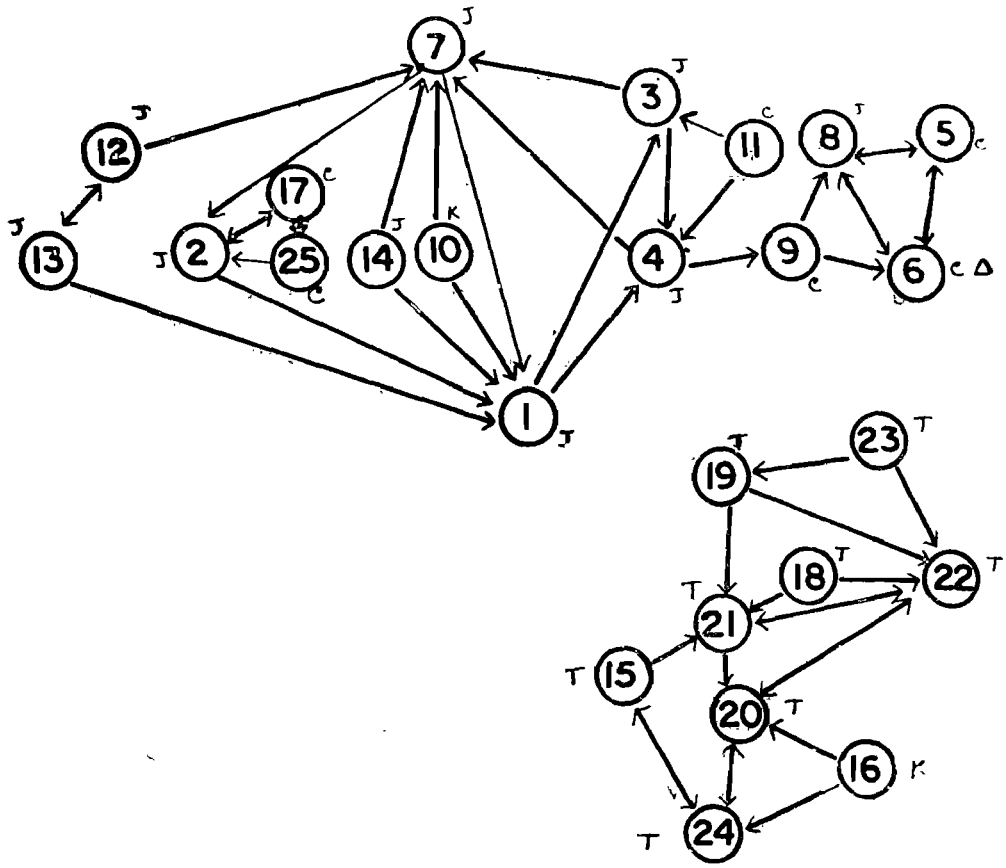


Fig. 2. Consult most in settling marriages.

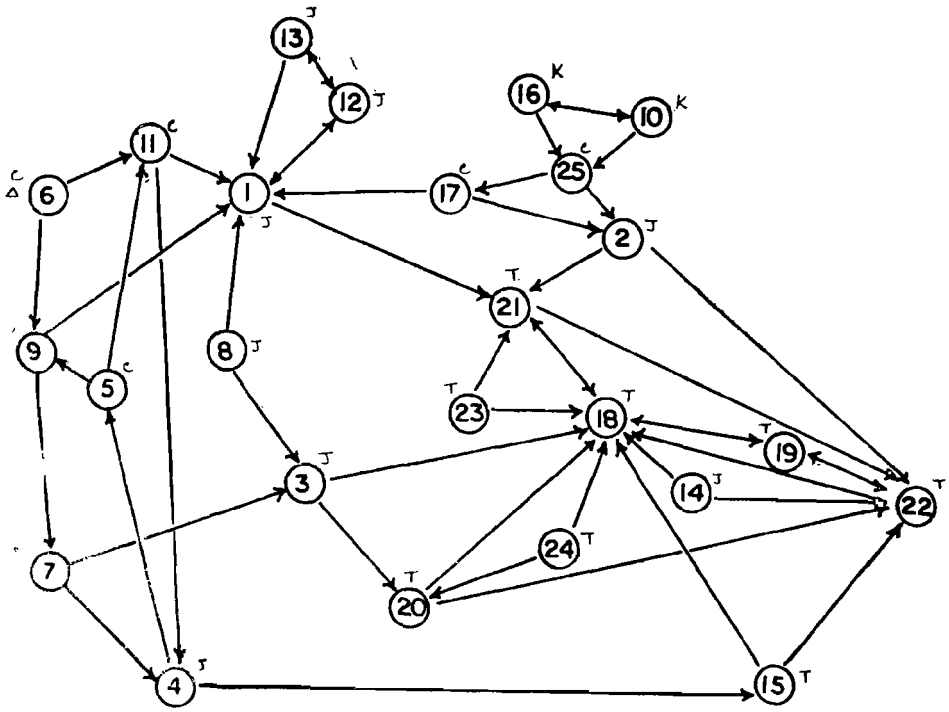


Fig. 3 Like to consult for farm problems.

farming and produced highest return. It clearly shows that in the field of agriculture, it is the progressiveness of the individual and not the age or caste which influences others. A few Jats had also given him their choices. The nature of new agricultural technology and its profitable results might be responsible for bringing changes in this aspect of rural leadership as also observed by Punia (1981). The emergence of progressive farmers as agricultural leaders also shows that leadership has become more specific and task-oriented. The village power now tends to be more diffused than centralized as also observed by Singh (1968) and Misra (1977).

The findings of the study suggest : (1) Different types of leaders in the village be spotted out before implementing any programme as leaders differ according to activity. (2) With the introduction of science and technology, leadership is becoming specific and task leaders are replacing the traditional ones, especially in the field of agriculture. Traditional leadership has gone out of gear. Hence, training for dissemination of agricultural technology should be given to middle or younger aged, educated and progressive farmers. (3) Caste and social status still enjoy high importance in other aspects of rural life which needs urgent attention of government and public both. An intensive campaign is required to eradicate social inequalities in our society.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 183—190 (June 1983)

STUDIES ON IMMUNITY PRODUCED BY IRRADIATED INFECTIVE LARVAE OF *HAEMONCHUS CONTORTUS*

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(Received : July 30, 1981; Revised : May 17, 1982)

ABSTRACT

Cellular immunity had no role in protection as was evident from the skin and leukocyte migration inhibition tests. Transfer of immune sera to the recipient goats from the double vaccinated group, gave 47.67% protection upon challenge and the sera from double vaccinated and challenged group could give 67.54% protection. However, the worms recovered from the recipient of sera from double vaccinated animals were more in number but were markedly stunted. The polyacrylamide gel electrophoresis revealed increase in IgG in parasite native animal even after challenge indicating the preparedness of immune mechanisms to resist the challenge and induce protection. A/G ratio always remained less than one. Counter-current electrophoresis appeared one of the immunodiagnostic tests against *H. contortus* in goats after 10-15 days of vaccination and lasting for a month only.

During development of parasitic nematodes the host animal is subjected to stimuli from many antigens, some being structural components of the worms and others being associated with the metabolism and development of the parasite. Living parasites or antigenic materials produced by them, seemed to be essential for the stimulation of a satisfactory resistance and the developmental stages would appear to be more important immunologically than the adult parasite (Mulligan *et al.*, 1961).

The panel on the use of isotopes and radiation (Anon., 1970) in studies of parasitic diseases in domestic animals recommended the agency to encourage a study on the mechanism of immunity to *H. contortus* infection in sheep.

In view of the above facts the present study was undertaken to investigate the duration and type of immunity *in vivo* and *in vitro* produced by irradiated infective larvae of *H. contortus* in goats.

MATERIAL AND METHODS

(a) Preparation of Adult Worm Antigen

Freshly collected worms were macerated in PBS solution of pH 7.2 to a final concentration of 10 per cent. The suspension was allowed to stand overnight at 4°C. The opaque supernatant obtained after centrifuging the suspension at 3000 rpm for 15 min formed the crude antigens.

(b) Preparation of Larval Antigen

The larval antigen was prepared as per method described by Stewart (1948). The protein content of the antigens was determined by the method of Lowry *et al.* (1951) and standardized as follows :

(a) 12 mg/ml and (b) 1.5 mg/ml.

Transfer of Immunity by Immune Serum

Two animals received sera collected and pooled from double vaccinated goats with irradiated larval vaccine. The goats were vaccinated orally with 2000 third stage 60 Kr irradiated larvae of *H. contortus* on 0 day. The second dose of vaccination was given with 5000 irradiated larvae orally on 35th day. On day 70 goats were challenged orally with 10,000 infective larvae. The next two animals received sera collected and pooled from double vaccinated and challenged goats. Two more animals kept as control were not given any serum. Serum was administered intravenously @ 30 ml per kg body weight in two divided doses after inactivation at 55°C for ½ hour. All the serum recipient goats were injected 1 ml Avil Vet (Hoechst) intramuscularly before the start of serum inoculation. These indigenous kids were of one to two months old locally procured and raised worm free up to six to nine months old and then were used for passive immunity transfer study.

Both the serum recipient and non-recipient (control) goats were challenged orally with 10,000 infective larvae within 48 h of the last serum administration. The goats were sacrificed 35 days after challenge and worm burden was recorded.

Demonstration of Cell Mediated Immune Response (CMIR)

The CMIR was studied in parasite native and worm free goats vaccinated with 60 Kr irradiated infective larvae of *H. contortus*. Cutaneous hypersensitivity reaction *(in vivo)* and leukocyte migration inhibition test *(in vitro)* were employed as the measure of CMIR.

(a) Cutaneous hypersensitivity (intradermal test). Skin area of about 6 × 6 cm on both sides of the neck was shaved and cleaned. The thickness of skin was measured with Vernier Callipers in mm and recorded before inoculation of the antigens. The animals were then injected intradermally with 0.1 ml of each of the larval and adult antigens at two different places of one shaved side of the neck (left). At the other side of the neck (right) 0.1 ml of PBS (Ag base) was injected intradermally as control. Skin reactions at the site of inoculation were recorded at 15 min and at 5 h after the intradermal injections. At the time of maximal hypersensitivity reaction, the skin biopsy was taken and examined histopathologically.

(b) Leukocyte migration inhibition test (LMIT). LMIT was done with peripheral leukocytes collected from experimental goats. The test was conducted as per method of Wolfson *et al.* (1972) with minor alterations in the procedure. The readings were taken after 18 and 24 h. The chambers were charged with the following reactants :

1. Leukocytes from vaccinated goats + antigen. (150 µg, 75 µg and 37.5 µg of antigen proteins/ml).

2. Leukocytes from vaccinated goats+ without antigen.

3. Leukocytes from vaccinated and challenged goats + antigen.

4. Leukocytes from vaccinated and challenged goats + without antigen.

5. Leukocytes from unvaccinated goats + antigen.

6. Leukocytes from unvaccinated goats + without antigen.

The migration pattern was read at 20 X magnification under an ordinary light microscope and drawing the projected image on a plain paper with a camera lucida. The area of migration was calculated by planimetry. The per cent inhibition of migration was calculated by the following formula :

$$\text{Per cent inhibition of migration} = 100 - \frac{\text{Average area of migration with antigen}}{\text{Average area of migration without antigen}} \times 100$$

Polyacrylamide Gel Electrophoresis

The serum proteins of the animals vaccinated with irradiated larvae as well as non-vaccinated (control) were fractionated by polyacrylamide gel electrophoresis using anionic system (Davis, 1964; Ornstein, 1964).

The gel tubes were carefully removed one by one and the column gels were ejected in a tray containing distilled water and transferred into 1% solution of Amido-black B. After 5 min the gels were rinsed with 7% acetic acid solution and then it was allowed to destain in the same solution with frequent changes. The gels were stored in screw capped test tubes containing 7% acetic acid and kept in refrigerator.

Each gel was scanned on Beckman photometer model 25 using 2A span of absorbence 2 cm/min gel speed and 2.5 cm/min. The different bands were identified numerically and alphabetically on the basis of literature (Bauer *et al.*, 1974; Knapp and Hunter, 1975).

Counter Current Electrophoresis

Counter current electrophoresis of gamma globulins was carried out by simple Ouchterlony method.

RESULTS

Intradermal test with larval and adult *H. contortus* antigens was done to record the *in vivo* CMIR in the vaccinated goats (Table 1). The results of intradermal test were found to be significant and in few isolated cases the cutaneous hypersensitivity reaction was more pronounced and the skin thickness increased by more than ten folds while in a sizeable number of cases the skin thickness increased only by 8 folds. However, the CMIR test did not differ significantly between the vaccinated and the non-vaccinated parasite native group. Though swellings developed in all vaccinated/and or challenged/infected groups within 15 min of inoculation of the antigens, they were noted to be maximum at 5 h of post inoculation. Skin biopsies from the

TABLE 1

Skin hypersensitivity reaction using larval and adult *H. contortus* antigen in experimental goats

Group	Goat No.	Status of goats	Skin thickness before test (mm)	Size of swelling (reaction mm)				Ag base (control) at 5 h
				Larval antigen (Ag)		Adult antigen (Ag)		
				At 15 min	At 5 h	At 15 min	At 5 h	
I. Parasite	5F	V2C	1.9	5.0	20.5	6.5	30.0	1.9
native	6M	V2C	1.4	6.0	15.0	5.0	15.0	1.5
	35F	V2C	2.8	6.5	15.5	6.5	14.6	2.7
	37M	V2C	2.6 (2.2)	4.5 (5.5)	12.8 (15.9)	4.5 (5.6)	20.5 (20.0)	2.7 (2.2)
	23M	C	2.0	6.6	18.5	6.6	20.2	2.2
	36F	C	1.4 (1.7)	6.0 (6.3)	15.0 (16.7)	3.5 (5.0)	12.5 (16.3)	1.6 (1.9)
Vaccine	15M	V2	2.2	7.0	12.0	4.5	15.2	2.3
control	17M	V2	1.7 (1.9)	6.8 (6.9)	9.6 (10.8)	10.0 (7.2)	12.0 (13.6)	1.8 (2.0)
II. Worm free	7M	V2C	1.2	5.0	17.5	7.5	15.5	1.3
	8F	V2C	1.3	7.0	21.0	3.0	11.5	1.2
	38F	V2C	2.0 (1.5)	7.0 (6.3)	9.8 (16.1)	12.0 (7.5)	16.8 (14.6)	2.0 (1.5)
	4M	C	2.0	6.8	18.0	8.0	25.0	2.2
	20F	C	1.6 (1.8)	7.0 (6.9)	42.0 (30.0)	6.5 (7.2)	45.5 (35.2)	1.7 (1.9)
Vaccine	18M	V2	1.5	5.2	20.0	9.4	32.0	1.6
control	33M	V2	2.0 (1.7)	6.2 (5.6)	30.5 (25.2)	4.5 (6.9)	22.0 (27.0)	2.0 (1.8)
Normal	25F	N	1.6	6.5	15.0	5.0	15.0	1.8
unvacci-	27F	N	1.9	6.6	10.0	7.0	12.0	1.7
nated	34M	N	1.5 (1.7)	4.5 (5.8)	30.0 (18.3)	6.5 (6.2)	22.0 (16.3)	1.4 (1.6)

V2C—Double vaccinated and challenged; C—Challenged; V2—Double vaccinated but not challenged; N—Normal and unvaccinated; Figures in parentheses indicate mean values.

The test was done after 10 days of V2/V2C/C. The protein concentrations of larval and adult antigens were 1.5 and 12.0 mg/ml, respectively.

affected portion revealed very less to negligible infiltration of mononuclear cells.

The per cent inhibition of leucocyte migration observed in the parasite native group though not optimum but was little bit in order. In one animal LMIT showed classical inhibition being 20, 14 and 5 per cent under 150, 75 and 37.5 μg/ml concentration of larval antigen, respectively. The per cent LMI remained inconsistent in rest of the cases (Table 2).

The animals which received sera from double vaccinated goats, showed 47.67% (Table 3) protection. But the animals which received sera from double vaccinated and challenged goats, could protect to the extent of 67.54 per cent. However, the worms recovered from the recipient of sera from double vaccinated animals were markedly stunted.

Distinct subfractions of alpha 1, alpha 2, beta and gamma globulins were evident in polyacrylamide gel electrophoresis. The albumin appeared as one band, alpha 1 as three, alpha 2 as three bands, the highly mobile beta globulin as two bands and the slow mobile beta globulin had three bands. The gamma globulin

TABLE 2

Leukocyte migration inhibition (LMI)* in experimental goats with different concentrations of protein in antigen

Group	Goat No.	Status of goats	Per cent LMI using different protein concentrations in larval antigen		
			150 μg	75 μg	37.5 μg
I. Parasite native	5F	V2C	ND	45.8	37.4
	6M	V2C	8.0	ND	6.0
	35F	V2C	20.0	14.0	5.0
	37M	V2C	ND	22.0	6.0
	23M	C	48.0	33.0	ND
	36F	C	5.0	ND	ND
Vaccine control	15M	V2	73.0	48.0	42.0
	17M	V2	69.5	69.0	ND
II. Worm free	7M	V2C	42.0	21.0	0
	8F	V2C	0	0	0
	38F	V2C	5.0	ND	0
	4M	C	10.0	18.0	5
	20F	C	30.0	18.0	7
Vaccine control	18M	V2	4.0	15.0	0
	33M	V2	ND	ND	ND

V2C—Double vaccinated and challenged; V2—Double vaccinated but not challenged; C—Challenged; ND—Not done.

*The test was conducted 10-15 days after 2nd dose vaccination/challenge. 1st vaccination on day 0; 2nd vaccination on day 35 and challenged on day 70.

TABLE 3

Effect of passive transfer of immune serum in susceptible goats against challenge with 10,000 infective *H. contortus* larvae

Goat No.	Body wt. (kg)	Source of serum	Dose and route @ (day/h)	Day of challenge and route	Worm burden at necropsy on 35 days after challenge	Mean % protection
25F	11.0	V2	Two divided doses @ 30 ml/kg body wt. within 24 h I/V.	48 h after 2nd dose of serum given orally	177	45.67
27F	11.5	V2			276 (226) (Most of the worm were stunted)	
34M	10.5	V2C			114	67.54
41M	10.0	V2C			157 (135)	
26M*	8.0	Nil	Nil		447	Nil
31M*	10.5	Nil	Nil		385 (416)	

V2 —Serum collected from goats 15 days after 2nd vaccination.

V2C—Serum collected 15 days after challenge from goats after double vaccination.

* —Control

Figures in parentheses indicate mean values.

formed only one band towards the anode. After first dose of vaccination there was significant increase in albumin in both parasite native and worm free groups. But after 2nd dose of vaccination apparently little or no change was seen in parasite native group, whereas in worm free group gamma globulins showed a trend of increase. However, on challenge the parasite native animals showed marked increase in IgG peak, whereas worm free goats showed decreased level of gamma globulins in respect of their previous status.

All the vaccinated goats of parasite native group showed precipitation line after double dose of vaccination in counter current electrophoresis. The precipitation line started appearing 10-15 days after the second dose of vaccination and lasted upto a month or so. The positive reaction was also seen after challenge but faint or no precipitation line developed in raised worm free vaccinated group. However, the vaccinated group of worm free animals could not be differentiated markedly from the parasite native vaccinated group.

DISCUSSION

Significant immediate type, cutaneous hypersensitivity reactions were observed in the vaccinated animals as the maximum

response was obtained by five hours after inoculation of the antigen. Stoll and Nelson (1930), Mayhew (1942), Kholoshchanov (1950), Sastry and Ahluwalia (1974), and Bali and Singh (1978) reported the cutaneous reaction as diagnostic test in *H. contortus* infection. Sastry and Ahluwalia (1974) reported difference of 10 mm and above between antigen and saline wheals to be considered as positive, whereas the average of such difference was 20.3 mm as noted by Bali and Singh (1978). During present investigation barring few cases where skin thickness increased 10 folds, most of the animals showed eight folds increase when compared with the control. The cellular infiltration was insignificant.

Swellings developed in vaccinated/ and or challenged/infected groups could not be differentiated.

After vaccination and challenge there was no LMI response. The response in LMIT correlated with the cutaneous hypersensitivity reaction. However, there was little LMI response in parasite native group. Only one animal of this group showed classical LMI response. On the basis of overall observations it was concluded that there was no involvement of CMIR.

Animals subinoculated with sera from double vaccinated goats showed 47.67% protection , whereas the animals which received sera from double vaccinated and challenged goats could protect themselves to the extent of 67.54 per cent. Although in previous case the per cent protection appeared to be less, the worms recovered from these animals were markedly stunted in appearance when compared to normal worms. These findings indicated presence of antilarval antibodies in the passively transferred serum from vaccinated and vaccinated challenged goats. Smith and Christie (1978) reported the presence of circulating IgG in the immune (lambs) animals. IgG was also detected in the mucus. In the present situation the circulating (probably) IgG might be the factor responsible for eliminating the challenge larvae from passively immunized goats.

Polyacrylamide gel electrophoresis (PAGE) showed a significant increase in beta-globulins as compared to gamma and alpha fractions in the vaccinated animals. The scanning revealed many individual proteins which were assumed to be beta-lipoprotein, transferrin, haptoglobins, 2-2 haptoglobins, ceryloplasmin, albumin, IgM and IgG. An increase in beta-globulin fraction was almost a constant finding in many helminthic infections including haemonchosis as postulated by Leland *et al.* (1955). An increase in gamma globulin fraction in haemonchosis indicated antibody synthesis (Kuttler and Marble, 1960). It was noted in the present study that the IgG peak in parasite native group revived again on challenge, whereas in the worm free group it started to decrease. This indicated that the immune mechanisms remained in a state of preparedness to deal with the challenge infection.

Countercurrent electrophoresis with immune sera and larval antigen gave encouraging results as a test for detection of immunity against *H. contortus*.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 191—194 (June 1983)

STUDIES ON SOME EGG QUALITY TRAITS AND THEIR RELATIONSHIP WITH SOME PRODUCTION TRAITS

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(Received : December 4, 1981; Revised : February 16, 1983)

ABSTRACT

The present investigation was conducted on 207 pullets belonging to a synthetic population of WLH. The average for egg weight, shell thickness, shape index, yolk index, Haugh units of egg albumen and yolk colour were obtained as 53.07±0.22 g, 0.25±0.04, 72.53±0.20, 46.13±0.23, 93.54±0.39 and 11.02±0.47, respectively The corresponding values for heritability were 0.53±0.25, 0.27±0.21, 0.51±0.25, 0.84±0.17, 0.28±0.21 and 0.32±0.16. Results of heritability and genetic correlations among egg quality traits showed that the overall egg quality can be improved by selection based on shape index only.

The importance of egg quality is increasing in India day by day due to consumer's consciousness for the nutritive value of the egg and to obtain wholesome eggs. But poultry breeders often overlook this aspect while selecting their flock for increased egg production. There is sufficient evidence in the literature that the egg quality is controlled partly by heredity. Genetic improvement can, therefore, be made through appropriate plan of selection. Moreover, egg quality is important from the point of view of their suitability for the manufacture of egg products, their transport, hatching, etc.

In the present study, the genetic, phenotypic and environmental correlations were studied among different egg quality and egg production traits in order to evolve a selection criteria for simultaneous improvement in egg quality traits.

MATERIAL AND METHODS

For the present investigation, 207 pullets produced by 28 sires were housed in individual cages at the age of 20 weeks. The pullets belonged to a synthetic population of white leghorns by crossing for egg laying commercial strains in the Department of Animal Breeding. The birds were managed under uniform and standard practices of management and feeding. Egg quality traits were studied at the age of 36 weeks as described by Kumar and Kapri (1967, 1968). The data were analysed statistically as per Snedecor and Cochran (1968) to draw the inferences.

RESULTS AND DISCUSSION

Averages alongwith their standard errors and coefficient of variation of egg

quality traits are presented in Table 1. The mean of egg weight and albumen index were higher than those reported by Mohapatra (1972), Jain *et al.* (1978) and Than garaju *et al.* (1978). The yolk index and shell thickness were observed lower than those obtained by Singh *et al.* (1976). Yolk colour and shape index did not show any marked deviations from the averages reported by Singh *et al.* (1976) from the very base population of this foundation stock.

Coefficient of variations for almost all the traits have been observed low in magnitude except for shape and yolk index.

Genetic Parameters : Heritability

Perusal of Table 2 indicates that egg weight, shape index and yolk index are high heritable traits but the Haugh units of egg albumen, shell thickness and yolk colour are low heritable traits. The low heritability of these traits indicates that they are highly affected by the environmental factors which need some family selection for improvement.

The standard errors of heritability of these low heritable traits are quite high which further indicate the effect of sampling error because of small sample size from which no conclusion can be drawn.

TABLE 1

Average of egg quality traits

Traits	Mean	C.V.
Egg weight (g)	53.07±0.22	6.18
Shape index	72.53±0.20	4.05
Shell thickness (mm)	0.25±0.04	9.79
Yolk index	46.13±0.23	9.03
Haugh units of egg albumen	93.54±0.39	6.05
Yolk colour	11.02±0.47	6.18

TABLE 2

Heritability, genetic and phenotypic correlations among egg quality traits

Traits	Egg weight	Shape index	Yolk index	Haugh unit	Shell thickness	Yolk colour
Egg weight	0.53±0.25	0.36±0.29	0.92±0.07	—0.35±0.36	—0.10±0.42	2.43±5.43
Shape index	0.03±0.69	0.51±0.25	—0.74±0.70	0.60±0.26	—0.15±0.42	0.08±1.10
Shell thickness	0.09±0.069	0.21±0.063	0.07±0.69	0.04±0.69	0.27±0.21	1.88±0.62
Yolk index	0.05±0.69	0.70±0.69	0.84±0.17	0.20±0.87	0.27±0.81	0.76±0.94
Haugh units of egg albumen	0.05±0.69	0.15±0.69	—0.030±0.66	0.28±0.21	0.15±0.52	1.88±3.52
Yolk colour	0.09±0.069	—0.15±0.69	—0.04±0.69	.05±0.69	—0.10±0.69	0.32±0.16

Note : Figures above diagonal, genetic and below phenotypic correlations and diagonal are the heritabilities.

Correlations

The genetic and phenotypic correlations among egg quality traits have been presented in Table 2. The genetic correlations of egg weight with Haugh units of egg albumen, yolk index, shell thickness and yolk colour could not be determined as the between sire component of covariance exceeded than the total component of covariance. The genetic correlations of egg weight with shape index and with yolk index were found to be high and positive. Similar results were reported by Johari and Singh (1968) and Jain *et al.* (1978) and this relationship is high and negative with Haugh units of egg albumen. The results indicate that any further improvement in egg weight will be at the cost of albumen quality and will effect the shell thickness to some extent.

The genetic correlation between shape index and Haugh units of egg albumen reported to be highly positive as that of the same direction and magnitude observed by Johari and Singh (1968). This correlation shows selection on the basis of shape index and may lead to an improvement in the internal egg quality as compared to the selection on egg weight. This inference is in agreement with that reported by Campos *et al.* (1964).

The other genetic correlations were very small with high standard errors of more than a unit due to high sampling error. The phenotypic correlations among all egg quality traits observed to be very small with high standard errors except the phenotypic correlation between shell thickness and shape index found to be high and positive and between Haugh units of egg albumen and yolk index to be high and negative. So, being small sample size it is a little bit difficult to generalize the results.

The genetic correlation of egg weight with age at first egg reported to be high (Table 3) and positive, is in close agreement with the results obtained by Kumar and Kapri (1968). The phenotypic correlation between the two is less as that reported by Aggarwal (1970). The positive genetic correlation found in this study, indicates that a lowering in the age at first egg may result in a lower average egg weight.

The genetic correlation of egg weight with number of eggs laid upto 280 days of age found to be more than unit and

TABLE 3

Genetic and phenotypic correlations of egg quality traits with some economic traits

Traits	Genetic correlation	Phenotypic correlation
Egg weight with age at first egg	0.28±0.30	0.056±0.06
Egg weight with egg number	—1.71±0.79	—0.11±0.06
Shell thickness with egg number	0.27±0.84	0.11±0.085
Haugh unit of egg albumen with egg number	—0.04±0.06	—0.18±0.06

negative due to large sampling error. The genetic correlation between Haugh units of egg albumen and number of eggs laid upto 280 days of age reported to be very small and negative, is in close agreement with the results obtained by Kumar and Kapri (1970). This genetic correlation is zero, since in this flock a correlated response to selection in one trait may not be expected in other trait. The genetic correlation between shell thickness and egg number was found to be moderate and with low standard errors, indicating thereby that with increasing egg production, the shell quality tends to be improved genetically. These findings are similar with that reported by Kumar and Kapri (1970).

The phenotypic correlations between egg quality traits and with production traits, are low in magnitude, making it difficult to draw any definite conclusions.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 195—199 (June 1983)

STUDIES ON THE EFFECT OF CHOPPING GREEN FORAGE ON MILK PRODUCTION AND COMPOSITION IN MURRAH BUFFALOES I. BERSEEM

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(Received : December 28, 1981; Revised : October 6, 1982)

ABSTRACT

Effect of different lengths of chopped green **berseem** (*Trifolium alexandrinum*) on dry matter and nutrient intake, DM digestibility, body weight changes, milk yield and milk composition in Murrah buffalo over a period of 15 weeks was compared with that of unchopped **berseem** The average DM intake per 100 kg body weight was 2.67, 2.70 and 2.93 kg for whole, 2.5 cm and 5 cm cut **berseem**, respectively. The corresponding figures of intake were 125.8, 127.4 and 129.7 g per unit metabolic body size ($W^{0.75}$ kg). The average DM digestibility was 63.5, 66.06 and 66.67 per cent in respective treatment groups. The corresponding coefficients for CP, EE, CF and NFE digestibilities were 76.72, 75.64, 72.92 and 67.74; 68.29, 67.64, 60.21 and 63.04; 64.63, 74.50, 70.10 and 73.40 per cent, respectively. All experimental animals consumed higher amounts of DCP and TDN. All animals gained weight. There was significant ($P<0.05$) increase in weekly milk yield, FCM and SCM when 2.5 cm cut **berseem** was fed. Differences in these parameters were not noted between whole and 2.5 cm cut **berseem** regimes. Feed cost/kg/FCM, including additional labour cost in feeding, was Re. 0.84, 0.92 and 1.07 for whole, 2.5 cm and 5 cm cut **berseem**, respectively.

In order to reduce the cost of milk production the feeding schedule should revolve around the roughages. Therefore, a major portion of ration to lactating animals should be supplied in the form of green and dry roughages. Increase in the voluntary intake of roughages is, therefore, desirable so that the animals may draw their nutrient requirements from this comparatively less expensive source.

The voluntary intake of roughages among other factors depends upon its palatability and method of processing. Chopping is the common method of processing green forage and has been used by the farmers since early ages.

In **kharif**, non-leguminous fodders like **jowar**, maize, **bajra**, etc. are chopped, but legume forage like **berseem** is not generally chopped especially where the number of animals is more, only to save labour and time. Variable results have been reported regarding the effect of chopping on forage composition, voluntary intake and digestibility in cattle, milk production and its composi-

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tion. Sahai and Choudhary (1977) worked on Gajraj grass (EBH 32-4 or EB-4) as a fodder for buffalo, with or without chaffing and reported that animals left large quantity of residue when it was offered without chaffing.

In the present paper the results of chopping length of green **berseem** (*Trifolium alexandrinum*) on milk yield, dry matter digestibility and nutrient intake in Murrah buffalo cows have been presented.

MATERIAL AND METHODS

A 3×3 latin square switch over design replicated thrice with 3 treatments and 3 periods of 4 weeks each was used utilizing 9 Murrah buffaloes of almost similar age, stage of lactation and milk yield. In between the periods, seven day adjustment period was allowed to avoid the residual effect of previous treatment. One animal from each triplicate was allotted to each treatment at random. These animals were housed in byre having arrangements for individual feeding. They were milked at 3 a. m. and 3 p. m. daily. The animals were let loose in the open area provided with loose housing system from 9 a. m. to 10 p. m. for exercise. The trial was conducted for 15 weeks from January 15 to April 29, 1982.

Treatments. Lush green **berseem** was obtained from the University Farm from continuous strip of land daily to get uniform stage (pre-flowering) of growth in a particular cut. The **berseem** was used from different cuts. As such, there was a little variation in chemical composition. The dry matter ranged from 14.90 to 23.60, while the crude protein ranged from 15.62 to 18.50. The forage was offered in the following forms :

(a) Whole green **berseem** fed as such (unchaffed);

(b) Green **berseem** was cut to an average length of 2.5 cm with power chaff cutter;

(c) Green **berseem** was cut by hand chaffing in 5 cm bits with the help of local chaffing knife (**Gandasa**) using a plain rectangular hard wooden plate, predemarcated at 5 cm length.

Feeding and watering. Green **berseem** whole and in different sized chops was offered at 4 p. m. daily at the rate of 60 kg per animal. Wheat straw was offered at the rate of 5 kg at 10 a.m. The left over for the entire day was collected at 8.30 a. m. in the following morning. During the last 15 days of each period, the refused dry matter was weighed. The green **berseem**, wheat straw and concentrate mixture were sampled twice in a week for determination of dry matter of feed as well as dry matter intake. The concentrate mixture (19.0% CP) was offered at the rate of one kg per animal at the time of milking for let down of milk. Clean and wholesome water was supplied thrice a day.

Recording and sampling of milk. Daily milk yield was recorded. Individual milk samples of 100 g in morning and afternoon were collected immediately

after milking once a week. The aliquots from morning and afternoon milkings were composited for estimation of fat (Ghouse and Jain, 1973), and total solids (TS) (ISI, 1972). The SNF content was arrived at by substracting fat content from the TS content. The solid corrected milk (SCM) was calculated by the method of Tyrell and Reid (1965).

Sampling of feed. The feed offered as well as the refusal collected following morning were sampled twice a week during each period. The dry matter (DM) content was determined, after which the feed samples were milled and bulked for each period as per treatment for determination of proximate composition.

Digestibility trial. A digestibility trial was conducted on all experimental animals with a 5 day collection period during the third experimental period.

Weighing of animals. The experimental animals were weighed at the beginning and at the end of each period in the morning an hour before offering water and feed, using a 1000 kg Avery balance (Dial type).

RESULTS AND DISCUSSION

Dry Matter Intake and Nutrient Digestibility

Average DM intake was similar at 2.67, 2.70 and 2.93 kg per 100 kg body weight in treatments A, B and C, respectively (Table 1). The corresponding figures were 125.8, 127.4 and 129.9 per cent when DM intake was expressed on 'metabolic body size ($W^{0.75}$ kg) basis. In case of silage feeding, Wilkinson *et al.* (1978) obtained higher DM intake for fine (7.67 mm) than coarse (33.3 mm) silage. Similar observations were made on silage by Dulphy and Demarquilly (1974). Sahai and Choudhary (1977) indicated that consumption of Gajraj grass could be improved through chopping.

DM intake/100 kg BW and metabolic body size observed herein are almost similar to those of Jackson *et al.* (1971) and Singh (1979). However, Yoelao *et al.*

TABLE 1

Average body weight, DM intake and digestibility coefficients of various nutrients in different experimental rations

Particulars	Treatment groups		
	A	B	C
Average body weight (kg)	488	492	478
DM intake per 100 kg body weight (kg)	2.67	2.70	2.93
DM intake/$W^{0.75}$ kg (%)	125.8	127.4	129.7
Digestibility coefficients			
Dry matter	63.50	66.06	66 67
Crude protein	76.72	75.64	72.92
Ether extract	67.74	66.29	67.64
Crude fibre	60.21	63.04	64.63
Nitrogen free extract	74.50	70.10	73.40

(1970) and Sharma *et al.* (1976) reported relatively lower values of dry matter intake.

Digestibility of nutrients was similar for different dietary treatments. On the contrary, Warren *et al.* (1974) reported that CP digestibility increased with a decrease in particle size of lucerne.

Digestible Nutrient Intake

DCP and TDN intakes were compared with those recommended by Sen and Ray (1971) for experimental buffaloes. All the experimental animals consumed 1.52 to 2.2 kg of TDN and 0.808 to 0.896 kg of DCP in excess of the requirement. Therefore, it is necessary to reduce green **berseem** allowance and substitute a part of it with low grade roughages.

Milk Yield and Composition

Differences due to treatments in weekly milk yield, FCM (6%) and SCM were significant ($P<0.05$) (Table 2). The milk yield was significantly higher in A and B treatments as compared to C treatment. Although higher yields were also obtained in treatment B as compared to treatment A, but the differences were insignificant. The reason for increased milk production in chopped (2.5 cm) and whole **berseem** might be due to efficient utilization in the said form of the forage for milk production.

The weekly mean percentage of fat was 8.26, 7.93 and 8.25; and 9.81, 9.98 and 10.09 for SNF in A, B and C treatments, respectively, the difference being significant ($P<0.01$) for fat only. Fat per cent was significantly higher in A and C treatments as compared to treatment B.

The length of cut of green **berseem** influenced the fat content of milk but had no influence upon SNF. Higher length of forage resulted in higher percentage of fat in milk which is in agreement with the findings of Miller *et al.* (1969) in cattle. That SNF content did not differ with length of forage is in support of Stiles *et al.* (1971).

TABLE 2

Total and weekly milk yield, fat and SNF content of milk of experimental buffaloes

Particulars	Treatment groups		
	A	B	C
Total milk yield (kg) in 12 weeks			
Whole milk	1381.60	1422.72	1251.21
FCM (6%)	1712.87	1738.17	1523.98
SCM	2159.02	2367.24	1944.68
Weekly milk yield (kg)			
Whole milk	38.37	39.51	34.75
FCM (6%)	47.57	48.06	42.32
SCM	59.96	60.99	53.96
Fat per cent	8.22	7.90	8 25
SNF per cent	9.81	9.98	10.09

Cost of Milk Production

The feed cost per kg 6% FCM was Re. 0.84, 0.92 and 1.07 in A, B and C treatments, respectively.

Small, marginal and agricultural labour owning 1-3 milch buffaloes for their livelihood can easily afford 45 min per buffalo of manual labour in chaffing green forage in 2.5 cm bits when some additional milk production could be obtained and spoilage of forage can be prevented.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 200—206 (June 1983)

EFFECT OF INFRA-RED AND INCANDESCENT LAMP BROODING SYSTEMS ON THE PERFORMANCE OF FOUR GENETIC GROUPS OF BROILERS

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(Received : January 1, 1982; Revised : April 28, 1982)

ABSTRACT

Infra-red brooding system did not show any advantageous effect on growth, feed consumption, feed efficiency, mortality and cost of producing broilers compared to incandescent (ordinary) bulbs brooding. Though the body weight of birds raised during winter was higher to those raised during summer, yet the performance of broilers in terms of feed consumption, feed efficiency and mortality was better for those raised in summer. The summer season appeared to be better for raising broilers compared to winter. The groups having G-1 dams (G-21 and G-11) performed better than those having G-2 dams (G-12 and G-22). Positive heterosis for body weight was evident for G-21 cross but not for G-12. Existence of maternal or/and sex linked effects were evident. Effect of genetic groups was not significant on feed consumption and feed efficiency. Significant interactions between different combinations of genetic groups, seasons and brooding systems indicated the existence of genotype environment interactions.

Brooding refers to early period of chick management when the chicks are unable to maintain body temperature. Use of infra-red heat lamps for chick brooding has recently been introduced in our country. It is claimed that performance of chicks under this system of brooding is economical (Radhakrishanan, 1976-77). Singh (1976) observed higher feed consumption, low mortality, better growth, overall less investment and higher returns with these brooders than conventional lamp brooding. Reports available in the literature indicate that the body growth and viability of chicks are increased by infra-red light irradiation (Sersunova, 1968; Aralov and Meljukov, 1969). However, adverse effects, such as, development of abnormal eye condition in broilers brooded under infra-red lamp was observed by McCluskey and Arscott (1967). Lysenko (1970) reported less weight gain and higher survivability rate under infra-red brooding. Ramappa *et al.* (1978) reported that the difference between body weight of birds reared under infra-red and incandescent lamp brooders was statistically non-significant It is hard to conclude from these conflicting reports and the study was. therefore, undertaken to find the effect of infra-red brooding on the performance of chicks.

Different workers (Osborne, 1952 and 1954; Hill and Nordskog, 1956; Kulikov

and Slyusar, 1976) have reported the existence of genotype-environment interactions between strains raised under different locations or same place with or without varying management and feeding conditions. Therefore, the present investigation was also aimed to study the effect of this new brooding system in relation to four different genetic groups and two different seasons.

MATERIAL AND METHODS

A total of 796 and 755 day-old broiler chicks were randomly divided into different replications during summer and winter, respectively (Table 1). The birds were reared on deep litter in similar pens of 3×1.5 m size located in the same shed. Infra-red bulbs of 250 watts with reflectors hanged 45 cm from litter during summer and 30 cm during winter were used for infra-red brooding. Bulbs were switched on and off depending upon need of heat during day and night. For incandescent lamp brooding two ordinary bulbs (100 watts each) were fitted in a wooden brooder of 90×75 cm size. Similar standard managemental practices were provided to all the groups. Individual body weights at 6, 7, 8, 9 and 10 weeks of age, feed consumption for each group from 0-6 weeks and later on at weekly intervals, and daily mortality records of individual birds were maintained during the experimental period. The cost of raising birds under different treatments refers to the cost of chick, feed and electricity as inputs. The mortality was taken into consideration while calculating the total costs. The means and standard errors were worked out for each group and the data were subjected to standard statistical analysis to find the significance of differences between means of different treatments (Pruthi, 1981).

RESULTS AND DISCUSSION

The means and standard errors showing the effect of brooding systems, seasons and the four genetic groups of birds on body weight and feed con-

TABLE 1

Experimental design showing the number of chicks allotted to each group

Genetic groups	Replications	Summer[1]		Winter[2]	
		Infra-red	Incandescent	Infra-red	Incandescent
G_{11}	R_1	50	49	57	55
	R_2	49	51	55	57
G_{22}	R_1	50	50	48	46
	R_2	50	42*	46	46
G_{21}	R_1	51	49	53	53
	R_2	51	51	54	52
G_{12}	R_1	51	51	33	33
	R_2	51	50	33	34

[1]11th March to 19th May, 1980.

[2]10th December to 17th February, 1981.

*Due to an accident in brooder house the number of birds was unequal under the two brooding systems in summer.

sumption have been presented in Table 2 and on feed efficiency and per cent mortality in Table 3. The differences in mortality were tested by Chi-square test and have been presented in Table 3.

Brooding Systems

The body weight at 6, 7, 8, 9 and 10 weeks of age was higher in birds raised under incandescent lamp brooding than those raised under infra-red lamp brooders. At 6 and 7 weeks age these differences were highly significant but the level of significance decreased at 8, 9 and 10 weeks age. Ramappa *et al.* (1978) reported that at 6 weeks of age, the body weight of birds reared under infra-red brooding was inferior to control (reared on ordinary bulbs) in one of the replicates and non-significant in the other. McCluskey and Arscott (1967), however, did not observe statistically significant effect on growth of birds reared under infra-red and incandescent brooders.

The feed consumption at 6, 7 and 8 weeks age was lower in infra-red brooding group compared to incandescent lamp brooded birds. At 9 and 10 weeks age the birds brooded under incandescent lamps consumed lesser feed than those reared under infra-red system. These differences were, however, statistically non-significant.

The feed efficiency was better for incandescent lamp brooding at all ages of measurements, but this difference too was not significant at 5% level of probability.

Chi-square test did not reveal significant difference in mortality of birds reared under two systems of brooding, at 7, 8, 9 and 10 weeks age. At 6 weeks age the per cent mortality was a little higher for the birds reared under ordinary bulb brooders.

It was noted that it was easier to observe the chicks under infra-red brooders. McCluskey and Arscott (1967) observed that birds brooded under infra-red light developed an abnormal eye condition, but in the present study no deformity was detected. The present results are in agreement with the findings of Ramappa *et al.* (1978).

The cost of rearing a chick to 10 weeks age was 9 paise more for infra-red brooding (Rs. 10.44) compared to incandescent lamp brooding (Rs. 10.35) system. The corresponding cost per kg live weight of broiler was Rs. 6.54 and 6.36, respectively.

Thus, it may be stated that infra-red brooding did not show any advantageous effect on growth, feed consumption, feed efficiency, mortality and cost of broiler production over the incandescent lamp brooding system.

Seasons

The 6 weeks body weight of birds reared during summer and winter was 736 and 709 g, respectively. Contrary to expectations the body weight in summer was significantly higher than that in winter. Since birds were given artificial heat for 24 days in both the seasons the stress due to cold might have resulted in poor growth in winter. Rao and Bose (1967) also reported a retardation in growth rate in White Leghorn chicks due

TABLE 2

Mean performance of four genetic groups of birds raised under two systems of brooding during summer and winter (body weight and feed consumption in grams)

Traits	Systems of brooding		Seasons		Genetic groups			
	Infra-red	Incandescent	Summer	Winter	G_{11}	G_{22}	G_{21}	G_{12}
6 week weight	710 ± 9^{a}	737 ± 6^{b}	737 ± 3^{a}	709 ± 5^{b}	708 ± 10^{a}	715 ± 7^{a}	747 ± 8^{b}	724 ± 10^{ab}
7 week weight	931 ± 10^{a}	991 ± 9^{b}	917 ± 4^{a}	1007 ± 6^{b}	961 ± 8^{a}	936 ± 8^{b}	985 ± 9^{c}	957 ± 11^{ab}
8 week weight	1184 ± 16^{a}	1193 ± 13^{a}	1076 ± 5^{a}	1310 ± 9^{b}	1213 ± 16^{a}	1157 ± 11^{b}	1253 ± 11^{c}	1110 ± 12^{d}
9 week weight	1383 ± 16^{a}	1411 ± 16^{b}	1291 ± 9^{a}	1514 ± 10^{b}	1425 ± 16^{a}	1354 ± 15^{b}	1443 ± 17^{a}	1347 ± 18^{b}
10 week weight	1595 ± 23^{a}	1627 ± 24^{b}	1469 ± 7^{a}	1769 ± 14^{b}	1676 ± 22^{a}	1557 ± 23^{b}	1658 ± 23^{a}	1518 ± 27^{b}
Cumulative feed consumption to								
6 week	1720 ± 50^{a}	1750 ± 30^{a}	1740 ± 20^{a}	1740 ± 30^{a}	1690 ± 40^{a}	1780 ± 70^{a}	1720 ± 50^{a}	1770 ± 60^{a}
7 week	2170 ± 20^{a}	2180 ± 50^{a}	1980 ± 20^{a}	2370 ± 30^{b}	2160 ± 10^{a}	2190 ± 30^{a}	2190 ± 30^{a}	2150 ± 20^{a}
8 week	2860 ± 50^{a}	2870 ± 50^{a}	2520 ± 20^{a}	3210 ± 30^{b}	2860 ± 40^{a}	2910 ± 50^{a}	2870 ± 40^{a}	2811 ± 40^{a}
9 week	3650 ± 60^{a}	3580 ± 90^{a}	3140 ± 30^{a}	4110 ± 50^{b}	3630 ± 10^{a}	3680 ± 60^{a}	3640 ± 60^{a}	3520 ± 20^{a}
10 week	4420 ± 50^{a}	4400 ± 50^{a}	3750 ± 40^{a}	5080 ± 90^{b}	4460 ± 50^{a}	4460 ± 50^{a}	4511 ± 10^{a}	4220 ± 70^{a}

Figures having superscripts in common within a row do not differ significantly at 5% level of significance for brooding systems, seasons and different genetic groups.

TABLE 3

Mean performance of four genetic groups of birds raised under two systems of brooding during summer and winter (feed efficiency and per cent mortality)

Traits	Systems of brooding		Seasons		Genetic groups			
	Infra-red	Incandescent	Summer	Winter	G_{11}	G_{22}	G_{21}	G_{12}
kg feed/kg gain at the age of								
6 week	2.59±0.06[a]	2.54±0.06[a]	2.51±0.03[a]	2.63±0.05[b]	2.56±0.07[a]	2.63±0.05[a]	2.45±0.04[a]	2.62±0.06[a]
7 week	2.48±0.08[a]	2.31±0.06[a]	2.28±0.04[a]	2.51±0.04[b]	2.37±0.07[a]	2.49±0.07[a]	2.34±0.06[a]	2.39±0.08[a]
8 week	2.61±0.09[a]	2.55±0.12[a]	2.50±0.03[a]	2.66±0.06[b]	2.50±10[ab]	2.68±0.05[a]	2.42±0.05[b]	2.72±0.11[a]
9 week	2.80±0.11[a]	2.68±0.07[a]	2.56±0.04[a]	2.92±0.07[b]	2.68±0.07[a]	2.84±0.02[a]	2.64±0.05[a]	2.81±0.14[a]
10 week	3.03±0.08[a]	2.85±0.11[b]	2.71±0.05[a]	3.18±0.09[b]	2.78±0.04[a]	3.10±0.11[b]	2.67±0.07[a]	3.12±0.13[b]
Cumulative per cent mortality to								
6 week	2.30[a]	4.55[b]	2.26[a]	4.64[b]	4.26[a]	3.70[a]	2.42[a]	3.27[a]
7 week	3.07[a]	4.81[a]	2.76[a]	5.17[b]	4.26[a]	4.23[a]	2.90[a]	4.46[a]
8 week	4.86[a]	4.94[a]	3.14[a]	6.75[b]	4.49[a]	5.03[a]	3.62[a]	6.85[a]
9 week	6.01[a]	6.11[a]	3.77[a]	8.42[b]	4.96[a]	5.56[a]	3.86[a]	10.71[b]
10 week	8.82[a]	8.19[a]	6.03[a]	11.13[b]	4.96[a]	10.32[b]	5.80[a]	14.29[c]

Superscripts in common within a row do not differ significantly at 5% level of significance for brooding systems, seasons and genetic groups.

to low temperature in winter. Gupta (1972) compared the performance of White Leghorn and Australorp chicks reared during December and April. Although the feed consumption was higher during winter, yet the birds had a comparatively slow growth rate. The 7 weeks body weight was significantly higher in winter than that in summer. Hassan *et al.* (1973), Ghany *et al.* (1976) and Abdov *et al.* (1979) also have reported that growth of birds was higher in winter compared to that in summer. It appeared that winter stress was either over or reduced after 6 weeks age. The body weight of birds at 8, 9 and 10 weeks of age was found significantly higher in winter compared to those in summer.

Feed consumption, feed efficiency and per cent mortality were significantly different in two seasons at all ages. The summer season seemed to be better for raising broilers compared to winter season. But the decision has to be implemented with caution because the prices of broilers are much lower in summer compared to those in winter.

Genetic Groups

The 6, 7 and 8 weeks body weights of G-21 cross were found to be significantly higher to the other three genetic groups. At 9 and 10 weeks age the body weight of G-21 and G-11 groups was statistically similar. G-11 cross was heavier to G-22 and G-12 at all ages. The 6 and 7 weeks body weight of G-12 was heavier to G-22, whereas reverse was true for 8, 9 and 10 weeks body weight. The significant differences in body weight of G-21 and G-12 crosses indicated the existence of maternal and/or sex linked effects for body weight. A number of workers (Warren, 1942; King and Bruckner, 1952; Bowman, 1959; Kusner and Heija, 1963; Lerner, 1964) have reported that crossbreds excel in body weight over purebreds. The performance of G-21 cross was better than G-11 and G-22 which was in line with the findings of above workers. The G-12 cross did not show a superiority for body weight over G-11 and G-22. Sneft (1962) observed that body weight of crosses were intermediate to that of parents indicating no heterosis. Dev and Singh (1970) studied the magnitude of heterosis in three commercial strains and found that heterosis was unimportant for body weights. The later results agree with the findings of these workers.

Genetic groups did not have a significant effect on feed consumption. Feed efficiency during these studies ranged from 2.34 to 3.12. At 6 and 7 weeks age the differences in feed efficiencies of various genetic groups were not significant. At 8 weeks age G-21 had significantly better feed efficiency than all other groups. At 9 weeks the differences levelled off. The birds having dam line G-1 (G-11 and G-21) had better feed efficiencies than the other two genetic groups.

Per cent mortality at 6, 7 and 8 weeks age did not differ significantly between genetic groups. At 9 and 10 weeks age significantly higher mortality was recorded for the G-12 crossbreds. No definite reason could be assigned to this difference.

Interactions

Significant interactions for body weight existed between seasons, brooding systems and genetic groups in all possible

combinations. This is in line with the findings of previous workers who have reported the existence of genotype, environment interactions in poultry. Interactions were not significant for feed consumption and feed efficiency.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 207—210 (June 1983)

FEED COST OF MILK PRODUCTION IN MILCH BUFFALOES AS INFLUENCED BY LEVEL OF CONCENTRATE IN THE RATION

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The feeding cost of animals constitutes about 75% of the total cost of milk production (Singh *et al.*, 1979), and of this, concentrate constitutes 60% of the feed cost (Puri and Singh, 1964). Therefore, it will be of practical use to the farmers as well as research workers to know the optimum level of concentrate feeding to the dairy animals. In view of this, an attempt was made to find out the feeding cost of milk production as influenced by different roughage concentrate ratios in old and young buffaloes.

Twelve old buffaloes (completed seven or more lactations) and twelve young (completed upto 5th lactation) milch buffaloes in early stage of lactation with almost equal milk yield were selected from the University herd during the winter of 1978. Each group of buffaloes was divided into three sub-groups of four animals each. The animals of each subgroup were allotted at random to three roughage concentrate ratios (b_1—70 : 30, b_2—50 : 50 and b_3—30 : 70 on TDN basis). The animals were fed according to their requirement individually as per Sen and Ray (1971). Green berseem and wheat bhusha were used as roughage. The concentrate mixture contained 50 parts barley and 50 parts wheat bran supplemented with 2 parts mineral mixture and 1 part common salt. The data pertaining to feed intake, residue left and milk yield were recorded daily for each animal. The feed cost of milk production was calculated by taking actual prices of feed and fodders charged by University farm. The feed cost was also worked out by taking market prices of feed and fodders.

The daily feed cost per buffalo and per kg of milk are given in Tables 1 and 2. The daily average feed cost varied from Rs. 4.59 in $a_1 b_1$ group to Rs. 6.63 in $a_1 b_3$ group. The average daily feeding cost of a old and young buffalo was Rs. 5.81 and 5.43, respectively. Feed cost per kg of milk was 10 paise less for old buffaloes as compared to young. Similarly feed cost per kg milk on 6% FCM basis (calculated as per the formula of Rice *et al.* (1970) was 6 paise less in old as compared to young buffaloes. This reduction in cost of milk production may be due to higher milk in old buffaloes. The daily feed cost in old and young buffaloes per day per animal increased as the

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TABLE 1

Average feed consumed and its cost during 90 days period based on farm prices*

	Old buffaloes (a_1)			Young buffaloes (a_2)		
	b_1	b_2	b_3	b_1	b_2	b_3
Berseem fed (kg)	2252.50	1486.00	849.13	2027 50	1464.75	732.63
Concentrate fed (kg)	256.43	427.28	590.60	235.93	408.83	563.23
Wheat bhusha fed (kg)	671.58	490.53	390.68	604.03	486.60	316.65
Total cost of berseem (Rs.)	102.24	67.46	38.54	92.03	66.50	33.26
Total cost of concentrate (Rs.)	205.14	341.62	472.48	188.00	327.06	450.58
Total cost of bhusha (Rs.)	147.08	107.43	85.56	132.28	106.57	69.35
Total feed cost per animal (Rs.)	454.46	516.71	596.58	412.31	500.13	553.19
Average daily feed cost per animal (Rs.)	5.05	5.75	6.63	4.59	5.56	6.15

* (I) Prices of berseem, concentrate and wheat bhusha were Rs. 4.54, 80.00 and 21.90 per quintal, respectively.

(II) Milk was sold @ Rs. 2.00 per kg.

TABLE 2

Average feed cost per kg of milk production based on farm and market prices

	Old buffaloes (a_1)			Young buffaloes (a_2)		
	b_1	b_2	b_3	b_1	b_2	b_3
Total milk yield during 90 days (kg)	634.33	628.38	674.58	566.10	563.95	540.05
6% FCM yield during 90 days (kg)	651.60	693.00	712.80	604.80	621.90	616.50
Feed cost per kg milk (Rs.)	0.72	0.75	0.88	0.73	0.89	1.02
Feed cost per kg FCM 6% (Rs.)	0.70	0.75	0.84	0.68	0.80	0.90
Total return over feed cost from sale of milk (Rs.)	14.20	740.05	752.58	718.89	627.77	526.91
Average feed cost per animal and per kg of milk based on market prices*						
Average feed cost per animal per day (Rs.)	6.42	6.64	7.14	5.81	6.45	6.48
Average feed cost per kg of milk (Rs.)	0.91	0.95	0.95	0.92	1 03	1.10
Average feed cost per kg 6% yield (Rs.)	0.89	0.86	0.90	0.86	0.93	0.96
Total return over feed cost from sale of milk (Rs.)	1008.36	973.10	1043.50	892.22	829.78	756,94

* (I) Prices of berseem, concentrate and wheat bhusha in market were Rs. 10.00, 80.00 and 21.90 per quintal, respectively.
(II) Milk was sold @ Rs. 2.50 per kg.

level of concentrate in the ration increased. The feed cost per kg 6% FCM was Re. 0.69, 0.77 and 0.87 in b_1, b_2 and b_3 treatments, respectively. Pathak (1979) who fed *ad lib.* green berseem to milch buffaloes of almost similar yield reported Re. 0.84 feeding cost per kg of 6% FCM on the same farm. These values are almost equal to the values obtained in b_3 treatment containing 70% concentrate of the present experiment. Similarly feed cost per kg milk was Rs. 1.25 in conventional feeding of cows (Panda and Mishra, 1981). The total return over feed cost in old and young buffaloes from the sale of 90 days was Rs. 765.61 and 624.52, respectively. The percentage feed cost per kg of FCM in b_1, b_2 and b_3 treatments through concentrate was 45.37, 65.77 and 80.33, respectively. The average daily feed cost for an old and young buffalo increased by Re. 0.92 and 0.82, respectively, based on market prices as compared to farm prices (Table 2). The feed cost per kg 6% FCM based on market prices in old and young buffaloes was Re. 0.88 and 0.91, respectively. It can be inferred from the findings of present study that 70 : 30 roughage concentrate ratio was most economical as compared to 50 : 50 and 30 : 70 ratio in old and young buffaloes yielding 6-8 kg of milk per day.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 211—212 (June 1983)

CLINICAL EFFICACY OF FENBENDAZOLE AGAINST *TAENIA HYDATIGENA* INFECTION IN DOGS

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(Received : January 12, 1982; Revised : June 18, 1982)

Fenbendazole* (Methyl-5-(Phenylthio)-2 benzimidazole carbamate), being a broad spectrum anthelmintic, is now used for the treatment of nematode infections in domestic animals. Its efficacy against intestinal nematodes in dogs has been reported by Kaushik *et al.* (1977), Singh *et al.* (1977) and Burke and Roberson (1978) but reports of its efficacy against tapeworm infections are scanty.

Fifteen apparently healthy mongrel dogs, divided into experimental (A) and control (B) groups, consisting of 10 and 5 dogs, respectively, were treated for hookworm infestation with Fenbendazole at 30 mg/kg body weight dose rate and repeated after 24 h so as to keep them free from any parasitic infestation. All the dogs of groups A and B were fed 4-10 cysts *(Cysticercus tenuicollis)* procured from sheep and goats slaughtered at local slaughter house, Hissar. The cysts were identified as per description given by Soulsby (1968). After recording the prepatent period of each dog, single oral dose of Fenbendazole at 75 mg/kg body weight was administered to the dogs of group A. Postmortem examination of all the dogs was carried out 7 days post-treatment to know the efficacy of drug on *T. hydatigena*.

The results of efficacy of Fenbendazole are shown in Table 1. Faecal exa-

TABLE 1

Efficacy of Fenbendazole treatment on *T. hydatigena* in experimentally infected dogs

Experimental groups	No. of cysts fed	Prepatent period	No. of worms recovered on postmortem
Experimental (A)			
1	6	58	—
2	10	52	—
3	5	55	—
4	9	55	—
5	5	50	—
6	5	55	—
7	10	48	—
8	5	52	—
9	5	53	—
10	4	52	—
Control			
1	5	55	5
2	5	56	5
3	5	55	5
4	6	52	6
5	5	50	5

*Panacur, Hoechst Pvt. Ltd.

mination of all the dogs was carried out daily to know the prepatent period which ranged from 48-58 days and according to Soulsby (1968) the tapeworm could grow adult in dogs in about 7 weeks.

Postmortem examination conducted one week after treatment with Fenbendazole revealed no worms in small intestines of group A dogs, whereas the worms recovered from control dogs corresponded to the number of cysts fed to them. From the results it could be inferred that Fenbendazole is 100% effective against *T. hydatigena* infection in dogs at a single dose rate of 75 mg/kg body weight. Duwel (1978) showed over 90% elimination of *Taenia* species from dogs with Fenbendazole at a single dose rate of 100 mg/kg body weight, whereas Burke and Roberson (1978) reported that Fenbendazole at 50 mg/kg body weight given for 3 days is effective against *Taenia* species.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 213—217 (June 1983)

EFFECT OF THYROIDECTOMY ON BONE MARROW CHROMOSOMES AND GROWTH OF SWISS ALBINO MICE AT VARIOUS STAGES OF DEVELOPMENT

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(Received : November 16, 1981; Revised : February 22, 1983)

ABSTRACT

Swiss albino mice were thyroidectomized at various stages of development to look for the changes occurring in bone marrow chromosomes and growth. Both gross as well as individual type alterations were encountered in the chromosomes. The frequency and type of chromosome aberrations bore a direct relationship with the duration proceeding thyroidectomy. Maximum loss in the body weight of the thyroidectomized individuals was observed upto fourth week of development after which there was a definite recovery of it.

Thyroid gland is regarded to be the most essential organ governing the general metabolism in an animal's body. Its hormones are identifiable in all the vertebrate classes but it has been difficult to demonstrate its calorigenic effects in poikilotherms unlike in homoiotherms where they increase the energy production and oxygen consumption of tissues (Frye, 1967). To some extent, they also control the release of somatotrophin, corticotrophin and gonadotrophins from the hypophysis. Their deficiency in the female may impair the ovaries and cause the cycles either to cease or to become irregular, ultimately leading to subnormal fecundity (Turner and Bagnara, 1971). The present study was an attempt to look for the changes occurring in the chromosomes and growth of Swiss albino mice during post-natal development and then after attaining sexual maturity following thyroidectomy (including, of course, parathyroidectomy).

MATERIAL AND METHODS

Laboratory bred and reared Swiss albino mice were used during the present investigation. In the first set of experiment, animals of one, two, three, four and five weeks (one each) taken from a single litter were thyroidectomized and were autopsied at six weeks, whereas in the second set animals of six, seven, eight, nine and ten weeks (one each) taken again from a single litter were thyroidectomized and were autopsied at eleven weeks. Sex of the animals used was not taken into consideration as the same was not possible to mark at least during their post-natal development. For convenience sake, the samples were marked G_1, G_2, G_3, G_4, G_5, G_6, G_7, G_8, G_9 and G_{10}.

The cellular studies were conducted on the bone marrow directly taken out of femur (Ford *et al.*, 1958; Rothfels and Siminovitch, 1958). From each sample,

50 intact and well spread metaphase plates were studied for chromosomal deformities. All deviations over the normal chromosomal pattern were reckoned and photomicrographed. The body weight of thyroidectomized animals and control was taken at weekly intervals.

RESULTS AND DISCUSSION

The chromosomal analysis was scored for the cells with normal complement of chromosomes, cells with no apparent structural abnormalities except loss or addition of chromosomes, fragments, deleted chromosomes, exchanges (dicentrics and translocations) rings and chromatid breaks (Figs. 1 and 2). A single polyploid cell was encountered in sample G_1 but was not found suitable for study. End to end fusion of the attenuated chromatids of various chromosomes were frequently noticed in all the samples (Fig. 3). Obviously thyroidectomy resulted in both gross as well as individual type alterations in the chromosomes. The former included anomalies like picnosis, stickiness, aneuploidy and polyploidy, while the latter contained chromatid type aberrations like deletions (Table 1). The data contained therein demonstrate that the frequency and the type of chromosome aberrations bear a direct relationship with the duration proceeding thyroidectomy. Longer was the time period, more were stable aberrations (attenuations and acentrics). To the contrary, the shorter period caused more unstable aberrations like dicentrics which tend to repair themselves with lapse of time. The chromosomal study in control revealed the anomalies in the form of aneuploid cells only (Table 1).

The data in Table 2 show loss in body weight as a function of time following

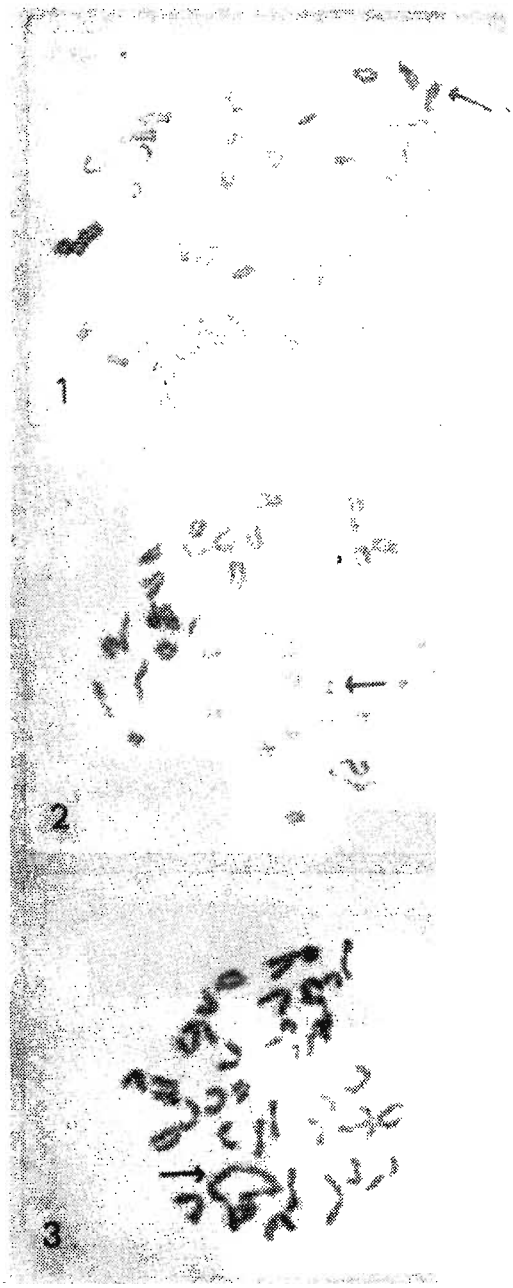


Fig. 1. Metaphase plate with dicentrics.
Fig. 2. Metaphase plate with acentric chromosomes.
Fig. 3. Metaphase plate with end-to-end fused chromosomes.

TABLE 1

Effect of thyroidectomy on chromosomes in Swiss albino mice

Age (weeks)	Cells with normal complement of 40 chromosomes	Aneuploid & polyploid cells	Unstable aberrations			Stable aberrations			
			Dicentrics	Metacentrics	Rings	Attenuations	Acentric chromosomes	Deletions	Acentric fragments
			***During post-natal development**						
1 (G_1)	49	1 Aneu.	14	0	0	End-to-end fused chroms.	12	14	5
2 (G_2)	49	1 Aneu.	16	0	0	,,	10	12	6
3 (G_3)	49	1 Aneu.	20	0	0	,,	8	7	5
4 (G_4)	48	1 Aneu. 1 Poly.	20	0	0	,,	2	3	4
5 (G_5)	50	0	26	0	0	,,	1	4	1
			****After attaining sexual maturity**						
6 (G_6)	50	0	1	0	0	End-to-end fused chroms.	17	4	2
7 (G_7)	50	0	3	0	0	,,	14	2	2
8 (G_8)	48	2 Aneu.	2	0	0	,,	10	2	2
9 (G_9)	48	2 Aneu.	4	0	0	,,	8	0	1
10 (G_{10})	47	3 Aneu.	4	0	0	,,	2	0	1

*(i) Autopsy done in each case at 6 weeks;

(ii) No. of the cells examined from each batch was 50;

(iii) Chromosomal study in control revealed the aneuploid cells only (0.5% in comparison with 1.6% of the thyroidectomized animals).

**(i) Autopsy done in each case at 11 weeks;

(ii) No. of the cells examined from each batch was 50;

(iii) Chromosomal study in control revealed the aneuploid cells only (0.8% in comparison with 2.8% of thyroidectomized animals).

thyroidectomy during post-natal development stages but after the animal attained its sexual maturity the body weight of thyroidectomized animal over the body weight of control did not show any conspicuous loss.

In a normal complement of Swiss albino mice, Levan *et al.* (1962) reported all the elements as acrocentrics. All the deviations from the normal chromosomal pattern were, therefore, recorded following Bloom *et al.* (1967). Cells containing

TABLE 2

Body weight of Swiss albino mice preceding and proceeding thyroidectomy

Thyroidectomy done at (weeks)	Normal body weight (g)	Body weight following thyroidectomy (g)					
		1st*	2nd*	3rd NS (weeks)	4th NS	5th NS	6th NS
During post-natal development							
1	2.500		2.500	4.250	5.000	8.000	10.000
2	4.500			4.750	6.000	9.500	10.500
3	7.750				7.000	9.500	11.500
4	11.000					10.500	15.000
5	16.000						16.000
6	17.500						
After attaining sexual maturity							
		6th*	7th*	8th NS	9th NS	10th NS	11th NS
6	13.500		13.500	18.000	20.125	21.375	22.250
7	15.000			19.250	19.875	20.750	22.500
8	20.000				20.750	21.125	22.250
9	21.500					21.625	22.625
10	22.000						22.250
11	22.750						

*Significant at 5% level n=12

NS=Non-significant at 5% level n=12

abnormal monocentric chromosomes, with the exception of ring chromosomes, may be considered to be stable type. A considerable proportion of the damaged cells here contained dicentrics which were likely to cause cell death at the time of division. Significantly larger production of dicentrics by thyroidectomy resembles the situation occurring due to low dose administration of radioisotopes to Swiss albino mice (Buckton *et al*, 1967; Pasahan and Srivastava, 1975). The dividing cells which contained unstable chromosome aberrations like dicentrics were unable to produce viable daughter cells. Vijaylaxmi (1975) and Vijaylaxmi and Sadasivan (1975) observed the consistent production of polyploid cells in rats fed on irradiated wheat. It was per chance that a single polyploid cell had also been encountered during present investigation.

The body weight of thyroidectomized animal over the body weight of control showed remarkable degree of loss during its early post-natal development stages which, however, tended to recoup with its advent towards sexual maturity. Maximum loss was observed upto second week of development after which there was a definite recovery of it. Statistical evaluation of the data regarding body weight preceding and proceeding thyroidectomy clearly showed significant loss of body weight upto first two weeks, whereas it was non-significant after that. This, however, was an indirect indication of a few possibilities like : (i) whether

the thyroid gland itself rejuvenates to take up its own function or (ii) there is an alternate source becoming available in the thyroidectomized body to take up the function of thyroid gland. Of these, only the latter seemed compatible in accomplishing the animal body weight and also sufficing the physiological needs of a thyroid deficient species in nature.

ACKNOWLEDGEMENT

Thanks are due to Dr. R. P. Kapil, Professor & Head, Department of Zoology, for constructive criticism and providing laboratory facilities.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 218—226 (June 1983)

PATH ANALYSIS OF HARVEST INDEX AND ITS RELATED CHARACTERS IN WHEAT

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(Received : March 25, 1982; Revised : July 29, 1982)

ABSTRACT

Fortyfive entries comprising nine parents and their 36 hybrids of spring wheat were studied for phenotypic and genotypic correlations. In general, correlations at genotypic level were higher than the corresponding phenotypic correlations. Grain yield was significantly associated with harvest index, biological yield, tiller number and spike length. Path coefficient analysis showed that harvest index was the most important yield component, followed by biological yield and number of tillers per plant. The usefulness of harvest index as an important component of an ideotype has been discussed in the light of results obtained in the present study.

Yield is a complex quantitative character and its expression depends on a number of component traits. Grafius (1959) even expressed his doubt regarding *per se* existence of genes for yielding ability and, thus, strongly advocated for component breeding approach in cereals. For further genetic improvement in yield potential, breeding for an ideotype with high harvest index has been suggested by Jain (1977). Studies on the correlations of harvest index and other components, their relative contributions, direct and indirect, towards yield are of immense value in the selection of superior genotypes. The present study was aimed at studying the extent and nature of direct and indirect effects of harvest index and yield contributing characters on yield using path-analysis.

MATERIAL AND METHODS

The experimental material comprised parental and F_1 generations of 9×9 diallel set (excluding reciprocals) of spring wheat. The experiment was laid out in a randomized block design in two environments, irrigated timely sown (November 20, 1978) and unirrigated late sown (December 1, 1978) conditions. The nine parents included were P 118, S 308, K 68, WG 377, C 591, UP 368, WH 147, WH 156 and K 227. The seeds were sown in 3 m long rows at 30×15 cm row to row and plant to plant distance. For each entry (parent and F_1) five competitive plants were selected randomly from each replication in both the environments for recording observations on characters, plant height, days to 50% flowering, tiller number, spike length, grains/spike, 1000-grain weight, biological yield, grain yield and harvest index.

Phenotypic and genotypic correlations were studied and path coefficient analysis was carried out for individual environ-

ment, using formula of Dewey and Lu (1959).

RESULTS AND DISCUSSION

Although, in general, the correlations at the genotypic and phenotypic levels showed the similar trend, yet the former were of greater magnitude than the latter (Tables 1 and 2). Further, in most cases, correlations were more pronounced under stress than under normal conditions. In both the environments, harvest index was significantly positively correlated with grain yield, and negatively with plant height. Grain yield showed significant positive association with biological yield, tiller number, spike length and 1000-grain weight. Biological yield had no correlation with harvest index. Singh and Stoskopf (1971), Chowdhury *et al.* (1977) and Thakral *et al.* (1979) also observed positive correlation of harvest index with grain yield, but negative correlation with biological yield. Thakral *et al.* (1979) observed that grain yield and biological yield were uncorrelated. Thus, an improvement in grain yield through indirect selection on harvest index appears possible without affecting the biological yield.

Path analysis is useful in determining the direct and indirect association among attributes. Grain yield was considered as the dependent variable and the other characters as the causal variables.

Under normal environment, biological yield and harvest index had the highest direct effect upon grain yield, while spike length and plant height had low direct effect but relatively important (Table 3). The indirect effect of plant height on yield via biological yield was relatively high and positive, via harvest index it was high but negative and via 1000-grain weight it was small and negative.

The high correlation of tiller number with grain yield was observed as a result of its indirect contributions through biological yield, harvest index and spike length. Most of the causal components exhibited high correlation with grain yield because of their indirect contributions through biological yield. The path analysis was also done after excluding harvest index from amongst the causal variables (Table 4). In this analysis tiller number was observed to have the highest positive direct effect upon yield. It was interesting to note that except height all the yield components contributed to yield through number of tillers.

Under stress environment, it was observed that the phenotypic measurement of eight characters accounted for 98.17% of total variation in grain yield but when harvest index was not considered as a causal component, the phenotypic measurement of the seven characters accounted for only 30.40% of the total variation in grain yield (Tables 5 and 6).

In the first situation, the tiller number, harvest index, plant height and number of grains were found to have intermediate direct effects upon yield. The direct effects of biological yield and days to heading were low and negative. When harvest index was not considered as a causal component, tiller number appeared to be the most important direct

TABLE 1

Simple correlation coefficients between all possible pairs of characters studied in normal environment

Characters		Plant height	Days to heading	Tiller number	Spike length	No. of grains/ spike	1000-grain weight	Biological yield	Grain yield	Harvest index
Plant height	g	—0.49	—0.05	0.08	0.11	0.57	0.60	0.08	—0 67
	p	—0.38**	0.05	0.11	0.09	0.45**	0.31*	0.11	—0.39**
	e	—0.14	0.34	0.32	—0.04	0.15	0.32	0.35	0.04
Days to heading	g		0.54	0.03	0.18	—0.48	0.31	0.34	0.15
	p		0.07	0.06	0.08	—0.37*	—0.05	—0.01	0.07
	e		—0.14	0.09	0.01	—0.22	—0.24	—0.21	—0.01
Tiller number	g			0.92	0.32	0.25	0.65	0.94	0.47
	p			0.48**	0.03	0.05	0.65**	0.77**	0.23
	e			0.33	—0.07	—0.05	0.65	0.73	0.16
Spike length	g				0.17	0.40	0.90	0.77	—0.09
	p				0.21	0.20	0.46**	0.51**	0.08
	e				0.25	—0.06	0.29	0.41	0.23
No. of grains/ spike	g					—0.07	0.55	0.46	0.10
	p					—0.01	0.21	0.25	0.08
	e					0.06	0.10	0.16	0.06
1000-grain weight	g						0.70	0.36	—0.25
	p						0.37*	0.25	—0.19
	e						0.25	0.21	—0.14
Biological yield	g							0.80	—0.16
	p							0.84**	—0.22
	e							0.85	—0.25
Grain yield	g								0.46
	p								0.31*
	e								0.26
Harvest index									—

g=genotypic correlation coefficient, p=phenotypic correlation coefficient, e=environmental correlation coefficient.
*,**Significant at 5 and 1 per cent, respectively

TABLE 2

Simple correlation coefficients between all possible pairs of characters studied in stress environment

Characters		Plant height	Days to heading	Tiller number	Spike length	No. of grains/ spike	1000-grain weight	Biological yield	Grain yield	Harvest index
Plant height	g	−0.72	0.04	0.25	−0.22	0.64	0.56	0.34	−0.47	
	p	−0.42**	0.21	0.32*	−0.05	0.53**	0.46**	0.37*	−0.36*	
	e	0.13	0.51	0 52	0.29	0.25	0.64	0.59	−0.19	
Days to heading	g		−0.02	−0.28	0.11	−0.75	−0.57	−0.48	0.01	
	p		0.14	−0.03	0.18	−0.41**	0.01	0.00	0.00	
	e		0.24	0.24	0.25	0.03	0.30	0.26	−0.03	
Tiller number	g			0.40	0.21	0.78	0.78	0.76	0.23	
	p			0.42**	0.33*	0.34*	0.79**	0.81**	0.10	
	e			0.47	0.42	0.09	0.80	0.82	0.03	
Spike length	g				0.04	0.52	0.51	0.51	−0.07	
	p				0.30*	0.46**	0.52**	0.52**	−0.06	
	e				0.56	0.40	0.57	0.56	−0.05	
No. of grains/ spike	g					−0.26	0.29	0.45	0.60	
	p					0.03	0.44**	0.52**	0.47**	
	e					0.41	0.54	0.59	0.29	
1000-grain weight	g						0.91	0.89	−0.11	
	p						0.48**	0.48**	0.01	
	e						0.32	0.35	0.23	
Biological yield	g							0.97	0.25	
	p							0.96**	0.03	
	e							0.96	−0.11	
Grain yield	g								0.46	
	p								0.34*	
	e								0.11	
Harvest index									—	

g=genotypic correlatign coefficient, p=phenotypic correlation coefficient, e=environmental correlation coefficient.

*,**Significant at 5 and 1 per cent, respectively.

TABLE 3

Path coefficient analysis of factors influencing grain yield in normal environment

Characters	Effect via								
	Plant height	Days to heading	Tiller number	Spike length	No. of grains/spike	1000-grain weight	Biological yield	Harvest index	Correlation with grain yield
Plant height	**0.30**	−0.01	0.03	0.03	−0.06	−0.29	0.79	−0.71	0.08
Days to heading	−0.15	**0.02**	−0.29	0.01	−0.06	0.24	0.41	0.16	0.34
Tiller number	−0.02	0.01	**−0.54**	0.39	−0.12	−0.13	0.85	0.50	0.94
Spike length	0.02	0.00	−0.49	**0.41**	−0.06	−0.20	1.19	−0.09	0.77
No. of grains/spike	0.05	0.00	−0.17	0.07	**−0.37**	0.04	0.73	0.11	0.46
1000-grain weight	0.17	−0.01	−0.13	0.17	0 03	**−0.51**	0.92	−0.27	0.36
Biological yield	0.18	0.01	−0.35	0.37	−0.20	−0.35	**1.32**	−0.17	0.80
Harvest index	−0.20	0.00	−0.25	−0.03	−0.04	0.13	−0.21	**1.06**	0.45

Residual = −0.0289

Values on diagonal are the direct effects.

TABLE 4

Path coefficient analysis of yield components excluding harvest index in normal environment

Characters	Effect via							
	Plant height	Days to heading	Tiller number	Spike length	No. of grains/ spike	1000-grain weight	Biological yield	Correlation with grain yield
Plant height	**0.09**	−0.05	−0.05	0.00	0.05	0.19	−0.15	0.08
Days to heading	−0.05	**0.10**	0.48	0.00	0.05	−0.16	−0.08	0.34
Tiller number	0.00	0.05	**0.89**	−0.01	0.10	0.08	−0.17	0.94
Spike length	0.00	0.00	0.82	**−0.01**	−0.05	0.14	−0.23	0.77
No. of grains/spike	0.02	0.02	0.29	0.00	**0.30**	−0.02	−0.14	0.46
1000-grain weight	0.05	−0.05	0.22	0.00	−0.02	**0.34**	−0.18	0.36
Biological yield	0.06	0.03	0.58	−0.01	0.16	0.23	**−0.26**	0.80
Residual=0.0707								

Values on diagonal are the direct effects.

TABLE 5

Path coefficient analysis of factors influencing grain yield in stress environment

Characters	Effect via								
	Plant height	Days to heading	Tiller number	Spike length	No. of grains/ spike	1000-grain weight	Biological yield	Harvest index	Correlation with grain yield
Plant height	**0.35**	0.15	0.02	0.04	—0.05	0 02	—0.03	—0.16	0.34
Days to heading	—0.25	**—0.21**	0.00	—0.04	0.02	—0.02	—0.03	0.00	—0.48
Tiller number	0.15	0.00	**0.56**	0.07	—0.05	0.03	—0.04	—0.08	0.76
Spike length	0.09	0.06	0.23	**0.16**	0.01	0.02	—0.03	—0.02	0.51
No. of grains/spike	—0.08	—0.02	0.12	0.01	**0.23**	—0.01	—0.02	0.23	0.45
1000-grain weight	0.22	0.16	0.43	0.08	—0.06	**0.03**	—0.05	—0.04	0.78
Biological yield	0.19	0.12	0.43	0.08	0.07	0.03	**—0.06**	0.09	0.97
Harvest index	—0.15	0.00	0.12	—0.01	0.14	0.00	—0.01	**0.38**	0.46

Residual=0.0183

Values on diagonal are the direct effects.

TABLE 6

Path coefficient of yield components excluding harvest index in stress environment

Characters	Effect via							
	Plant height	Days to heading	Tiller number	Spike length	No. of grains/ spike	1000-grain weight	Biological yield	Correlation with grain yield
Plant height	**5.40**	2.91	0.40	0.21	—1.29	2.02	—9.32	0.34
Days to heading	—3.87	**—4.07**	—0.17	—0.24	0.62	—2.37	9.62	—0.48
Tiller number	0.23	—0.07	**9.46**	0.35	1.20	2.43	—12.99	0.76
Spike length	1.35	1.16	3.84	**0.85**	0.22	1.62	—8.53	0.51
No. of grains/spike	—1.22	—0.44	1.97	—0.03	**5.76**	—0.81	—4 84	0.45
1000-grain weight	3.48	3.07	7.35	0.44	—1.49	**3.14**	—15.22	0.78
Biological yield	3.02	2.34	7.36	0.43	1.67	2.86	**—16.71**	0.97

Residual=0.6951

Values on diagonal are the direct effects.

contributor to the grain yield. Biological yield and days to heading had high but negative direct effect upon yield. In this case also, almost all the yield components contributed mainly via tiller number. Most of the causal components except days to heading were observed to have high and negative indirect effects via biological yield upon grain yield in case of both the situations under stress environment.

Thus, the results discussed above clearly showed that the harvest index accounted for the major portion of genetic variability for yield and was highly associated with grain yield. In addition, biological yield had substantial direct contribution to yield under normal conditions. When harvest index was not considered as a causal component, tiller number with highest positive direct effect was observed to be the component most closely associated with grain yield. Thus, on the basis of these findings it may be inferred that harvest index and biological yield in normal environment and harvest index and tiller number in stress environment are the main characters to be taken into account while making selection of superior genotypes.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 227—229 (June 1983)

A RAPID SCREENING TECHNIQUE FOR NITROGEN FIXATION IN SOYBEAN

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(Received : December 5, 1981; Revised : January 17, 1983)

Nitrogen fixation in Rhizobium-legume symbiosis is being measured in variety of ways. These include Kjeldahl's method of N determination in plant material, number and size of nodules, nodule weight, leghaemoglobin content, acetyline reduction assay and biological yield. Nodule number, nodule weight and seed yield have been found to be positively related with the rate of N fixed. Likewise, nitrogenase activity per plant has been found to be significantly and positively related with seed yield (Caldwell and Grant, 1970; Nancron *et al.*, 1978; Lakshminarayana *et al.*, 1979). Several approaches like Leonard jar technique (Leonard, 1943) for screening of rhizobial strains for bold seed legumes under temperate conditions and Chillum jar assembly (Dahiya and Khurana, 1981) for hot arid climate were found suitable under pot culture experiments. *In situ* acetylene reduction assay (Lakshminarayana *et al.*, 1979) was standardized for screening of superior bacterial culture and superior legume plant under field conditions. Wacek and Brill (1976) developed a modified acetylene reduction method using vermiculate and 16 ml of N free plant nutrient media in 20 ml glass vials to screen large populations on single seed basis.

The present technique is an improvement over Wacek and Brill's technique and has an edge over other standard techniques viz., Leonard jar, Chillum jar assembly and pot cultures using sterilized soil/sand. This technique is simple, easy to work, economical, and permits not only the visual observation of nodules/plant in the glass tube but also has an added advantage of screening large number of mutated seeds/cross seeds for high nodulation and high N_2 fixing ability at a much faster rate without disturbing or damaging the plant nodules. The selected plants can be removed intact and transplanted in pots/soil and raised to maturity for obtaining seeds. Thus, this technique which enables the microbiologists to screen efficient rhizobia has been extended for use by pulse breeders to screen large number of genotypes/hybrid progenies/irradiated seeds for high nodulation and N_2 fixing ability and to obtain ad-

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vance generation seeds of selected plants/ hybrid progenies even during off season, under pot house conditions. In Leonard jar technique, Chillum jar assembly and pot cultures the visual observation for nodule number is possible only when the plants are uprooted. This damage due to uprooting of the plants affects adversely their nitrogenase estimations. Moreover, all other techniques are time consuming, require large working space and are cumbersome. But this technique has an added advantage over Wacek and Brill's technique as in the latter technique vermiculate has been used in media and it is not easily available in India. On the other hand, agar media in place of vermiculate has been successfully used in the present technique. Above all the test tube technique can be suitably and effectively employed in large seeded pulse legumes like gram, **arhar**, cowpea, beans, etc.

Briefly, the technique consisted of raising the sprouted and inoculated seeds in test tubes of 150 ml capacity on 3% agar, and Brayan (1922) N free medium slants. Fifty ml medium was used for making slants. The tubes were plugged with cotton and placed in the screen house. The growing seedlings were observed for nodulation after 25 days. One can easily observe and count the nodules through the semi transparent medium slants (Fig. 1). The tubes with the nodulating seedlings were observed for estimation of nitrogen fixed through acetylene reduction technique. The desired plants were removed intact from the slants and transplanted in pots containing soil, sand and FYM mixture.

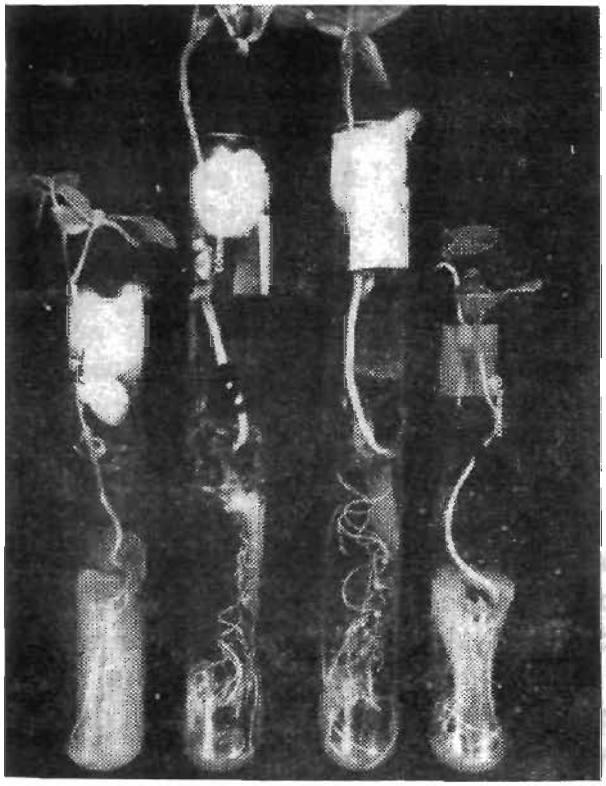


Fig. 1. Nodulated soybean seedlings grown in glass slants containing N-free nutrient media.

This technique was applied to dry irradiated (25 kr and 35 kr) seeds of high yielding cobb variety of soybean in isolating nodulating mutants. Normally, this variety is a very poor nodulating type and does not form nodules at all, even with *Rhizobium japonicum* strain 1028 which is known for its very high effectiveness for nitrogen fixation in most of soybean varieties. Three hundred and fifty seeds were screened under each treatment and finally 17 nodulating plants were identified and raised to maturity.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 230—237 (June 1983)

STUDIES ON YIELD, QUALITY AND NUTRIENT UPTAKE BY BERSEEM AS INFLUENCED BY N P K FERTILIZATION

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(Received : July 4, 1980; Revised : November 10, 1980)

ABSTRACT

Forty kg N/ha significantly increased the yield of berseem fodder, seed and straw, N P K content and their uptake over the control treatment. Eighty kg N/ha reduced the yield and nutrient uptake compared to 40 kg N/ha, but generally, gave a trend of higher N P content at most of the cuttings with variable results in K content. Similarly, N P content and their uptake increased significantly with increase in the level of P ranging from 0 to 105 kg P/ha with variable K content. Application of 66 kg K/ha improved the yield, NPK content and their uptake to a great extent over the control, but the differences between 66 and 132 kg K/ha were not well marked at some of the cuttings.

Of all the legume fodder crops grown in India, berseem is considered to be the most suitable crop for its enormous yield and high quality fodder. Nitrogen, phosphorus and potassium are the most important elements which are necessary for plant growth and, fortunately, berseem responds to each of the three nutrients, though voluminous work reveals that phosphate manuring is always remunerative and increases fodder yield two-three fold. Tomer and Arora (1972) found that berseem responded well to the application of 80 kg N/ha. Ganguli *et al.* (1977) reported that green fodder yields showed positive responses of 51.57 and 148.98 q/ha at 50 and 100 kg N/ha, respectively, over no nitrogen application. In India, phosphate manuring of berseem yielded 100-300% more fodder as a result of superphosphate application (Sen and Bains, 1952; Tomer, 1969). Sinha (1972) and Husain and Bains (1978) used very high levels of phosphorus ranging from 0 to 320 kg P_2O_5/ha and found substantial increase in fooder yield. Though work with potassium is scanty, yet there is substantial information that this nutrient in combination with N and P helps in increased fodder production besides improving the nutritive value (Santos and Cabral, 1979). Similarly, workers have shown that nitrogen and phosphorus application not only increase N P content of forage, but also enhance their uptake to a great extent. In view of beneficial effects of N P K on yield and nutritive value of berseem, field experiments were conducted.

MATERIAL AND METHODS

Field experiments were carried out in sandy loam soil of medium fertility (total

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N, available P and K 980, 17 and 174 kg/ha, respectively) at the Indian Agricultural Research Institute, New Delhi, during **rabi** seasons of 1977-78 and 1978-79. A split-plot design was used with three replications having levels of nitrogen (0,40 and 80 kg N/ha) and levels of potassium (0, 66 and 132 K/ha) in main plots and levels of phosphorus (0, 35, 70 and 105 kg P/ha) in sub-plots. Diploid berseem *(Trifolium alexandrinum)*, variety 'Muscowi' was used in the experiment. Planting was done on October 14, 1977 in the first season and on October 28, 1978 in the second season. In both the seasons, berseem crop was left to seeding after fifth and fourth cuttings in 1977-78 and 1978-79, respectively. A representative sample from freshly cut green fodder of each plot was collected and weighed immediately for chemical analysis. The plants were dried first in the sun and then subjected to 70°C in an electric oven for 24 h. The dry weight of the plant material was obtained. Total N was determined by modified macro-Kjeldahl's method as per AOAC (1955). Phosphorus estimation was done by Vanadomolybdo-phosphoric yellow colour method (Jackson, 1958). Potassium content was estimated by flame photometer. N P K uptake was computed by multiplying the dry matter yield with the respective percentage of the nutrient in different components.

RESULTS AND DISCUSSION

Yield of Berseem

Forty kg N/ha gave significantly higher yield of berseem fodder and seed during both the years over the control (Table 1). The difference in respect of straw did not reach the significant level. Eighty kg N/

TABLE 1

Yield of green fodder, seed and straw (q/ha) of berseem as influenced by nitrogen, phosphorus and potassium application

N P K (kg/ha)	1977-78			1978-79		
	Fodder	Seed	Straw	Fodder	Seed	Straw
N_0	827	8.9	47.4	574	11.1	42.2
N_{40}	904	10.4	46.7	634	11.9	45.9
N_{80}	853	8.9	47.4	605	11.9	44.4
S. Em.±	18.9	0.2	2.3	11.2	0.3	2.6
CD at 5%	40.1	0.4	NS	23.7	0.6	NS
P_0	693	7.4	42.2	447	10.4	35.6
P_{35}	846	9.6	45.2	616	11.9	47.4
P_{70}	923	10.4	51.1	668	12.6	45.9
P_{105}	982	10.4	50.4	688	12.6	46.7
S. Em.±	22.5	0.3	2.0	9.5	0.3	1.8
CD at 5%	45.2	0.5	4.1	21.0	0.6	3.6
K_0	807	8.9	45.2	583	11.9	43.7
K_{66}	862	9.6	47.4	607	11.9	40.7
K_{132}	916	9.6	48.9	626	11.9	48.1
S. Em.±	18.9	0.2	2.3	11.2	0.3	2.6
CD at 5%	42.1	0.4	4.9	23.7	NS	5.5

ha, however, reduced the yield of fodder slightly compared to 40 kg N/ha. This may be due to detrimental effect of higher dose of nitrogen which inhibited nitrogen fixation through symbiosis by the bacteria. These findings are similar to those of Brock and Hogland (1974).

There was a trend of increase in fodder yield with the subsequent increase in the level of phosphorus. The optimum doses of phosphorus were worked out to be 90 and 72 kg P/ha in 1977-78 and 1978-79, respectively. The yield of seed also increased upto 70 kg P/ha, but in straw the yield did not show consistent results. Increase in phosphorus induced the plant to absorb more amount of nitrogen which helped in manufacture of cell components and other organic compounds in the plant system. Increase in yield could also be attributed to increased activity of soil bacteria in fixing atmospheric nitrogen, as high supply of phosphorus stimulated the activities of soil micro-organisms. These results are supported by Sinha (1974).

Similarly, application of potassium favoured much in increasing the yield of fodder and 66 kg K/ha proved significantly superior to control in both the seasons. Lunin and Gallatin (1964) and Dautkulov and Zheksembieva (1977) also reported higher yield of fodder due to application of potassium. The increase in seed and straw yield was noted due to potassium, but in 1978-79 the results were not consistent in respect of straw.

NPK Content

Forty kg N/ha significantly increased N content over the control at all the cuttings in both the seasons (Table 2). The highest N content was obtained in treatment receiving 80 kg N/ha which proved significantly superior to 40 kg N/ha at most of the cuttings in both the seasons. This may be attributed to a greater concentration of the nutrient in soil media resulting in its greater absorption in plant system. These results are in close confirmity with those of Husain and Bains (1978). Likewise, 80 kg N/ha pushed up P content over 40 kg N/ha at all the cuttings, while in 1978 the trend reversed upto fourth cutting. The general tendency of increase in P content may be due to the beneficial effect of nitrogen on rooting system leading to more absorption of phosphorus. The present findings confirm the observations made by Santos and Cabral (1979). Similarly, 40 kg N/ha gave higher K content than that of control at all the cuttings in both the seasons, except at fifth one in 1977-78 and at first and third ones in 1978-79. Eighty kg N/ha slightly increased K content over 40 kg N/ha in seed and straw only in 1977-78 and at first three cuttings during 1978-79.

Thirtyfive kg P/ha gave significant increase in N content over the control at all the cuttings in both the seasons (Table 3). The highest N content was obtained at 105 kg P/ha at all the cuttings except at fourth one in 1977-78 and in straw during both the seasons. The results obtained are similar to those of other workers (Husain and Bains, 1978). Similarly, increase in level of P resulted in corresponding increase in P content of berseem fodder, seed and straw. Thirtyfive kg P/ha gave significantly higher P content over the control at all the cuttings in both the seasons. One hundred and five kg P/ha resulted in the highest P content.

TABLE 2

Effect of nitrogen on NPK content (%) of berseem

Kg N/ha	1977-78							1978-79					
	1st	2nd	3rd	4th	5th	Seed	Straw	1st	2nd	3rd	4th	Seed	Straw
						N content (%)							
0	2.56	2.64	2.60	2.54	2.32	4.21	0.62	3.70	3.86	3.75	2.87	4.84	0.48
40	2.86	2.91	2.92	2.85	2.52	4.64	0.72	4.06	4.08	4.07	2.94	5 27	0.57
80	3.00	3 07	3.07	3.04	2.46	4.76	0.78	4.19	4.24	4.19	2.96	5.41	0.64
S.Em.±	0.01	0.01	0.02	0.03	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.03	0.01
CD at 5%	0.03	0 03	0.03	0.06	0.04	0.04	0.03	0.03	0.04	0.04	0.04	0.07	0.03
						P content (%)							
0	0.267	0.221	0.202	0.136	0.077	0.560	0.049	0.187	0.163	0.147	0.106	0.480	0.047
40	0.368	0.253	0.228	0.170	0.082	0.501	0.053	0.274	0.247	0.224	0.202	0.550	0.043
80	0.409	0.297	0.237	0.179	0.088	0.581	0.054	0.267	0.239	0 218	0.147	0.554	0.048
S.Em.±	0.008	0.004	0.008	0 008	0.004	0.008	0.001	0.004	0.004	0.004	0.004	0.008	0 001
CD at 5%	0.013	0.008	0.018	0.013	0.008	0.018	0.004	0.008	0.008	0.008	0.008	0.018	0.004
						K content (%)							
0	0.99	1.09	1.14	1.07	0.92	1.00	0.35	1.15	1.24	1.29	1.23	1.24	0.39
40	1.29	1.12	1.41	1.11	0.87	1.04	0.39	1.14	1.25	1.26	1.26	1.26	0.44
80	1.02	1.11	1.16	1.05	0.83	1.87	0.40	1.18	1.28	1 28	1.20	1.25	0.44
S.Em.±	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01
CD at 5%	0.03	NS	NS	0.04	NS	0.02	0.02	0.02	NS	NS	0.03	NS	0.02

TABLE 3

Effect of phosphorus on NPK content (%) of berseem

Kg P/ha	1977-78							1978-79					
	1st	2nd	3rd	4th	5th	Seed	Straw	1st	2nd	3rd	4th	Seed	Straw
						N content (%)							
0	2.58	2.67	2.67	2.65	2.30	4.26	0.60	3.71	3.84	3.82	2.77	4.92	0.46
35	2.81	2.89	2.88	2.81	2.46	4.51	0.73	4.00	4.07	4.02	2.93	5.13	0.58
70	2.92	2.97	2.95	2.90	2.49	4.67	0.78	4.09	4.16	4.09	3.00	5.28	0.63
105	2.93	2.98	2.97	2.88	2.49	4.72	0.72	4.13	4.17	4.09	3.00	5.37	0.58
S.Em.±	0.01	0.01	0.01	0.03	0.03	0.03	0.01	0.03	0.01	0.03	0.03	0.03	0.01
CD at 5%	0.03	0.02	0.03	0.07	0.04	0.05	0.04	0.04	0.04	0.04	0.04	0.08	0.04
						P content (%)							
0	0.162	0.142	0.126	0.102	0.062	0.440	0.030	0.167	0.114	0.128	0.096	0.427	0.029
35	0.378	0.267	0.236	0.173	0.083	0.576	0.054	0.219	0.197	0.186	0.123	0.528	0.046
70	0.415	0.300	0.254	0.198	0.089	0.589	0.060	0.279	0.248	0.228	0.152	0.554	0.051
105	0.438	0.319	0.271	0.197	0.095	0.594	0.072	0.305	0.277	0.253	0.175	0.585	0.052
S.Em.±	0.008	0.008	0.008	0.008	0.008	0.608	0.001	0.004	0.004	0.004	0.004	0.008	0 001
CD at 5%	0.018	0.013	0.013	0.018	0.018	0.018	0.004	0.008	0.013	0.013	0.013	0.018	0.004
						K content (%)							
0	0 98	1.08	1.15	1.00	0.90	1.00	0.36	1.14	1.23	1.29	1.25	1.22	0.39
35	1.05	1.15	1.16	1.10	0.89	1.04	0.38	1.21	1.30	1.32	1.23	1.29	0.43
70	1.02	1.10	1.15	1.06	0.85	1.06	0.39	1.17	1.27	1.29	1.21	1.28	0.44
105	1.00	1.09	1.13	1.05	0.89	1.07	0.40	1.15	1.24	1.26	1.21	1.24	0.44
S.Em.±	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01
CD at 5%	0.03	0.05	NS	NS	NS	0.02	0.02	0.03	0.05	NS	NS	0.03	0.02

TABLE 4

Effect of potassium on NPK content (%) of berseem

Kg K/ha	1977-78							1978-79					
	1st	2nd	3rd	4th	5th	Seed	Straw	1st	2nd	3rd	4th	Seed	Straw
						N content (%)							
0	2.66	2.75	2.73	2.67	2.41	4.29	0.63	3.82	3.94	3.87	2.89	4.88	0.49
66	2.85	2.90	2.90	2.85	2.43	4.52	0.72	4.04	4.08	4.03	2.95	5.18	0.57
132	2.91	2.97	2.97	2.92	2.47	4.82	0.77	4.08	4.16	4.12	2.93	5.47	0.63
S.Em.±	0.01	0.01	0.02	0.03	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.03	0.01
CD at 5%	0.03	0.03	0.03	0.06	0.04	0.04	0.03	0.03	0.03	0.04	0.04	0.07	0.03
						P content (%)							
0	0.301	0.232	0.203	0.173	0.084	0.537	0.051	0.223	0.238	0.180	0.129	0.506	0.043
66	0.362	0.271	0.234	0.176	0.082	0.564	0.052	0.242	0.214	0.194	0.130	0.524	0.044
132	0.382	0.269	0.229	0.168	0.080	0.576	0.055	0.263	0.237	0.215	0.147	0.554	0.048
S.Em.±	0.008	0.004	0.008	0.008	0.004	0.008	0.001	0.004	0.004	0.004	0.004	0.008	0.001
CD at 5%	0.013	0.008	0.018	0.013	0.008	0.018	0.004	0.013	0.008	0.013	0 013	0.018	0.004
						K content (%)							
0	0.92	0.98	1.02	0.95	0.83	0.90	0 28	1.09	1.41	1.15	1.16	1.16	0.33
66	1.05	1.14	1.20	1.15	0.91	1.09	0.42	1.20	1.29	1.34	1.29	1.28	0.44
132	1.08	1.20	1.21	1.13	0.91	1.15	0.45	1.22	1.35	1.37	1.28	1.30	0.49
S.Em.±	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01
CD at 5%	0.03	0.05	0.05	0.04	0.06	0.02	0.02	0.02	0.04	0.04	0.03	0.03	0.02

There was significant difference between 70 and 105 kg P/ha at all the cuttings except fourth and fifth ones and in seed during 1977-78 and in straw during 1978-79. Generally, K content in berseem increased upto the application of 35 kg P/ha, thereafter variable results were obtained mostly with reduction in K content at various cuttings which may be attributed to dilution effects due to increased yield. The effect of phosphorus in stimulating root development is a commonly accepted principle. The results obtained are supported by Wayse (1968).

Sixtysix kg K/ha gave significant increase in N content over the control at all the cuttings in both the seasons, except at fifth one in 1977-78 (Table 4). One hundred thirtytwo kg K/ha recorded the highest N content, except at fourth one in 1978-79. This may be due to the beneficial effect of potassium on nitrogen metabolism in the plant system. The results obtained are supported by Dautkulov and Zheksembieva (1977). Although there was increase in P content at most of the cuttings due to potassium application, yet the data were not consistent. Likewise, 66 kg K/ha gave significantly higher K content over the control at all the cuttings in both the seasons except second cut in 1978-79 where K content reduced. One hundred thirty two kg K/ha further enhanced K content over 66 kg/ha at most of the cuttings during both the seasons. This may be directly due to greater concentration of potassium in soil media and its passage to the plant system. The results are supported by Sen and Bains (1952).

NPK Uptake

Forty kg N/ha proved significantly superior to control in respect of NPK uptake by berseem during both the seasons

TABLE 5

NPK uptake by berseem as influenced by nitrogen, phosphorus and potassium application

NPK	1977-78			1978-79		
(kg/ha)	N	P	K	N	P	K
N_0	534	37.8	218	566	27.3	200
N_{40}	654	50.5	228	666	47.0	226
N_{80}	637	50.2	222	659	40.1	216
S. Em.	8.2	0.9	4.8	8.8	0.7	3.3
CD at 5%	24.4	2.5	14.3	26.4	1.9	9.9
P_0	459	22.2	188	454	18.9	164
P_{35}	597	45.9	227	640	33.7	224
P_{70}	663	54.7	241	703	44.0	233
P_{105}	698	60.4	251	724	58.1	237
S. Em.±	6.9	0.9	3.7	7.4	0.9	2.9
CD at 5%	19.6	2.8	10.5	20.9	2.4	8.0
K_0	529	37.9	193	590	32.7	186
K_{66}	613	48.1	256	632	35.9	217
K_{132}	663	49.7	251	669	41.4	235
S. Em.±	8.2	0.9	4.8	8.8	0.7	3.3
CD at 5%	24.4	2.5	14.3	26.4	2.4	9.9

(Table 5), while 80 kg N/ha reduced their uptake compared to 40 kg N/ha. The reduction is mainly attributed to relatively lower yield of berseem as already detailed earlier, since nutrient uptake is largely a function of yield.

With the increase in the level of phosphorus, the NPK uptake by berseem also increased successively. Thirtyfive kg P/ha gave enormous increase in NPK uptake during both years and proved significantly superior to control. It may be noted that in most of the cases, the differences between any two consecutive levels to phosphorus reached the significance level, except between two higher levels with regard to K content.

Likewise, there was a continuous increase in NPK uptake by berseem with the enhancement in the level of potassium. While 66 kg K/ha increased NPK substantially over control, 132 kg K/ha also proved significantly superior to 66 kg K/ha in most of the cases and this shows that potassium plays key role in nutrition of berseem.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 238—244 (June 1983)

CRITICAL LIMITS OF AVAILABLE PHOSPHORUS FOR **BAJRA** (*PENNISETUM TYPHOIDES* STAPF ET HUBB.) AND BARLEY (*HORDEUM VULGARE* L.) IN SIEROZEM SOILS OF HARYANA

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(Received : April 21, 1981; Revised : April 16, 1982)

ABSTRACT

Two rapid soil tests were evaluated for sierozem soils for **bajra** (HB-14) on the basis of their correlation coefficients with different yield parameters, i.e., dry matter yield of control pots, per cent dry matter yield, P uptake of control pots and per cent P uptake. Olsen method was found to be the best. In case of low P soils, the application of P significantly increased the dry matter yield, i. e., seven fold increase over control. Similarly application of P increased barley (BG-105) dry matter yield considerably. Two methods, viz. graphical *procedure and mathematical two-mean-discontinuous model have been tried* for establishing critical limit for **bajra** which was 12.5-12.8 kg P/ha. The Linear Response and Plateau (LRP) model was applied for establishing critical limit of barley which was 12.2 kg P/ha.

A refinement in the fertilizer recommendation is very important under present circumstances when the fertilizers are very dear. Fertilizer application based on soil test is a necessity for efficient use of fertilizers. The critical limits of available P varies widely with different soil groups and crops. On P critical limits quite divergent views have been expressed by various workers. Khera and Datta (1969) found different critical limits of available P for Delhi soils even for different wheat varieties, i.e., 11.0 kg P/ha for M. P. wheat 823, 824 and 30-45 kg P/ha for Sonara-64. So there is urgent need to establish P critical limits for different crops for sierozem soils in order to obtain maximum return out of the money spent per unit of fertilizer. This study was undertaken to establish critical limits for sierozem soils for barley and **bajra** crops and to evaluate different extractants for available P determination.

MATERIAL AND METHODS

Two potted studies, one on **bajra** (HB-14) in **kharif** and other on barley (BG-105) in **rabi** (1979-80) were conducted. For **bajra** experiment, 15 bulk soil samples from different locations, varying in available P, representing sierozem soils were collected. The soils varied from sand to silty clay loam in texture. In the greenhouse study earthen pots of 25 cm diameter lined with polythene were filled with 4 kg soil. Treatments consisted of 40 and 80 ppm P applied as potassium dihydrogen phosphate alongwith 100, 50

and 10 ppm of N, K and Zn, respectively, in the form of urea, potassium chloride and zinc sulphate and replicated thrice. Three plants of **bajra** were raised in each pot using deionised water for irrigation. Plants were harvested 4 weeks after germination, dried at 60-70°C and weight of dry matter was recorded. After grinding, plant samples were analysed for total P uptake by using the procedure described by Jackson (1958). In order to evaluate different chemical extractants for their suitability in predicting available P status, the same 15 soils were extracted with two methods, viz., Olsen *et al.* (1954) and Bray and Kurtz P_1 (1945), colour developed by ascorbic acid as described by John (1970). For establishing critical limit of available P for **bajra**, two procedures, i.e., graphical (Cate and Nelson, 1965) and mathematical (Cate and Nelson, 1971) were used.

For barley experiment an extremely P deficient sierozem soil was taken. Phosphorus in the form of potassium dihydrogen phosphate was applied at the rate of 0, 1, 2, 4, 6, 8, 10, 12, 15, 20, 40, 80, 100, 150 and 200 ppm with two replications and soil samples from these treatments were taken after 21 days of incubation for available P determination. Four plants of barley (BG-105) were raised per pot for four weeks. All other details were similar to **bajra** experiment. To find out the critical limits of available P a discontinuous Linear Response and Plateau (LRP) model as described by Waugh *et al.* (1973) was used.

RESULTS AND DISCUSSION

Bajra (HB-14)

Most of the soils were alkaline in reaction and texture varied from sand to silty clay loam. A perusal of dry matter yield data in Table 1 shows that highly significant response to P application was obtained in all but one soil. The soil which did not respond to P application

TABLE 1

Soil test value, dry matter yield of control pots, per cent dry matter yield, P uptake of control pots, and per cent P uptake of **bajra** (HB-14) in pot culture experiment

S. No.	Available P (kg/ha)		Dry matter yield of control (g/pot)	Per cent yield	P uptake of control (mg/pot)	Per cent P uptake
	Olsen	Brays				
1	13.8	21.6	9.3	48.7	4.85	27.7
2	12.5	15.8	9.6	46.2	6.67	25.6
3	9.6	33.8	8.8	48.9	5.77	21.4
4	6.2	29.6	9.5	35.7	5.90	13.3
5	7.8	24.6	6.5	25.6	3.43	10.4
6	9.6	23.8	10.3	44.6	6.19	21 4
7	12.8	31.8	5.7	58.2	4.40	18.3
8	27.2	48.4	24.1	94.5	26.47	71.2
9	9.6	17.6	3.1	11.2	2.14	5.9
10	15.6	33.8	23.4	69.9	20.81	78.5
11	12.8	41.6	6.1	33.7	4.56	29.3
12	16.6	40.4	17.3	66.0	13.00	33.1
13	9.6	16.6	9.3	37.5	4.80	18.0
14	12.8	31.8	11.8	62.8	8.46	43.7
15	14.8	13.8	7.3	38.6	5.23	26.7
Average	12.7	28.3	10.2	—	—	—

contained highest amount 27.2 kg P/ha of available P. In case of low P soils, the application of P significantly increased the dry matter yield, i.e., seven fold increase over control.

A perusal of available P data (Table 1) clearly indicates a wide range of soils from critically poor to high in available P. In general, the highest amount of P was extracted with Bray's P_1 (28.3) followed by Olsen's P (12.7). The higher amount extracted by Bray's P_1 method was due to the higher extracting power, being acidic in nature. Olsen method extracted the smallest amount of P and gave distinctly higher correlation coefficient values with all the yield parameters. These results are in confirmity with Alban (1972).

Out of two methods tried for their suitability to predict correctly and precisely available P from sierozem soils of Haryana, Olsen method gave highest correlation with all the yield parameters (Table 2). The probable reason of best suitability of Olsen method under these soils which are alkaline in reaction is that it controls the ionic activity of Ca through solubility product of $CaCO_3$. Thakur *et al.* (1977) also reported the superiority of Olsen method over Bray's P_1 method for Madhya Pradesh soils.

Correlation coefficient values between available P by different methods and yield parameters (Table 2) clearly depict per cent yield as the best yield parameter for predicting their relative suitability. The other yield parameters also gave significant correlation values with available P by different methods. Bhan and Shanker (1973) also reported similar results.

Critical limit of available P by Olsen method for **bajra** crop in sierozem soils of Haryana was established by two procedures, i.e., graphical and mathematical two-means-discontinuous-model (Figs. 1 and 2). The procedure prescribed by Cate and Nelson (1971) for mathematical model establishes critical limit precisely and accurately as the peak indicates on the graph when average available P is plotted against coefficient of determination (R^2) values. The critical limit by mathematical model and graphical procedure has been established as 12.8 and 12.5 kg P/ha for **bajra** crop. Dhillon *et al.* (1977) found 8.5 and 12.5 kg P/ha as critical limit for rice and wheat crops in alkaline soils of Punjab.

TABLE 2

Correlation coefficient of soil test values with dry matter yield of control, per cent yield, P uptake of control and per cent P uptake

S. No.	Soil test methods	Correlation coefficient			
		Dry matter yield of control	Per cent yield	P uptake of control	Per cent P uptake
1	O lsen P	0.767**	0.891**	0.865**	0.814**
2	Bray's P_1	0.585*	0.657**	0.638**	0.563*

*' **Significant at 5 and 1 per cent levels, respectively.

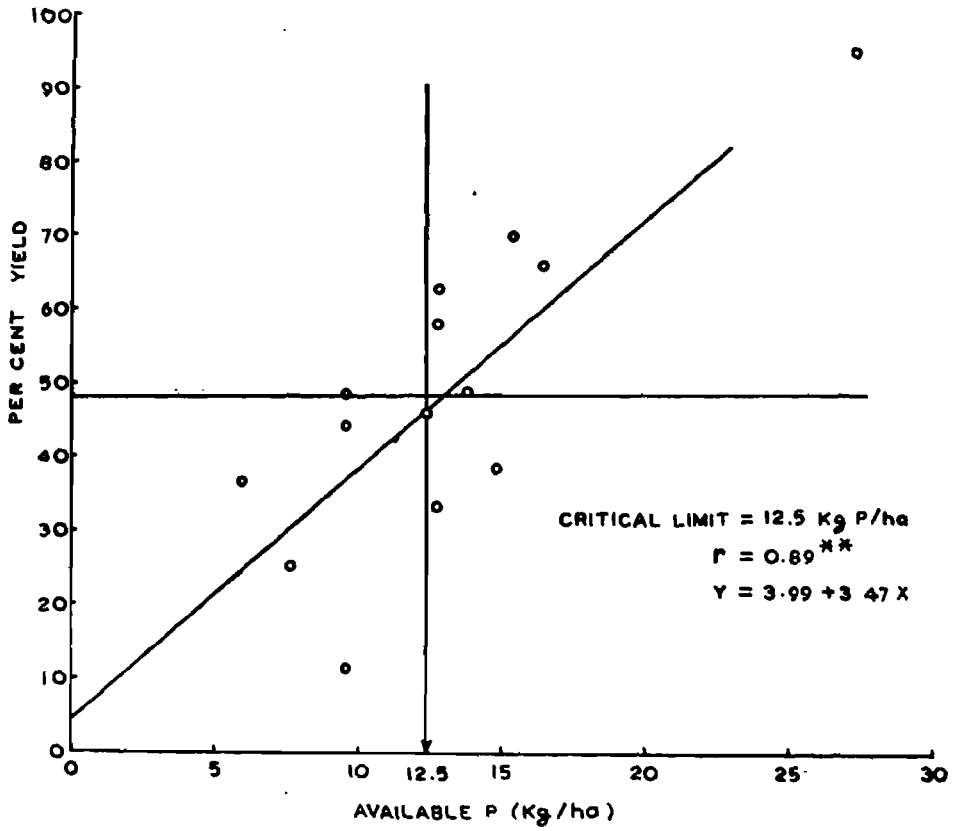


Fig. 1. Relationship between Olsen P and per cent dry matter yield of bajra (HB-14).

Barley (BG-105)

Highly significant dry matter yield response to P application was obtained in barley crop (Table 3). Dry matter yield increased significantly with the increase in P fertilizer from control to 12 ppm P. The per cent increase in dry matter yield over control with the application of 1, 2, 4, 6, 8, 10 and 12 ppm P was 47.6, 95.4, 126.3, 153.0, 182.9, 228.8 and 243.2, respectively, clearly depicting the acute P deficiency and the responsiveness to P of barley (BG-105) crop. These contentations were further confirmed by very low available P (2.5 ppm) in soil. However, there was no significant increase in dry matter yield beyond 10 ppm P dose. The discontinuous Linear Response and Plateau (LRP) model as described by Waugh *et al.* (1973) was used to establish the critical limit of available P (Fig. 3). In this technique, response to each nutrient was interpreted separately by using the Threshold and Plateau yield levels. In this model yield response to each nutrient was considered to have a starting point (Threshold yield) and ending point (Plateau yield). Relative

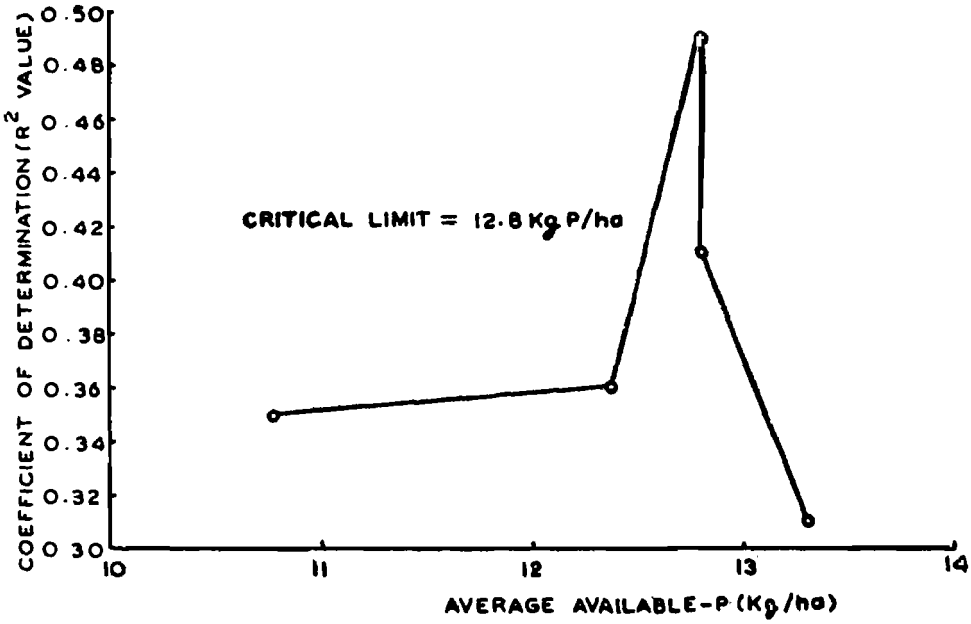


Fig. 2. Relationship between average available P of last value of group-1 and first value of group-II, and coefficient of determination (R^2-value) for two-mean discontinuous model for bajra (HB-14).

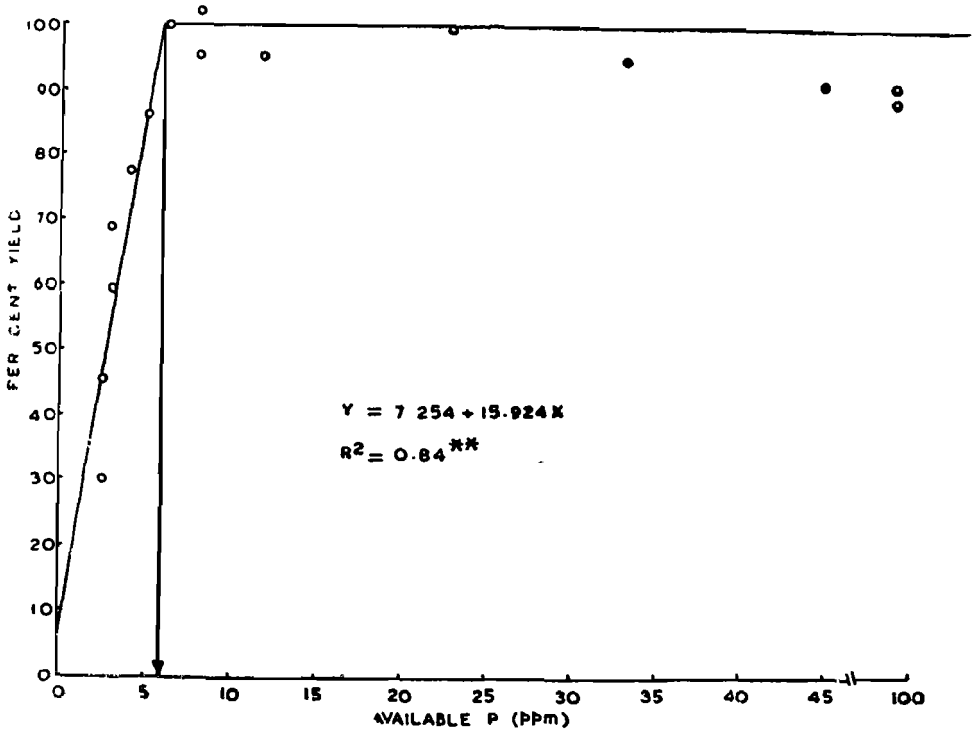


Fig. 3. Relationship between available P and % yield of barley (BG-105).

TABLE 3

Available P (Olsen method), fertilizer doses and dry matter yield of barley crop

S. No.	P fertilizer dose (ppm)	Available-P (ppm)	Average dry matter yield (g/pot)
1	0	2.5	5.25
2	1	2.5	7.75
3	2	3.0	10.26
4	4	3.0	11.88
5	6	4.0	13.28
6	8	5.0	14.85
7	10	6.1	17.26
8	12	8.3	18.02
9	15	8.3	16.44
10	20	12.0	16.40
11	40	23.0	17.15
12	80	33.0	16.24
13	100	45.0	15.70
14	150	77.5	15.70
15	200	82.0	15.90
CD at 10% level			0.80

yield was defined as Threshold yield divided by Plateau yield. The Linear Response and Plateau lines were established and the point of intersection was used to determine the critical limit of available P for barley (BG-105) crop (Fig. 3). As the yield difference between 10 and 12 ppm P dose was non-significant, the critical limit of available P by Olsen method for barley was established as 12.2 kg P/ha. Similar results were obtained by Dhillon *et al.* (1977) for wheat in alkaline soils of Punjab.

The above results conclude that Olsen method is the best and most suitable for the estimation of available P in sierozem soils of Haryana. The per cent yield is the best yield parameter for the selection of method for available P determination. The critical limits of available P for **bajra** (HB-14) and barley (BG-105) have been established as 12 8 and 12.2 kg P/ha, respectively.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 245—248 (June 1983)

EFFECT OF SEED TREATMENT AND FOLIAR APPLICATION OF CYTOZYME ON GROWTH AND GREEN POD YIELD OF OKRA (*ABELMOSCHUS ESCULENTUS* L.)

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(Received : April 27, 1981; Revised : September 17, 1981)

ABSTRACT

An experiment to study the effect of seed treatment and foliar application of cytozyme on growth and green pod yield of okra was conducted during *kharif* season of 1977 and 1978. The height of plant, number of branches per plant, number of pods per plant, length of pod and green pod yield increased with increase in the concentration of both seed treatment as well as crop$^+$ formulation of cytozyme. The highest yield of green pod was given under the combined effect of 10% seed treat and 1.25% crop$^+$ spray.

Cytozyme* constitutes related micronutrients (copper, 0.06%; iron, 0.22%; manganese, 0.15%; zinc, 0.20%), enzymes (diastase, maltase, invertase, cellulase, inulase) and hormones (mainly cytokinins) (Singh *et al.*, 1979). Two main formulations, cytozyme seed treat and cytozyme crop$^+$ spray have been reported to have beneficial effect on growth and yield of several field crops and vegetables e. g., potato (Pandita and Hooda, 1979), groundnut crop (Singh *et al.*, 1979) and radish (Pandita *et al.*, 1981). Cytozyme seed treat has been reported to catalyze beneficial microbial activity in the ecological system of both soil and developing seedlings. The present investigations were undertaken to study the effect of seed treat and crop$^+$ formulations of cytozyme on growth and green pod yield of okra.

MATERIAL AND METHODS

A field trial was conducted for two years (**kharif**, 1977 and 1978) at the Research Farm, Department of Vegetable Crops of the Haryana Agricultural University, Hissar. The treatments consisted of four concentrations of, cytozyme seed treat (0, 5, 7.5 and 10 per cent) and four concentrations of cytozyme crop$^+$ spray (0, 0.75, 1 and 1.25 per cent). For seed treatment the seeds were dipped in the solution for 15 min and after removal dried in shade before planting. The spraying of foliage was done at 21, 42 and 63 days after sowing. The experiment was conducted in randomised block design with three replications. The soil of the experimental fields was sandy loam having higher status of K_2O and medium status of P_2O_5 and nitrogen

*Manufactured by Cytozyme Laboratories, Inc., 134 South West, Salt Lake City, Utah, U. S. A.

content. Recommended dose of 100 kg N, 60 kg P_2O_5 and 50 kg K_2O/ha was applied to all the plots uniformly. Variety Pusa Sawani was grown in this experiment. The crop was sown at a spacing of 45 cm×30 cm on 30th June, 1977 in the first year and on 28th June, 1978 in the second year. The experimental crops were irrigated and plant protection measures followed whenever necessary. The height of plant and number of branches/plant were recorded in 10 plants in a treatment selected at random at the time of last picking.

RESULTS AND DISCUSSION

Effect of Seed Treat

The data on height of the plant revealed that the differences between various seed treatments were significant during both the years (Table 1). Increase in the concentration of cytozyme seed treat increased the height of plants during both the years. Comparatively greater increase in height of the plant in second year than first year, might be due to scanty rainfall during first year crop season, where the crop suffered more due to moisture, whereas quite high rainfall during second year was more helpful in increasing height of the plant. Maximum plant height was observed under 10% seed treat followed by 7.5% and 5% in descending order in both the seasons. The plant height was minimum in control. Same was true for the number of branches per plant and number of pods per plant. In both the years the length of pod also increased with increase in the concentration of cytozyme seed treatment and the maximum length of pod was observed in 10% seed treatment, whereas shortest length of pod was noted in control. With increase in the concentration of cytozyme seed treatment there was corresponding increase in yield of green pod in both the years. This may be attributed to significantly greater number of pods per plant and greater length of pod. The highest yield of green pod was observed under 10% seed treatment followed by 7.5% seed treat, whereas the lowest yield of green pod was obtained from control plots.

Effect of Foliar Spray

The data on height of plant, number of branches per plant, number of pods per plant and length of pods (Table 1) indicated significant differences among various cytozyme foliar application treatments. Height of plant was maximum under 1.25% crop$^+$ spray followed by 1% spray, whereas the shortest plants were noted in control treatment. The differences in the number of branches per plant and number of pods per plant were also significant and highest number of branches per plant and number of pods per plant were recorded in plants which received 1.25% crop$^+$ spray closely followed by 1% crop$^+$ spray. Cytozyme was also helpful in improving the length of pods and the highest length was recorded under 1.25% crop$^+$ spray, whereas control plots had shortest length of pod. A significant difference in yield of green pods due to different concentrations of crop$^+$ spray was obtained in both the years as well as in pooled data (Table 1). On an average there was an increase of 6, 10 and 14 per cent over control due to 0.75, 1 and 1.25% crop$^+$ spray, respectively.

TABLE 1

Effect of seed treatment and foliar application of cytozyme on growth and green pod production of okra

Treatment	Height of plants (cm)		No. of branches per plant		No. of pods per plant		Length of pods (cm)		Green pod yield (q/ha)		
	1977	1978	1977	1978	1977	1978	1977	1978	1977	1978	Mean
Seed treatments											
Control	88.14	152.15	2.54	2.25	11.06	11.83	11.15	11.98	117.22	134.11	125.66
5% seed treat	92.91	156.25	2.58	2.40	11.67	12.16	11.06	12.08	122.84	133.98	128.41
7.5% seed treat	92.02	159.10	2.81	2.46	12.21	12.41	11.78	12.59	122.18	137.31	129.74
10% seed treat	94.94	161 15	2.96	2.69	13.18	12.50	12.72	13 33	131.45	143.36	137.40
Foliar spray											
Control	88.34	150.53	2.38	2.23	11.09	11.50	11.13	11.75	115.13	127.81	121.47
0 75% crop+	90.94	157.83	2.75	2.44	11.79	11.75	11.27	12.45	121.81	134.38	128 09
1% crop+	93.98	160.00	2.85	2.50	12.31	12.66	11.64	12 68	125.69	141.00	133 34
1.25% crop+	95.35	164.00	2.90	2.63	12.93	13.00	12.00	13.09	131.05	145.98	138.51
C. D. at 5%	1.45	5.34	0.41	0.20	0.16	0.69	0.45	0.40	3.14	3.99	2.52

TABLE 2

Effect of seed treatment × foliar spray interaction on green pod production of okra (q/ha) in 1977

Treatments	Seed treat (%)			
	0	5.0	7.5	10.0
Foliar spray (%)				
0	101.37	114.43	117.45	127.25
0.75	117.83	119.81	120.46	129.12
1.00	122.82	127.81	122.22	129.92
1.25	126.84	129.29	128.56	139.51

C. D. at 5% = 6.26

The interaction for yield between seed treatment and foliar spray was found to be significant in first year only (Table 2); the lowest yield was recorded from untreated control plots and the highest yield was recorded under the combined effect of 10% seed treat and 1.25% crop$^+$ spray. The highest potato tuber yield was also observed under the combined effect of 10% seed treat and 1.25% crop$^+$ spray by Pandita and Hooda (1979).

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Haryana agric. Univ. J. Res. Vol. XIII, No. 2, pp. 249—253 (June 1983)

RESPONSE OF WHEAT TO ZINC FERTILIZATION AS INFLUENCED BY FARMYARD MANURE APPLICATION

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(Received : May 16, 1981 ; Revised : October 7, 1981)

ABSTRACT

In a screen-house experiment conducted in a Zn-deficient soil, the grain and straw yields of wheat increased with the application of farmyard manure or when supplemented with Zn. Grain yield was augmented with Zn application, but straw yield depressed at 5 and 10 ppm Zn in the presence of 5 and 10 tons FYM/ha. Grain and straw ratio improved appreciably with Zn and FYM. Zinc concentration in grain and straw improved significantly with Zn application. Application of farmyard manure alone increased Zn concentration in grain while a reduction was noticed in straw at all levels of farmyard manure irrespective of Zn levels. Application of 10 tons FYM/ha increased the effectiveness of Zn response in wheat.

Beneficial effect of organic manures on the availability of Zn has been reported by Himes and Barber (1957) and Miller and Ohlrogge (1958). The use of organic manures augment the micronutrient availability and may alleviate the deficiency of Zn in crops. Shukla *et al.* (1978) reported a considerable increase in dry matter yield of maize with the use of farmyard manure.

The information on the use of farmyard manure and its effect on plant growth in relation to Zn availability is scanty. Hence, the present study was undertaken to investigate the effect of farmyard manure on Zn response of wheat in a Zn deficient soil.

MATERIAL AND METHODS

A screen-house experiment was conducted in earthen pots filled with 4 kg soil. The soil was sandy in texture having pH 8.1, EC 0.15 mmhos/cm, organic carbon 0.04%, and DTPA extractable Zn 0.48 ppm. Available Zn was determined according to Lindsay and Norvell (1978) and other properties as per Kanwar and Chopra (1959).

The treatments consisted of 3 levels of Zn (0, 2.5 and 5 ppm) and 5 levels of farmyard manure (0, 1.25, 2.50, 5 and 10 tons/ha). Zinc from $ZnSO_4.7H_2O$ was mixed with farmyard manure and then added in the soil. A basal dose of N, P and K @ 100, 50 and 50 ppm, respectively, was applied in all the pots. The various combinations were replicated thrice. There was no compensation for nutrients supplied by farmyard manure. Wheat, variety WH-147, was grown till maturity and then grain and straw yields were recorded. Plants were washed

with deionised water and analysed for Zn after digestion in diacid mixture of HNO_3 and $HClO_4$ in the ratio of 5 : 1. Zinc in the digested samples was analysed by atomic absorption spectrophotometry.

RESULTS AND DISCUSSION

Application of farmyard manure alone increased the yield significantly (Table 1) over control except at 1.25 tons/ha level. The effect of farmyard manure was more pronounced at 10 tons/ha than lower levels of its application. The highest grain yield was registered when farmyard manure was supplemented with Zn. There was significant difference in Zn response with graded doses of Zn. In the presence of 2.5 ppm Zn, addition of 2.5 and 5.0 tons FYM/ha marginally augmented the grain yield. However, when 2.5 ppm Zn was mixed with 10 tons FYM/ha the yield obtained was 19.3 g/pot, whereas at 5 tons FYM/ha the yield was only 14.73 g/pot.

The increase in yield with 2.5 ppm Zn when supplemented with 10 tons FYM/ha was 42% against 2.5 ppm Zn alone. Application of 5 ppm Zn alone or in combination with FYM increased the yield significantly over 2.5 ppm Zn alone

TABLE 1

Effect of FYM and Zn levels on the grain and straw yields of wheat

FYM (tons/ha)	Zn levels (ppm) 0	2.5	5.0	Mean
		Grain yield (g/pot)		
0	7.00	13.60	17.40	12.67
1.25	8.06	14.56	18.16	13.49
2.50	8.73	14.36	18.70	14.70
5.00	10.30	14.73	18.90	14.64
10.00	12.53	19.30	21.56	17.79
Mean	9.32	15.31	18.94	—
C. D. at 5%	Zn levels mean =0.62 FYM levels mean=1.08 Zn × FYM =1.30			
		Straw yield (g/pot)		
0	17.35	20.36	20.13	19.27
1.25	19.00	20.80	20.70	20.17
2.50	20.30	22.03	22.66	21.66
5.00	23.76	22.83	22.00	22.86
10.00	23.93	23.33	21.66	21.43
Mean	20.80	21.87	21.43	—
C. D. at 5%	Zn levels mean =0.64 FYM levels mean=0.82 Zn × FYM =1.43			

or with FYM. Lower levels of FYM could not increase the yield appreciably even in the presence of Zn. The increase in yield due to interaction was significant and positive. Application of 10 tons FYM/ha with 5 ppm Zn yielded 21.56 g/pot in contrast to 17.40 g/pot with 5 ppm Zn alone. The increase in grain yield with 5 ppm Zn in the presence of 10 tons FYM/ha against 5 ppm Zn alone was 24 per cent, whereas at 2.5 ppm Zn this increase was 42 per cent. This indicated that the effect of FYM was more pronounced at lower levels (2.5 ppm) than at higher levels of Zn.

The results revealed that in a Zn-deficient soil lower doses of FYM help marginally in alleviation of Zn deficiency. Application of 10 tons FYM/ha did contribute towards Zn either directly or due to chelation effect. The effectiveness of applied Zn also increased with FYM perhaps due to its chelating nature.

It is evident from the data (Table 1) that straw yield increased significantly with Zn and FYM. Mean values indicate a non-significant depression in straw yield with 5 ppm Zn as well as 10 tons FYM/ha over lower levels of Zn and FYM, respectively. In sharp contrast to this, there was significant increase in grain yield due to this treatment. It obviously signifies the role of Zn in grain formation at the expense of straw production. These results are in agreement with the findings of Shukla *et al.* (1978) who reported similar results in maize yield.

It is evident from the data in Table 2 that application of FYM depressed the straw/grain ratio. Mean values indicate that straw/grain ratio was reduced by 50% with the application of 5 ppm Zn over control. Grain/straw ratio progressed with the addition of both FYM and Zn. It is, thus, evident that FYM and Zn both help in improving the grain/straw ratio. Addition of 5 ppm Zn supplemented with 10 tons FYM/ha narrowed the straw/grain ratio (1 : 1).

Zinc concentration in grain increased significantly with Zn application (Table 3). In the absence of applied Zn, addition of FYM enhanced Zn concentration and uptake (Fig. 1) significantly with favour-

TABLE 2

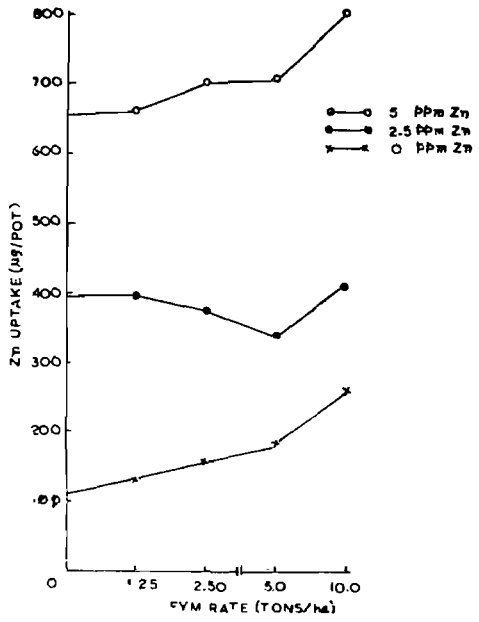
Effect of FYM and Zn levels on the straw/grain and grain/straw ratio of wheat

FYM (tons/ha)	Zn levels (ppm)							
	0	2.5	5.0	Mean	0	2.5	5.0	Mean
	Straw/grain ratio				Grain/straw ratio			
0	2 47	1.49	1.15	1.70	0.40	0.52	0.86	0.59
1.25	2.35	1.42	1.13	1.63	0.42	0.66	0.87	0.65
2.50	2.32	1.53	1.21	1.68	0.43	0.70	0.82	0.65
5.00	2.30	1.54	1.16	1.68	0.43	0.65	0.85	0.64
10.00	1.90	2.20	1.00	1.36	0.52	0.82	0.99	0.77
Mean	2.27	1.43	1.13	—	0.44	0.67	0.89	—

TABLE 3

Effect of FYM and Zn levels on Zn concentration (ppm) of grain and straw of wheat

FYM (tons/ha)	Zn levels (ppm) 0	2.5	5 0	Mean
		Zn conc. (ppm) in grain		
0	15.95	29.00	37.90	27.62
1.25	16.92	27.33	36.90	27.05
2.50	17.88	26.10	37.53	27.17
5.00	17.88	22.70	37.46	26.01
10.00	21.15	21.30	36.16	26.54
Mean	17.95	25.28	37.39	—
C. D. at 5%	Zn levels mean =0.91 FYM levels mean=1.18 FYM × Zn =2.03			
		Zn conc. (ppm) in straw		
0	5.80	9.18	14.02	9.66
1.25	5.80	6.28	8.23	6.77
2.50	5.80	6.28	7.40	6.49
5.00	4.83	5.80	7.30	5.97
10.00	4.83	5.30	7.10	5.73
Mean	5.40	6.56	8.81	—
C. D. at 5%	Zn levels mean =0.51 FYM levels mean=0.66 FYM × Zn =1.15			



able effect on grain yield. In the presence of 2.5 ppm Zn, a significant depression in Zn concentration was registered when FYM was added. At 5 ppm Zn, application of FYM did not influence the Zn concentration in wheat grain. The uptake of Zn was also improved. The interaction effect of organic matter and Zn on Zn concentration was also statistically significant. The data in Table 3 reveal that addition of farmyard manure alone reduced Zn concentration in wheat straw. Application of Zn increased Zn content of straw, whereas FYM applied alone or in combination with Zn had a depressing

← Fig. 1. Effect of zinc and FYM rates on zinc uptake by wheat grain.

effect on Zn concentration in wheat straw. A depression in Zn concentration of maize by FYM was also reported by Shukla *et al.* (1978).

Zn concentration in grain was much higher than that of straw, which proves that Zn absorbed by the plants during vegetative growth gets translocated to the reproductive organs. In general, Zn uptake by grain increased with FYM, while uptake of Zn by straw was reduced with FYM in the presence of applied Zn. The uptake and concentration of native Zn increased with FYM as a consequent of increased yield. This might be due to the reason that chelates produced by FYM affected the absorption of Zn by plants due to their higher solubility or the FYM directly contributed towards Zn.

ACKNOWLEDGEMENT

The authors are thankful to the Indian Council of Agricultural Research, New Delhi, for providing financial help.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 254—259 (June 1983)

EFFECT OF ETHREL ON CHEMICAL COMPOSITION OF TOMATO (*LYCOPERSICON ESCULENTUM* MILL.) VARIETIES HS-101 AND HS-102

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(Received : April 25, 1981; Revised : July 30, 1981)

ABSTRACT

The experiment was conducted during 1976 on two varieties of tomato viz., HS-101 and HS-102 to study the effect of ethrel on chemical composition of tomato fruits. Increasing concentrations of ethrel upto 250 ppm reduced the acid content when applied to the mature green fruits of tomato under attached and detached conditions. Increasing concentrations of ethrel (upto 500 ppm) increased the ascorbic acid content as compared to control under attached condition. T. S. S. declined with increasing levels of ethrel upto 500 ppm under attached and detached conditions. Ethrel at 250 ppm gave the highest lycopene and carotene contents of fruits as compared to control under attached and detached conditions.

Tomato is well known for its nutritive value among important vegetable crops. Fruit quality in relation to vitamin C content, particularly in tomato is very important because they are consumed raw also. The quality of tomato fruit is judged by its ascorbic acid, sugar, total soluble solids, acidity and lycopene contents. The chemical composition in tomato varies greatly with the varieties (Arora *et al.*, 1975, 1982), soil and climatic conditions (Jayadeviah *et al.*, 1965) in which they are grown. Application of plant growth regulators (Pandita *et al.*, 1976) and micro-nutrients (Shkvaruk and Nikolaichuk, 1973) has also been found to influence the quality of tomato fruits. Gull (1969) reported reduction in acid content of fruits while Orzolek and Angell (1974) found increase in the ascorbic acid by application of ethrel. Little information is, however, available on the effect of ethrel on quality of tomato fruits. The present investigation was, therefore, undertaken to assess the effect of ethrel, i.e., 2-chloroethyl phosphonic acid, a ripening agent (Robbins and Peterson, 1972) on chemical composition of tomato fruits under attached and detached conditions in the commercial varieties of this region.

MATERIAL AND METHODS

Attached Condition

Experiment was conducted at the Vegetable Research Farm and Laboratory of the Department of Vegetable Crops, Haryana Agricultural University, Hissar. The experiment was laid out in split plot design with four replications. Tomato

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varieties viz., HS-101 and HS-102 were used as main plot treatment, whereas five concentrations of ethrel (0, 50, 100, 250 and 500 ppm) as sub-plot treatments. Seeds were sown in the raised nursery beds on 7th June, 1976 and the crop was transplanted in the field by ridge and furrow method and plants were transplanted on one side of the ridge on 25th July, 1976. Furrows were used for weeding, irrigation, fertilizer application, etc. The field selected for this study was uniform in fertility having sandy-loam type of soil with pH 8.6. There were 16 plants per treatment planted on 60 cm wide raised beds and 45 cm apart. Recommended doses of fertilizers and necessary plant protection measures were followed during the experimentation and the field was irrigated as and when required. Ethrel was applied to foliage and fruits at mature green stage of both the varieties when attached to the plants. Tween-20 was used as surfactant @ 0.005 per cent. The distilled water was used for spraying control plants and preparing various solutions.

Detached Condition

Four kg of mature green fruits of tomato varieties HS-101 and HS-102 were given dip treatment in 0, 50, 100, 250 and 500 ppm solutions of ethrel on 10th September, 1976 for 5 min at room temperature (34.5°C). The experiment was laid out in a randomized block design with four replications. The fruits were kept in gunny bags after treatments.

The observations from attached and detached conditions were recorded for acidity, ascorbic acid (vitamin C), total soluble solids, lycopene and carotene contents. The fruits from third picking done on 24th Sept., 1976 under attached conditions were used for quality analysis, whereas red ripe fruits taken on 20th Sept., 1976 under detached conditions were analysed for quality determinations. Ten red ripe fruits were selected at random from each treatment for the estimation of quality characters. The acidity of extracted juice was estimated by titrating against $\frac{N}{10}$ NaOH using phenolphthalein as an indicator and expressed as g citric acid per 100 ml juice. Ascorbic acid content of ripe fruits was determined by 2, 6 dichlorophenol titration method (AOAC, 1960). Total soluble solids was determined by means of Hand Refractrometer. Lycopene and carotene contents of red ripe tomato fruits were determined using benzene and acetone solutions (Zschule *et al.*, 1942). Pigments were separated with the help of column chromatography using aluminium oxide (neutral) in the column. The data were expressed as absorbance at 470 nm wavelength using Spectronic-20.

RESULTS AND DISCUSSION

Acidity

The data relating to acid content of fruits (Table 1) showed no significant differences between varieties although fruits of HS-101 were slightly more acidic than HS-102. Acid content was lowest (0.56 g) in 250 ppm ethrel sprayed fruits, whereas highest (0.95 g) was found in 500 ppm ethrel treatment. The interaction between varieties and ethrel concentrations was also significant and 500 ppm ethrel spray increased the acid content of fruits of HS-101 (1.01 g), whereas least was recorded in HS-102 by ethrel 250 ppm

TABLE 1

Effect of various concentrations of ethrel on acidity, ascorbic acid, total soluble solids, lycopene and carotene contents of tomato varieties HS-101 and HS-102 under attached and detached conditions during 1976

Concentrations of ethrel (ppm)	Acidity (g citric acid per 100 ml of juice)			Ascorbic acid (mg/100 g of edible portion)			Total soluble solids (%)			Lycopene content (absorbance)			Carotene content (absorbance)		
	HS-101	HS-102	Av.	HS-101	HS-102	Av.	HS-101	HS-102	Av.	HS-101	HS-102	Av.	HS-101	HS-102	Av.
A. Attached condition															
Control	0.82	0.78	0.80	19.9	21.2	20.6	5.8	6.0	5.9	0.26	0.20	0.23	0.10	0.09	0.10
50	1.10	0.72	0.91	21.3	24.1	22.7	5.2	5.4	5.4	0.32	0.46	0.39	0.13	0.14	0.14
100	0.69	0.72	0.71	23.1	23.1	23.1	5.3	5.3	5.3	0.34	0.36	0.35	0.16	0.17	0.17
250	0.59	0.53	0.56	24.0	25.4	24.7	5.0	5.1	5.1	0.48	0 54	0.51	0.18	0.18	0.18
500	1.01	0.89	0.95	28.8	29.2	29.0	4.7	4.8	4.8	0.36	0.22	0.29	0.14	0.13	0.14
Average	0.84	0.72		23.4	24.6		5.2	5.3		0.35	0.36		0.14	0.14	
B. Detached condition															
Control	0.59	0.90	0.75	20.3	20.1	20.2	5.4	5.2	5.3	0.14	0.14	0.14	0.08	0.14	0.11
50	0.58	0.69	0.64	21.5	21.6	21.6	4.9	5.0	5.0	0.25	0.31	0.28	0.12	0.16	0.14
100	0.65	0.64	0.65	23.5	23.0	23.3	4.9	4.8	4.9	0.31	0.33	0.32	0.14	0.16	0.15
250	0.54	0.59	0.57	24.5	26.9	25.7	4.9	4.9	4.9	0.48	0.49	0.49	0.15	0.18	0.17
500	0.82	0.61	0.72	20.7	28.1	24.4	4.8	5.0	4.9	0.30	0.24	0.27	0.12	0.11	0.12
Average	0.64	0.69		22.1	23.9		5.0	5.0		0.30	0.30		0.12	0.15	
C. D. at 5% level															
	Attached	*Detached*		*Attached*	*Detached*		*Attached*	*Detached*		*Attached*	*Detached*		*Attached*	*Detached*	
Variety	NS	NS		1.11	NS		0.08	NS		NS	NS		NS	NS	
Concentration	0.16	0.11		1.23	0.50		0.25	NS		0.07	0.18		0.03	0.02	
Interaction	0.18	0.21		2.01	0.71		NS	0.23		0.11	0.21		0.07	0.06	

spray (0.53 g). These findings are in agreement with the findings of Gull (1969) and Knys and Largskij (1970) who found reduced acid content of fruits with ethylene treatment but are contrary to the findings of Russo *et al.* (1975) who found no appreciable effect on tomato acidity when ethephon was applied @ 2.9 kg/ha when 20-30% of the fruits were ripe. The probable reason for the increase in acidity with highest level of ethrel application under attached condition may be due to more favourable effect of the chemical (ethrel) which accelerated the metabolic pathway by activating the enzyme aconitase (responsible for reversible inter-conversions of the first three acids of the Kreb's Cycle—citric acid, cis-aconitic acid and isocitric acid) resulting in accumulation of citric acid (Devlin, 1974).

The differences among varieties were also not significant with regard to acid content under detached condition (Table 1). However, fruits of HS-102 were more acidic than HS-101. Dipping of mature green fruits of tomato in 250 ppm ethrel lowered the acid content (0.57 g) as compared to control treatment(0.75 g). The interaction effect of variety and ethrel concentrations showed that 250 ppm ethrel lowered the acidity (0.54 g) in HS-101 while it increased (0.90 g) in control treatment of HS-102. Ribereau-Gayon (1968) suggested that transformation of organic acid to sugars was one of the reasons for decrease in citric acid during fruit ripening, therefore, another possibility seems that ethephon enhanced the conversion of organic acid to sugar due to enhanced rate of respiration.

Ascorbic Acid Content

The differences in ascorbic acid content between varieties were significant under attached and detached conditions (Table 1) and higher ascorbic acid content was observed in HS-102 under both conditions. The increase in the ethrel concentrations helped in inducing linear increase in the ascorbic acid content of fruits. 500 ppm ethrel sprayed on mature green fruits gave the highest ascorbic acid in both varieties under attached condition, whereas same concentration under detached conditions lowered the ascorbic acid content. The least ascorbic acid content was found in control treatments under attached as well as detached conditions. The results of the present investigations confirmed the earlier findings of Orzolek and Angell (1974) who found appreciable rise in vitamin C content in cv. Campbell 28 when ethephon @ 0.9 kg/ha was sprayed on plants when 20-30% of the fruits were ripe. The increase in ascorbic acid content with ethrel application was due to synthesis of some metabolic intermediary substances which promoted the greater synthesis of the precursor of ascorbic acid during fruit ripening.

Total Soluble Solids

The trend in the T.S.S. content of fruits was reverse to that of ascorbic acid content under attached condition although the interactions between varieties and ethrel concentrations for T.S.S. were not significant (Table 1). 500 ppm ethrel spray gave the lowest T.S S. (4.8%) as compared to control (5.9%) which confirms the earlier work of Orzolek and Angell (1974). Similarly under detached condition highest T. S. S. was recorded

from control treatment of HS-101 and HS-102 as compared to rest of the treatments. There was no difference in T.S.S. of HS-101 and HS-102 under detached condition and the interaction was also not significant. The gradual decline in the T.S.S. content of fruits with increasing concentration of ethrel may be due to prompt breakdown of hexose sugar (usually glucose) to pyruvic acid involved in the glycolysis (Devlin, 1974). Another reason for change in T.S.S. content of fruits may be due to synthesis of some metabolic intermediary substances which retarded the synthesis of T.S.S.

Lycopene and Carotene Contents

The differences in lycopene content between varieties were not significant under attached and detached conditions although HS-102 had slighty higher lycopene content under attached condition. Highest lycopene content in HS-101 and HS-102 was induced by 250 ppm ethrel (0.48 and 0.54, respectively), whereas least (0.26 and 0.20, respectively) was observed in control treatments. Similar results with lycopene in HS-101 and HS-102 were obtained when the fruits were given dip treatment with ethrel (Table 1). Higher concentration of ethrel (500 ppm) was inhibitory to such formation.

There were no significant differences in carotene content between HS-101 and HS-102 under attached and detached conditions (Table 1). 250 ppm ethrel gave the highest carotene content (0.18 in each) in HS-101 and HS-102 under attached conditions. Similar results with HS-101 and HS-102 (0.15 and 0.18, respectively) were obtained under dip treatment of fruits with 250 ppm ethrel. Least carotene content was noticed in control treatment of HS-101 and HS-102 under both the conditions. The increased level of lycopene and carotene due to ethrel treatment has also been confirmed by Herner and Sink (1974) and Russo *et al.* (1975). The increase in lycopene and carotene contents of fruits was due to the increase in the internal level of ethylene which converted chlorophyll content of fruits into lycopene in the presence of chlorophyllase enzyme (Barmore,1975). Muthukrishnan *et al.* (1974) reported that increased lycopene synthesis due to ethrel spray may be because of increased activity of acid phosphatase enzyme which was required in the conversion of intermediaries which ultimately resulted in lycopene synthesis.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 260—267 (June 1983)

EVAPORATION FROM SANDY LOAM AND CLAY LOAM SOILS AS INFLUENCED BY THICKNESS OF SOIL MULCH, DEPTH OF WETTING AND EVAPORATION DEMAND

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(Received : June 9, 1981; Revised : September 21, 1981)

ABSTRACT

An attempt was made to study the effect of varying thicknesses of soil mulch and different depths of wetting on evaporation from sandy loam and clay loam soils under two atmospheric demands. Five mulches were used i.e., no mulch, 2.5, 5.0, 10.0 cm soil mulches and sand mulch under four depths of wetting i.e., 15, 30, 45 and 90 cm. This study indicated that sand mulch was the best. Among various soil mulches, 2.5 cm thick mulch was superior. Increased depth of wetting had favourable effect on reducing evaporation. The effect was more pronounced in the clay loam soil and for a given soil in high demand than in low demand. The water which could penetrate a soil profile below 45 cm remained more conserved.

Several soil water budget studies (Peters, 1960; Bertrand, 1966; Oswal and Dakshinamurty, 1975) have shown that during a normal growing season of crop, evaporation accounts for about 50% of rain water loss from agricultural soils in dry land areas. A small reduction in this loss may go a long way in increasing crop production under limited water supply conditions. Therefore, it is logical to assume that the most successful water conservation procedure relates to control of evaporation.

Lemon (1956) described three stages of evaporation of water from soil viz., rapid, falling and extremely slow rates. But potential for suppressing evaporation from soil lies within first and second stages of evaporation. Mulches of various types have been advocated (Jacks *et al.*, 1955; Wiegand and Taylor, 1961) as management practices for moisture conservation, but they reduce evaporation only during early stage of drying, when evaporation is determined largely by climatic factors. For most light textured soils, during first stage of evaporation, usually the soil surface dries out rapidly and forms a 'self mulch' which is more effective than gravel or straw mulches (Hanks and Woodruff, 1958). Chemicals like Kaolin, VAMA, Cetyl alcohol and tillage practices have been recommended by many researchers as a measure to control evaporation during its falling rate stage. But in the era of energy crisis, the choice is left to use suitable minimum tillage device to reduce evaporation.

Several studies indicated the beneficial effect of soil mulch (Mc Call, 1925; Willis and Bond, 1971; Lindstrom *et al.*, 1974; Gill *et al.*, 1977) on controlling

evaporation. But information regarding optimum thickness of soil mulch for different soils is meagre. Similarly, a few workers (Hillel, 1971; Hadas, 1973) have suggested the possibility of beneficial effects of deep irrigation over shallow irrigation in reducing evaporation, but without any quantification. The present investigations were, therefore, carried out to quantify these parameters affecting evaporation.

MATERIAL AND METHODS

This study was conducted on two soils viz., sandy loam and clay loam, collected from the Research Farms of Dryland Agriculture Research Project and Farm Colony, Haryana Agricultural University, Hissar. Bulk soil samples were air dried and passed through 2 mm sieve. The sandy loam soil was almost structureless and non-expanding but the clay loam soil developed surface cracks during drying.

Eighty pits, each of 50 cm sq. and of pre-determined depths i.e. 25, 40, 55 and 100 cm were dug in four rows at the site of sandy loam soil. The sides of the pits were lined with polythene sheet protruding 5 cm above the level of soil surface. Forty pits were filled with the sandy loam soil and an equal number with the clay loam soil. The filling was done in 5 cm layer at a bulk density of 1.4 g/cc. After filling, the pits were exposed to natural environment of rainfall, temperature, etc. for about 2 months. During this period total 27.9 mm rainfall was received. After that, one irrigation was given which was just sufficient to bring the experimental soil to field capacity and the pits were left for natural evaporation for about 3 weeks.

On 25th Oct., 1979, soil samples in 15 cm depth interval were taken from all the pits for moisture determination. The initial moisture content of each of the soil profiles was determined gravimetrically and was used to calculate the amount of water needed to bring the profile to its field capacity. To bring 15, 30, 45 and 90 cm soil profiles to field capacity, varying amounts of water were applied with a hand irrigator on the next day. The experimental soils came to working condition 2 days after irrigation. After taking the soil moisture samples in layers of 15 cm from all the soil profiles, soil surfaces corresponding to each depth of wetting of each soil were loosened to different depths i.e. 0, 2.5, 5.0 and 10.0 cm with the help of a **khurpi** (hand tool) to create fine soil mulch of different thicknesses. A sand dunal sand (<1 mm) layer of 2.5 cm was applied on each soil surface of different depths of wetting of each soil. The soil moisture sampling was started at 9.00 a.m. on 28th October, 1979 and subsequent all samples were taken at 9.00 a.m. For the low demand (daily average evaporation < 5 mm) soil sampling was continued upto 6th December, 1979. For high evaporation demand (daily average evaporation > 10 mm) the above procedure was repeated from 5th April and continued upto 30th April, 1980. The soil samples for moisture determination (gravimetrically) were taken with the help of a tube sampler* having inner diameter 1.9 cm.

After taking each set of soil samples of desired depth the tube hole was filled with the same soil at the same bulk density. While taking the next soil

*Manufactured by Soil Moisture Equipment Corporation, California, U.S.A.

samples, care was taken not to collect the samples from the previous tube holes.

RESULTS AND DISCUSSION

Some of the physico-chemical properties viz., mechanical composition, bulk density, field capacity, pH and E. C. of the experimental soils have been given in Table 1. It is evident from this table that the two soils differed greatly in their properties.

The value of daily average pan-evaporation during the low demand period was found to be 3.6 mm with maximum value of 5.8 mm and minimum value of 1.0 mm. The corresponding values for high demand period were 10.8, 16.4 and 6.1 mm, respectively. In 24 days, under the low demand, the cumulative pan-evaporation was found to be 88.0 mm, while it was 259.0 mm under high evaporation demand. The first week cumulative pan-evaporation under low and high demands was found to be 30.0 and 58.0 mm, respectively. Thus, under low evaporation conditions the daily evaporation rate was initially high and then declined with time but its reverse was true in case of high demand.

The average loss of soil profile moisture under different treatments of depth of wetting, mulching, evaporative demand and soil type is given in Table 2. It is clear from the table that minimum amount of moisture was lost under the treatment of sand mulch followed by 2.5, 5.0 and 10.0 cm soil mulch and no mulch from both the soils wetted to 15, 30, 45 and 90 cm depths in low demand. In case of high demand, similar trend was observed in all cases excepting the 15 cm depth of wetting where the maximum loss was found under 10.0 cm soil mulch. This is because most of the limited profile (15 cm) was loosened for creating 10 cm soil mulch resulting in the loss of major quantity of applied water in giving the treatment.

The superiority of sand mulch in reducing evaporation was reported by a number of workers (Lemon, 1956; Gardner and Fireman, 1958; Hielman *et al.*, 1968; Wiegand *et al*, 1968; Hadas and Hillel, 1972). But limited information is available on the effect of varying thicknesses of sand mulch on evaporation. Only the study of Gardner and Fireman (1958) indicated that the evaporation rate from a Pachappa sandy loam soil

TABLE 1

Some physical and chemical properties of the experimental soils

Soil	Mechanical composition (%)			Bulk density (g/cc)	Field capacity (% cm^3/cm^3)	pH	E.C. (mmhos/cm)
	Sand	Silt	Clay				
Sandy loam	79	10	11	1.46	27	7.9	7.4
Clay loam	45	20	35	1.40	30	8.2	7.3

TABLE 2

The average initial and final status of soil profile moisture in 24 days under different treatments of mulching, soil and evaporative demand

Depth of wetting (cm)	Thickness of mulch layer (cm)	Sandy loam						Clay loam					
		Low demand			High demand			Low demand			High demand		
		Initial moisture (mm)	Final moisture (mm)	Loss of moisture (mm)	Initial moisture (mm)	Final moisture (mm)	Loss of moisture (mm)	Initial moisture (mm)	Final moisture (mm)	Loss of moisture (mm)	Initial moisture (mm)	Final moisture (mm)	Loss of moisture (mm)
15	0	27.6	14.6	13.0	25.5	9.5	16.0	30.5	17.4	13.1	26.7	12.7	14.0
	2.5	27.0	17.0	9.4	25.4	11.5	13.9	29.6	19.6	10.0	26.2	14.4	11.8
	5.0	27.5	17.0	10.5	28.2	12.7	15.5	29.6	18.4	11.2	27.0	13.5	13.5
	10.0	28.0	16.4	11.6	25.2	9.0	16.2	29.8	18.0	11.8	28.2	9.6	18.6
	Sand mulch	28.5	21.4	7.1	26.0	13.2	12.8	31.8	23.0	8.8	27.0	16.8	10.2
30	0	64.0	36.0	28.0	63.0	24.8	38.2	68.0	42.3	25.7	66.5	35.5	31.0
	2.5	62.5	42.0	20.5	61.0	34.8	26.2	67.0	47.4	19.6	67.0	40.7	26.3
	5.0	61.2	40.0	21.2	61.5	33.0	28.5	65.0	45.0	20.0	69.0	38.5	30.5
	10.0	62.8	39.0	23.8	61.0	31.0	30.0	66.4	44.6	21.8	68.5	38.5	30.0
	Sand mulch	69.0	53.0	16.0	65.0	38.0	27.0	68.6	51.7	16.9	69.5	44.8	24.7
45	0	109.6	57.8	41.8	106.0	49.0	57.6	111.0	78.0	33.0	105.5	59.3	46.2
	2.5	102.5	71.0	31.5	103.0	60.0	43.0	111.0	85.2	25.8	105.0	70.0	35.0
	5.0	104.0	70.4	33.6	100.0	57.0	43.0	112.0	83.7	28.3	113.7	73.7	40.0
	10.0	105.3	69.0	36.3	113.0	64.0	49.0	109.0	81.0	28.0	109.0	67.5	41.5
	Sand mulch	100.1	80.9	19.2	107.0	67.0	40.0	110.0	90.0	20.0	114.0	80.5	33.5
90	0	205.5	136.3	69.2	210.0	129.0	81.0	242.0	183.0	59.0	240.0	172.0	68.0
	2.5	192.0	154.5	38.5	195.0	138.5	56.5	247.0	198.0	49.0	235.3	177.0	58.3
	5.0	191.8	151.0	40.4	198.0	141.0	57.0	246.0	195.0	51.0	242.0	179.0	63.0
	10.0	192.0	148.0	44.0	203.0	144.0	59.0	245.0	190.0	55.0	250.0	180.0	70.0
	Sand mulch	202.0	170.0	32.0	206.0	153.0	53.0	245.0	206.0	39.0	241.0	182.0	59.0

decreased with progressive increase in thickness of 1-2 mm screened sand mulch from 0 0 to 6.0 cm. In our study the sand dunal sand had size less than 1 mm.

The study further shows that creation of surface soil mulch definitely helped in reducing evaporation from both the soils. This finding has got strong support of several workers (Mc Call, 1925; Willis and Bond, 1971; Lindstrom *et al.*, 1974; Gill *et al.*, 1977). This may be attributed to the stratification of the soil profile with the top mulch layer having relatively high porosity and less capillary conductivity than the soil beneath. This modification of soil helps in reducing water transport to the evaporation site. Among the various soil mulches, 2.5 cm soil mulch was the most effective and economical in conserving moisture. The results reported in the literature are not in agreement with the present findings. While majority of scientists viz., Hanks and Woodruff (1958), Tselishcheva (1965), Acharya and Prihar (1969), Willis and Bond (1971), and Hillel and Hadas (1972) favoured soil mulch of thickness less than 5 cm, but others like Papendick *et al.* (1973) and Hadas (1975) working with aggregated (>1 mm) soil mulch suggested the use of soil mulch more than 5 cm, for effective control of evaporation losses. The greater optimum thickness of the aggregated soil mulch to control evaporation may be attributed to its larger pore size conducive to easy and deeper penetration of the atmospheric wind gusts requiring thicker barrier for its effective check. Theoretically, a mulch layer conserves soil moisture through increased resistance to water movement from underlying moist layers to the atmosphere and through increased thermal insulation of moist soil below the top dry mulch. Therefore, the optimum thickness of a mulch layer would depend upon its thermal and water transmission characteristics. In the present study, 2.5 cm soil mulch was found to be not only optimum in controlling evaporation but is also more practical and economically feasible.

The fractional loss of soil moisture in 24 days under different treatments is shown in Fig. 1. It is evident from the figure that during low demand, in a period of 24 days, the sandy loam soil profiles lost 14.9, 23.2, 19.2 and 15.8 per cent moisture for 15, 30, 45 and 90 cm depths of wetting, respectively, under sand mulch treatment. The corresponding loss under 2.5, 5.0 and 10.0 cm soil mulch and no mulch was 34.8, 38.2, 41.4 and 47.1 per cent for 15 cm depth of wetting; 32.8, 34.6, 37.8 and 43.7 per cent for 30 cm depth of wetting; 30.7, 32.3, 34.5 and 38.3 per cent for 45 cm depth of wetting; and 20.1, 21.1, 22.1 and 23.7 per cent for 90 cm depth of wetting. Similarly in clay loam soil the profile moisture loss continued to decrease as the depth of wetting increased.

The study on the effect of depth of wetting on evaporation loss clearly indicated a favourable role of increasing depth of wetting on reducing evaporation and subsequently better conservation of moisture under different treatments of mulching, soil type and evaporative demand. A few experimental evidences (Hillel, 1971; Hadas, 1973) are available to support this finding which is theoretically sound. Definitely water, which infiltrates deeper

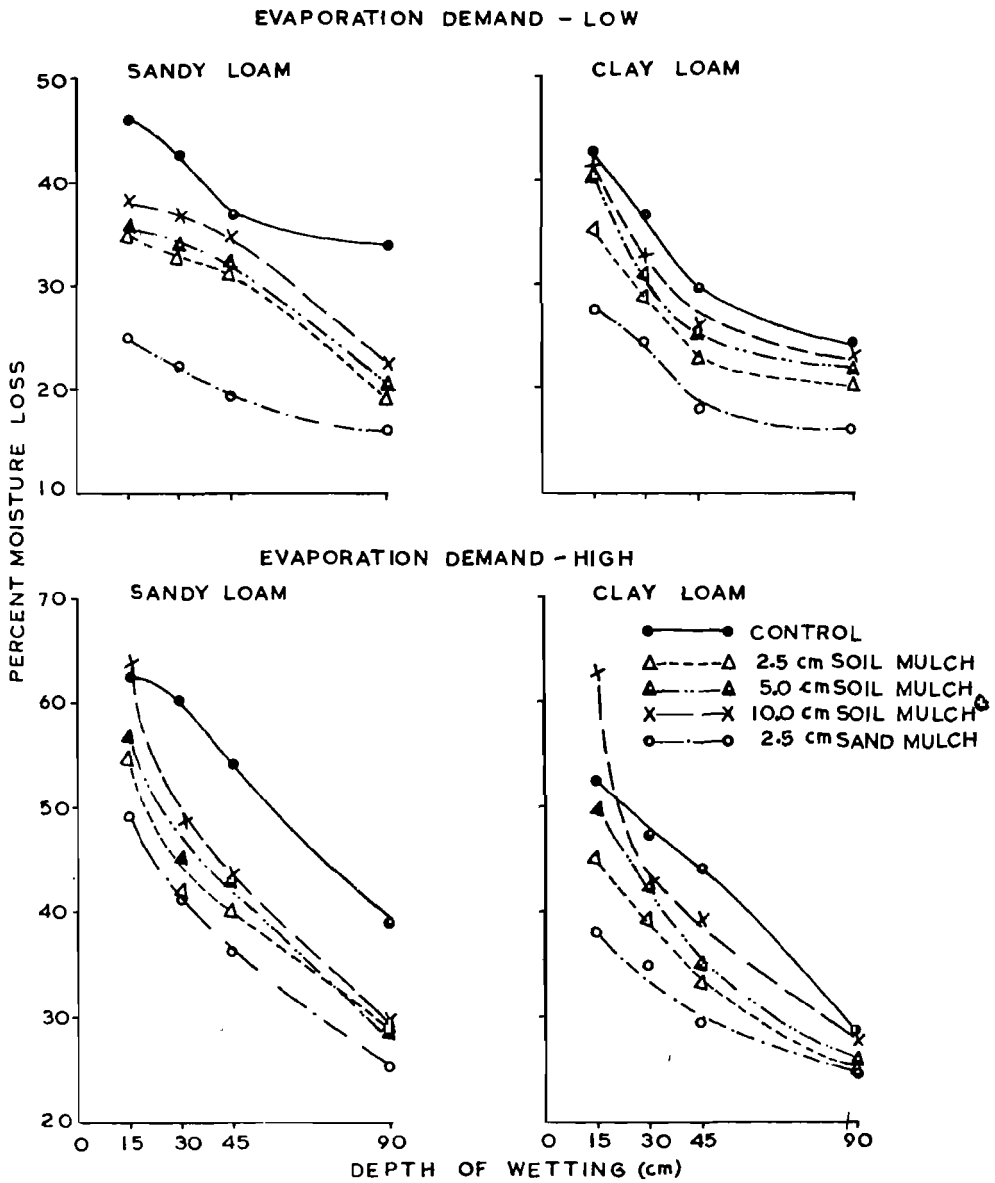


Fig. 1. Moisture loss from the two soils as affected by depth of wetting, mulching treatments and evaporative demands.

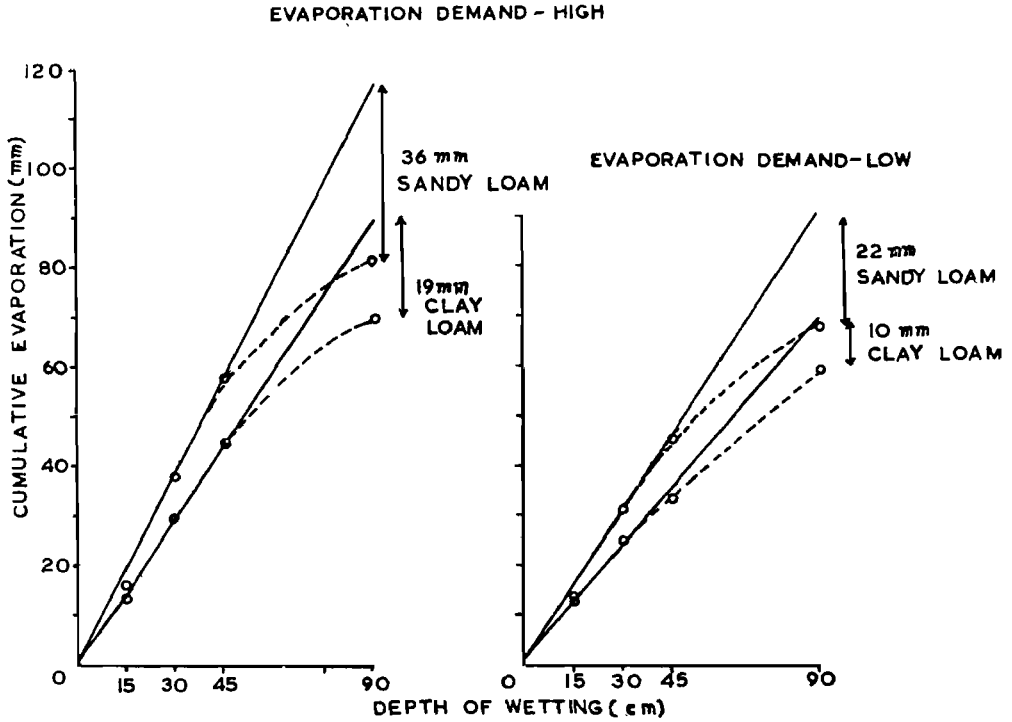


Fig. 2. Cumulative evaporation from the two soils as a function of depth of wetting under low and high demands.

in a soil profile, is not easily accessible to be lost as evaporation. The role of increasing depth of wetting in conserving moisture appeared to be dependent on soil type and evaporative demand. Increasing depth of wetting could conserve more moisture in the clay loam soil than the sandy loam soil, under both the evaporativities (Table 2). This differential behaviour of soil in conserving moisture is attributed to their differential pore size distributions. Atmospheric wind gusts could penetrate deeper in soils having larger proportion of bigger pores (as found in sandy loam soil) and would cause higher vapour diffusion coefficient. A graph showing effect of different depths of wetting on cumulative evaporation (after 24 days) from the two soils, under the two demands is shown in Fig. 2. It is clear from this graph that cumulative evaporation in both the soils, under both the demands, increased generally upto 45 cm depth of wetting and then decreased considerably. This indicates that the quantity of water which had penetrated a soil profile below the depth of 45 cm was relatively less susceptible to evaporation loss. This effect appears to be more pronounced in high demand and in light soil. These results are of much practical value in adopting measures for efficient conservation of soil profile moisture.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 268—274 (June 1983)

EFFECT OF SALINITY ON FLOWERING BEHAVIOUR AND FRUIT-SET OF BRINJAL GENOTYPES

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(Received May 14, 1981; Revised : November 13, 1981)

ABSTRACT

Twenty three varieties of brinjal (*Solanum melongena* L.) and two wild species were evaluated for their salt tolerance during 1977-78 in relation to flowering and fruit-set in artificially salinized soils (0, 4, 6, 8 and 10 mmhos/cm Ece) prepared by mixing the salts, viz. NaCl, Na_2SO_4, $CaCl_2$ and $MgCl_2$. The flowering was delayed and the percentage of fruit-set depressed with an increase in soil salinity levels. Number of long styled and medium styled flowers per plant decreased, whereas pseudo short and true short styled flowers increased significantly with the increasing salinity levels above 4 mmhos/cm Ece.

Brinjal (*Solanum melongena* L.) is one of the most important vegetable crops cultivated in India and particularly in Haryana. The cultivation of this crop is handicapped by several factors, among which soil salinity is one of the most limiting one. In saline soils, the presence of excessive salts in the root zone lead to various physiological changes in the plants which ultimately affect the flowering and fruiting behaviour of the plant. In Haryana, the total area of salt affected soils is about 0.64 million hectares (Bhumbla, 1972). This problem is further aggravated by the rising underground water table which is of poor quality (brackish). The literature available indicates that no work in India and little work outside the country has been done on the salt tolerance behaviour of brinjal. Hence, the present investigation was carried out to study the effect of salinity on flowering behaviour and fruit-set in brinjal genotypes.

MATERIAL AND METHODS

The experiment was conducted at the Research Farm of the Department of Vegetable Crops, Haryana Agricultural University, Hissar during 1977-78 in cement pots (45 × 45 × 45 cm) filled with artificially salinized soil. The physico-chemical characteristics of the soil used for the studies were texture—sandy loam (sand 83.2%, silt 9.7% and clay 7.1%); organic carbon—0.06%; available N, P and K—158.6, 21.0 and 230 0 kg/ha, respectively; saturation percentage—25.5; pH—8.1; ECe—1.30 mmhos/cm and cation exchange capacity—4.65 Meq/100 g soil. The soil was treated with aqueous solution of calculated amount of different salts (NaCl, Na_2SO_4, $CaCl_2$ and $MgCl_2$) to obtain the salinity levels of 0, 4, 6, 8 and 10 mmhos/cm ECe which were mixed in such a ratio that the SAR of soil did not exceed 10 0. After mixing the soil and salts the actual salinity levels

were : 1.3 (control), 3 9, 6.0, 8.1 and 9.9 mmhos/cm. These artificially prepared salinized soils were filled in cement pots @ 60 kg per pot. The cement pots were without drainage holes and were painted with black paint from inside to prevent the loss of salts due to leakage.

Six weeks old seedlings of brinjal genotypes were transplanted on 20.8.1977, accommodating two plants in each pot. Split plot design was used in 4 replications where salt concentrations were the main treatments and varieties were the sub-treatments. The application of 200 ml of nutrient solution (Arnon and Hoagland, 1940) was made 5 times in each pot at an interval of two weeks during the growing season in order to supply adequate nutrients to the crop. The pots were irrigated with an equal amount of canal water at an interval of ten days having an electrical conductivity of 2500 micromhos/cm. The cultural operations and plant protection measures were carried out as and when required. The number of days taken for opening of first flower from the day of transplanting was recorded. The flowers per plant were counted under two categories : (1) long styled and medium styled, (2) pseudo short styled and true short styled. The percentage of fruit-set was calculated by the following formula :

$$\text{Fruit set } (\%) = \frac{\text{Total number of fruits per plant}}{\text{Total number of flowers per plant}} \times 100$$

At the end of the experiment the salinity levels were 1.4 (control), 4.2, 6.2, 8.3 and 10.2 mmhos/cm. Statistical analysis of the data was carried out by the method of analysis of variance (Panse and Sukhatme, 1967).

RESULTS AND DISCUSSION

The perusal of data presented in Table 1 indicates that number of days taken to flower after transplanting increased with the increase in salinity level and the values of population mean show that the increase in number of days to flower was significant except at 4 mmhos/cm ECe. The varieties also differed significantly. At the highest level of salinity (10 mmhos/cm ECe) the minimum increase in number of days to flower was recorded in varieties Round Panipat, White Long, New York Spineless and *Solanum torvum* (11) as compared to control. The maximum days for flowering were recorded in variety Black Beauty (96), whereas minimum were taken by Sel-1 (A-61) Long type (55) followed by S-3 (56) and PH-4 (59) at 10 mmhos/cm ECe. The interactions between varieties and concentrations were not significant. The reports of Toniolo and depoli (1958) in pea and beans; Osawa (1960) in beans, tomato, pepper and cucumber; Morgan (1966) in okra; and Malik *et al.* (1977) in pea are in conformity with the present findings.

The data presented in Table 2 show that the number of long styled and medium styled flowers per plant decreased with increasing salinity levels, however, the population mean values show that the differences were not significant upto 4 mmhos/cm ECe as compared to control. The varietal differences were also significant. At 10 mmhos/cm ECe the maximum number of long styled and medium styled flowers per plant was

TABLE 1

Effect of different salinity levels on the days taken to flower after transplanting in different varieties/species of brinjal

S. No.	Variety/sp.	Salinity levels in mmhos/cm					Mean
		Control	4	6	8	10	
1.	PH-4	45	47	50	53	59	51
2.	BR-112	41	48	53	54	59	51
3.	PPR	71	78	84	—	—	78
4.	S-3	33	40	43	50	56	44
5.	R-34	43	48	53	57	61	52
6.	Pusa Kranti	46	54	56	59	62	55
7.	Round Panipat	61	65	67	72	72	67
8.	New York Spineless	55	58	61	64	66	61
9.	White Long	56	59	61	64	67	61
10.	Varanasi-6	41	44	46	52	—	46
11.	Arkasheel	44	48	52	56	—	50
12.	Shanker Vijay	48	53	56	61	—	54
13.	*Solanum sysembrifolium*	34	37	—	—	—	35
14.	*Solanum torvum*	49	54	58	60	60	56
15.	Sel-1(A-61) Long type	43	46	49	53	55	49
16.	Black Beauty	79	85	88	95	96	89
17.	Manjari Gota	43	47	51	53	—	48
18.	Round Purple	47	50	54	59	60	54
19.	Sel-2	37	40	44	48	59	46
20.	American Wonder	46	51	55	60	61	55
21.	PPC-2	45	50	54	59	—	52
22.	Egg shaped cluster	46	50	53	58	61	54
23.	Green Long	51	55	58	61	66	58
24.	Cluster Long	55	59	63	68	74	64
25.	Faizabad Local	69	76	81	86	94	81
Mean		49.12	53.68	57.91	60.95	66.00	

C. D. at 5% level

Varieties : 15.6

Concentrations : 8.2

Varieties × Concentrations : NS

TABLE 2

Effect of different salinity levels on the number of long styled and medium styled flowers and pseudo short styled and true short styled flowers per plant in different varieties/species of brinjal

S. No.	Variety/sp.	Salinity levels in mmhos/cm					Mean
		Control	4	6	8	10	
1.	PH-4	32.50(19.00)	30.25(26.25)	24.75(31.00)	22.00(34.00)	20.00(48.00)	25.90(31.65)
2.	BR-112	24.50(9.75)	22.00(14.25)	20.25(20.50)	17.75(24.50)	8.00(29.50)	18.50(19.70)
3.	PPR	13.75(3.25)	8.50(8.25)	7.50(13.50)	6.00 —	—	8.94(8.33)
4.	S-3	49.25(20.50)	45.25(24.75)	40.25(29.50)	36.00(33.75)	33.25(37.50)	40.80(29.20)
5.	R-34	40.75(47.50)	38.50(51.50)	35.50(55.25)	31.00(60.00)	25.75(64.00)	34.30(55.65)
6.	Pusa Kranti	23.50(5.75)	16.75(8.50)	14.25(14.25)	10.00(19 50)	7.25(25.25)	14.35(14.65)
7.	Round Panipat	12.25(1.75)	9.50(3.00)	9.00(5.50)	6.00(7.25)	5.00(9.25)	8.35(5.35)
8.	New York Spineless	15.75(3.25)	13.75(6.25)	12.00(11.00)	10.25(13.25)	7.25(16.00)	11.80(9.95)
9.	White Long	15.25(5.25)	13.50(6.50)	11.75(8.25)	10.00(11.75)	7.50(19.00)	11.60(10.15)
10.	Varanasi-6	28.00(8.00)	26.00(12.50)	24 25(23.25)	22.00(31.50)	—	25.06(18.81)
11.	Arkasheel	27.75(5.25)	26.50(10.50)	24.25(18.00)	21.00(24.50)	—	24.88(14.56)
12.	Shanker Vijay	22.75(7.50)	21.00(11.00)	15.00(14.15)	14.00(18.50)	2.00(25.00)	14.95(15.25)
13.	*Solanum sysembrifolium*	40.25(4.00)	38.00(7.00)	—	—	—	39.13(5.50)
14.	*Solanum torvum*	39.25(11.25)	37.50(13.50)	34.75(17.00)	31.75(19.50)	10.00(28.00)	30.65(17.85)
15.	Sel-1(A-61) Long type	18.25(24.00)	10.75(24.00)	8.50(35.25)	7.25(41.75)	6.66(50.00)	10.28(35.00)
16.	Black Beauty	6.25(7.00)	5.25(14.25)	4.00(17.50)	3.75(23.25)	3.00(33.50)	4.45(19.10)
17.	Manjari Gota	21.50(13.75)	18.00(17.50)	11.75(24.75)	4.00(26.66)	—	13.81(20.67)
18.	Round Purple	26.75(7.00)	21.75(17.50)	18.00(18.00)	14.00(26.66)	4.00(28.00)	16.90(19.43)
19.	Sel-2	107.75(21.50)	86.25(22 00)	75.25(31.75)	45.50(48.33)	3.50(52.50)	63.65(35.22)
20.	American Wonder	23.25(13.25)	20.75(16.75)	17.25(20.00)	11.75(32.50)	6.00(41.00)	15.80(24.70)
21.	PPC-2	62.25(5.00)	47.75(10.25)	43.00(25.00)	9.00(28.00)	—	40.50(17.06)
22.	Egg shaped cluster	24.50(6.00)	19.50(10.25)	15.25(18.25)	12.00(26.75)	10.50(37.66)	16.35(19.78)
23.	Green Long	33.25(8.00)	24.75(10.50)	19.75(17.75)	5.00(20.25)	2.50(25.00)	17.05(16.30)
24.	Cluster Long	16.25(16.00)	14.00(19.00)	9.66(22.00)	6.25(27.00)	4.00(36.00)	10.03(24.00)
25.	Faizabad Local	12.75(4.50)	10.00(10.25)	6.75(16.25)	6.00(35.00)	5.33(33.33)	8.17(17.87)
Mean		29.53(11.12)	25.03(15.04)	20.94(21.16)	15.09(27.14)	9.02(33.60)	

C. D. at 5% level

Varieties : 15.57(13.78)
Concentrations : 6.95 (6.17)
Varieties × Concentrations : NS

Note : Values given in parentheses indicate the number of pseudo short and true short styled flowers.

recorded in variety S-3 (33.25), whereas minimum was in variety Shanker Vijay (2.0). At the highest salinity level (10 mmhos/cm ECe) the minimum reduction in number of long styled and medium styled flowers was recorded in variety S-3 (32.49%) followed by R-34 (36.81%) and PH-4 (38.46%), whereas maximum reduction was in variety Sel-2 (96.75%) as compared to control. The interactions between varieties and concentrations were not significant. Variety Black Beauty showed no significant reduction in number of long styled and medium styled flowers even upto 10 mmhos/cm ECe as compared to control.

The number of pseudo short and true short styled flowers per plant increased significantly with an increase in salinity level above 4 mmhos/cm ECe as compared to control. The varieties also differed significantly. At 10 mmhos/cm ECe the maximum increase in number of pseudo short and true short styled flowers per plant was recorded in variety Egg shaped cluster (31.66) followed by PH-4 (29.00) and Faizabad Local (28.83), whereas minimum increase was in variety Round Panipat (7.50) as compared to control. The interactions between varieties and concentrations were not significant. Upto 8 mmhos/cm ECe the increase in number of pseudo short and true short styled flowers was not significant in variety Round Panipat as compared to control.

The data recorded on long styled, medium styled and pseudo short and true short styled flowers (Table 2) indicate that the rate of development of long styled and medium styled flowers decreased and of pseudo short and true short styled flowers increased significantly with increasing levels of salinity above 4 mmhos/cm ECe. Maximum long styled and medium styled flowers per plant at the highest salt concentration (10 mmhos/cm ECe) were recorded in variety S-3 followed by R-34 and PH-4, whereas minimum were in varieties Shanker Vijay and Green Long. The differential behaviour of different genotypes of brinjal with respect to flowering may be due to their individual genetic potential to tolerate excess salts. Similar results were reported by Osawa (1957) in brinjal.

The perusal of data recorded in Table 3 indicates that increasing level of salinity had a depressing effect on percentage of fruit-set. At 10 mmhos/cm ECe the maximum fruit-set was in variety Round Panipat (12.28%) followed by PH-4 (12.21%) and S-3 (10.95%), whereas minimum was in variety BR-112 (1.33%). The maximum decrease in percentage of fruit-set at 10 mmhos/cm ECe was in variety New York Spineless (40.67%) and minimum decrease was in R-34 (3.85%) as compared to control. Percentage of fruit set decreased tremendously with an increase in salt concentration because the long styled and medium styled flowers decreased while pseudo short and true short styled flowers increased with increased level of salinity. The present findings are contradictory to those reported by Osawa (1957). The reduction in per cent fruit-set with increased salt concentration may be associated with osmotic effect, specific ion effect or altered enzyme activity (Kurian and Iyengar, 1967). The data presented in Tables 1, 2 and 3 show that salts not only delayed flowering

TABLE 3

Effect of different salinity levels on the percentage fruit-set in different varieties/species of brinjal

S. No.	Variety/sp.	Salinity levels in mmhos/cm					Mean
		Control	4	6	8	10	
1.	PH-4	25.72	21.68	16.14	15.63	12.21	18.28
2.	BR-112	18.97	16.55	13.50	8.88	1.33	11.85
3.	PPR	29.41	14.54	10.53	8.33	—	15.70
4.	S-3	17.20	16.35	15.61	12.19	10.95	14.46
5.	R-34	13.88	12.77	12.36	10.99	10.03	12.01
6.	Pusa Kranti	33.33	28.71	22.81	8.47	6.43	19.95
7.	Round Panipat	33.92	26.00	22.41	20.75	12.28	23.07
8.	New York Spineless	46.05	32.50	26.09	9.57	5.38	23.92
9.	White Long	19.51	15.00	11.25	6.90	2.88	11.11
10.	Varanasi-6	27.08	11.68	9.47	7.48	—	13.93
11.	Arkasheel	38.63	24.32	16.57	14.29	—	23.45
12.	Shanker Vijay	39.66	23.43	13.68	5.38	—	20.54
13.	*Solanum sysembrifolium*	62.14	51.16	—	—	—	56.65
14.	*Solanum torvum*	31.68	26.96	13.04	10.73	—	20.60
15.	Sel-1(A-61) Long type	23.07	17.26	10.86	7.43	4.17	12.56
16.	Black Beauty	15.09	8.97	5.81	3.70	4.00	7.51
17.	Manjari Gota	13.47	9.85	4.11	—	—	9.14
18.	Round Purple	11.85	10.19	7.64	4.86	3.13	7.53
19.	Sel-2	14.11	8.54	7.01	4.72	3.57	7.59
20.	American Wonder	45.20	24.00	17.01	11.23	—	24.36
21.	PPC-2	33.45	20.25	19.61	—	—	24.44
22.	Eggs shaped cluster	29.50	28.57	27.88	8.39	6.72	20.21
23.	Green Long	35.15	34.87	30.67	8.91	—	27.40
24.	Cluster Long	27.90	25.00	16.24	9.02	5.00	16.63
25.	Faizabad Local	34.78	24.69	15.69	8.87	8.62	18.53
Mean		27.63	21.35	15.25	8.99	6.45	

but also decreased the number of long styled and medium styled flowers which led to decreased fruit-set. This shows that brinjal is sensitive to salinity at flowering and fruit-set stages.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 275–280 (June 1983)

COMPARATIVE PERFORMANCE OF **TORIA** VARIETIES WITH DIFFERENT DATES OF SOWING AND PLANT PROTECTION MEASURES

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(Received : June 10, 1981: Revised : December 2, 1981)

ABSTRACT

Sowing of **toria** on 9th and 19th September was found to be the optimum dates for obtaining higher grain yields during 1979-80 and 1980-81, respectively. During 1979-80 all the three varieties under study were at par in respect of grain yield. However, during second year Sangam and TL-15 varieties outyielded Shyamgarh variety significantly by a margin of 27 and 23 per cent, respectively. Plant protection measures showed significant effect on grain yield only during 1980-81.

Toria (*Brassica campestris* var. toria) being a short duration crop occupies an important place in multiple cropping. As it matures early, it is taken as a catch crop before the sowing of wheat or sugarcane crop. Sangam, the only high yielding recommended variety of **toria** by HAU, is a long duration variety. It takes 100-115 days from sowing to seed. After a catch crop of Sangam **toria,** sowing of wheat is delayed which results in drastic reduction of wheat yield. Recently, a short duration (75-85 days) and high yielding variety of **toria** (TL-15) has been evolved and released for cultivation in the North-West part of the country by Punjab Agricultural University, Ludhiana. Another short duration local variety of **toria** viz. Shyamgarh is also cultivated by farmers. Comparative performance of these three varieties with different agro-techniques has not been studied so as to fit it in the multiple crop rotation to get the maximum return per unit area and per unit time. Keeping these objectives in view, the present experiment was conducted to compare the growth and yield of three varieties of **toria** with three dates of sowing and with and without plant protection measures.

MATERIAL AND METHODS

Field experiment was conducted at the Agronomy Research Farm of Haryana Agricultural University, Hissar during **zaid** (September-December) seasons of 1979-80 and 1980-81. Eighteen treatment combinations comprising three sowing dates viz., August 30, September 9 and September 19 and three varieties of **toria** viz., Sangam, Shyamgarh and TL-15 with and without plant protection measures were tried. The experiment in both the years was laid out in factorial randomised block design with three

replications. The gross and net plot sizes were 18 and 7.20 sq. m., respectively. The soil of the experimental field was sandy loam in texture, medium in available nitrogen and phosphorus and high in potash.

The crop was sown after pre-sowing irrigation. Thirty kg nitrogen through urea, 30 kg P_2O_5 through single superphosphate and 25 kg zinc sulphate per hectare were applied at the sowing time. Another 30 kg N/ha was top dressed after irrigation. Only one irrigation was applied after sowing at the time of flowering. Hoeing after irrigation was also done to control weeds and to conserve soil moisture.

For full plant protection measures, seeds were treated with Bavistin at the rate of 2 g/kg seed before sowing. Painted bug and Mustard sawfly were controlled by using BHC 10% @ 25 kg/ha and Malathion @ 750 ml in 750 l of water per hectare. Dithane M-45 @ 2 kg/ha was used against Alternaria blight, downy mildew and white rust. The crop was sown with row to row spacing of 30 cm. After germination the plant spacing with the row was maintained at 15 cm by thinning. Harvesting of plots, sown on August 30, was done after 75 days of sowing in case of TL-15 and Shyamgarh varieties, and 95 days after sowing in case of Sangam variety. Crop sown on September 9 was harvested after 80 days of sowing in case of TL-15 and Shyamgarh varieties and 100 days after sowing in case of Sangam variety, while the crop sown on September 19 was harvested after 85 days and 105 days after sowing, respectively. Number of branches per plant, pods per plant, grains per pod, test weight and yield per plant were recorded from randomly selected five plants in each plot. Plant population per running meter row length was recorded at the time of harvesting from five randomly selected places. Grain yield was recorded in kg/plot and converted into q/ha.

Weather data. The weather data during the crop growth period are presented in Table 1. In 1979-80 during crop growth period a total of 52.4 mm rainfall was received and it was concentrated mainly in the month of September. In 1980-81, 44.4 mm rain was received and it was well distributed throughout the crop growth period. High relative humidity and low evaporation were recorded at maturity stage which were conducive for the growth of the crop and for better grain filling.

RESULTS AND DISCUSSION

Effect of Varieties

Data presented in Table 2 reveal that the number of plants per running meter and the test weight remained unaffected by varieties during both the seasons of study. Sangam and TL-15 varieties produced more branches than Shyamgarh during 1979-80 and similar effect of varieties was observed on number of pods in 1980-81. Variety TL-15 produced significantly more number of grains per pod than Sangam and Shyamgarh only, during 1979-80, and during second year no effect of varieties on this parameter was observed.

In this study, number of pods per plant proved to be the most important

parameter contributing to the yield per plant. The data in Table 2 reveal that during 1980-81, higher yield per plant was recorded in varieties Sangam and TL-15 than Shyamgarh which was mainly due to the higher number of pods recorded in these two varieties. The higher yield per plant ultimately resulted in higher grain yield per hectare of varieties Sangam and TL-15 over Shyamgarh during 1980-81 (Table 2). However, during first year, varieties did not differ significantly for their grain yield per hectare.

Effect of Date of Sowing

The data in Table 2 also indicate that the date of sowing had effect on the plant stand and branches per plant. Better germination and plant population was obtained when the crop was planted on September 19 in comparison with early planting. However, number of branches was reduced with the delay in sowing of crop. During both the years pods per plant and grains per pod were affected significantly due to different sowing dates. Highest number of pods was produced in August 9 sown crops and successive delay in sowing resulted in significant reduction in number of pods. The number of grains per pod, however, increased significantly with delay in sowing and maximum grains were produced by the crops sown on September 9 during 1979-80 and on September 19 during 1980-81. Test weight of grains remained unaffected due to time of sowing during both the years.

Time of sowing also affected the seed yield per plant during both the years of study. September 9 and 19 sowings produced higher grain yield per plant than August 30 sowing. The number of branches and pods per plant was reduced by delay in sowing, however, it seems that increase in number of grains per pod might have not only neutralized the adverse effect of these two parameters but also enhanced the grain yield per plant under September 9 and 19 over August 30 sowing. Low temperature at grain formation stage was perhaps the most important climatic factor affecting the final yield of the crop. Under late sowings the crop could get more favourable conditions (Table 1) for the formation of more number of grains and so ultimately yield was higher in late sowings particularly during crop season 1980-81. The grain yield per hectare (Table 2) increased by delaying the

TABLE 1

Mean monthly weather data during the crop growing season

Month	Maximum temp. (°C)		Minimum temp. (°C)		Relative humidity (%)		Evaporation (mm)		Total rainfall (mm)	
	1979-80	1980-81	1979-80	1980-81	1979-80	1980-81	1979-80	1980-81	1979-80	1980-81
September	35.1	36.3	22.6	22.4	56.0	67.0	5.9	6.4	50.4	—
October	34.5	34.7	16.6	17.9	56.5	59.5	5.7	5.3	1.0	8.2
November	28.6	28.0	14.5	10.5	69.0	65.5	3.2	2.9	—	6.9
December	24.5	22.0	6.8	6.4	66.5	71.0	2.2	2.1	1.0	29.3

TABLE 2

Effect of sowing dates and plant protection measures on plants/m, branches/plant, yield attributes and yield of **toria** varieties

Treatments	Plants/m		Branches/plant		Pods/plant		Grains/pod		1000-grain wt. (g)		Yield/plant (g)		Grain yield (q/ha)	
	1979-80	1980-81	1979-80	1980-81	1979-80	1980-81	1979-80	1980-81	1979-80	1980-81	1979-80	1980-81	1979-80	1980-81
Varieties														
Sangam	4.85	5.00	9.46	8.19	345.50	378.64	11.24	14.62	2.71	3.28	6.87	9.06	11 74	15.17
Shyamgarh	5.10	4.76	7.81	7.20	356.44	304.32	11.13	13.45	2.63	3.24	5.67	6.66	11.22	11.94
TL-15	4.55	4.78	8.95	7.84	314.72	369.50	12.76	14.43	2.60	3.27	5.72	9.96	12.32	14.77
S. Em.	0.21	0.24	0.42	0.65	15.86	22.16	0.45	0.60	.08	0.10	0.54	0.55	0.46	0.73
C. D. at 5%	NS	NS	1.23	NS	NS	63.60	1.29	NS	NS	NS	NS	1.58	NS	2.10
Sowing dates														
August, 30	4.76	4.49	10.22	7.19	435.50	420.27	10.33	12.96	2.71	3.26	4.93	7.07	9.05	9 64
September, 9	4.82	4.44	8.83	8.11	337.61	355.17	12.83	13.37	2.56	3.37	6.73	9.05	14 29	13 68
September, 19	4.92	5.61	7.17	7.93	243.56	277.02	11.97	16 17	2.67	3.17	6.60	9.55	11.96	18 55
S. Em.	0.21	0.24	0.42	0.65	15.86	22.16	0.45	0.60	.08	0.10	0.54	0.55	0.46	0.73
C. D. at 5%	NS	0.67	1.23	NS	45.53	63.60	1.29	1.74	NS	NS	1.50	1.58	1.32	2.10
Plant protection measures														
Without plant protection	4.60	4.83	8.83	7.59	340.56	329.41	11.41	14.20	2.62	3.22	6.14	8.40	11 58	12.36
With plant protection	5.07	4.86	8.65	7.90	337.22	372.23	12.00	14.13	2.67	3.30	6.04	8.71	11.94	15.56
S. Em.	0.18	0.20	0.35	0.53	15.04	18.10	0.36	0.49	.06	0.08	0.44	0.44	0.37	0.60
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1.72

TABLE 3

Pods per plant as influenced by dates of sowing × plant protection measures in 1980-81

Plant protection measures	Dates of sowing		
	August 30	September 9	September 19
Without plant protection	320.26	378.82	289.16
With plant protection	520.29	331.51	264.89
S. Em.	31.34		
C. D. at 5%	89 95		

TABLE 4

Grains per pod as influenced by dates of sowing × plant protection measures

Year	Plant protection measures	Dates of sowing		
		August 30	September 9	September 19
1979-80	Without plant protection	9.60	11.88	12.77
	With plant protection	11.06	13.78	11.18
	S. Em.	0.63		
	C. D. at 5%	1.81		
1980-81	Without plant protection	11.57	14.14	16.88
	With plant protection	14.34	12.60	15.45
	S. Em.	0.85		
	C. D. at 5%	2.46		

sowing to September 9 during 1979-80 and then decreased. However, it increased significantly upto the last date of sowing during 1980-81. Similar results have also been reported by Singh *et al.* (1963) and Dhindsa *et al.* (1973).

Effect of Plant Protection

Data in Table 2 also reveal that the yield attributes were not affected significantly by plant protection measures during both the years of study. However, during 1980-81 full plant protection treatment gave significantly higher grain yield as compared to no plant protection. The beneficial effect of plant protection measures has also been reported by Sandhu *et al.* (1969) and Kaushik *et al.* (1978).

Effect of Planting Time and Plant Protection

It was observed that early planted crop needed more plant protection measures against painted bug as compared to late sown crop. It is apparent from Table 3 that the number of pods per plant was significantly higher over control in full plant protection treatment in early planted crop on August 30. Similarly, plant protection measures also helped the early planted crop to produce more number of grains per pod (Table 4).

Other interaction effects were not significant during both the years.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 281—290 (June 1983)

IMPACT OF CANAL IRRIGATION ON GROUND WATER REGIME OF LOWER GHAGGAR BASIN—HARYANA

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(Received : July 1, 1981; Revised : March 27, 1982)

ABSTRACT

Water table fluctuations and quality variation trends were recorded from 280 observation wells spread over an area of approximately 11,000 sq km in the lower Ghaggar basin of Haryana from 1974 to 1979. It was noticed that the water table rose at an average rate of 50 cm per year over the entire basin during the above cited period. The area under less than 4 m water table depth increased five fold (2.87 to 13.02 per cent). The seepage from canal water accounted for 72% of the total rise in water table from all sources. Sub-surface inflow and outflow were almost in equilibrium with each other. About 45% of the area was overlain by saline ground water of 6,000—10,000 micromhos/cm electrical conductivity. Low transmissivity values of intervening layer in the Southern and North-Western portion were mainly responsible for the present ground water situation in basin.

Introduction of canal irrigation in semi-arid regions results in the rise of water table which in turn is closely related with the basement topography, lithology of underlying strata, ground water quality and its depth (Uppal and Gulati, (1966). In areas irrigated by Bhakra Canal, the water table has risen alarmingly, i. e., over 6 m with pockets of even 12 m rise. Such a significant rise in water table is due to excessive seepage from the canal water courses. These are mostly found in Kaithal, Narwana, extreme north part of Hissar, Fatehabad, Dabwali and major part of Sirsa. The rise in water table since 1955 is continuous in all areas commanded by the Bhakra Canal System. A substantial rise of ground water is taking place, which, if, not checked may lead to water logging problem in the near future on the same pattern and scale as happened in the old irrigated areas of Punjab (Pakistan) (Jasbir Singh, 1976). The studies conducted by Haryana State Minor Irrigation and Tubewells Corporation revealed that in the lower Ghaggar river basin, there was an average annual rise of 60 cm in the Pokhri area and 30 cm in Nazadelakalan area during the period 1959-70 (Anonymous, 1972). Therefore, an attempt was made to study the dynamic behaviour of water table as a result of canal irrigation in lower Ghaggar basin.

GROUND WATER MONITORING SYSTEM

To analyse different factors contributing to the change in ground water behaviour, it was necessary to determine the ground water movement in the saturated

strata. The data on ground water fluctuations were recorded by Haryana State Minor Irrigation and Tubewells Corporation (HSMITC) from 280 observation wells during the months of June and October every year. Various ground water regime maps were drawn on the basis of this data and were subsequently analysed in detail.

GEOLOGY AND GEOMORPHOLOGY

The Saraswati and Chautang streams originating in Sirmur area used to flow through Jind, Hansi and Hissar and the Ghaggar river joined these streams at Hanumangarh and Bhatnau and thereafter, flowed southwardly. The uplift of the Himalayas in relation to the Shivaliks resulting in feeding glacier's cut off or the increasing aridity in Rajasthan and adjoining areas, have checked the Saraswati and Chautang streams. Its relict beds can be traced with few broken levees and bars all along its earlier course. The channel beds were more or less low plains with raised level portions occupied by the canals system introduced parallel to earlier courses. This was one of the reasons resulting in the distrubance of hydrodynamic equilibrium of the basin. Presently, Ghaggar is the only seasonal river. It is also shifting laterally, too frequently leaving many relict channels, bars and interlocked levees. The exact depth of alluvium in the basin is not accurately known but from geophysical and bore hole data, it is found to vary from 100 to 400 m. The sediments are mostly calcarious with high percentage of salt and have yellow colour which is due to limonite pigmentation in recent calcarious alluvium (Anonymous, 1978).

IRRIGATION SYSTEM

The area was supplied irrigation water through Bhakra and Western Yamuna Canal Systems. There were 340 canals, distributaries and minors in the study area and were being run for 200 days in a year. The discharge and length of main channels are given below :

S. No.	Name of channel	Length (km)	Discharge (cumec)
1.	Bhakra main branch (lined)	134.85	133.70
2.	Kheri distributary	47.70	4.60
3.	Kaluana distributary	53.10	7.30
4.	A.M.K. distributary	40.50	9.70
5.	Fatehabad branch	48.12	33.40
6.	Fatehabad distributary	62.19	6.40
7.	Barawala branch	41.88	14.50
8.	Hissar major distributary	55.59	9.00
9.	Petwar distributary	52.71	13.70

Availability of canal water, recharge from canal water and equivalent rise in water table in the basin during 1974 to 1979 are given in Table 1. Although the culturable command area (CCA) was around 992,000 ha but to estimate the equivalent rise in water table, total area (1100,000 ha) of the basin was considered. The pumpage (in cm) during different years has also been presented in Table 1. The average annual rise in water table during 1974 to 1979 was 145.74 cm from canal irrigation losses and corresponding average annual pumpage was 109.83 cm. Therefore, canal water alone amounted to the rise in water table at an average annual rate of 36 cm.

TABLE 1

Canal water availability, recharge and pumpage

S. No.	Description	Year					
		1974-75	1975-76	1976-77	1977-78	1978-79	Av. per year
1.	Total canal water available (ha-cm)	23,907,280	28,970,678	29,426,875	24,013,300	27,275,223	26,118,671
2.	Recharge to ground water (ha-cm)	14,344,368	17,382,407	17,656,125	14,407,980	16,365,134	16,031 202
3.	Equivalent rise in water table (cm)	130.40	158.02	160.51	130.98	148.77	145.74
4.	Pumpage (cm)	97.32	101.71	114 37	117.16	118.59	109.83

Source : Personal Communication, Deputy Secretary Groundwater Cell, Haryana.

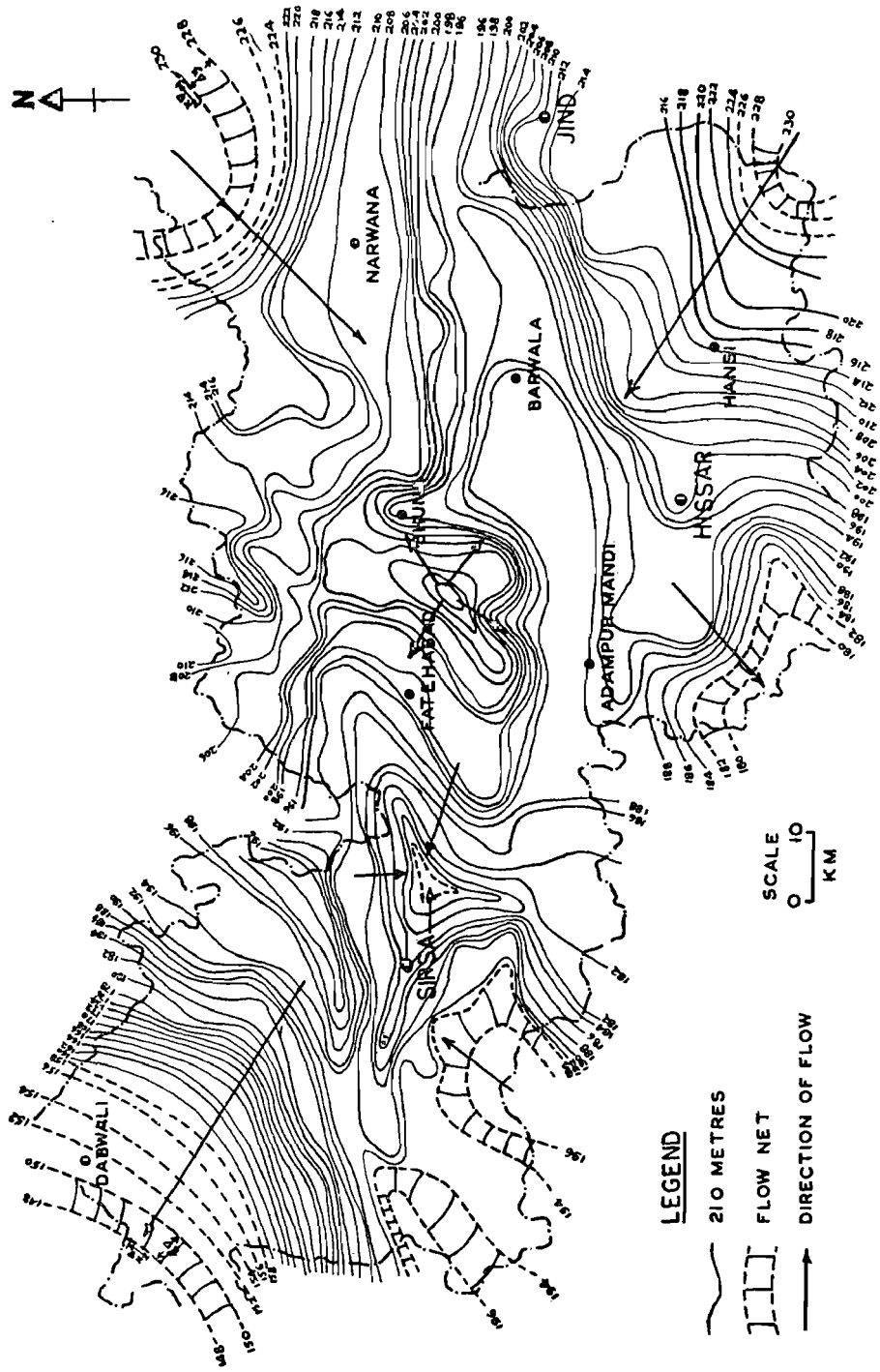


Fig. 1. Average ground water contour map (June 1974—June 1979) and flow net.

GROUND WATER MOVEMENT

The ground water contour map (Fig. 1) of the area was drawn on the basis of water table observations from June 1974 to June 1979. It was observed that the sub-surface flow entered the basin from the North-Eastern and South-Eastern directions and then flowed in the South-Western and North-Western directions. Near Ottu feeder, there was sub-surface flow from South-Western to North-Western direction. Ground water mound was found in between Fatehabad and Bhuna. Similarly a ground water depression existed near Sirsa which was probably due to excessive pumpage of good quality under ground water. The rates of sub-surface inflows and outflows through the area boundaries were estimated by using flow net techniques (Anonymous, 1974). Series of flow lines were drawn perpendicular to the system of equipotential lines (water table contours) such that squares were formed. The flow rate to any channel or path of flow between two adjacent flow lines was obtained from Darcy's law (Anonymous, 1974). Considering a width 'Y' of unit thickness of the aquifer measured normal to the direction of flow, indicated by 'X', Darcy's equation for this part of the aquifer is written as ;

$$q = K \frac{dh}{dx} Y \quad \ldots\ldots\ldots \quad (1)$$

Where q = flow rate occurring between a pair of adjacent flow lines (m^3/day);

Y = Spacing of flow lines (m);

K = hydraulic conductivity (m/day).

If 'X' represents the spacing of equipotential lines, 'h' is the drop in hydraulic head between equipotential lines, 'n' is the number of squares and 'D' is the full saturated thickness of aquifer, then the equation (1) may be written as follows :

$$Q = n.\ h.\ K.\ D. \quad \ldots\ldots\ldots \quad (2)$$

or $Q = nh.\ T$

where Q = Total flow in the entire saturated thickness 'D' (m^3/day);

T = Transmissivity of aquifer formation (m^2/day).

The aquifer transmissivity 'T' values for water table condition ranged from 300-400 m^2/day. From Fig. 1 the number of squares in all the directions was counted and by considering the average value of 'T' in the respective direction, inflow and outflow were determined by using equation (2).

$$Q_{in} = (8 \times 2 \times 400 + 5 \times 2 + 350 + 9 \times 2 \times 300 + 10 \times 2 \times 300) = 21{,}300 \text{ m}^3\text{/day}$$

$$Q_{out} = (8 \times 2 \times 350 + 7 \times 2 \times 300) = 9800 \text{ m}^3\text{/day}$$

Therefore, the net sub-surface inflow into the ground water storage over an area of 11,000 sq km is :

$$Q_{net} = Q_{in} - Q_{out} = 11500 \text{ m}^3\text{/day}$$

Net rise = 0.38 mm/year

Thus, the sub-surface flow component resulted in the rise of water table less than 1 mm/year.

CHANGE IN GROUND WATER STORAGE

Water table fluctuation map (Fig. 2) graphed from June 1974 to June 1979

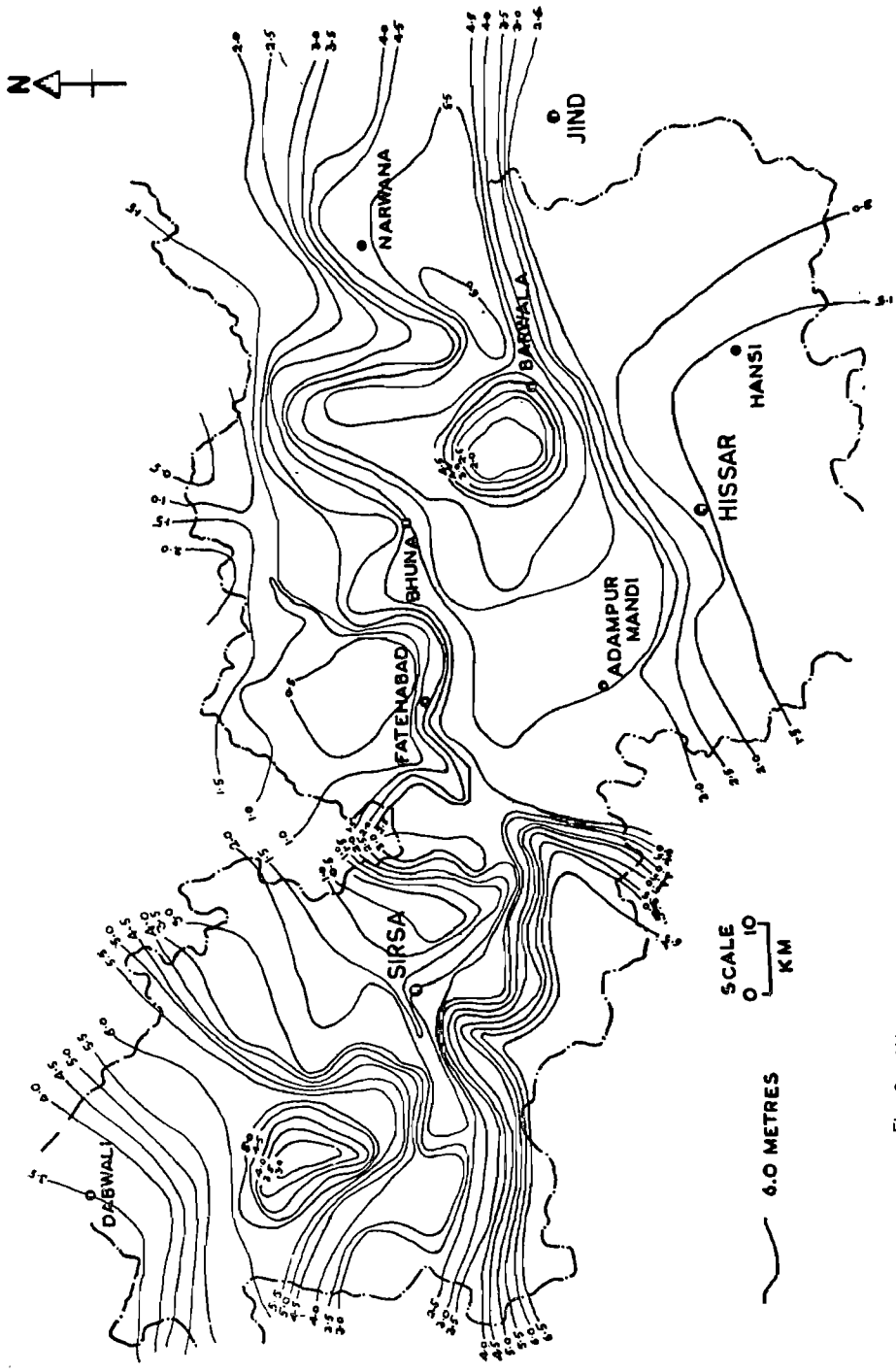


Fig. 2. Water table fluctuation map of part of lower Ghaggar basin (June 1974—June 1979).

has been used to estimate the net average change in water table. The rise in water table ranged from 0.5 to 6 m. The per cent area under different ranges of fluctuation is given in Table 2. On the basis of lithologs of the area an average value of 10% of specific yield was assumed. The following relationship (Brown *et al.*, 1972) was used to calculate the net change in storage during five years period.

$$q = \mu . \Delta H . A \quad \ldots\ldots\ldots (3)$$

where q = change in ground water storage for time interval 'ΔT' hectare-meter

μ = Specific yield for aquifer formation —

A = Area corresponding to change 'ΔH' hectare-meter

Change in ground water storage (5 years) = 275228 ha−m

Net average rise in water table per year = 50 cm.

Thus, the water table had risen at an average rate of 50 cm per year during the five years period under study. The sub-surface component contributing to this phenomenal rise in water table was almost negligible (0.38 mm). The canal irrigation losses amounted to an average annual rise of 36 cm i. e., 72% of the total rise. The rest of the rise (14 cm) was due to the recharge from rainfall and streams. Therefore, the aquifer system of the area was only able to take care of subsurface flow component but unable to cope with the additional seepage water available from canals and thereby resulting in the rise of water table.

VARIATION OF PER CENT AREA UNDER DIFFERENT WATER TABLE DEPTH RANGES

Isobath or depth to water table maps were prepared for June 1974 and June 1979 by plotting the depth of water table below ground surface and drawing the lines of equal water table depths. From these maps, the per cent of total area mapped under various water table depths was measured and has been presented in Table 3. The area under less than 4 m depth was 2.87% during June 1974 and increased to 13.02% by June 1979. Similarly, area under more than 36 m was 6.22% which decreased to zero by the end of June 1979. There had been re-adjustment among different classes but more area came under lower water table depth ranges. Even at present 70% of the area is under more than 12 m water table depth, but if no preventive action is taken at this stage it will lead to more area under lower water table depth ranges.

GROUND WATER QUALITY

The average isoconductivity map (Fig. 3) shows the areas under different water quality ranges. Southern and North-Western part of the area usually underlained by poor ground water quality. The ground water movement was from North-Eastern to North-Western direction. The transmissivity of water bearing formation was higher in the North-Eastern side and decreased in the North-Western direction leading to poor ground water quality. Similarly, the salts were being brought from Rohtak and Jhajjar area either through sub-surface flow or by surface

TABLE 2

Per cent and absolute area under different water table fluctuation amplitude for lower Ghaggar basin (June 1974 to June 1979)

	Range of fluctuation (m)										
	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0	5.0-5.5	5.5-6.0
Percentage	4.40	15.42	5.28	8.37	3.96	15.41	11.01	7.04	7.09	5 28	16.74
Area (ha)	4840	16962	5808	9207	4356	16951	12111	7744	7799	5808	18414

TABLE 3

Per cent and absolute area under different water table depths

	Depth range (m)										
	<4	4-8	8-12	12-16	16-20	20-24	24-28	28-32	32-36	36-40	>40
June 1974											
Percentage	2.87	10.05	11.96	21.53	23.92	7.66	4.31	6.22	5.26	2.39	3.83
Area (ha)	3157	11055	13156	23683	26312	8426	4741	6842	5786	2629	4213
June 1979											
Percentage	13.02	17.67	10.70	17.67	12.56	11.16	7.91	4.65	4.65	—	—
Area (ha)	1432	19437	11770	19437	13816	12276	8701	5115	5115	—	—

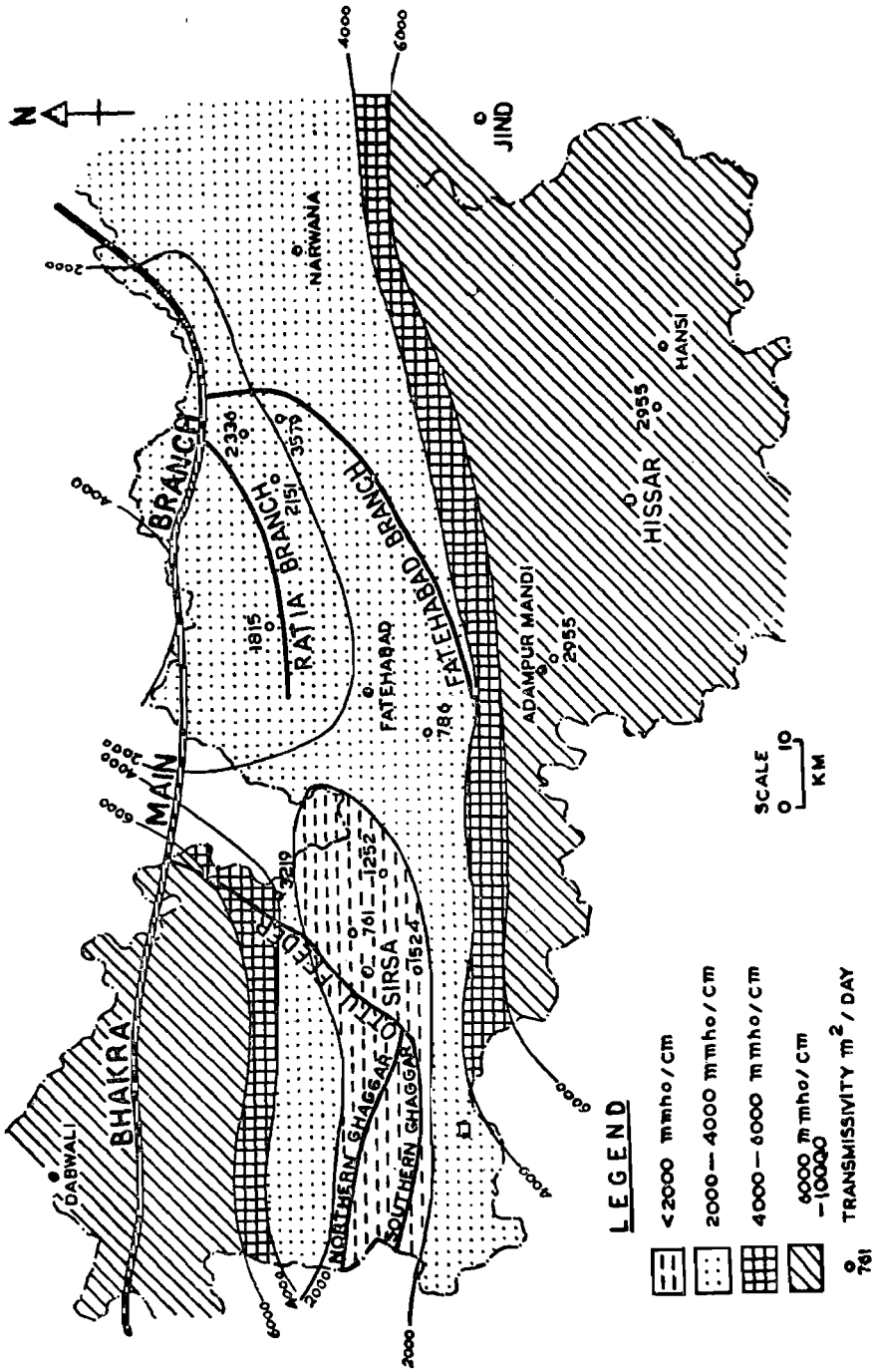


Fig. 3. Map showing canal net work transmissivity values of deeper layer and different quality zones.

TABLE 4

Per cent and absolute area under different water quality ranges

	Electrical conductivity range in micromhos/cm			
	<2000	2000-4000	4000-6000	6000-10,000
Percentage	7.44	39.67	8 26	44.63
Area (ha)	8184	43637	9086	49093

run off and deteriorates the quality in the South-Eastern direction. Per cent and absolute area under 6,000-10,000 mmhos/cm electrical conductivity range are presented in Table 4. The water quality along the Ghaggar river and canals is usually good because of excessive seepage of good quality water.

ACKNOWLEDGEMENTS

The authors acknowledge with thanks the assistance received from Sh. Tajinder Puri, Geohydrologist of Haryana State Minor Irrigation and Tubewells Corporation.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 291—294 (June 1983)

CORRELATIONS AND PATH COEFFICIENT ANALYSIS IN HEXAPLOID TRITICALE (*TRITICALE HEXAPLOIDE* LART)

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(Received : July 4, 1981; Revised : June 5, 1982)

ABSTRACT

Sixty genotypes of hexaploid triticale were evaluated for some important characters of economic importance and related with fitness. Wide genetic variability was recorded for all the characters. Simple correlation and path coefficient analysis suggested plant height, days to ear emergence, 100-grain weight and grains per spike to be the important characters in triticale. Experimental results have been discussed in light of their importance in triticale breeding.

Conventional breeding methods for the improvement of self-pollinated crops could not be extensively used in triticale, presumably because of narrow gene pool and instability of its genotypes. Though triticale resembles wheat morphologically, where the yield components are well defined, the situation might be different due to rapid development and consequent broadening of the genetic base of triticale populations. In view of the recent emphasis for the improvement of secondary hexaploid triticale, studies on correlation and path coefficient analysis would be useful in utilizing yield components effectively. However, only a few reports are available in triticale with respect to character association (Sethi and Singh, 1972; Sethi *et al.*, 1977). Present study was, therefore, planned to assess the relationship among various yield components in this cereal.

MATERIAL AND METHODS

Sixty hexaploid triticale strains obtained from International Maize and Wheat Improvement Centre (Mexico) were evaluated in a randomized block design with three replications. Three metre long two rows, spaced 30 cm apart, were assigned to each genotype in each replication. Distance between plant to plant within a row was 15 cm. Observations on 10 plants were recorded on plant height, days to ear emergence, number of tillers per plant, number of grains per spike, 100-grain weight and grain yield per plant.

Mean values for all the characters were subjected to analysis of variance. Genotypic and phenotypic correlation coefficients in all possible combinations were computed with the help of variance-covariance matrix by the usual statistical analysis. Genotypic correlation coefficients were used in path coefficient analysis as proposed by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Analysis of variance revealed significant differences among genotypes for all the characters indicating the presence of

wide variability for all these characters in the material under study. Genotypic and phenotypic correlation coefficients are presented in Table 1. In most cases genotypic correlation coefficients were higher in magnitude than their phenotypic values. Thus, even phenotypic association provided a good index of genotypic association among characters. The characters viz., plant height and 100-grain weight did not show significant associations with any other character. However, a positive association between plant height and tiller number almost approached the level of significance. Three other characters, grains per spike, tiller number and days to ear emergence exhibited significant correlation with grain yield and, thus, appeared to influence considerably this character. Sethi and Singh (1972) also reported strong positive association between grain yield and number of spikes per plant.

The real contribution of individual characters towards the grain yield can be assessed through path-coefficient analysis. The direct and indirect effects of various characters on grain yield (Table 2) indicated an interesting picture. The number of tillers per plant, which appeared to be the major component of grain yield based on simple correlation analysis, had direct negative effect on grain yield. Its positive influence was exerted indirectly through plant height and days to ear emergence. Dewey and Lu (1959) also reported that in crest wheat grass the plant size and fertility were negatively associated with each other. Such effects may by attributed to the existence of a gap between number of effective tillers and total number of tillers per plant. All other characters showed positive direct effects on grain yield, maximum being in plant height followed by days to ear emergence, 100-grain weight and grains

TABLE 1

Genotypic and phenotypic correlation coefficients for various characters

Characters		Plant height	Tiller number	Grains per spike	100-grain weight	Grain yield
Days to ear emergence	G	—0.4298	0.2188	0.0803	0.2351	0.4610
	P	—0 0194	0.1244	0.0883	0.0271	0.2534*
Plant height	G		0.4153	0.0952	0.4029	0.2962
	P		0.2329	0.2035	0.0272	0.1102
Tiller number	G			0.2127	0.0111	0.3951
	P			0.0138	0.0440	0.2726*
Grains per spike	G				0.3982	0.5816
	P				0.0013	0.4546*
100-grain weight	G					—0.0926
	P					0.0973

*Residual effect=0.3860.

TABLE 2

Direct and indirect effects of some characters on grain yield in triticale

Characters	Days to ear emergence	Plant height	Tiller number	Grains per spike	100-grain weight	Genotypic correlation with yield
Days to ear emergence	*1.2030*	—0.5255	—0.0470	0.0567	—0.2260	0.4610
Plant height	—0.5170	*1.2227*	—0.893	0.0672	—0.3874	0.2962
Tiller number	0.2632	0.5078	*—0.2150*	—0.1501	—0.0107	0 3951
Grains per spike	0.0966	0.1164	0.0457	*0.7056*	—0.3829	0.5816
100-grain weight	—0.2828	—0.4926	0.0024	—0.2800	*0.9615*	—0.0926

per spike. The indirect effect of 100-grain weight through other characters, particularly plant height and grains per spike, was negative on grain yield. The indirect effects of grains per spike through all other characters except 100-grain weight were positive. The indirect effects of days to ear emergence through other characters were mostly negative, whereas the indirect effects of plant height were negative through tillers per plant and 100-grain weight only.

In general, tall strains of triticale had longer spikes than the dwarf ones. The longer spikes, in turn, have more room for grain setting and usually produce more grains. Therefore, plant height indicated a positive direct effect on grain yield through grains per spike. Sethi *et al.* (1977) reported a less but positive direct effect of plant height on this character. This difference appears to be due to differences in genetic material studied and prevalent environmental conditions.

Correlation and path analysis suggested that the plant height, days to ear emergence, 100-grain weight and grains per spike were important characters influencing grain yield in triticale. Gill *et al.* (1976) also reported a high positive direct effect of days to heading on grain yield. Its indirect effect through grain weight was negative in their study. In fact, early flowering varieties have more time for grain development than the late flowering ones and one can expect heavier grains in the former, thereby, affecting grain yield (Nass and Reiser, 1975). However, association analysis and mean performance suggested that slightly late flowering genotypes yielded better in triticale. This may be due to the fact that though in early genotypes the grain formation period is larger which permitted the degradation of accumulated starch by amylase enzyme for a longer period (Rao *et al.*, 1976). Thus, in triticale striking balance between accumulative and degradative processes is more important than the days to ear emergence.

Residual effect (0.336) appeared to be quite high, suggesting the importance of some other characters possibly spike length, floret fertility and days to fertility affecting yield not included in this study. Sethi *et al.* (1977) also reported a very high positive direct effect of these characters on grain weight in triticale.

Since tall genotypes tend to lodge, dwarf strains with good spike length and more number of grains per spike should be developed. But dwarf genotypes, in general, had poor fertility (Kiss, 1973). Selection, therefore, should be based on high 100-grain weight, more grains per spike and medium flowering strain alongwith more number of effective tillers in this crop. This is expected to lead to the desired improvement in secondary hexaploid triticales. Direct selection for yield in such a base population may also prove worthwhile.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 295—298 (June 1983)

EFFECT OF N, P, K AND ZN ON THE GRAIN YIELD OF PEARL MILLET UNDER RAINFED CONDITIONS

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ABSTRACT

Experimental results obtained at farmers' field indicated that application of nitrogen and phosphorus significantly increased the grain yield of **bajra**. The per unit response of nitrogen was higher at lower dose of fertilizer application. Average response due to the application of 90 kg N/ha over control was 4 q/ha with 60 kg P_2O_5 over 90 kg N/ha was 3.7 q/ha and with 60 kg K_2O over N_{90} P_{60} kg/ha was 1.5 q/ha. Zinc application did not increase the grain yield significantly.

Amongst the cereal crops grown in Haryana in the **kharif** season, pearl millet (**bajra**) occupies an important place. It covers an area of 872 thousand hectares (1978-79) which is about 24% of the total cultivated area in the State. About 83% of the total area under this crop is rainfed. Average yield of **bajra** in Haryana State is 4.4 q/ha, however, 20 to 30 q/ha yields have been obtained by the dry land agriculture scientists of Haryana Agricultural University, Hissar. This indicates a wide scope of increasing the yield of this crop by adopting the improved dry land technology coupled with balanced use of fertilizers. Keeping in view the meagre information available, an endeavour was made to study the response of **bajra** (HB-1) to fertilizer application and to work out its economics under dry land conditions.

MATERIAL AND METHODS

Experiments on farmers' fields were conducted for three years (1977-80) at Barwala, Bhuna, Fatehabad and Hissar, the NES blocks of Hissar district. In each block five villages were randomly selected and in each village one experiment was conducted with 12 treatments (Table 1).

Sources for N, P and K were calcium ammonium nitrate, single superphosphate and muriate of potash, respectively and Zn was applied @ 25 kg $ZnSO_4$/ha. All the fertilizers were drilled 5 cm below the seed. Soil analysis of these fields indicated that pH varied from 8.4 to 8.9, electrical conductivity from 0.26 to 1.25 mmhos/cm at 25°C, organic carbon from 0.12 to 0.35 per cent, available N from 100 to 156 kg/ha, available P from 21 to 40 kg/ha and available K from 300 to 385 kg/ha. The rainfall pattern of the area indicated that highest rainfall (163-209 mm) was received during the month of July in all the three years. Rainfall received during August was 109, 92 and 127 mm in 1977-78, 1978-79 and 1979-80, respectively. Rains were also spread up to September.

TABLE 1

Effect of N, P, K and Zn on the grain yield of **bajra** (HS-1) under rainfed conditions

Treatments	Yield (q/ha)				Average response over control (q/ha)	Per unit response (kg/ha)
	1977-78	1978-79	1979-80	Average		
1. $N_0P_0K_0$	8.2	8.1	6.2	7.5	—	—
2. $N_{30}P_0K_0$	9.7	9.0	8.9	9.2	1.7	5.67
3. $N_{60}P_0K_0$	10.7	9.8	10.7	10.4	2.9	4.84
4. $N_{90}P_0K_0$	11.7	10.6	12.0	11.5	4.0	4.45
5. $N_{30}P_{30}K_0$	11.4	11.1	10.0	10.9	3.4	5.67
6. $N_{60}P_{30}K_0$	12.2	11.7	12.0	11.9	4.4	4.89
7. $N_{90}P_{30}K_0$	14.0	12.9	13.8	13.6	6.1	5.09
8. $N_{60}P_{60}K_0$	13.3	13.0	13.8	13.3	5.8	4.84
9. $N_{90}P_{60}K_0$	16.2	14.1	15.5	15.2	7.7	5.14
10. $N_{60}P_{60}K_{30}$	15.8	14.8	16.5	15.7	8.2	5.47
11. $N_{90}P_{60}K_{60}$	17.4	15.4	17.4	16.7	9.2	4.38
12. $N_{90}P_{60}K_{60}+Zn_{25}$	17.5	15.5	19.1	17.4	9.9	4.22
C. D. at 5%	0.77	0.46	0.81			
SE	0.39	0.24	0.41			

Economics of fertilizer application in **bajra** was worked out by calculating the cost of fertilizers applied under different treatments.

RESULTS AND DISCUSSION

A perusal of the data presented in Table 1 reveals that the grain yield of **bajra** varied from year to year with the fertilizer treatments. Comparatively, there was low magnitude of response to applied fertilizer during 1978-79. Higher rainfall in the month of July (1978-79) might have caused leaching of applied nutrients which in turn may be responsible for low efficiency. Increase in the grain yield over control with the application of 30, 60 and 90 kg N/ha was of the order of 19, 31 and 43 per cent during 1977-78; 12, 21 and 31 per cent during 1978-79; and 44, 73 and 94 per cent during 1979-80, respectively. This indicates that application of N alone led to a marked increase in the yield of **bajra**. Kumar and Sardana (1973) and Pal and Kaushik (1973) also reported the beneficial effect of N on **bajra**.

Application of nitrogen in combination with phosphorus increased the yield consistently and significantly. When 30 kg P_2O_5/ha in combination with 30, 60 and 90 kg N/ha was applied, respective increase in the yields was of the order of 18, 14 and 20 per cent in 1977-78; 24, 20 and 22 per cent in 1978-79; and 13, 14 and 15 per cent in 1979-80 over the corresponding doses of N. Average response to 60 kg P_2O_5/ha over 90 kg

N/ha was 3.7 q/ha and with 60 kg K_2O/ha over $N_{90}P_{60}$ was 1.5 q/ha. No significant increase in the grain yield of **bajra** was observed with Zn application except during 1979-80 when the increase in yield was 1.7 q/ha. Data further indicate that the application of 60 kg P_2O_5/ha increased the grain yield of **bajra** over 30 kg P_2O_5/ha at all levels of N application. Highest grain yield was obtained with $N_{90}P_{60}K_{60}$ + Zn_{25} kg/ha.

The data in Table 1 also indicate that per unit response of N decreased with the increasing level of N fertilizer. At 30, 60 and 90 kg N/ha levels, the per unit increase in the grain yield was 5.67, 4.84 and 4.45 kg/ha. Unit response of P at 30 kg P_2O_5/ha was of the order of 5.67, 5.00 and 7.67 kg/ha over 30, 60 and 90 kg N/ha, respectively during 1977-78.

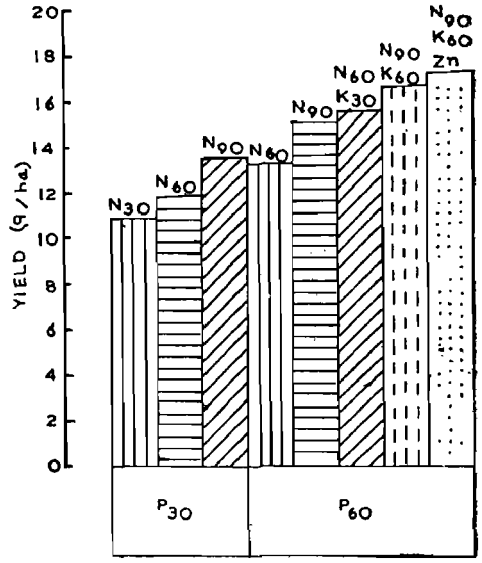


Fig. 1. Effect of different fertilizer levels on the grain yield of pearl millet.

TABLE 2

Economics of fertilizer use in **bajra** under rainfed conditions

Treatments		Average grain yield (q/ha)	Cost of fertilizer (Rs.)	Value of additional yield (Rs.)	Net profit (Rs.)	Profit per Re. investment
1.	$N_0P_0K_0$	7.5	—	—	—	—
2.	$N_{30}P_0K_0$	9.2	192.00	263.50	71.50	0.37
3.	$N_{60}P_0K_0$	10.4	384.00	449.50	65.00	0.17
4.	$N_{90}P_0K_0$	11.5	576.00	620.00	44.00	0.07
5.	$N_{30}P_{30}K_0$	10.9	375.00	527.00	152.00	0.40
6.	$N_0P_{30}K_0$	11.9	576.00	682.00	115.00	0.20
7.	$N_{90}P_{30}K_0$	13.5	759.00	930.00	171.00	0.23
8.	$N_{60}P_{60}K_0$	13.3	750.00	899.40	149.40	0.16
9.	$N_{90}P_{60}K_0$	15.2	942.00	1193.50	251 50	0.26
10.	$N_{60}P_{60}K_{30}$	15.7	850.50	1271.00	420.50	0.58
11.	$N_{30}P_{60}K_{60}$	16.7	1053.00	1426.00	373.00	0.35
12.	$N_{90}P_{60}K_{60}+Zn_{25}$	17.4	1140.50	1534.50	394.00	0.34

N	—	Rs. 6.40/kg
P_2O_5	—	Rs. 6.30/kg
K_2O	—	Rs. 1.85/kg
Zn	—	Rs. 3.25/kg
Bajra	—	Rs. 155/q

The corresponding values during 1978-79 and 1979-80 were 7.00, 6.33 and 7.67; and 4.00, 4.33 and 6.00 kg/ha, respectively. Thus, it indicates the beneficial effects of N and P when applied together in a certain proportion (Sekhon and Joshi, 1968). The per unit response of 30 kg/ K_2O/ha over $N_{60}P_{60}$ was 8 kg/ha and that of 60 kg K_2O over $N_{90}P_{60}$ was only 2.5 kg/ ha, indicating that unit response of K decreased with increasing level of K. Increase in yield due to Zn was 0.7 q/ha only.

Data in Table 2 depict the economics of fertilizer use in **bajra** crop. It is evident from this table that phosphorus application in combination with nitrogen increased the net profit and the profit per rupee investment. The lowest net profit of Rs. 44.00 was obtained when 90 kg N/ha alone was applied and the highest value (Rs. 420.50) was obtained when 60 kg N/ha was applied alongwith 60 kg P_2O_5 and 30 kg K_2O/ha. Sekhawat *et al.* (1972) reported similar findings. Zinc application also resulted in an increase in the net profit but did not affect the unit profit. The highest net benefit was obtained with $N_{60}P_{60}K_{30}$ kg/ha.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 299—303 (June 1983)

RESPONSE OF GRAPE CULTIVAR BEAUTY SEEDLESS TO GRADED DOSES OF NITROGEN

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ABSTRACT

Vines of Beauty Seedless planted in 1973 at 3 × 3 m distance and trained on Head system of training were used. Graded doses of nitrogen @ 0, 100, 150, 200, 250 and 300 g per plant were given through soil from urea with a fixed dose of phosphorus and potassium for three years, viz., 1977 to 1979. The yield increased with the age of the vines. The mean yield/vine (12.71 kg) recorded with 150 g nitrogen/plant was statistically higher than control (10.71 kg) and 100 g (11.45 kg), whereas it was non-significant in relation to all other higher doses. Hence, this dose was found better and economical.

Beauty Seedless cultivar of grape commands considerable area in Haryana and is next to Perlette in acreage. However, the nutritional requirement of various grape cultivars has not yet been properly worked out in this State. The nutritional surveys of the orchards of the State revealed that the farmers were applying fertilizers on empirical basis (Vashistha, 1975; Surender Singh, 1979). Another survey of vineyards around Hissar revealed that the farmers who were applying high doses of nitrogen were getting lower yields (Chundawat *et al.*, 1977). Chundawat *et al.* (1979) also suggested that the problem of bud flower and berry drop in Beauty Seedless was probably due to improper nutrient schedule, particularly the nitrogen. Therefore, this study was carried out to find the optimum dose of nitrogen for Beauty Seedless cultivar planted on Head system of training.

MATERIAL AND METHODS

The experiment was conducted at Haryana Agricultural University Regional Research Station, Gurgaon, on Beauty Seedless vines planted in 1973 on Head system at 3 × 3 m distance. The soil of the area was sandy loam with pH 8.2, low in organic carbon, medium in phosphors and high in potassium contents. The graded doses of nitrogen were given for three years (1977–1979). The treatments were as under :

Control	$=N_0$
100 g nitrogen/vine	$=N_1$
150 g nitrogen/vine	$=N_2$
200 g nitrogen/vine	$=N_3$
250 g nitrogen/vine	$=N_4$
300 g nitrogen/vine	$=N_5$

Experiment was carried out in randomized block design. There were three

replications with two plants as a unit. The nitrogen was applied through urea. Each vine was given a uniform dose of 25 kg Farm Yard Manure, 150 g P_2O_5 (superphosphate) and 125 g K_2O (muriate of potash). FYM was applied in December. Half of the nitrogen and full dose of phosphorus and potassium were given in February and rest half dose of nitrogen was applied after fruit setting. Side plants were fertilized with the same treatment, but kept as non-experimental. Normal management and irrigation practices were given to all the plants uniformly. The vines were pruned at 2 buds with 12 canes per vine in 1977 and 10 canes per vine during 1978 and 1979. Observations were recorded on various vegetative and reproductive characters. Nitrogen was estimated with Nessler's reagent, phosphorus by vanadomolybdic yellow colour and potassium with flame photometer (Chapman and Pratt, 1961).

RESULTS AND DISCUSSION

Girth of Vines

The application of nitrogen increased the girth of vines significantly over control (Table 1). The maximum girth was obtained with the treatment N_3 which was, however, at par with N_2 and other higher doses. Similar results have also been reported by Chadha and Lakhbir Singh (1971) and Desai and Phadnis (1979).

Number of Bunches and Yield per Vine

The number of bunches per vine was recorded more in 1977 and 1978 as compared to 1979, whereas the mean yield per vine was more during 1979 (Tables 2 and 3). Thus, the number of bunches per vine showed no relation with the yield. The increase in yield was probably due to

TABLE 1

Effect of graded doses of nitrogen on increase in trunk girth (per cent increase over initial in 3 years)

N_0	N_1	N_2	N_3	N_4	N_5
7.65	19.65	27.11	33.38	26.08	31.98
(15.96)	(26.27)	(31.23)	(35.26)	(30.63)	(34.33)

C. D. at 5% 5.95
Figures in parentheses are angular transformations.

TABLE 2

Effect of graded doses of nitrogen on the mean number of bunches/vine

Treatment	1977	1978	1979	Mean
N_0	31.0	31.7	24.7	29.1
N_1	31.7	32.0	29.8	31.2
N_2	33.0	32.8	36.5	34.1
N_3	34.5	34.7	29.5	32.9
N_4	36.0	37.7	29.7	34.5
N_5	36.7	38.7	28.2	34.5
Mean	33.8	34.6	29.7	
C. D. at 5%	Treatment—NS	Year—3.03	Interaction—NS	

relatively bigger size of bunches. The number of bunches per vine was not affected by nitrogen application.

With the application of nitrogen the yield per vine increased. Application of 200 g or more nitrogen per vine did not yield extra crop over its lower rate i. e., 150 g nitrogen per vine. Therefore, these studies suggest that it is not beneficial to apply more than 150 g nitrogen per vine to Beauty Seedless cultivar planted on Head system. Similar beneficial responses with low levels of nitrogen were recorded by Nijjar and Sewa Ram (1969) in Anab-e-shahi, Chitkara *et al.* (1972) in Thompson Seedless and Desai and Phadnis (1979) in Cheema Sahibi grapes.

Weight of Pruned Wood

The data in Table 4 reveal that weight of pruned wood was more in 1978 than in other two years where the differences were non-significant. It may be because the vines were kept with 12 canes in 1977, whereas in later years there were 10 canes per vine. Secondly, the graded doses of nitrogen did not improve the yield in 1977 but increased the vine vigour only. Except N_3 and N_4, other treatments increased the weight of pruned wood of the vines. Increase in weight of pruned wood with the application of nitrogen is self-explanatory. Similar results were obtained by Chitkara *et al.* (1972).

TABLE 3

Effect of graded doses of nitrogen on yield/vine (kg)

Treatment	1977	1978	1979	Mean
N_0	8.93	9.00	14.20	10.71
N_1	9.53	9.33	15.50	11.45
N_2	10.47	10.83	16 83	12.71
N_3	11.10	11.50	15.33	12.64
N_4	11.50	12.50	16.30	13.57
N_5	11.57	13.20	15.37	13.38
Mean	10.52	11.12	15.59	
C D. at 5%	Treatment—1.07		Year—0.76	Interaction—NS

TABLE 4

Effect of graded doses of nitrogen on mean weight of pruned wood (kg/vine)

Treatment	1978	1979	1980	Mean
N_0	2.00	1.63	1.70	1.78
N_1	2.37	1.93	2.10	2.13
N_2	2.80	1.87	2.07	2.25
N_3	2.07	1.70	1.67	1.81
N_4	2.37	1.90	1.73	2.00
N_5	2.77	2.23	1.93	2.31
Mean	2.40	1.88	1.87	
C. D. at 5%	Treatment—0.32		Year—0.22	Interaction—NS

TABLE 5

Effect of graded doses of nitrogen on the N, P, K contents of leaf petioles during 1979

Treatment	N (%)	P (%)	K (%)
N_0	0.87	0.24	2.71
N_1	1.20	0.18	2.32
N_2	1.18	0.12	1.75
N_3	1.15	0.12	1.76
N_4	1.19	0.15	2.27
N_5	1.27	0.14	2.15
C. D. at 5%	0.21	0.05	NS

N, P, K Content of Leaf Petioles

The nitrogen and phosphorus contents of leaf petioles were significantly higher than control (Table 5). However, the differences among various treatments were not significant. Beattie and Baldauf (1960) have shown that within the range of 0.85 to 1.3 per cent nitrogen there is a direct and positive correlation between nitrogen content of the leaf petioles and yield. The studies clearly revealed that as the nitrogen content of leaves did not change, the differences in the yield obtained with graded dose of nitrogen were also not significant.

The potassium content did not vary among various treatments including control because the soil of the area was high in available potassium. Chitkara *et al.* (1972) also reported that when the increase in yield was not significant, the nitrogen level of petioles also did not vary. However, Chadha and Lakhbir Singh (1971) reported that the petiole nitrogen increased with the increase in nitrogen application, whereas Clore (1958) reported that excessive nitrogen depressed the yield by increasing the vegetative growth.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 304—306 (June 1983)

LOSSES CAUSED BY SORGHUM SHOOTFLY, *ATHERIGONA SOCCATA* (RONDANI) IN SOME COMMONLY GROWN FORAGE SORGHUM VARIETIES

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(Received : October 31, 1980; Revised : July 22, 1982)

ABSTRACT

Pre-sowing furrow application of disulfoton 5G @ 2.5 kg a. i./ha to four varieties (IS 4776, SSG 59-3, J-69 and IS 6090) of forage sorghum resulted in overall 13.1% reduction in dead hearts caused by shootfly; and 15.0 and 25.0 per cent increase in green fodder and dry matter yields, respectively. Increase in dry matter yield was more (39.2%) in variety IS 4776 than in variety SSG 59-3 (6.3%) and IS 6090 (19.0%). This recommendation is considered to be economical only when the pest incidence is severe.

Shootfly, *Atherigona soccata* (Rondani) (Diptera : Muscidae) causes heavy damage to sorghum crop in early stages of its growth. This pest has been effectively controlled with insecticides applied alongwith the seed, on foliage or in soil (Sandhu and Young, 1974; Singh and Jotwani, 1975; Sukhani and Jotwani, 1980).

Since earlier studies were almost confined to grain sorghum, it was considered necessary to investigate the avoidable losses caused by this pest in forage sorghums as well. In these studies four commonly grown forage sorghum varieties were used and the pest was controlled by soil application of disulfoton 5% granules.

MATERIAL AND METHODS

The experiments were conducted at the Research Area of Haryana Agricultural University, Hissar. Both during 1976 and 1977, four promising forage sorghum varieties (SSG 59-3, IS 4776, J-69 and IS 6090) were sown on July 23, in a randomized block design with six replications and plot size of 20 sq m. In each variety, disulfoton 5G @ 2.5 kg a.i./ha was applied in three repeats and the remaining three repeats were kept untreated. Granules were drilled and seeds were sown by **Kera** method using a seed rate of 40 kg/ha. The fertilizers applied were 30 kg N and 60 kg P_2O_5 per hectare at sowing and 30 kg N at first irrigation.

The damage by shootfly in all the plots was recorded by counting all the dead hearts on 17, 24 and 31 days after sowing the crops. At each observation, all dead hearts were pulled out and counted. Green fodder yield was recorded at harvest. One kg green fodder in each

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variety was dried in the sun for 30 days and then its weight was recorded. This information was used in calculating dry fodder yield.

RESULTS AND DISCUSSION

The data on shootfly damage and fodder yield, during both the years, were pooled together. Incidence of shootfly was minimum in the variety IS 4776, followed by IS 6090 and was highest in J-69. There was no difference between the varieties J-69 and SSG 59-3. The plots treated with the insecticide had less dead hearts as compared to the control (Table 1).

Green fodder yield was more in the insecticide treated plots than in untreated plots. Such differences for individual varieties were, however, non-significant (Table 2). Dry matter yield was also more in treated than in untreated plots. Variety IS 4776, though at par with J-69 yielded more than SSG 59-3 and IS 6090. The differences between varieties IS 4776 and J-69 and also between SSG 59-3 and IS 6090 were non-significant (Table 2). It may be seen that soil application of disulfoton resulted in 39.2% increase in dry matter yield in variety IS 4776. The corresponding values for the varieties J-69, IS 6090 and SSG 59-3 were 31.4, 19.0 and 6.3 per cent, respectively.

In earlier studies also the use of disulfoton granules (@ 2.5 kg a.i./ha) has been reported to effectively check the shootfly incidence and enhance fodder and grain yields (Baskaran, 1972; Jotwani *et al.*, 1979). The use of disulfoton in these studies resulted in an overall increase in green fodder yield to the extent of 15 per cent. At the current prices of the insecticides and the green fodder, the use of insecticide may not be an economical proposition. The ideal approach for checking shootfly damage

TABLE 1

Shootfly damage in forage sorghum varieties grown with and without application of disulfoton granules

Sorghum variety	Mean number of dead hearts/plot*		Percentage reduction in damage
	Disulfoton application**	No application	
SSG 59-3	243.0(15.57)***	264.0(16.14)	8.0
IS 4776	79.0(8.81)	108.0(10.30)	26.9
J-69	260.7(16.10)	278.3(16.66)	6.3
IS 6090	115.7(10.72)	139.7(11.82)	17.2
Mean	174.6(12.80)	197.5(13.73)	13.1

*20 sq m.

**Applied in seed furrows @ 2.5 kg a.i./ha.

*** $\sqrt{N}$ transformation.

TABLE 2

Green fodder and dry matter yields of forage sorghum varieties grown with and without soil application of disulfoton

Sorghum variety	Mean green fodder (a) and dry matter (b) yields (q/ha*)				Percentage increase in yields	
	Disulfoton application**		No application			
	(a)	(b)	(a)	(b)	(a)	(b)
SSG 59-3	65.7	9.26	64.3	8.71	2.2	6.3
IS 4776	78.3	16.44	67.3	11.81	16.3	39.2
J-69	79.7	13.94	61.0	10.61	30.7	31.4
IS 6090	78.0	12.15	70.0	10.21	11.4	19.0
Mean	75.4	12.95	65.7	10.34	14.8	25.2

*Converted from plot size of 20 sq m.

**Applied in seed furrows @ 2.5 kg a.i./ha.

in forage sorghum seems to develop resistant varieties. The authors, however, agree with Jotwani *et al.* (1979) that the use of costlier systemic granular insecticides may be economical when pest incidence is severe.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 307—311 (June 1983)

EFFECT OF IRRIGATION AND NITROGEN LEVELS ON THE GREEN AND DRY FORAGE YIELD OF CHINESE CABBAGE *(BRASSICA PEKINENSIS)* AND JAPAN RAPE *(BRASSICA CAMPESTRIS* VAR. LGL)

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(Received : July 4, 1981; Revised : March 3, 1982)

ABSTRACT

Chinese cabbage outyielded Japan rape significantly both in green forage and dry matter production. There was a significant increase in green forage and dry matter yield upto the application of 80 kg N/ha. Both the crops gave maximum yields of green and dry fodder with the application of two post-sowing irrigations.

Chinese cabbage (*Brassica pekinensis*) and Japan rape (*Brassica campestris* Var. LGL) are important short duration **rabi** fodders, which can be grown pure as well as in mixture with berseem for obtaining high tonnage in first cutting. These are quick growing in habit and free from toxic constituents and can be fed to cattle at any stage of their growth. Gill *et al*: (1979) reported that these crops can be sown in early September to overcome the scarcity of green fodder during November and December. However, a suitable package of practices for nitrogen and irrigation requirements of these crops is lacking, as enough work on these aspects is not reported. The present study was, therefore, undertaken to find out the optimum requirements of these two costly and scarce inputs.

MATERIAL AND METHODS

A field experiment was conducted in the Research Area of the Department of Forage Research, Haryana Agricultural University, Hissar during **rabi** 1977-78 and 1978-79. The treatments comprised two crops (Chinese cabbage and Japan rape), three levels of irrigation* (one, two and three irrigations) and four levels of nitrogen (0,40, 80 and 120 kg N/ha). The treatments were replicated thrice in split-plot design, keeping crops and irrigation in main plots and nitrogen levels in sub-plots. The soil of the experimental field was sandy loam in texture having pH 8.3, low in available nitrogen (185 kg N/ha) and medium in available phosphorus (21.5 kg P_2O_5/ha) in 1977-78; and in 1978-79, pH was 8.1 with

*The source of irrigation was canal which runs in rotational system. Therefore, the irrigation treatments could not be fixed as per the recent trend of evaporation or available soil moisture.

available nitrogen 176 kg/ha and available P_2O_5 19.5 kg/ha. Potash was not determined as Hissar soils, in general, are rich in it.

After pre-sowing irrigation, the crops were sown in lines 40 cm apart on September 22, 1977 and October 1, 1978, using 5 kg seed/ha. The crops were given uniform dose of 20 kg P_2O_5/ha through single superphosphate at the time of sowing. The amount of nitrogen as per treatment was applied through urea. The irrigations were distributed in such a way that in each treatment the irrigation was applied at an equal interval. In case of treatments with one irrigation, the crop was irrigated at 40 days after sowing (DAS) with two irrigations at 30 and 60 DAS and with three irrigations at 20, 40 and 60 DAS. At each irrigation 6 cm water was applied.

The crop was harvested on 13th and 16th December in 1977-78 and 1978-79, respectively and the data on green forage and dry matter were recorded.

RESULTS AND DISCUSSION

Yield Performance of Crops

Chinese cabbage outyielded Japan rape significantly in green forage and dry matter during both the years, except during 1977-78 when both the crops were at par in dry matter production (Table 1). Higher yields given by Chinese cabbage may be attributed to higher green fodder weight per metre row length (Table 2) as compared to Japan rape. Whereas, the difference in case of dry

TABLE 1

Effect of irrigation and nitrogen levels on the green and dry forage yield of Chinese cabbage and Japan rape

Treatments	Green fodder yield (q/ha)		Dry matter yield (q/ha)	
	1977-78	1978-79	1977-78	1978 79
Crops				
Japan rape	354.08	475.37	42.72	57.79
Chinese cabbage	398.67	556.02	45.47	62.46
S. Em. ±	11.86	14.01	1.04	1.08
C. D. at 5%	37.38	44.13	3.28	3.41
Number of Irrigations				
One	319.68	454.31	36 58	51.28
Two	400.40	536.20	47.21	64.22
Three	409.03	556.69	48.49	64.87
S. Em. ±	14.53	17.16	1.27	1.33
C. D. at 5%	45.79	54.08	4.01	4.18
Nitrogen Levels (kg/ha)				
0	315.60	439.97	32.53	44.71
40	359.64	494.63	41.02	56.67
80	403.66	554.36	49.14	67.27
120	426.60	574.27	53.67	77.86
S. Em. ±	7.44	9.57	1.70	2.09
C. D. at 5%	23.48	30.15	5.39	6.59

matter of both the crops was less because Japan rape was taller than Chinese cabbage and was having more dry matter percentage as compared to Chinese cabbage. These results confirm the findings of Gill *et al.* (1979). However, Arora and Batra (1961) have reported that Japan rape is a quick growing forage crop, especially suitable for sowing in autumn season.

Effect of Irrigations

It is evident from Table 1 that application of post-sowing irrigation had considerable effect on the forage yield during both the years. Maximum green forage and dry matter yields were obtained by the application of two or three post-sowing irrigations which were at par with each other but both were significantly superior to one post-sowing irrigation. This increase in green forage and dry matter yield (Table 2) with the increase in number of irrigations was due to more availability of plant nutrients, which resulted in significantly taller plants and higher green forage yield per running metre row length (Tisdale and Nelson, 1975).

Effect of Nitrogen

Application of nitrogen resulted in a marked effect on the green forage and dry matter yield of these crops (Table 1). There was a significant increase in green fodder as well as dry matter yield upto the level of 80 kg N/ha, beyond which the increase in forage yield was not significant. In increasing the proportion of protoplasm to cell wall materials nitrogen has many effects. One of them is to increase in the size of the cell (Tisdale and Nelson, 1975), which morphologically expresses an increase in the height of plants (Table 2). The increased yield under higher levels of nitrogen was due to more availability of the nutrient, which had favourable effect on growth attributes, height and green fodder per metre row length (Table 2). Similar results have been reported by Singh *et al.* (1970) who found 60 kg N/ha as the optimum dose for getting high forage yield of sarson crop. However, for Chinese cabbage only 50 kg N/ha was recommended by RFPDC (1975). Further, Gill *et al.* (1979) reported that there was a linear response to the application of nitrogen upto 90 kg N/ha in Chinese cabbage and Japan rape.

The interaction between nitrogen and irrigation levels was also found significant for green forage yield during both the years (Table 3). During both the years, the green forage yield did not increase significantly with one irrigation and three irrigations and with the application of nitrogen beyond 80 kg N/ha, while in case of two irrigations treatment significantly higher green forage yield was recorded with the application of 120 kg N/ha. The non-significant increase in green forage yield under three irrigations treatment at high fertility level (120 kg N/ha) was due to the lodging of the crop. In case of two irrigations no lodging was observed even with the application of 120 kg N/ha. This clearly showed that there is definite interaction between fertilizer and moisture use. Bauer *et al.* (1965) and Olsen *et al.* (1964) also found that nitrogen fertilization increased yield and water-use-efficiency under adequate availability of moisture in the soil in case of grain crops.

TABLE 2

Effect of irrigation and nitrogen levels on the plant height and green fodder yield/ metre length of Chinese cabbage and Japan rape

Treatments	Height of plant (cm)		Green fodder yield/metre length (kg)	
	1977-78	1978-79	1977-78	1978-79
Crops				
Japan rape	110.87	170.43	0.858	1.458
Chinese cabbage	94.26	106.27	0.965	1.565
S. Em. ±	0.55	2.80	0.027	0.045
C. D. at 5%	1.74	8.83	0.084	0.141
Number of Irrigations				
One	96.09	129.64	0.823	1.416
Two	105.05	143.45	0.950	1.550
Three	106.55	141.97	0.961	1.568
S. Em. ±	0.68	3.43	0.010	0.055
C. D. at 5%	2.13	10.81	0.031	0.172
Nitrogen Levels (kg/ha)				
0	89.08	127.03	0 716	1.029
40	98.71	136.33	0.872	1.395
80	109.00	143.47	1.013	1.774
120	113.47	146.58	1.043	1.848
S. Em. ±	1.87	1.75	0.020	0.056
C. D. at 5%	5.38	5.05	0.057	0.163

TABLE 3

Effect of irrigation × nitrogen on the green fodder yield

	1977-78				1978-79			
	kg N/ha				kg N/ha			
	0	40	80	120	0	40	80	120
One irrigation	277.5	306.0	350.0	344.5	399.7	433.0	491.6	492.4
Two irrigations	320.7	381.0	425.5	474.3	434.4	506.8	572.7	630.4
Three irrigations	348.5	391.8	434.7	460.9	484.4	543.8	598.4	599.6
S. Em. ±	12.9				16.5			
C. D. at 5%	40.6				52.2			

ACKNOWLEDGEMENTS

The authors are thankful to the Director of Research, Haryana Agricultural University, Hissar for providing research facilities. Thanks are also due to Dr. G. P. Lodhi, Sorghum Breeder, for his constant interest during the course of this research.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 312—318 (June 1983)

FREQUENCY ANALYSIS OF ANNUAL MAXIMUM POINT RAINFALL OF NORTH-EASTERN REGION OF HARYANA

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(Received : September 29, 1981; Revised : April 27, 1982)

ABSTRACT

Frequency analysis, using 25 years of point rainfall data, for 1-day and 2-day period on annual series basis employing three types of distributions, viz. log-Pearson type-III, log-normal and Gumbel distributions was carried out. The expected theoretical rainfall values from these distributions, both for 1-day and 2-day rainfall, were compared with the observed rainfall values. All the three distributions gave reliable prediction for the probability ranging between 15 to 80 per cent. The Gumbel distribution is relatively more reliable where the predictions for return periods of greater than 20 years are required.

For designing soil and water conservation structures and storage capacity of irrigation reservoirs, determination of maximum rainfall amounts of different durations and return periods is essential. This is accomplished through frequency analysis by employing various theoretical distributions. Frequency analysis is a procedure to fit the historical hydrologic data to a mathematical model of distribution to interpret past record of hydrologic events in terms of future probabilities of occurrence. Various types of distributions were employed for frequency analysis by selecting the hydrologic data on an annual series or partial duration series basis. In the annual series, only the maximum values of the events in each year were used while in the partial duration series all values above the given base were selected regardless of the number within a given time period. The decision for the use of a certain distribution depends upon the verification of data. Benson (1968) made considerable efforts to define the best distribution and suggested that there is no distinctly superior distribution. There is no reason to expect that single distribution will apply to all kinds of hydrologic data.

In this paper the frequency distribution of annual maximum point rainfall data have been computed theoretically using three distributions viz., the log-Pearson type-III distribution, the log-normal distribution and the Gumbel distribution which is also called as the distribution of extreme values for comparison with the observed data and prediction. The log-Pearson type-III distribution conforms to the log-normal distribution with skew equal to zero.

THEORETICAL CONSIDERATIONS

Log-Pearson type-III Distribution

The general and basic equation to define the probability density of a Pearson

distribution is

$$P(x) = e\int_{-\infty}^{x} \frac{a+x}{(b_0+b_1 x+b_2 x^2)}dx$$

Where a, b_0, b_1 and b_2 are constants. The criteria for determining types of distribution are β_1, β_2 and K.

$$\beta_1 = \frac{\mu_3^2}{\mu_2^3}$$

$$\beta_1 = \frac{\mu_4}{\mu_2^2}$$

$$K = \frac{\beta_1 (\beta_2+3)^2}{4(4\beta_2-3\beta_1)(2\beta_2-3\beta_1-6)}$$

Where μ_2, μ_3 and μ_4 are second, third and fourth moments about the mean, respectively.

For the log-Pearson type-III distribution, $K=\infty$, the probability density with the origin at the mode is

$$P(x) = P_0\left(1+\frac{X}{a}\right)e^{c-cx/a}$$

Where

$$C = \frac{4}{\beta_1} - 1$$

$$a = \frac{C\mu_3}{2\mu_2}$$

$$P_0 = \frac{N C^{c+1}}{a e^c \sqrt{(c+1)}}$$

Where N is the total number of observations.

Log-normal Distribution

This is a transformed normal distribution in which the variate is replaced by its logarithmic value.

The probability density of this distribution is

$$P(x) = \frac{1}{\sigma_y e^y \sqrt{2\pi}} e^{-(y-\mu_y)^2/2\sigma_y^2}$$

Where

$Y = \ln X$, μ_y = mean of Y, σ_y = Standard deviation of Y.

Gumbel Distribution

The probability density of this distribution is

$$P(x) = \frac{1}{c} e^{-(a+x)/c - e^{-(a+x)/c}}. \quad \text{for} -\infty < x < \infty$$

The cumulative probability distribution is

$$P(X \leqslant x) = e^{-e-(a+x)/c}$$

The parameters, a and c, have been evaluated by the method of moments as

$$a = yc - \mu$$

$$c = \frac{\sqrt{6}}{\pi}\sigma$$

Where y = Euler's constant (0.57721), μ = mean, σ = standard deviation.

MATERIAL AND METHODS

The point rainfall data for 1-day and 2-day consecutive period for 25 years (1950-74) for the Karnal in North-Eastern part of Haryana was analysed for frequency distribution on annual series basis as Langbein (1949), Chow (1951a) and Hershfield (1961) have shown that both methods of data selection gave essentially identical results for return periods greater than 10 years for rainfall and floods. The standard deviation (σ), coefficient of variation (Cv) and coefficient of skewness (Cs) of the transformed variates were computed and compared for log-Pearson type-III distribution (Pearson, 1930), log-normal distribution (Hazen, 1914) and the

Gumbel distribution (Gumbel, 1954). Return period (T) and the corresponding per cent probability (P) of occurrence were selected and the corresponding values of the frequency factor (K) which depends on the law of occurrence and the expected theoretical rainfall magnitudes were computed using the computed values of coefficient of skewness for log-Pearson type-III distribution and log-normal distribution by adopting methods as given by Benson (1968) and Chow (1964), respectively. For Gumbel distribution, the values of frequency factor (K) and expected theoretical rainfall magnitudes were computed by using selected values of return period (T) by the method given by Chow (1951b, 1953).

The observed annual maximum point rainfall data was arranged in descending order of magnitude. The return period (T) and probability (P) values were computed for the corresponding rainfall by commonly used Weibull's formula (Weibull, 1939) as Benson (1962) found that on the basis of theoretical sampling from the externe values and normal distribution, this formula provided the estimates that are consistent with experience.

Weibull's formula is as follows :

$$P=\frac{m}{n+1}\times 100 \text{ or } T=\frac{n+1}{m}$$

Where P=per cent probability of occurrence of rainfall of given magnitude.

T=return period or recurrence interval in years.

m=rank number (1, 2, 3,.....n)
n=number of years of rainfall record.

The observed rainfall values and corresponding computed probability values from Weibull's formula were plotted on normal probability paper and theoretical frequency curves of all the three distributions were also plotted and compared with the observed data.

RESULTS AND DISCUSSION

The descending order magnitudes of the observed annual maximum point rainfall for 1-day and 2-day periods are given against the corresponding return periods and probability in Table 1.

For the period under study, the rainfall range for the return period of 26.0 to 1.04 years was observed to be 250.0–20.0 mm and 279.0–31.0 mm for 1-day and 2-day periods, respectively.

Using the computed values of coefficient of skewness for the three types of distribution, the expected theoretical rainfall values were calculated for 1-day and 2-day periods for these distributions which are given in Tables 3, 4 and 5.

Figures 1 and 2 show the theoretical curves for different distributions for 1-day and 2-day rainfall, respectively. It is evident from Fig. 1 that all the three distributions closely fit in the observed data for the probability values ranging from about 15 to 80 per cent. All the three distributions predicted higher values of expected theoretical rainfall than the observed rainfall for 1-day period values at probability more than 95 per cent. At lower (less than 15%) and higher (more than 80%) probabilities, the log-Pearson type-III distribution gave higher expected

TABLE 1

Observed annual maximum rainfall for different periods against the corresponding return period and probability

Return period (T) years	Per cent probability (P)	Rainfall (mm)	
		1-day	2-day
26.00	3.85	250.0	279.0
13.00	7.69	242.0	274.1
8 67	11.54	218.0	273.7
6.50	15.38	181.7	267.5
5.20	19.23	165.0	237.4
4.33	23.08	150.0	233.0
3.71	26.92	134.0	218.0
3.25	30.77	133.0	181.2
2.88	34.60	130.0	170.4
2.60	38.46	115.7	158.0
2.36	42.31	111.0	154.75
2.16	46.15	109.3	151.0
2.00	50.00	100.75	150.0
1.85	53.84	100.1	149.5
1.73	57.69	93.8	149.2
1.62	61.53	91.75	146.5
1.52	65.38	91.25	131.3
1.44	69.23	91.0	100.0
1.36	73.08	89.5	95.5
1.30	76.92	75.0	85.75
1.23	80.77	72.5	85.50
1.18	84.62	62.3	70.0
1.13	88.46	62.0	66.3
1.08	92.31	60.0	66.0
1.04	96.15	20.0	31.0

TABLE 2

Statistical parameters for the transformed variates for different distributions

Distribution type	Standard deviation		Coefficient of variation		Coefficient of skewness	
	1-day	2-day	1-day	2-day	1-day	2-day
Log-Pearson type-III distribution	0.2299	0.2393	0.2127	0.2216	0.6477	0.6757
Log-normal distribution	0.5304	0.6852	0.5154	0.6939	1.6831	2.4267
Gumbel distribution	0.5705	0.7337	0.7825	0.7546	2.8266	2.6935

TABLE 3

Log-Pearson type-III distribution

Return period (T) years	Per cent probability (P)	Frequency factor (K)		Expected theoretical rainfall (mm)	
		1-day	2-day	1-day	2-day
1.0101	99	−1.8450	−1.8240	40.43	50.62
1.0526	95	−1.4413	−1.4315	48.81	62.92
1.1111	90	−1.1919	−1.1871	55.71	79.90
1.25	80	−0.8570	−0.8570	66.51	86.24
2	50	−0.1079	−0.1119	98.88	130.00
5	20	+0.7952	+0.7924	159.50	214.00
10	10	+1.3314	+1.3318	211.70	288.00
25	4	+1.9536	+1.9602	294.40	407.20
50	2	+2.3841	+2.3953	369.80	569.30
100	1	+2.7911	+2.8072	458.70	649.50
200	0.5	+3.1796	+3.2009	563.50	806.90

TABLE 4

Log-normal distribution

Return period (T) years	Per cent probability (P)	Frequency factor (K)		Expected theoretical rainfall (mm)	
		1-day	2-day	1-day	2-day
1.0101	99	−1.3851	−1.1647	33.76	38.11
1.0526	95	−1.1634	−1.0147	47.25	55.46
1.25	80	−0.7917	−0.7400	69.85	76.38
2	50	−0.2183	−0.2600	104.72	128.67
5	20	+0.6534	+0.5673	163.74	218.80
20	5	+1.8900	+1.8800	232.94	361.81
100	1	+3.3992	+3.6553	324.36	555.22
1000	0.1	+8.5259	+6.8047	636.52	898.32

TABLE 5

Gumbel distribution

Return period (T) years	Per cent probability (P)	Frequency factor (K)	Expected theoretical rainfall (mm)	
			1-day	2-day
1.0101	99	−1.6411	24.38	36.59
1.0526	95	−1.3061	43.49	61.17
1.1111	90	−1.1005	55.22	76.26
1.25	80	−0.8213	71.14	96.74
2	50	−0.1642	108.63	144.95
5	20	+0.7200	159.03	209.83
10	10	+1.3058	192.50	252.81
25	4	+2.0408	234.43	306.73
50	2	+2.5900	265.76	347.03
100	1	+3.1485	297.62	388.01
200	0.5	+3.7074	329.51	429.01

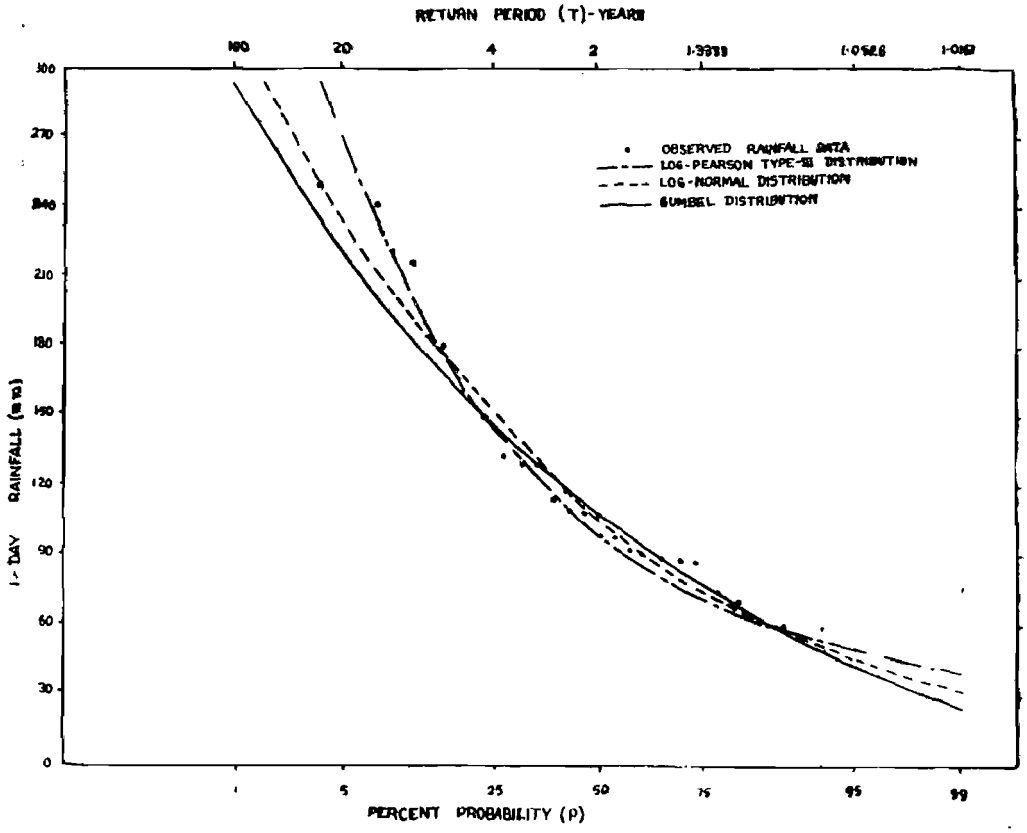


Fig. 1. Theoretical curves for different distributions and observed rainfall 1-day period.

theoretical rainfall followed by log-normal and Gumbel distributions. For 2-day rainfall all the three distributions gave more expected theoretical rainfall values for probabilities less than 5% and more than 95% as seen from Fig. 2.

From this study it can be concluded that for the structures such as agricultural drainage system and other soil conservation works which are designed for return period of upto 6 years, any of these three distributions can be adopted for prediction of maximum rainfall amount. However, for medium and major works which are designed for a return period of more than 20 years frequency analysis by Gumbel distribution predicts more reliable rainfall values.

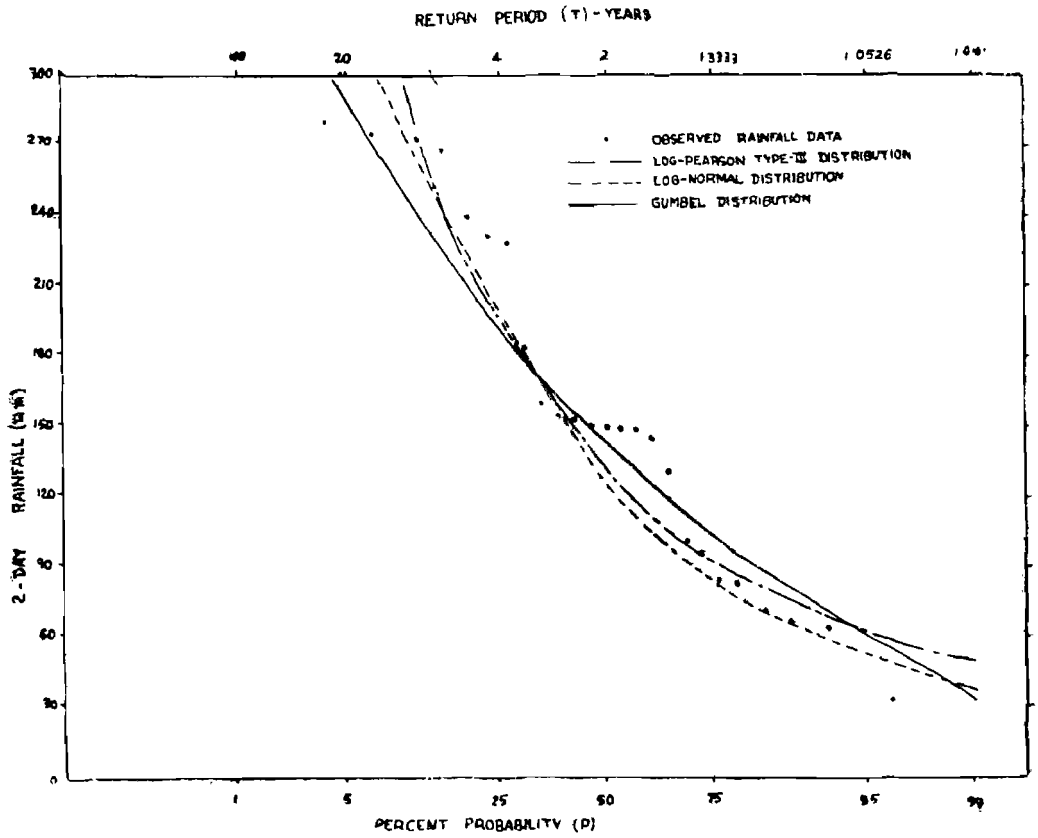


Fig. 2. Theoretical curves for different distributions and observed rainfall 2-day period.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 319—324 (June 1983)

STUDIES ON VARIABILITY AND HERITABILITY IN WATER-MELON *(CITRULLUS LANATUS* (THUNB) MANSF.*)*

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(Received : November 13, 1980; Revised : April 22, 1983)

ABSTRACT

The varietal differences of watermelon were highly significant for all important characters. A wide range of variation was observed for almost all the characters. Variety Ryugu with highest sugar content (TSS %) and number of branches per plant was found earliest in flowering. Tarbooj Selection recorded highest fruit weight and yield per plant. However, all small seeded varieties were promising. Variety Jaunpuri had lowest TSS %. Coefficient of variation was high for weight of fruit followed by fruit yield per plant, TSS, length of main shoot and branches per plant. Heritability estimates were also high for all the characters except yield per plant. Simple selection of yield components to improve yield and TSS % in the material at hand has been suggested.

The knowledge of genetic variability of breeding material and its quantitative assessment usually helps a plant breeder in choosing desirable parents for schematic breeding approach and to improve the characters of economic importance. Further, the genetic variability in connection with the total variability can be well utilized to incur gain for a given selection intensity. Many crops have been exposed for such studies. Since, the information on watermelon crop is scanty, this investigation was undertaken to elicit information on the nature and magnitude of heritable and non-heritable components of variation and the genetic parameters such as genetic coefficient of variation, heritability and genetic advance in some of the characters related to yield in a set of 14 watermelon varieties.

MATERIAL AND METHODS

In toto 14 exotic and Indian varieties of watermelon were grown in randomised block design with three replications spacing 60 and 250 cm within and between the rows, respectively during summer seasons of 1978–79 and 1979–80 at the Vegetable Research Farm of Haryana Agricultural University, Hissar. Five meters long single row constituted a treatment. Randomly selected five plants per treatment per replication were observed for days to 50% female flowering, node number bearing first female flower, number of branches per plant, length of main shoot, fruit weight, number of fruits per plant and fruit yield per plant. The average data of two seasons were subjected to statistical analysis. Genotypic

and phenotypic coefficients of variation were calculated using the formula of Burton (1952). Heritability in broad sense was calculated as per formula suggested by Burton and De Vane (1953) and the expected genetic advance was computed using the formula of Lush (1949) and Johnson *et al.* (1955).

RESULTS AND DISCUSSION

The statistical analysis revealed significant genotypic differences for all the characters under study except number of fruits per plant (Table 1). Sachan and Tikka (1971), Tikka *et al.* (1974), Thakur and Nandpuri (1974), Chhonkar (1977) and Sidhu and Brar (1978) also found significant varietal differences for yield and other yield components in watermelon. General mean and range values are also given in Table 1. Maximum range of variation was observed for length of main shoot followed by days to 50% flowering, node bearing first female flower, TSS (%) and number of branches per plant. Thakur and Nandpuri (1974) and Sidhu and Brar (1978) also reported a wide range of variation for yield per plant.

Ryugu was earliest in female flowering followed by Sugar Baby and Nantomidori, whereas Black Big Seeded, Jaunpuri and Indian Sweet Heart were late of all. Sugar Baby followed by Nantomidori and Fuken had minimum number of node bearing first female flower. Highest number of branches per plant was recorded for Ryugu followed by Fuken. Farukhabadi had least branching tendency. The length of main shoot was maximum in case of Tarbooj Selection, while minimum shoot length of Indian Sweet Heart was closely followed by Sugar Baby and Fuken. New Hempshire Midget recorded highest number of fruits followed by Ryugu and Nantomidori. Minimum fruits per plant were observed in variety Sugar Sweet. As regards weight of fruit, it was highest in case of Tarbooj Selection followed by Farukhabadi, Sugar Sweet and Black Big Seeded. Similar trend was also obvious for fruit yield per plant. Per cent TSS was observed maximum in Ryugu followed by Sugar Baby, Nantomidori, Fuken, Asahi Yamato and Indian Sweet Heart. Variety Jaunpuri had lowest TSS. Soressi *et al.* (1974) reported that small seeded types were high yielding than large seeded types and Japanese varieties had the highest sugar content. The present study is in confirmity with this report.

Genotypic and phenotypic variances and coefficients of variation alongwith heritability in broad sense, genetic advance and genetic advance as a per cent of mean are given in Table 2. Higher magnitude of phenotypic variances and coefficients of variation than the genotypic values indicated considerable influence of environment on the expression of all the characters except TSS (%) where very little differences between genotypic and phenotypic values were present. It was further supported by its high heritability. The coefficients of variation of population mean followed different trend than the components of variance of characters. Weight of fruit followed by fruit yield per plant, TSS, length of main shoot and branches per plant recorded high coefficients of variation and a wide range of variation for these characters, suggesting an ample scope of effective improvement. However, components of variance and coefficients of

TABLE 1

Performance of watermelon varieties for different characters

S. No.	Variety	Seed size and source	Days to 50% female flowering	Node No. bearing first female flower	Number of branches per plant (primary)	Length of main shoot (cm)	Weight of fruit (kg)	Number of fruits per plant	Fruit yield per plant (kg)	Total soluble solids (%)
1.	Sugar Baby	S, A	55.03	15.03	7.88	204.79	1.79	1.81	3.07	8.60
2.	Sugar Sweet	B, I	57.83	20.86	6.11	283.21	2.70	1.37	3.93	6.20
3.	Farukhabadi	B, I	56.26	18.92	5.47	271.61	2.96	1.54	4.58	5.91
4.	Ryugu	S, J	54.53	17.51	8.51	223.45	1.84	2.03	3.58	9.33
5.	Fuken	S, J	56.63	16.23	8.14	207.37	1.59	1.50	2.21	8.55
6.	Jaunpuri	B, I	59.86	18.33	6.92	262.01	2.09	1.51	3.08	4.50
7.	Tarbooj Selection	B, I	58.63	17.93	5.40	333.52	3.05	1.44	4.63	6.67
8.	Jaunpuri Selection	B, I	57.50	16.66	7.00	254.53	1.78	1.68	3.04	6.33
9.	Asahi Yamato	S, J	56.60	18.01	7.34	225.56	1.39	1.58	2.07	8.28
10.	Black Big Seeded	B, I	61.16	21.40	6.59	291.31	2.23	1.80	3.86	5.15
11.	New Hempshire Midget	B, A	57.23	17.91	6.68	228.16	1.78	2.09	3.78	5.55
12.	Local Line B	S, I	58.80	17.39	7.48	226.67	1.22	1.88	2.31	7.16
13.	Nantomidori	S, J	55.96	16.12	7.48	228.72	1.47	2.01	3.11	8.61
14.	Indian Sweet Heart	S, I	59.46	17.61	7.86	183.20	1.78	1.62	2.54	8.16
	General mean	—	57.53	17.35	7.13	244.58	1.98	1.70	3.27	7.07
	Range		54.53 to 61.16	15.03 to 21.40	5.40 to 9.51	183.20 to 333.52	1.22 to 3.05	1.37 to 2.09	2.07 to 4.63	4.50 to 9.33
	Treatment variance	—	10.70**	8.86**	3.55**	4870.8**	0.96**	NS	2.64*	6.95**
	S. Em.	—	1.05	1.18	0.50	15.26	0.29	—	0.69	0.22
	C. D. at 5%	—	2.16	2.43	1.03	31.37	0.60	—	1.41	0.44

B=Big, S=Small, I=Indian, J=Japanese, A=American, NS=Non-significant.

*,**Significant at 5 and 1 per cent level, respectively.

TABLE 2

Components of variance, coefficients of variation, heritability and genetic advance in seven characters of watermelon

S. No.	Characters	Components of variance		Coefficients of variation (%)		Heritability in *broad sense* (%)	Expected genetic advance	Genetic advance as a per cent of mean
		Genotypic	Phenotypic	Genotypic	Phenotypic			
1.	Days to 50% female flowering	3.01	4.68	3.01	3.76	64 31	2.87	4.78
2.	Node number bearing first female flower	2.25	4.36	8.40	11.69	51.60	2.22	12.43
3.	Branches per plant (primary)	1.06	1.44	14.41	16.80	73 54	1.82	25.46
4.	Length of main shoot (cm)	1507.12	1856.50	15.87	17.61	81.18	72.06	29.46
5.	Weight of fruit (kg)	0.28	0.41	26.56	32.20	68.02	0.89	45.12
6.	Fruit yield per plant (kg)	0.44	1.15	20.36	31.84	38.43	0.85	25.99
7.	Total soluble solids (TSS)	2.29	2.36	21.41	21.74	97.03	3.07	43.47

variation were almost equal and low for days to 50% female flowering indicating less scope of selection, further substantiated by its low genetic advance as a per cent of population mean.

Broad sense heritability varied from 38.43% (fruit yield per plant) to 97.03% (TSS). These estimates were also high for all other characters. Thakur and Nandpuri (1974) and Sidhu and Brar (1978) also observed high heritability for all these characters except yield per plant and branches per plant. However, Sachan and Tikka (1971) and Chhonkar (1977) observed high heritability for yield per plant. Sidhu and Brar (1978) reported low heritability for TSS (%). The genetic advance as a per cent of population mean was above 25% for all the characters except days to 50% flowering and node number bearing first female flower. High heritability values coupled with high genetic advance are indicative of additive gene action (Panse, 1957). Sachan and Tikka (1971), Sachan and Nath (1976), Brar and Nandpuri (1977) and Prosvirnin (1978) also suggested that additive gene action was important for earliness, fruit weight and TSS while non-additive gene action played its role for fruit yield in watermelon. Present study agrees with these informations. Yield in watermelon depends on yield components such as main shoot length, number of branches, number of days to first female flower and average fruit weight (Sachan and Tikka, 1971; Tikka *et al.*, 1974) which are simple in inheritance. Therefore, from the study it is concluded that the yield and quality of the material at hand can be improved through selection. With some exceptions, the small seeded varieties can be exploited for such improvements.

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 325—326 (June 1983)

CHEMICAL CONTROL OF ANTHRACNOSE OF GUAVA CAUSED BY *GLOMERELLA CINGULATA*

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(Received : September 30, 1981; Revised : April 5, 1982)

A major proportion of guava fruits is damaged between harvest and consumption owing to anthracnose caused by *Glomerella cingulata* (Stonem) Spauld. and Schrenk (Sharma *et al.*, 1981; Singh and Sharma, 1981, 1982). This paper reports the results of the experiments conducted to save the fruits from fungal decay by treating them with fungicides/antibiotics.

For determining the relative efficacy of three fungicides viz., Roveral (iprodione), Thiabendazole and Blitox-50 and two antibiotics viz., Tetracycline and Aureofungin on the inhibition of the fungus, preliminary studies were conducted by testing their effect on spore germination *in vitro*. EC_{50} was calculated by plotting per cent inhibition against concentration of fungicide/antibiotic on log-probit scale as suggested by Horsfall (1956).

For *in vivo* studies, the chemicals were tested in both pre- and post-inoculation treatments. In case of pre-inoculation treatment, apparently healthy matured guava fruits of cv. Allahabadi Safeda were first surface sterilized with ethanol and then allowed to dry for 5 min. After drying, the fruits were dipped in the required concentration of the solutions for 5 min and kept for 24 h in the sterile desiccators maintaining saturated atmosphere. After the lapse of this period, the coated fruits were inoculated by making pin-prick injury on their surface (Tomkins and Trout, 1931). The pricked surface was dipped for 2 min in the young culture suspension of *G. cingulata* having 2×10^3 spores per ml. After inoculation, the coated fruits were transferred to another set of sterilized desiccators having 100 per cent humidity at 30°C temperature. For post-inoculation treatment, the fruits after surface sterilization were inoculated by *G. cingulata*. The inoculated fruits after storage for 24 h in sterilized desiccators having saturated atmosphere at 30°C temperature were treated with test chemicals.

The observations on the effectivity of each treatment were recorded after 4 and 8 days of storage. The disease intensity was determined by the formula of Srivastava and Tandon (1968). The data were analysed statistically by using factorial completely randomized design.

None of the chemicals inhibited the spore germination completely even at a

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high concentration of 100 ppm. The maximum inhibition was obtained in Thiabendazole followed by Aureofungin and Blitox-50. Similar results were reported by Cargo and Dewey (1970), Rao and Agarwal (1976) and Singh *et al.* (1977) in case of *Penicillium expansum*, *Alternaria citri* and *Colletotrichum capsci*, respectively.

Out of the five chemicals used in pre-inoculation treatment, none could protect the fruit completely from rotting. Relatively Thiabendazole and Aureofungin proved better in protecting the fruits from rotting. Blitox-50 and Tetracycline were the second best in order of efficacy. Roveral was not effective in protecting fruits from rotting. The observations recorded in case of Thiabendazole are more or less similar to those reported by Quimio *et al.* (1974). For post-inoculation treatment, the performance of Thiabendazole and Aureofungin was good as they prevented considerable rotting. Next in order of efficacy were Blitox-50, Tetracycline and Roveral.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 327—334 (June 1983)

EFFECT OF BACKGROUND OF GIRL STUDENTS OF HARYANA ON THEIR CLOTHING PATTERN

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(Received : July 1, 1982)

ABSTRACT

Study on effect of background (urban and rural) and caste (high and middle) of girls on their clothing pattern revealed that a high correlation existed between colour choice and background of the girls. Girls from high caste and rural background wore salwar kamiz most of the times and a low percentage of rural girls wore western dresses as against urban girls who used western dresses. Most of the changes in clothing pattern of girls were found to take place during the third year of their stay in the college.

Clothing is one of the basic needs of man. There is a marked difference in the clothing pattern of people. It varies from place to place and time to time. Chambers and Moulton (1961) opined that clothing is a mean of expression of the person reflecting his ways of living, patterns of thinking and pride in self and family. Indira Devi *et al.* (1971) pronounced the idea of giving coaching classes to students regarding their clothing care. This, they found was helping in solving the problems to a great extent.

This report contains the results of an investigation carried out on a fairly heterogenous population. The study was directed at finding out among girl students the changes in clothing pattern which gradually take place in college life particularly due to the effects of factors like background (rural/urban), years of stay in urban areas, type of residence (hostler/non-hostler) and caste.

MATERIAL AND METHODS

Two hundred under-graduate students selected at random from the College of Home Science of the Haryana Agricultural University, Hissar, represented the subjects for this study. Fifty students were chosen from each class. The subjects were given a questionnaire for recording their background, caste, clothing pattern and choice. Background information included :

a) Urban/rural belonging
b) Hostler/non-hostler
c) Number of years of stay in city

Caste included :

a) High caste —Brahmin, Jat
b) Middle caste —Bania, Sunar, Sikh, Ahir, Gujjar, Arora
c) Low caste —Chammar, Bhangi, Dhobi, Dhanak

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Scoring and coding were done and the data were subjected to statistical analysis (Snedecor and Cochran, 1968) using ECIL-316 computer.

RESULTS AND DISCUSSION

Correlation coefficients were worked out to ascertain the strength of relationship between various components used to determine the choice of clothes of the girls and their background and caste as specified above.

It was assumed that during the Ist year of their college life, almost all the girls were novice and were not exposed to the prevailing trend of wearing clothes, since they were just out from their schools. There is a great psychological factor operating in our Indian society regarding wearing clothes, particularly when the girls are in the schools. College atmosphere exposes them to the new ideas and ways of thinking, there can, at times, be complete transformation atleast in their wearing habits. Among the Ist year girls, almost all the correlation coefficients were found to be non-significant except the correlation coefficient (.4537) between accessories which the girls had at the time of investigation and the type of residence (hostler/non-hostler). This supports the assumption.

It was observed that in the 2nd year there was significant ($P<0.05$) positive correlation coefficient between colour choice in winter and background (.2808) and a significant ($P<0.01$) negative correlation coefficient between residence and sleeves worn (—.3893).

In the 3rd year, there was a significant positive correlation between winter colour choice and background ($P<0.01$), years in city ($P<0.05$) as also between prints choice and type of residence ($P<0.01$). On the other hand, a significant ($P<0.05$) negative correlation existed between restriction on clothing choice and both background and years in city. A highly significant negative correlation ($P<0.01$) was observed between caste and sleeves worn.

In the 4th year, positive correlations were found between background and accessories which the girls wore ($P<0.05$), and between years in city and choice of prints ($P<0.01$).

To check the independence between different occasions and different garments, chi-square test was used under the hypothesis that different occasions have no effect on the wearing of different garments. To have a closer look, the data were split into different sub-groups comprising high caste, middle caste, rural and urban background. Since only one subject was found in the low caste group, this group was dropped from the chi-square analysis. Background included years of stay in the city as well as type of residence. Therefore, the latter two were not considered separately.

Calculated values of chi-square in each of these groups were found to be highly significant and, thus, coefficient of contingency was found to be above 80% in all the groups considered. Thus, the hypothesis was rejected and hence, there is definite relationship between different occasions and different garments under different groups.

Also chi-square test was used for the make of garments and type of garments.

TABLE 1

Percentage of high caste girls wearing different dresses at different occasions

S. No.	Dresses	Occasion								
		Daily wear	Festival	Marriage	Party	College function	Movies	Cultural programme	At night	Sports
1.	Salwar—Kamiz	100.0	92 1	71.4	82.5	88.9	96.8	88.9	44.4	54.0
2.	Jeans/Pants/Belbots	23.8	20.6	23.8	31.8	28.6	31.8	25.4	1.6	9.5
3.	Sarees	1.6	14.3	49.2	31.8	28.6	3.2	17.5	0	1 6
4.	Maxi/Midi	19.0	9.5	15.9	19.0	6.4	9.5	11.1	19.0	3.1
5.	Nightie/Night suit/Gown	19.0	0	0	0	0	0	0	88.9	0
6.	Churidar, Kurta	23.8	23.8	19.0	17.5	19.0	22.0	19.0	3.2	1.6
7.	Skirts/Frocks	7.9	3.2	1.6	1.6	3.2	3.2	4.8	7.9	9.5
8.	Shorts	0	0	0	0	0	0	0	0	12.7
9.	Coats/Blazors/Jackets	31.8	23.8	27.0	27.0	30.2	28.6	27.0	0	12.7
10.	Sweaters	98.4	90.5	88.9	85 7	87.3	87.3	90.5	22.2	66.7
11.	Shawls	68.2	57.1	57.1	50.8	50.8	55.6	52.4	25.4	17.5
12.	Chappals,Sandels/Shoes	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0	82.5

TABLE 2

Percentage of middle caste girls wearing different dresses at different occasions

S. No.	Dresses	Occasion								
		Daily wear	Festival	Marriage	Party	College function	Movies	Cultural programme	At night	Sports
1.	Salwar—Kamiz	97.0	84.9	67.4	72.0	81.8	90.1	74.2	53.8	46.2
2.	Jeans/Pants/Belbots	25.0	14.4	18.2	28.8	15.9	24.2	18.9	1.5	9.1
3.	Sarees	1.5	20.5	57.6	33.3	25.8	1.5	22.7	0	0
4.	Maxi/Midi	24.2	19.7	38.6	41.7	17.4	12.1	19.7	22.7	1.0
5.	Nightie/Night suit/Gown	15.9	0	0	0	0	0	0	84.9	0
6.	Churidar, Kurta	34.9	31.1	24.2	28.8	28.8	30.3	26.5	0	3.8
7.	Shirts/Frocks	11.4	4.6	6.8	9.1	4.6	5.3	4.6	2.8	8.3
8.	Shorts	0	0	0	0	0	0	0	1.0	9.1
9.	Coats/Blazors/Jackets	31.1	31.8	31.8	34.9	33.3	38.6	25.8	1.5	11.4
10.	Sweaters	93.9	83.3	82.6	81.8	82.6	84.9	75.8	26.5	55.3
11.	Shawls	62.1	34.1	35.6	34.9	34.1	40.9	34.9	19.7	5.3
12.	Chappals, Sandels/Shoes	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0	63.6

TABLE 3

Percentage of girls with rural background wearing different dresses at different occasions

S. No.	Dresses	Occasion								
		Daily wear	Festival	Marriage	Party	College function	Movies	Cultural programme	At night	Sports
1.	Salwar—Kamiz	98.6	90.3	68.1	79.2	84.7	90.3	80.6	50.0	58.3
2.	Jeans/Pants/Belbots	12.5	12.5	16.7	22.2	16.7	22.2	18.1	1.4	5 6
3.	Sarees	1.4	13.9	56.9	37.5	30.6	0	22.2	0	0
4.	Maxi/Midi	11.1	15.3	16.7	20.8	5.6	4.2	12.5	22.2	2 8
5.	Nightie/Nightsuit/Gown	12.5	0	0	0	0	0	0	77.8	0
6.	Churidar, Kurta	15.3	22.2	16.7	19.4	18.1	16.7	15.3	1.4	1.4
7.	Shirts/Frocks	2.8	2.8	1.4	1.4	2.8	2.8	5.6	4.2	8.3
8.	Shorts	0	0	0	0	0	0	0	0	8.3
9.	Coats/Blazors/Jackets	19.4	23.6	23.6	22.2	23.6	23.6	20.8	1.4	8.3
10.	Sweaters	90.3	83.3	79.2	80.6	80.6	79.2	73.6	15.3	51.4
11.	Shawls	81.9	59.7	56.9	52.8	58.3	68.1	56.9	20.8	11.1
12.	Chappals, Sandels/Shoes	100	100.0	100.0	100.0	100.0	100.0	100.0	0	90.3

TABLE 4

Percentage of girls with urban background wearing different dresses at different occasions

S. No.	Dresses	Occasion								
		Daily wear	Festival	Marriage	Party	College function	Movies	Cultural programme	At night	Sports
1.	Salwar—Kamiz	96.8	84.8	64.0	72.8	82.4	92.0	76.8	39.2	44.8
2.	Jeans/Pants/Belbots	30.4	18.4	21.6	33.6	21.6	28.0	2.4	2.4	12.0
3.	Sarees	1.6	20.8	52.8	32.8	25.6	4.8	19.2	1.6	1.0
4.	Maxi/Midi	28.8	17.6	40.0	40.8	18.4	16.0	19.2	18.4	1.6
5.	Nightie/Night suit/Gown	13.6	0	0	0	0	0	0	89.6	0
6.	Churidar, Kurta	40.0	30.4	24.8	27.2	29.6	33.6	28.0	1.0	3.2
7.	Shirts/Frocks	14.4	5.6	8.0	10.4	5.6	7.2	4.8	4.0	11.2
8.	Shorts	0	0	0	0	0	0	0	1.0	12.8
9.	Coats/Blazors/Jackets	38.4	33.6	34.4	38.4	37.6	42.4	29.6	0	15.2
10.	Sweaters	96.0	86.4	87.2	84.8	85.6	88.0	84.0	29.6	61.6
11.	Shawls	56.0	35.2	35.2	34.4	29.6	34.4	32.0	23.2	9 6
12.	Chappals, Sandels/Shoes	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0	79.2

TABLE 5

Percentage of various categories of girls getting their dresses stitched from different sources

S. No.	Dresses	High caste			Middle caste			Rural background			Urban background		
		Tailor made	Ready made	Home made	Tailor made	Ready made	Home made	Tailor made	Ready made	Home made	Tailor made	Ready made	Home made
1.	Salwar—Kamiz	84.1	3.2	63.5	78.0	6.9	69.7	73.6	6.9	79.2	83.2	4.0	62.4
2.	Jeans/Pants/Belbots	39.7	19.0	0	33.3	25.0	4.6	27.8	13.9	0	40.0	27.2	4.8
3.	Sarees	0	49.2	0	0	62.9	0	0	58.3	0	0	57.6	0
4.	Maxi/Midi	19.0	33.3	15.9	43.9	44.7	13.6	15.3	30.6	11.1	46.4	45 6	15.2
5.	Nightie/Night suit/Gown	36.5	36.5	47.6	26.5	47.0	44.7	26.4	33.3	45.8	31.2	49.6	44 0
6.	Churidar, Kurta	27.0	11.1	12.7	40.2	12.9	15.9	20.8	2.8	13.9	42.4	18.4	15.2
7.	Shirts/Frocks	12.7	4.8	7.9	15.2	6.8	5.3	12.5	1.4	5.6	15.2	9.6	7.2
8.	Shorts	9.5	1.6	1.6	6.1	4.6	0	5.6	5.6	0	9.6	3.2	1.0
9.	Coats/Blazors/Jackets	38.1	14.3	4.8	31.8	28.8	4.6	27.8	15.3	5.6	39.2	31.2	3.2
10.	Sweaters	0	76.2	87.3	0	68.9	87.9	0	73.6	87.5	0	71.2	87.2
11.	Shawls	0	77.8	20.6	0	68.9	12.9	0	87.5	26.4	0	62.4	11.2
12.	Chappals, Sandels/Shoes	0	100.0	0	0	100.0	0	0	100.0	0	0	100.0	0

In this case also, calculated value of chi-square was very much above chi-square tabulated for 22 degrees of freedom, thus, establishing the relationship between makes and type of garments under different sub-groups.

Table I reveals that all of the students considered under high caste group wore salwar-kamiz daily and sarees were worn mostly at the time of special occasions like marriages (49.2%) and parties (31.8%). At night most girls (88.9%) wore nighties/night suits. A very low percentage (12.7%) of students preferred shorts while playing. During winter, the order of preference was sweaters followed by shawls and coats. In case of students of middle caste group (Table 2), the pattern of clothing choice was similar to that of high casts group except that more number of such girls continued to wear salwar-kamiz at night and during winter; comparatively less number of students used shawls. Surprisingly, the middle caste girls used more of western dresses like maxi-midi as compared to high caste girls.

Girls from rural background (Table 3) wore mostly salwar-kamiz for daily use and otherwise too, only a low percentage of girls took to western dresses. During winter, most of the times, they preferred shawls.

Urban girls (Table 4) too wore salwar-kamiz most but they also used western dresses like jeans/pants, maxis, etc. As compared to rural girls, more percentage of girls wore nighties/night suits at night. Most of the urban girls used sweaters. The percentage of girls using coats was more than what it was in case of rural girls.

While comparing makes of dresses (Table 5) of urban and rural girls, it was found that percentage of rural girls getting salwar-kamiz stitched at home and by tailor were almost equal, while urban girls preferred tailor made salwar-kamiz. In general, urban girls seemed to prefer tailor made garments as compared to rural girls. High and middle caste girls had almost same pattern of make of garments.

In conclusion it may be said that most of the changes in the clothing pattern of girls were found to take place during the third year of their college life and by the time of fourth year of their stay in the college, their clothing pattern gets stabilized.

Different occasions have definite role to play in the selection of garments. Girls of high and middle castes followed almost the same clothing patterns, while background played vital role in the selection of garments both with respect to occasion and make.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 335—341 (June 1983)

ECONOMICS OF PRODUCTION OF CAULIFLOWER IN THE HINTERLAND OF HISSAR CITY

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(Received : November 9, 1981; Revised : March 26, 1982)

ABSTRACT

The yield per hectare of cauliflower was maximum (187.97 q) on large farms in mid season among all the three seasonal crops of cauliflower grown on different sizes of farms. The total cost of production per hectare was nighest in early season cauliflower but at the same time this crop gave the highest net return per hectare when compared with other seasonal crops of cauliflower grown on different sizes of farms. Human labour was found to be used in excess than required on small farms. There was a further scope of increasing farmers, income through intraseasonal reallocation of acreage and application of more fertilizers, irrigation and plant protection measures.

Vegetables constitute an important human food and are the cheapest natural nutritive source. In terms of nutritive value, vegetables contribute next to milk. These are rich in carbohydrates, minerals, salts and vitamins. An added advantage of vegetable production is that it yields higher income per unit of land than cereals and two to three successive crops can be grown on the same piece of land. For those farms which are located near the cities, vegetable growing on them is of significant importance due to readily available market.

Among the colecrops, cauliflower is one of the most important vegetables grown during autumn and winter months in our country. It occupies nearly 5% of the total area under vegetables (excluding potato and other tuber crops) in Northern and Eastern India. Cauliflower is available in Hissar vegetable market from early September to March. It is one of the major cash crops of the Hissar vegetable growers and also contributes significantly towards their farm income. As such, an attempt was made to find out the costs, returns and resource productivity in cauliflower.

METHODOLOGY

A complete list of farmers growing cauliflower, around Hissar, was prepared and arranged in the ascending order of their operational holdings. Cumulative frequency of the operational area was calculated and the total area was divided into three parts i.e. small farms (upto 1.62 ha), medium farms (1.62 to 2.77 ha) and large farms (2.77 ha and above). Thirty per cent farms from each size group were selected randomly. Size of farms, average size of farms, total number of farms and the number of farms selected are shown in Table 1.

TABLE 1

Average size of farms, distribution of total and sample farms under different farm sizes

Particulars	Small	Medium	Large	Total
Size of farms (ha)	0-1.62	1.62-2.77	2.77 & above	—
Average size of farms (ha)	0.80	2.18	3.57	1.61
Total number of farms	167	78	47	292
Number of farms selected	51	23	14	88

A total of 88 farms, i.e., 51,23 and 14 from small, medium and large size groups, respectively, were selected randomly. Selected farms were located within a radius of 5 to 6 km of Hissar city. These farms were visited and information relating to farm inventory, cropping pattern, and input output details of cauliflower were collected on a detailed schedule. The data pertain to the year 1975-76. To find out costs and returns, cost 'C' approach was used, whereas to determine the resource productivity, the following regression analysis model was used :

$$Y = a\, x_1^{b_1}\, x_2^{b_2}\, x_3^{b_3}\, x_4^{b_4}$$

where

Y = value of the gross return from crop production per hectare.

x_1 = the cost of human labour per hectare;

x_2 = the cost of fertilizers per hectare;

x_3 = the cost of irrigation per hectare;

x_4 = the cost of insecticides and pesticides per hectare;

a = intercept. It stands for the value of the dependent variable when all the independent variables are assumed equal to zero;

b_1 to b_4 = Elasticity coefficients of the respective input variables.

The expenditure incurred by the farmer to bring his produce to the market was also included in the cost of production. This mainly included transportation and octroi charges. The former was taken as the actual cost paid by the farmer, while the latter was computed at the rate of Re. 0.70/q of the produce or Re. 0.40 per rickshaw as fixed by the Government. Cauliflower was found to be grown in three different seasons or as such it was categorised into three different crops viz., early season crop, mid season crop and late season crop.

RESULTS AND DISCUSSION

The number of farms, area and yield per hectare on different sizes of farms in early, mid and late season cauliflower are given in Table 2. In case of early season cauliflower the yield per hectare being 96.08 q was maximum on large farms followed by 92.27 q on small farms and 90.14 q on medium farms. The highest yield on large farms was due to the fact that this group of farms, besides having assured irrigation facilities also used more fertilizers and plant protection measures as compared to small and medium farms. The large farms used 115.47, 110.83 and 112.49 kg of nitrogen

TABLE 2

Number of farms, area and yield per hectare on different sizes of farms in early, mid and late season cauliflower (1975-76)

Size of farm	Number of farms	Total area (ha)	Total production (q)	Average yield/ha (q)
		Early season cauliflower		
Small	51	22.11	2040.00	92.27
Medium	23	15.85	1428.72	90.14
Large	14	13.25	1273.06	96.08
Sample	88	19.06	1759.43	92.31
		Mid season cauliflower		
Small	21	4.63	856.91	184.88
Medium	12	3.77	690.29	183.10
Large	9	4.21	791.35	187.97
Sample	42	4.29	793.78	185.03
		Late season cauliflower		
Small	15	2.55	368.91	144.67
Medium	9	1.72	245.25	142.59
Large	8	1.47	218.25	148.47
Sample	32	2.04	295.86	145.03

per hectare in early, mid and late season cauliflower, respectively against the recommended dose of 120 kg N/ha, whereas the small and medium farms used 86.47, 77.74 and 83.59 kg and 79.86, 79.70 and 80.37 kg of nitrogen per hectare, respectively. However, the difference in the yield on small and medium farms was very low because there was a little variation in the use of fertilizers, insecticides, etc. Similar findings were observed in mid and late season cauliflower. The average yield per hectare on sample farms was highest (185.03 q) in case of mid season cauliflower. Mid season was best suited for the yield of the cauliflower. However, most of the growers put more area under early season cauliflower because of the higher profitability of the early season crop due to higher price per kg of the crop produced. Table 3 shows the total cost, gross income and net return per hectare on different farm sizes in early, mid and late season cauliflower. In early season cauliflower, the total cost per hectare was highest (Rs. 6140.79) on large farms followed by Rs. 5802.25 on small farms and Rs. 5668.68 on medium farms. The highest cost on large farms was because of high fixed cost per hectare of the cropped acreage. Similarly, on large farms the cost was highest in mid and late season cauliflower (Table 3). However, the difference was very small in case of small and medium farms in mid and late season cauliflower. The average cost per hectare on sample farms was maximum (Rs. 5821.10) in case of

TABLE 3

Total cost, gross income and net return per hectare on different sizes of farms in early, mid and late season cauliflower (1975-76)

S. No.	Items	Small (Rs.)	Medium (Rs.)	Large (Rs.)	Sample (Rs.)
	Early season cauliflower				
1.	Variable cost	4539 61	4279.38	4534.29	4470.71
2.	Fixed cost	1020.73	1160.85	1353.86	1110.30
3.	Marketing cost paid by the producer (transportation + octroi charges)	241.91	228.45	252.64	240.09
4.	Total cost (1+2+3)	5802.25	5668.68	6140.79	5821.10
5.	Gross income	11002.34	10748.29	11456.57	11008.20
6.	Net return	5200.09	5079 61	5315.78	5187.10
	Mid season cauliflower				
1.	Variable cost	3001.30	2861.45	2993.59	2959.79
2.	Fixed cost	1019.49	1181.45	1382.82	1143.61
3.	Marketing cost paid by the producer (transportation + octroi charges)	482 64	477.99	489.68	482.82
4.	Total cost (1+2+3)	4503.44	4520.89	4866.09	4586.22
5.	Gross income	8494.03	8412.85	8635.34	8501.11
6.	Net return	3990.59	3891.96	3769.25	3914.89
	Late season cauliflower				
1.	Variable cost	3167.09	2995.23	3072.47	3095.34
2.	Fixed cost	1026.24	1169.05	1348.13	1147.11
3.	Marketing cost paid by the producer (transportation + octroi charges)	367.77	370.90	393.89	379.39
4.	Total cost (1+2+3)	4570.10	4535.18	4814.49	4621.84
5.	Gross income	7269.88	7165.14	7460.61	7288.10
6.	Net return	2699.78	2629.96	2646.12	2666.26

early season cauliflower followed by Rs. 4621.84 in late season and Rs. 4586.22 in mid season cauliflower.

Net return per hectare in case of early season cauliflower was highest (Rs. 5315.78) on large farms followed by Rs. 5200.09 on small farms and Rs. 5079.61 on medium farms. Because of the higher price per quintal, a small difference in the yield resulted in higher net return on large farms as compared to small and medium farms. Net return per hectare was highest on small farms in mid season (Rs. 3990.59) and late season (Rs. 2699.78) cauliflower crops. The net return per hectare in mid season cauliflower was higher (Rs. 3891.96) on medium

TABLE 4

Production elasticities of input factors, returns to scale (sum of elasticities) and coefficient of multiple determination (R^2) on different sizes of farms in early, mid and late season cauliflower

Size of farm	No. of observations	Value of a	Production elasticities				Sum of elasticities	R^2
			X_1	X_2	X_3	X_4		
Early season cauliflower								
Small	51	424.40	0.0734 (0.1281)	0.1030** (0.0379)	0.1467* (0.0564)	0.0769** (0.0169)	0.4000	0.9266
Medium	23	23.13	0.5059* (0.2184)	0.0283** (0.0080)	0.1632* (0.0648)	0.0735** (0.0161)	0.7709	0.9013
Large	14	19.35	0.5672* (0.2503)	0.0216 (0.0812)	0.1937* (0.0821)	0.0603* (0.0261)	0.8428	0.9238
Mid season cauliflower								
Small	21	469.30	0.0951 (0.0859)	0.1524** (0.0399)	0.1058* (0.0379)	0.0180* (0.0075)	0.2713	0.9392
Medium	12	69.47	0.4096* (0.1535)	0.1246** (0.0355)	0.0963* (0.0376)	0.0163* (0.0057)	0.6468	0.9181
Large	9	121.30	0.4068* (0.1120)	0.0073 (0.0537)	0.1172* (0.0408)	0.0049 (0.0329)	0.5362	0.9514
Late season cauliflower								
Small	15	571.00	0.0429 (0.0248)	0.1646** (0.0504)	0.0962* (0.0394)	0.0097* (0.0039)	0.3134	0.9162
Medium	9	43.44	0.3896* (0.0984)	0.1840** (0.0398)	0.1238* (0.0343)	0.0138* (0.0053)	0.7112	0.9081
Large	8	62.10	0.4056* (0.0965)	0.0369 (0.0142)	0.1838* (0.0573)	0.0059 (0.0031)	0.6322	0.9421

Figures in parentheses indicate standard errors of respective variables.

* **Significant at 5 and 1 per cent level, respectively.

farms than on large farms (Rs. 3769.25). However, the difference in the net return per hectare in late season cauliflower on medium and large farms was negligible. No doubt the yield per hectare of cauliflower was highest on large farms in mid and late season. The price which played the main role in higher net return per hectare on large farms in case of early season did not compensate the cost difference in mid and late season cauliflower.

The production elasticities of input factors and coefficient of multiple determination (R^2) on different sizes of farms

in case of early, mid and late season cauliflower are given in Table 4. In case of early season cauliflower on small farms the value of R^2 was 0.9266 which indicated that about 92% variations in output were caused by the independent variables viz., human labour, fertilizers, irrigation and plant protection measures selected for the analysis. The production elasticity of human labour was positive but non-significant indicating that it did not contribute to the output significantly. However, the production elasticities of fertilizers, irrigation and plant protection measures were positive and significant reflecting that these inputs contributed to the output significantly. On medium farms the value of R^2 was 0.9013 and the production elasticities of all the variables were positive and significant. On large farms the value of R^2 was 0.9238 and the production elasticities of human labour, irrigation and plant protection measures were positive and significant, whereas the elasticity of fertilizers was positive but non-significant. Similar results were observed on small and medium farms in mid and late season cauliflower. On large farms, in mid and late season cauliflower, the production elasticities of fertilizers and plant protection measures were positive but non-significant. Table 5 shows the marginal value productivities (MVPs) of input factors used on different sizes of farms in early, mid and late season cauliflower. In case of early season cauliflower on small farms the MVPs of human labour, fertilizers, irrigation and plant protection measures were Re. 0.26, 2.58, 1.95 and 3.26, respectively. The low MVPs of human labour indicate that the level of use of this resource had already reached a point where no scope was left to yield profit by incurring additional investment on this input. However, the MVPs of

TABLE 5

Marginal value productivities (MVPs) of input factors used on different sizes of farms in early, mid and late season cauliflower

Size of farm	Marginal value productivity			
	X_1 (Rs.)	X_2 (Rs.)	X_3 (Rs.)	X_4 (Rs.)
Early season cauliflower				
Small	0.26	2.58	1.95	3.25
Medium	1.80	2.60	1.98	2.59
Large	2.20	0.42	2.28	1.41
Mid season cauliflower				
Small	0.41	3.54	2.68	2.53
Medium	1.76	2.80	2. 6	2.28
Large	1.80	0.12	2.98	0.49
Late season cauliflower				
Small	0.16	3.18	1.61	1.54
Medium	1.43	3.45	2.01	2.03
Large	1.57	0.53	2.87	0.62

fertilizers, irrigation and plant protection measures suggested that there was a scope to increase their level of use to enhance the profit. On medium farms the MVPs of all the variables indicated the scope of their further use. on large farms, the MVPs of all the variables were positive and greater than Re. 1.00 except for the fertilizers where it was positive but less than Re. 1.00. Similar findings were observed on small and medium farms in mid and late season cauliflower. On large farms, the MVPs of fertilizers and plant protection measures were positive but less than Re. 1.00 in mid and late season cauliflower.

Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 342—347 (June 1983)

PLANNED CHANGE AS A FACTOR IN MODERNIZATION— A STUDY OF TWO HARYANA VILLAGES

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(Received : November 25, 1981; Revised : June 23, 1982)

ABSTRACT

The study, conducted with 368 respondents in two villages of Nilokheri block of Haryana State, revealed that though modern orientation and adoption of improved technology are significantly associated, yet the planned change has exercised significant influence more on adoption of improved technology than on value-orientation. This falls in line with a major generalization that material aspects of culture undergo change more rapidly than non-material ones. The findings suggest that traditional values are not always opposed to the modern beliefs and practices. This is in contrast with the Western scholar's assertion that tradition and modernity are two polar opposites which cannot exist together. The study suggests that the process of modernization can be accelerated with the gradual increase in contact with client system, financial inducements and greater participation in developmental organisation.

Among the various forces promoting modernization in the traditional societies like ours, induced or planned change is of special significance, particularly, in the rural context. The rural development as a programme of planned change has worked as powerful instrument for modernization since its inception in 1952. The process of modernization has been accelerated in the State of Haryana since its emergence in the year 1966. However, a little attempt has been made to measure the impact of planned change on the modernization of people of Haryana. Most of the available studies are confined mainly to the adoption of new practices, with little attention to the changing value-orientation. These studies have hardly examined all the aspects of planned change in relation to modernization.

The present study was, therefore, designed with a view to meet the following objectives :

1. To assess the effects of the programme of planned change on modernization of village people.
2. To ascertain relationship between modern value orientation and adoption of modern practices.

METHODOLOGY

The study was conducted in two villages of Nilokheri block of Haryana State. All the 368 households, 98 in Unispur and 270 in Karsadod, were covered under the study. The data were collected with the help of an interview schedule. Secondary information pertain-

ing to financial assistance was also used. Planned change was conceived as a deliberate and collaborative process involving change agent and client system in solving a problem (Bennis *et al.*, 1962).

An exposure to the planned change was measured by considering the participation in developmental organization, contact with extension agency and financial assistance received by the target people.

Modernization is viewed as a process of adoption of new beliefs and practices (Loomis, 1967). Accordingly it was measured through (1) adoption of new beliefs as reflected in individuals' orientation and attitudes concerning such life aspects as caste, family, religion, etc.; and (2) adoption of improved technology in the field of agriculture, animal husbandry and public health. Based on the literature on the subject (Weber, 1947; Sen, 1973; Sharma, 1979), eight measures of modern orientation were considered in this study: non-traditional orientation, rationality, secular orientation, achievement/mobility orientation, non-fatalism, egalitarian orientation, universalistic orientation and knowledgeability. Composite scores for both adoption of improved technology and modern orientation were used.

RESULTS AND DISCUSSION

The analysis of data reveals that the programme of planned change did not provide equal opportunities to the people. Hence, an exposure of the respondents to components of planned change has been differential as shown in Table 1.

A majority of the respondents was found in the lowest exposure category, remaining were in high or moderately exposed categories. If the programme of planned change was aimed at inducing

TABLE 1

Distribution of respondents according to their exposure to planned change (N=368)

S. No.	Exposure	Number	Percentage
1.	Extension contact		
	High	70	19.0
	Moderate	100	27.2
	Low	198	53.8
2.	Financial assistance		
	High	90	24.5
	Moderate	81	22.0
	Low	197	53.5
3.	Social participation		
	High	65	17.7
	Moderate	116	31.5
	Low	187	50.8

change in people's thinking and doing, the differential exposure must have exercised varying influence on the people's modern orientation and adoption behaviour.

It is evident from Table 2 that though more respondents with high extension contacts were high in their modern orientation, yet the relationship between extension contact and modern orientation was not found significant ($x^2=5.7$, d.f.$=2$, $p=>.05$).

The relationship of the extension contact with the adoption of improved practices (Table 2) shows that the respondents with high extension contact (82.9%) were good adopters. This percentage is significantly low (12.1%) with regard to the respondents with low extension contact. The chi-square test indicated a highly significant association of improved technology with extension contact ($p<.01$). The coefficient of contingency has revealed quite strong relationship between both the variables.

Perusal of data in Table 3 reveals that the percentage of respondents with high modern orientation increases with the respective increase in the degree of financial gains which people have received from the programme of planned change. But the difference among the respondents with respect to their modern orientation is not very striking. The chi-square test indicated that the association between these two variables is not significant ($p>.05$).

Data in Table 3 also indicate that the financial gain is positively associated with adoption of improved technology, i.e., higher the financial gain greater the percentage of respondents with high adoption. It implies that in a group of low financial gain, more people are found with low adoption behaviour. The chi-square test revealed that these two variables are significantly associated ($p<.01$). A fairly strong association between them is evident from the coefficient of contingency (0.3890).

TABLE 2

Distribution of respondents by extension contact and modernization

Extension contact	Modern orientation			Adoption of improved technology		
	High	Low	Total	High	Low	Total
High	30 (42.9)	40 (57.1)	70 (100)	58 (82.9)	12 (17.1)	70 (100)
Moderate	41 (41.0)	59 (59.0)	100 (100)	63 (63.0)	37 (37.0)	100 (100)
Low	59 (29.8)	139 (70.2)	198 (100)	24 (12.1)	174 (87.9)	198 (100)
Total	130 (35.2)	238 (64.8)	368 (100)	145 (39.4)	223 (60.6)	368 (100)

Values in parentheses are the percentages.

Chi-square value=5.7; d.f.=2
Non-significant $p>.05$
Coefficient of contingency=0.1245

Chi-square value=140.3; d.f.=2
Significant $p<.01$
Coefficient of contingency=0.5254

TABLE 3

Distribution of respondents by financial assistance and modernization

Financial assistance	Modern orientation			Adoption of improved technology		
	High	Low	Total	High	Low	Total
High	40 (44.4)	50 (55.6)	90 (100)	67 (74 4)	23 (25.6)	90 (100)
Moderate	28 (34.6)	53 (65.4)	81 (100)	31 (38.3)	50 (61.7)	81 (100)
Low	62 (31.4)	135 (68.6)	197 (100)	47 (23.9)	150 (76.1)	197 (100)
Total	130 (35.2)	238 (64.8)	368 (100)	145 (39.4)	223 (60.6)	368 (100)

Values in parentheses are the percentages.

Chi-square value=4.6; d. f.=2

Non-significant $p>.05$

Coefficient of contingency=0.1111

Chi-square value for the total sample=66.0; d. f.=2

Significant $p<.01$

Coefficient of contingency=0.3890

We shall now turn to the study of modernization in relation to the participation in the developmental organisations. As in the case of two measures of exposure of planned change, this also seems to be positively related with the modernization. Table 4 reveals that as we proceed from low to high degree of participation in developmental organisations, the percentage of respondents with high modern orientation tends to increase. It implies that the respondents with higher participation scores have figured more in high modern orientation category. The association between the two was found to be statistically significant ($p<.05$).

As in case of modern orientation, adoption of improved technology is also found to be positively and significantly associated with the participation in developmental organizations. The percentage of respondents with higher adoption scores increased with the respective increase in their level of participation. The chi-square test has indicated highly significant association between the two ($p<.01$). The values of coefficient of contingency revealed fairly strong relationship between social participation and adoption of improved practices (0.3459).

It will be of crucial importance to examine whether the orientation of an individual has anything to do with his action. The relationship between modern orientation and adoption level has been shown in Table 5. It provides that the greater percentage of the respondents with high modern orientation are high adopters as compared to those with low modern orientation. Similarly, the percentage of low adopters is much more pronounced among the respondents with low modern orientation. The chi-square test has indicated highly significant association between modern value-orientation and adoption of improved technology ($p<0.01$).

The findings of the study suggest that the people with folk values resist while

TABLE 4

Distribution of respondents by social participation and modernization

Social participation	Modern orientation			Adoption of improved technology		
	High	Low	Total	High	Low	Total
High	30 (46.2)	35 (53.8)	65 (100)	47 (72.3)	18 (27.7)	65 (100)
Moderate	44 (37.9)	72 (62.1)	116 (100)	53 (45.7)	63 (54.3)	116 (100)
Low	56 (29.9)	131 (70.1)	187 (100)	45 (24.1)	142 (75.9)	187 (100)
Total	130 (35.2)	238 (64.8)	368 (100)	145 (39.4)	223 (60.6)	368 (100)

Values in parentheses are the percentages.

Chi-square value=6.04; d. f.=2
Significant $p<0.05$
Coefficient of contingency=0.1271

Chi-square value=50.0; d. f.=2
Significant $p<0.01$
Coefficient of contingency=0.3459

TABLE 5

Distribution of respondents by modern orientation and adoption of improved technology

Modern orientation	Adoption of improved technology		
	High	Low	Total
High	66 (50.7)	64 (49.3)	130 (100)
Low	79 (33.2)	159 (66.8)	238 (100)
Total	145 (39.4)	223 (60.6)	368 (100)

Values in parentheses are percentages.

Chi-square value=10.9, d. f.=2, Significant $p<.01$
Coefficient of contingency=0.1696

those with urban values accept change readily. In Redfield's (1955) model of folk-urban continuum, the peasant society is considered to be intermediate between folk and urban society. In such societies, some individuals have value system expected in folk society while others have value system of urban society. Srinivas (1966) opines that the technology and traditions may be two distinct and discrete areas of culture and, therefore, existence of folk or traditional values do not always come in the way of adopting modern technology.

The study has rejected the assumption that in traditional societies people are always averse to change towards new beliefs and practices. It has been observed that people are everywhere adopting a progressive outlook and practices. The study has refuted the common notion of some Western scholars that traditional values and modern practices cannot exist together (Lerner, 1964). Two sets of forces have worked to bring this change towards modernization : (1) planned change and (2) other forces. It is assumed that the programmes of planned change have

initiated the process of modernization and also intensified some other forces of the modernization which were already operating in Indian villages.

It is not difficult to provide explanation to our findings. The contact with change agents overcomes geographic isolation of the rural people and brings them in contact with modern ideas and practices and induces them to accept change. However, all people are not in a position to accept them since some of the innovations are costly. Financial assistance may partly overcome the resource constraint in modernising the ways of doing and thinking. Social participation provides people an opportunity to involve themselves actively in planning and executing the programme of change. Also, such participation widens mental horizon owing to the opportunity of contact with people of new ideas and practices.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 2, pp. 348—352 (June 1983)

CONFORMITY AND SCIENTIFIC PRODUCTIVITY AMONG FARM SCIENTISTS

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(Received : December 21, 1981; Revised : August 10, 1982)

ABSTRACT

The study revealed that the farm scientists were mild non-conformists. It was also observed that the scientists, who were Ph.D., had more experience and guided some post-graduate students, were more non-conformists. Though it had very low correlation with the publication score, an indicator of scientists' productivity, yet further analysis revealed that scientists, who were low on conformity status had high publication score.

A study of biography of some of the ancient scientists such as Paracelsus, Copernicus, Galileo Galilei, etc. reveals that most of them were unorthodox, skeptic, protestants, and resolute in their thinking and behaviour. They used to look at them with an inquiring, inquisitive, interrogative and analytical mind rather than accepting the phenomenon *per se*. Several authors and researchers (Roe, 1961; Cattell, 1963; Hinrichs, 1963; Heiman, 1965; Raudsepp, 1965; Smith, 1967; Hofstede, 1972) have mentioned that scientists are more egoistic, self-centred and unsocial. It suggests that they neither accept the status-quo nor easily conform to all the aspects and norms. They evaluate each aspect on merits and express their dissent insolently, if need be. Handy (1976) also observed that more intelligent people conform less readily. The job of the scientists also demands them to be more inquisitive as their role is to discover unknown facts or verify the dubious one. Keeping these observations in view, a study was conducted to know the conformity tendency of farm scientists and its relationship with their antecedent variables. The subjects comprised 130 scientists of varying background belonging to a leading agricultural University in India.

The concept of conformity. Conformity has been defined as a change in behaviour toward or belief about a group resulting from real or imagined group pressure (Kiesler and Kiesler, 1969). According to them, it may be either 'compliance' i. e. when overt behaviour becomes more in line with that of desired by the group or 'private acceptance' which refers to a change in attitude or belief in the direction of group attitudes or beliefs. It implies not only an overt change in the

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behaviour but also internal acceptance of the group values necessitating the change.

Handy (1976) explained that an individual's response to group norms can be of three types :

(i) Compliance : complying as a matter of convenience but without real conviction.

(ii) Internalization : fully accepting the group norms.

(iii) Counter-Conformity : rejecting the norms or the group or both.

Conformity, thus, seems to be in two forms. The concept of 'compliance' as explained by Handy (1976), and by Kiesler and Kiesler (1969) seems to be the same. Handy's approach of 'internalization' is more or less similar to the one described by Kiesler and Kiesler as 'private acceptance'. By conformity we, therefore, mean the acceptance or the feeling of acceptance of group/majority norms/ decisions. While non-conformity is opposite to conformity i. e. the rejection of group norms or desire to express his personal feelings/desires or act according to his own decision/conviction though it may be against the wishes of the majority or group. The concept of 'non-conformity' is closer to Handy's concept of 'counter conformity'.

METHODOLOGY

To measure the feeling of conformity Rao's (1968) scale was used. The scale has 14 hypothetical situations, each having three possible outcomes. One of them represents the feeling of conformity, another represents non-conformity and the third one indicates neutrality or undecidedness. The statements representing conformity were scored as 1, neutral statements 0 and the statements indicating non-conformity as —1. Thus, the possible range of score could be 14 to-14. Higher the score more is the conformity, conversely, lesser the score more is the feeling of non-conformity.

The scientific productivity was measured in terms of publication score, which was worked out with the following formula.

$$\text{Publication Score} = \frac{\frac{PC_{ij}}{NA_{ij}}}{NY} + K_{ASETPs}$$

Where

PC_{ij} = Prestige class of ith journal in which jth article was published.

NA_{ij} = Number of author(s) of jth article published in ith journal.

NY = Number of years of which the data have been calculated. In the present study, the publications of last 5 years were considered and hence it was 5.

K_{ASETPs} = Constants due to antecedent factors, such as academic status (A), supervisory status (S), Experience (E), time devoted to research (T) and number of post-graduate students guided (Ps), worked out with the approach suggested by Harvey (1960).

Details about the rationality of the technique can be seen in a comprehensive paper by Laharia and Singh (1977).

RESULTS AND DISCUSSION

The respondents seemed to be mild non-conformists as the mean score was —3.44. It supports our premise as well as observations of other workers such as Roe (1961), Heiman (1965), Raudsepp (1965), Handy (1976), etc. that scientists, by and large, are non-conformists and egostic. The variation among them was less (S. D. and C. V. 0.64 and 18.54, respectively), indicating high homogeneity in the sample. The low value of S. E. (0.056) also shows the high reliability of the estimates.

Conformity Score and Antecedent Factors

The respondents were also classified in different categories on the basis of their background factors. The category-wise mean conformity scores and t/F values are presented in Table 1.

The perusal of Table 1 reveals that supervisory status and time devoted to research has no relation with the conformity feeling. The conformity score of Ph.D.s, however, is significantly lower which means they are more non-conformists than non-Ph.D.s. The findings are in line with Handy's (1976) observations. Similarly, persons having experience of five or more than five years are more non-conformists. The respondents having some experience of guiding post-graduate students have also been found non-conformists. The data, thus, suggest that the scientists who were Ph.D.s, more experienced and guided some post-graduate students tended to be individualists and non-conformists. They would prefer to work in their own way and assert their point of view rather than following the beaten track. However, it does not mean that they are social deviates. It only implies that they would prefer to express

TABLE 1

Conformity score of respondents classified on the basis of antecedent factors

S. No.	Criteria	Category	Mean score	t/F
I	Academic background	1. Ph.D.	—4.19	2.31*
		2. Non-Ph.D.	—2.92	
II	Supervisory status	1. Supervisory	—4.00	0.57
		2. Non-supervisory	—3.53	
III	Experience	1. Upto 5 years	—2.36	6.20*
		2. Between 5-10 years	—3.43	
		3. More than 10 years	—4.76	
IV	Time devoted to research	1. One-third	—3.31	1.92
		2. Two-third	4.43	
		3. Full	—3.19	
V	Number of post-graduate students guided	1. Nil	—3.11	4.53*
		2. Upto 5	—4.84	
		3. More than 5	—5.57	

*Significant at 5% level of significance

their feelings even if it opposes the established norms, and endeavour to pursue their line of work.

Conformity Status and Scientific Productivity

The data reveals that the conformity score has very low correlation (—0.029) with the publication score. However, to have a deep insight of the situation, the data were further analysed. The range of conformity score was worked out and the six class-intervals of equal width were formed. The mean publication score of the respondents falling in each class interval is shown in Table 2. The data reveal some salient observations. First is the concentration of respondents in the range of 0 to —5. It suggests that most of them are mild non-conformists. Secondly, high F value tells that these class-intervals differ significantly with one another with respect to their publication score. To ascertain the differing classes, t test was applied. The t values of all possible pairs have also been given in Table 2. It provides a striking information that the last two class-intervals (having maximum mean publication score) are significantly different from rest of the four lower classes in their mean publication scores. It suggests that persons having lower conformity score (i. e. non-conformists) have more publications. Though the correlation coefficient is weak, yet the t analysis provides a clue of the general trend. Low correlation may be due to more variation in publication score than conformity score.

Thus, the study reveals that the respondents were mild non-conformists. It was also observed that the scientists, who were Ph.D.s, had more experience and guided some post-graduate students, were more non-conformists. Though, it had

TABLE 2

Conformity score and mean publication score of different categories

Conformity category	I	II	III	IV	V	VI
Conformity score	6 to 4	3 to 1	0 to —2	—3 to —5	—6 to —8	—9 to —12
f	4	29	50	32	10	5
Mean publication score	4.82	4.25	4.61	5.29	9.44	9.47
			t Value			
I		0.633	0.239	0.522	4.620*	4.079
II		—	0.667	2.417*	6.758*	5.146
III			—	1.789	8.186*	6.127*
IV				—	6.803*	5.160*
V					—	0.033
VI						—

F value : 21.93*

*Significant at 5% level of significance

very low correlation with the publication score, yet further analysis revealed that scientists, having low conformity score, had high publication score.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 353—358 (September 1983)

COMPARISON OF DIFFERENT METHODS OF CORRECTING WEANING WEIGHT FOR AGE IN NALI PURE BRED, CORRIEDALE × NALI AND MERINO × NALI CROSSBRED SHEEP

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ABSTRACT

Various age correction factors were developed to predict weaning weights in Nali, Corriedale × Nali and Merino × Nali sheep. Mean comparison indicated that weight recorded at average age of 90 days of flock predicted least biased weaning weight. The predicted weights by various age correction factors had highly positive correlations. Heritability of both actual and predicted weaning weight was very low, indicating that adjustment of data for non-genetic factors or age differences had no influence on it.

The general practice is to wean all the lambs in a flock on a fixed day or date instead of a fixed age. Though it curtails the labour and managemental problems, it results in a great deal of variation in the weaning weights due to differences in the age of the lamb at the time of weaning. Several reports have indicated significantly high association between age and corresponding weight at weaning. The age correction factors should be developed which could be applied to weaning weight for predicting it at a fixed age (Warwick and Cartwright, 1958; Notter *et al.*, 1975; Gregory *et al.*, 1976).

Several statistical factors have been developed for correcting the differences in age at weaning. Efficiencies of these factors were evaluated by comparing heritability estimates and working out correlations of age corrected weight with actual weaning weight (Harrington *et al.*, 1962; Robertson, 1969; Gregory *et al.*, 1976, 1977a, b).

In the present study an attempt was made to compare various age correction factors and their relative efficiencies with a view to identify the best possible criterion of predicting weaning weight in an organised form.

MATERIAL AND METHODS

Data for this investigation were recorded on Nali, Corriedale × Nali and Merino × Nali sheep maintained in the sheep farm of Animal Breeding Department, Haryana Agricultural University, Hissar. Body weights of 258 lambs born in the year 1978 during March-April (season I) and Aug.-Sep. (season II) were recorded at birth and at weaning according to the following criteria :

Symbols used	Criteria	Average age of flock (days)	Range (days)
WW_1	When the first lamb in the flock was of 90 days	67	39-90
WW_2	When the average age of the flock was 90 days	90	69-113
WW_3	When the last lamb in the flock was of 90 days	117	90-140
WW_4	When each individual lamb in the flock was actually of 90 days	—	—

All the lambs were weaned at 90 days of age. Effects of several non-genetic factors (sex, season, partity, weight of dam at lambing and birth weight of lamb) on weaning weight were evaluated by least-squares method of fitting constants, and the data were adjusted for significant effects. The data were pooled over all the genetic groups, owing to non-significant differences.

Several age correction factors (bi values) used for correcting the weaning weight (WW_1, WW_2 and WW_3) on unadjusted and adjusted data were :

1. Simple regression of weaning weight on age.
2. Intrasire regression of weaning weight on age.
3. Weight per day of age i.e. Y_1/X_1, where Y_1 is weight and X_1 is age of the ith lamb at weaning.
4. Average daily gain i.e. $\frac{Y_1-B_1}{X_1}$, where B_1's are corresponding birth weights.
5. Standard daily gain i.e. $\frac{Y_1-SBW}{X_1}$, where SBW is standard or average birth weight.

These b_1 values were used to predict the 90 days weaning weight for each of the three criteria (WW_1, WW_2 and WW_3) separately by the prediction equation $Y_{90}=Y_1+b_1(90-X_1)$.

The efficiency of different age correction methods was done on the basis of means, correlation coefficients and heritability estimates and the comparison of predicted with actual 90 days weaning weight.

RESULTS AND DISCUSSION

Means Comparison

Average weaning weights as predicted by different criteria, without and with age corrections applied on unadjusted and adjusted data are presented in Table 1. The average age for actual 90 days unadjusted weaning weight was 10.9 kg, whereas the adjusted average weaning weight was 10.2 kg. Taking these averages as the base, comparisons of various age correction factors and different criteria of recording weaning weights were carried out. Averages for WW_1 prior to age corrections were 9.3 and 8.8 kg for unadjusted and adjusted data, respectively. The corresponding averages for WW_2 were 11.1 and 10.4 kg, and for WW_3 were 12.3 and 11.5 kg. Variation in these weights by different

TABLE 1

Means and standard errors of uncorrected and age corrected weaning weight (kg) on unadjusted and adjusted data

Particulars	Unadjusted			Adjusted		
	WW_1	WW_2	WW_3	WW_1	WW_2	WW_3
Without correction for age	9.3*±0.17	11.1±0.20	12.3*±0.21	8.8*±0.16	10.4±0.19	11.5*±0.20
With age correction by						
Simple regression	10.7 ±0.17	11.1±0.19	10.7 ±0.21	10.9*±0 16	10.4±0.18	9.7*±0.19
Intrasire regression	10.3 ±0.17	11.1±0.20	11 1 ±0.21	10.7*±0.17	10.4±0.18	9.6*±0.19
Weight per day of age	12.9*±0.25	11.2±0.20	9.6*±0.16	12.0*±0 22	10.3±0.18	9.0*±0.15
Average daily gain	11.7*±0.23	11.1±0.20	10.2*±0 16	10.8*±0 21	10.4±0.18	9.6*±0.15
Standard daily gain	11 7*±0.23	11.1±0.20	10 2*±0.16	10.8*±0.21	10.4±0.19	9.6*±0.15
No. of observations	225	223	215	222	218	213
Average age (days)	67.48	90.22	116.56	67.48	90.22	116.56
Actual 90 days weaning weight (WW_4)		10.9±0.20			10.2±0.18	

*Estimates differ significantly from mean of WW_4.

criteria was due to differential average age for each of the criteria, and this difference was reduced by applying age correction factors on WW_1 and WW_3. Perusal of means for age corrected weights for different criteria of weaning weight indicated that the means for WW_2 were not significantly different from actual weaning weight. Therefore, the actual 90 days weaning weight of a lamb may be predicted from its weight recorded on the day when average age of the flock was 90 days (WW_2) after applying any of the age correction factors. However, the average weaning weight of the flock by WW_2 criterion may be taken as best representative of actual 90 days weaning weight without any adjustment or correction for weaning age. The other criteria viz., WW_1 and WW_3 with or without age correction were poor estimate of actual weaning weight. Out of the five age correction factors, only regression technique (simple or intrasire) could be found suitable under the conditions when estimates are used without adjusting the data for significant non-genetic differences. Gregory *et al.* (1976) also observed least biasness in the weight recorded at 90 days average age of flock (WW_2) and found it to be as most reliable estimate of actual weaning weight, after applying any one of the five age correction factors.

Correlation Coefficients

The correlation coefficients of predicted weaning weights by different criteria (after applying age correction factors) with actual 90 days weaning weight ranged between 0 86 and 0.97.

Though WW_2 gives a least biased estimate, yet the ranking of the individuals is likely not to be affected significantly either on basis of WW_1 or WW_3 because of the fact that each measure is a component of the 90 days weaning age directly or indirectly. These results are in agreement with those of Warwick and Cartwright (1958) and Gregory *et al.* (1976). All the age correction factors used in the present study were found to be equally efficient on the basis of correlation coefficients of age corrected weaning weights with actual weaning weight. Similar results were also obtained by Harrington *et al.* (1962), Robertson (1969) and Gregory *et al.* (1977a).

Heritability Estimates

Heritability estimates of weaning weights (by different criteria and corrections) are presented in Table 2. All these estimates on actual or predicted weaning weight basis were low. Any adjustment for significant non-genetic differences or for differential age of lambs on the day of weighing had little influence on the heritability estimates. These observations are in agreement with the findings of Harrington *et al.* (1962) and Gregory *et al.* (1977b).

From the results obtained in the present study it may be observed that the practice of recording weight on a fixed day instead of fixed age of the lamb shall give a reliable prediction of actual weaning weight particularly if recorded on the day when average age of the flock is the same as the standard weaning age, thereby reducing the managemental problems. Further, it can be observed that any of the age correction factors may be used as per convenience. However, in case the recording on birth weight is not available, regression methods may

TABLE 2

Heritability estimates alongwith standard errors of weaning weight on unadjusted and adjusted data with and without correction for age

Particulars	Unadjusted				Adjusted			
	WW_1	WW_2	WW_3	WW_4	WW_1	WW_2	WW_3	WW_4
Without correction for age	0.13±0.17	0.21±0.18	0.32±0.21	0.09±0.16	—	—	—	0.04±0.16
With age correction by								
Simple regression	<0	<0	0.07±0.16	—	0.08±0.15	<0	<0	—
Intrasire regression	<0	<0	0.11±0.17	—	0.08±0.15	<0	<0	—
Weight per day of age	0.05±0.15	0.03±0.15	0.12±0.16	—	0.32±0.21	0.08±0.16	0.02±0.15	—
Average daily gain	<0	0.01±0.14	0.11±0.17	—	0.22±0.18	0.01±0.12	<0	—
Standard daily gain	<0	0.05±0.15	0.14±0.18	—	0.19±0.18	<0	<0	

effectively be used without loosing the efficiency of prediction.

ACKNOWLEDGEMENTS

The award of merit fellowship to the first author by Haryana Agricultural University, during the tenure of study is thankfully acknowledged.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 359—361 (September 1983)

RECOVERY OF ADULT *HAEMONCHUS CONTORTUS* DEVELOPED FROM DOUBLE VACCINATED GOATS WITH IRRADIATED LARVAE

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ABSTRACT

The development of *Haemonchus contortus* infective larvae irradiated at 60 Kr in goats double vaccinated showed 75.67 and 58.50 per cent worm load in parasite native and worm free animals, respectively. In parasite native, no male parasite was recovered and in worm free only 9 males were collected. The damage was noted in female worms.

Gamma rays could cause vacuolization of cell plasma, pyknosis of nuclei and later disintegration of cells, tissues and organs (genital). It also damages the male larvae more than the females either through some morphological abnormalities of the male gonads or through a selective destructive effect on the larvae which were to develop into male worms. In female worms pronounced inhibition of oogenesis occurred along with some morphological abnormalities in their reproductive organs like cuticular thickening of the vulva and vagina, and degeneration and atrophy of the uterus (Jovanovic *et al.*, 1965). Miller (1971) mentioned that these females usually did not lay eggs or laid infertile eggs So the environmental contamination and endemicity of the disease were also reduced by such vaccination. Thus, this study was conducted to see the recovery of adult *H. contortus* worms developed from experimentally double vaccinated goats with irradiated larvae.

MATERIAL AND METHODS

During culture, female worms were cut on slide in small pieces then triturated gently in glass mortar pestle with little 0.1% sodium carbonate. This material was put to charcoal faecal culture (Roberts and O'Sullivan, 1950) to obtain the third stage infective larvae.

The cleaned larvae were suspended in suitable volume of cold isotonic saline solution and larvae in 0.1 ml suspension were counted. After this, the volume was adjusted for 1000 to 1500 larvae/ml. The separate glass vials were prepared for 2000, 5000, 10,000 larvae for future use. No antibacterial or antifungal agent was added. These vials were stored at 5 to 10°C for use in vaccination infection of the experimental goats.

Irradiation of larvae was done as per method of Mulligan *et al.* (1961) with a little modification. The irradiation was

carried out in gamma chamber 900 with cobalt 60 source (Bhabha Atomic Research Centre, Bombay). The irradiated larvae were maintained at 20–25°C. The rate of irradiation dose 500 r/min was kept for two hours to achieve 60 Kr dose (the instrument was running in half life). The irradiation and vaccination were performed within 25 days of harvest of the larvae from the culture. The required number of irradiated larvae in the vials were suspended in suitable volume of cold physiological saline and given orally to each goat with a plastic syringe. All the seven animals were housed in disease free environment and were maintained on wholesome and nutritious diet.

The goats were sacrificed on day 105 post first vaccination. The worms were recovered from abomasa of the goats and males/females were counted and recorded.

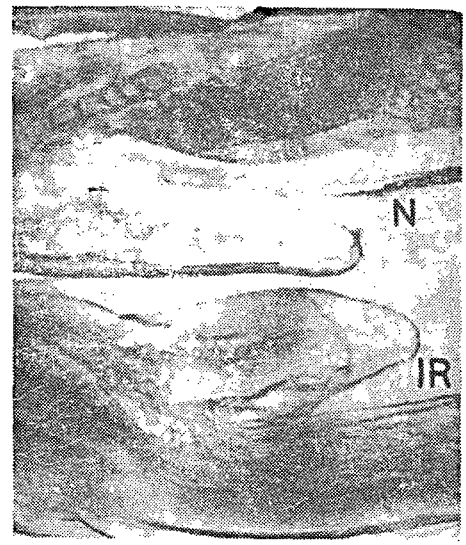


Fig. 1. (N) Mid body of normal adult female worm showing eggs intact and normal size valvular flap.
(IR) Mid body of adult sterile female worm developed from irradiated/60 Kr larvae showing stunted valvular flap of *H. contortus*.

TABLE 1

Recovery of adult *H. contortus* worms from experimentally double vaccinated goats* at necropsy

Group	Goat No.	Worms recovered at necropsy**				Remarks
		Adult		Mean	Earlier stages	
		Male	Female			
Parasite native	12M	NF	NF	75.67	24.6	The goat died on 20th day after 1st vaccination
	15M	Nil	61		Nil	
	17M	Nil	78		Nil	
	39M	Nil	88		Nil	
Worm free	14F	NF	NF	58.50	130	The goat died on 29th day after 1st vaccination (Most of the female worms were in early 5th stage)
	18M	8	52		Nil	
	33M	1	65		Nil	

N. B. The size of both male and female worms appeared to be reduced in both the groups as compared to the normal.

*The goats were vaccinated with 2000 (IR) larvae on day 0 followed by 5000 (IR) larvae on day 35, orally.

NF—Not found.

**The goats were sacrificed on day 105 post first vaccination.

RESULTS AND DISCUSSION

The development of *H. contortus* infective larvae, irradiated at 60 Kr in goats after double vaccination has been shown in Table 1. In parasite native animals the mean worm load appeared to be 75.67, whereas in worm free it was 58.50. But in case of parasite native animal no male parasite was recovered and in worm free a small number i.e., 9 male parasites were collected. The details of adult female developed out of these irradiated larvae have been shown in Fig. 1. This indicated that male larvae were more susceptible to the effects of irradiation than the female. This finding is in accordance with Miller (1971) who reported that these females usually did not lay eggs or laid infertile eggs avoiding environmental contamination.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 362—365 (September 1983)

EFFECT OF CHOPPING GREEN FORAGE ON MILK PRODUCTION AND COMPOSITION IN MURRAH BUFFALOES. II. KHARIF FODDER (SORGHUM)

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(Received : January 29, 1982; Revised : September 24, 1982)

ABSTRACT

The average DM intake was 2.69, 2.62 and 2.70 kg per 100 kg body weight with DM digestibility coefficients of 55.8, 54.3 and 53.5 in 5, 2.5 and 1 cm cut **jowar**, respectively. The digestibility for CP was 55.6, 57.4 and 53.4; for EE 60.6, 56.7 and 62.8; for CF 56.3, 60.5 and 56.5; and for NFE 63.5, 62.3 and 62.8, respectively. Intake of DCP and TDN was similar in all the 3 treatments. Slightly more milk production was obtained on feeding **jowar** cut into 1 cm bits to milch buffaloes. The results also showed that a slight deficiency of DCP in 5 and 1 cm sized bits did not affect the weight of animal in any way. The actual needs of buffaloes should be worked out independently afresh.

The experiment was planned to investigate into the effect, if any, of the length of chopping of green **jowar** (*Sorghum vulgare*), on milk yield and composition, feed and nutrient intake and digestibility in Murrah buffaloes. The hypothesis was that summer fodder needs chopping in view of comparatively higher proportion of stem in the plant.

MATERIAL AND METHODS

A 3×3 latin square switch over design, repeated thrice, with 3 treatments and 3 periods was used utilizing 9 Murrah buffaloes of almost similar age, stage of lactation and milk yield. Other details of selection of animals, statistical design, management, recording and sampling of milk and digestibility trials have already been reported (Pathak and Pal, 1983). One animal from each triplicate was allotted to each treatment at random. The animals were housed in byre having arrangement for individual feeding. They were milked at 3.00 a.m. and 3.00 p.m. daily. The animals were let loose in the open area provided with loose housing system from 9.00 to 10.00 a.m. for exercise. All the animals were given water shower twice daily at 11.00 a.m. and 2.30 p.m. The study was conducted for 9 weeks during the months of August, September and October, 1978.

Fresh whole green **jowar** was obtained from the University Farm daily as far as possible from the same area to ensure

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uniform stage of growth by staggered planting. Samples of feeds and fodders were analyzed for proximate principles (AOAC,1970). The crude protein varied from 5.04 to 5.63 and the crude fibre from 33.65 to 36.79. Concentrate mixture contained 20.29 crude protein and 7.79 crude fibre. Feaces were also analyzed for proximate composition by the same procedures.

Five cm length fodder was obtained with power chaff cutter fitted with one blade in the chaff-cutter. This ensured 5 cm length as measured occasionally from the bulk. 2.5 cm length bits were also obtained from the same power chaff cutter fitted with two blades. For 1 cm length hand chaff cutter (**Toka**) was used (Treatments A, B & C, respectively).

In each treatment, the chopped forage was offered at the rate of 30 kg daily in two equal instalments. The concentrate mixture having 19.0% DCP was offered @ 0.5 kg per kg milk produced as recommended by Sen and Ray (1971).

RESULTS AND DISCUSSION

Dry Matter (DM) Intake

Average DM intake expressed as kg/100 kg body weight and g/$kg^{0.75}$ was 2.69, 2.62 and 2.70 kg and 124.0, 120.0 and 124.1 g for treatments A, B and C, respectively. Analysis of variance revealed no significant difference between treatments and periods. However, the differences amongst animals were found to be significant ($P < 0.01$).

Nutrients Digestibility Coefficient

The perusal of the data with regards to nutrient digestibility (Table 1) revealed no difference due to treatments. The mean DM digestibility tended to increase with increase in the length of chopped fodder.

Nutrient Intake (DCP and TDN)

The data with regard to daily nutrient intake vis-a-vis requirement are given in Table 2. In treatments A and C, DCP was deficient (—0.057 and —0.052 kg)

TABLE 1

Average body weight, DM intake and digestibility coefficients (means of 3 observations) of various nutrients in different experimental rations

Particulars	Treatment groups		
	A	B	C
Average body weight (kg)	450	453	448
DM intake/100 kg body weight (kg)	2.69	2.62	2.70
DM intake/$W^{0.75}$ kg (g)	124.00	120.00	124.10
Digestibility coefficients			
Dry matter	55.75	54.34	53.45
Crude protein	55.61	57.40	53.39
Ether extract	60.64	56.68	62.76
Crude fibre	56.26	60.45	56.52
Nitrogen free extract	63.48	62.28	62.84

TABLE 2

Average daily milk yield and nutrient intake compared to requirements

Particulars	Treatment groups		
	A	B	C
Milk yield (kg)	6.74	6.78	6.88
FCM yield (kg)	7.09	7.24	7.25
SCM yield (kg)	9.21	9.41	9.52
Fat (%)	6.66	6.55	6.45
SNF (%)	9.94	9.96	10.07
Total requirements (*)			
DCP (kg)	0.691	0.687	0.690
TDN (kg)	6.311	6.330	6.351
Total intake			
DCP (kg)	0.634	0.702	0.632
TDN (kg)	6.741	6.030	7.106

*As per Sen and Ray (1971)

and in treatment B just sufficient (+0.015 kg) to meet the requirement as per Sen and Ray (1971). TDN intake was in excess in all the treatments, i.e., +0.430, +0.712 and +0.756 kg in A, B and C treatments, respectively. Analysis of variance for both DCP and TDN intakes revealed that no significant differences existed between treatments.

None of the experimental animals showed any decline in milk yield or body weight though there was a deficiency of DCP in A and C treatments. Presumably, the DCP requirement of milk production in Murrah buffaloes is less than those for cows. This aspect needs further investigations.

Milk Yield and its Composition

The data for milk yield, FCM and SCM (kg/day) are presented in Table 2. The milk yield tended to increase with the fineness of the cut of the chopped fodder, the highest yield being in case of 1 cm cut. The differences were, however, statistically non-significant. This study confirms the results of Brabander *et al.* (1976) who also observed increased milk and FCM production in finely chopped silage in comparison to coarsely cut silage in dairy cows. It is also in agreement with the observations of Dulphy and Demarquilly (1974) who reported higher milk and FCM yield in short cut silage in comparison to longer one.

The weekly average per cent fat for treatments A, B and C were 6.66, 6.55 and 6.45, and the SNF (%) 9.94, 9.96 and 10.07, respectively. The fat content tended to decline with fineness of cut, while the SNF content tended to increase (Table 2). This is in agreement with Salewski *et al.* (1973), Dulphy and Demarquilly (1974) and Benzenko and Zelner (1978). The reasons for higher fat (%) are complex one and as fat (%) varied

as much as 30% from unknown causes (Foley *et al.*, 1972).

The total feed cost/buffalo/day under A, B and C treatments was Rs. 5.93, 6.01 and 5.95, respectively. When it was calculated on the basis of milk (FCM 6%), the costs were Rs. 0.84, 0.83 and 0.82 per kg, indicating progressive profit of one paisa/kg milk with decrease in size of forage cut.

ACKNOWLEDGEMENTS

One of the authors (JNP) is thankful to the authorities of Assam Agricultural University, Jorhat, for providing fellowship in the pursuit of this study at Haryana Agricultural University, Hissar.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 366—373 (September 1983)

HISTOLOGICAL AND CERTAIN HISTOCHEMICAL STUDIES ON INTERSTITIAL TISSUE OF THE TESTIS OF GOAT

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(Received : March 4, 1982; Revised : May 17, 1983)

ABSTRACT

Seasonal variations had no apparent effect on the histology and histochemistry of the interstitial tissue of the testis of sexually mature goats. Three categories of Leydig cells, based on their nuclear morphology, have been described. The distribution of PAS-positive material, nucleic acids, fats, proteins, alkaline phosphatase and acid phosphatase was recorded.

The interstitial tissue of the testis is believed to produce hormone responsible for functional maturation and maintenance of male genital system. Literature on its histomorphology and histochemistry in goat in relation to different climatic conditions is sparse and scattered. The present studies were, therefore, undertaken to study the effect of different seasons on the histological and histochemical status of interstitial tissue of testis in goat.

MATERIAL AND METHODS

Twenty sexually mature healthy male goats of 2 to 3 years of age were grouped in five. The tissues were collected in autumn (Sep.-Oct.), winter (Dec.-Jan.), spring (March-April) and summer (June-July) for the study of seasonal effects. The testes were surgically removed and small pieces of tissues measuring approximately 3-5 mm^3 were cut by sharp razor and processed for general histological and histochemical studies. The general histological studies were based on Harris haematoxylin and eosin, Mallory's method for collagen fiber, Gomori's method for reticular fibers, and Weigert's method for elastic fibers (Luna, 1968). The histochemical studies were based on McManus method for glycogen, Best's carmine method for glycogen, PAS reaction for glycogen with saliva control, Alcian blue method for demonstration of acid mucopolysaccharides, Feulgen reaction for demonstration of nucleic acid (Luna, 1968), Methyl green-pyronin Y method for demonstration of DNA and RNA (Daoust and Clermont, 1955), Mercury-bromophenol blue method for demonstration of proteins (Pearse, 1968), Gomori's calcium cobalt method for alkaline phosphatase and Gomori's lead nitrate method for acid phosphatase (Thompson, 1966), Sudan black B in propylene glycol (Luna, 1968) and nile blue staining technique for the demonstration of neutral fats and

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fatty acids (Drury and Wallington. 1967). Karyometrics of the Leydig cells nuclei was done on 50 nuclei from each testis. The ratio of intertubular and tubular area was calculated from the microphotographs taken from the different representative areas of the stained sections.

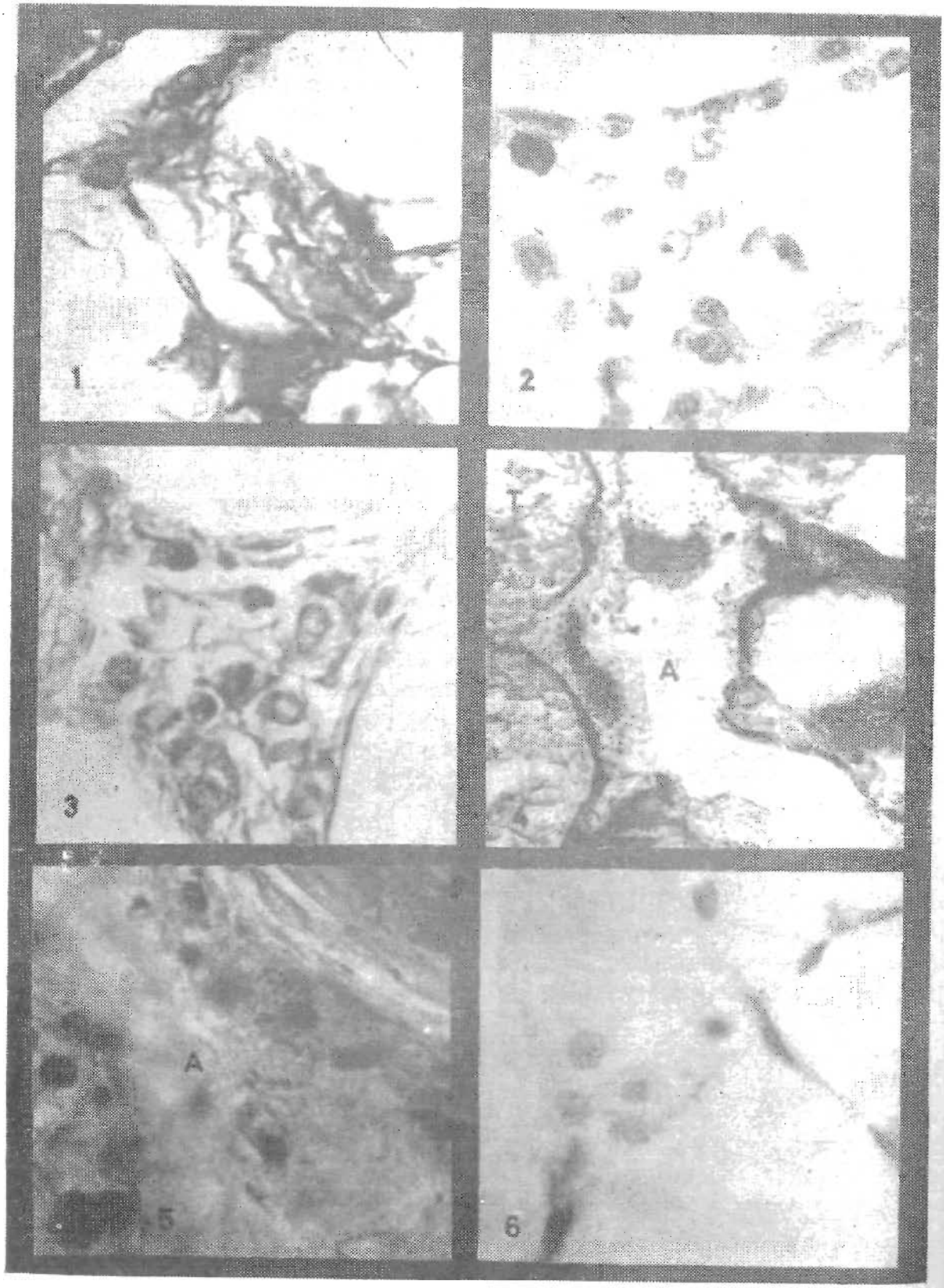
RESULTS

The intertubular area was composed of loose connective tissue and contained mostly fine collagenous and reticular fibers (Fig. 1). Fine elastic fibers were also seen associated with the walls of the intertubular blood vessels and lymphatics The ratio of intertubular to tubular area is shown in Table 1. No marked variation in the intertubular area in relation to tubular area was observed in any season. The intertubular area lodged a variety of cellular components primarily Leydig cells, fibrocytes, fibroblasts in different stages of development and undifferentiated cells (Figs. 2 & 3). Occasionally wandering cells from the circulatory system were also observed. The Leydig cells were spherical or irregularly polyhedral in shape. Their nuclei were usually rounded, vesicular and more or less eccentrically placed. Their nuclear diameter ranged from 3.3 to 6.6 μm. One to three large nucleoli were scattered in the granular chromatin which was distributed predominantly towards the periphery of the nucleus and, thus, resulted in a distinct nuclear membrane. The cytoplasm was lightly eosinophilic and vacuolated. Based on the staining characters, size of the nuclei and position of their nucleoli, three types of Leydig cells were recognised. The Leydig cells type-I were smaller in size and demonstrated weak staining reaction. Their average nuclear diameter was 3.1 μm and were spherical in shape. The chromatin was finely granular and located near the nuclear envelope. The nucleoli were large and central in position. The cytoplasm was scanty and lightly eosinophilic. The Leydig cells type-II were medium sized cells. Their average nuclear diameter was 4.9 μm and were round in shape. The chromatin granules were coarse and located adjacent to the nuclear envelope. The nucleoli were slightly eccentric. The cytoplasm was scanty and faintly stained. The Leydig cells type-III were comparatively large cells. The nuclei were round and measured 6.6 μm in diameter. The granular chromatin was evenly distributed in the nucleoplasm and also along the nuclear envelope. The nucleoli were generally central in position. The cytoplasm was moderate in amount and faintly stained. No marked difference was

TABLE 1

Percentage ratio of seminiferous tubular area and intertubular area in different seasons

Group	Season	No. of Animals	Mean tubular area (%)	Mean intertubular area (%)
I	Autumn	5	64.2	35.8
II	Winter	5	62.4	37.6
III	Spring	5	65.4	34.6
IV	Summer	5	64.0	36.0



Figs. 1—6

observed in their distribution in different seasons. The fibroblasts were oval to spindle shaped. Their nuclei exhibited affinity for basic stains but magnitude of coloration varied depending upon the maturity of the cells. The nucleus of the fibrocytes was spindle shaped and darkly stained. Their cytoplasmic boundaries were rarely perceptible. The nuclei of fibroblasts stained lightly, and their cytoplasmic boundaries were comparatively more pronounced. The undifferentiated cells were somewhat oval in shape. Their nuclei were vesicular and contained one to three coarse chromatin granules. The cytoplasm was abundant and weekly acidophilic but cell boundaries were indistinct.

The cellular components of the intertubular area, particularly the undifferentiated cells and developing fibroblasts demonstrated light PAS reaction. Glycogen was absent in Leydig cells but the fibroblasts and undifferentiated cells exhibited faint reaction. The wall of the blood vessels revealed a moderately positive PAS reaction for glycogen and acid mucopolysaccharides. The Feulgen reaction was strong in the nuclei of type-1 Leydig cell and immature fibroblasts demonstrated moderate to weak reaction. The undifferentiated nuclei were feebly stained. Whereas moderate to intense reaction was observed in the nuclei of endothelial lining cells of lymphatics and blood vessels. No variation in Feulgen reaction was marked in different seasons (Fig. 3). The intensity of reaction for proteins varied in different components. The reaction was moderate in nuclei of the Leydig cells. The nuclear envelope in all cases demonstrated comparatively more reaction. The cytoplasm showed diffuse reaction. Fibrocytes were comparatively more reactive than the fibroblasts. The undifferentiated cells demonstrated a faint reaction. Besides, the endothelial cells of the vessels also exhibited moderate positive reaction. All the cellular components of the intertubular area demonstrated positive alkaline phosphatase reaction (Fig. 2). Moderate alkaline phosphatase reaction was observed in the nuclei of Leydig cells and fibrocytes. The reaction was comparatively weak in undifferentiated cells in the nuclear envelope and lymphatics. Comparatively intense alkaline phosphatase reaction was observed in the endothelial lining cell of the vessels. The

Fig. 1. Microphotograph of the intertubular area of goat testis showing the presence of fibers. Gomori's method for reticulum × 400.

Fig. 2. Microphotograph of the intertubular area of the goat testis showing alkaline phosphatase activity. Gomori's calcium cobalt × 800.

Fig. 3. Microphotograph of the intertubular area of the goat testis showing protein reaction in its cellular and fiberous components. Mercury bromophenol blue × 800.

Fig. 4. Microphotograph of the intertubular area (A) of the goat testis showing acid phosphatase activity in its cellular component. The seminiferous tubule (T) are also seen. Gomori's lead nitrate × 400.

Fig. 5. Microphotograph of the intertubular area (A) of goat testis showing distribution of lipids. T indicates a part of the cross section of the seminiferous tubule. Sudan black B × 800.

Fig. 6. Microphotograph of the intertubular area of the goat testis showing distribution of nucleic acids in its cellular components. Methyl green pyronin Y × 800.

acid phosphatase reaction was mild in the intertubular area (Fig. 4). However, moderate reaction was revealed in the endothelial lining cells of the blood vessels and lymphatics. Neutral fat droplets were also scattered in the intertubular areas. The Leydig cells and fibroblasts usually contained fat droplets of varying sizes in all seasons (Fig. 5). In occasional cases, heavy accumulation of fat droplets were observed adjacent to the blood vessels and lymphatics. The nucleoli of the Leydig cells demonstrated pyronin Y positive reaction (Fig. 6). Their cytoplasm exhibited occasional granules and their distribution did not differ in different types of Leydig cells. The fibroblasts demonstrated RNA positive material in their nuclei, however, the fibrocytes were weakly reactive. The undifferentiated cells showed moderate pyroninophilic reaction.

DISCUSSION

The fibrous component of intertubular area was composed of fine collagenous and reticular fibers and only walls of the intertubular vessels revealed a few elastic fibers. Fawcett *et al.* (1973) reported abundant edematous areolar connective tissue and vessels in the intertubular area of ram, bull, monkey, man, hyrax and elephant. Goyal and Dhingra (1973 a, b) observed collagenous and reticular fibers in the intertubular area with few elastic fibers in the intertubular blood vessels of the buffalo calf testis. No change was recorded in the bulk of interstitial tissue in goat testis in different seasons. Wislocki (1949) reported more voluminous interstitial tissue in deer in rutting season than in the sexually quiescent stage. The intertubular area in different seasons did not exhibit accountable variations in goat. The percentage ratio between the tubular and intertubular areas differed from that of bull (Swierstra, 1966), stallion (Swierstra and Eagen, 1974), boar (Kennelly and Foote, 1964; Swierstra, 1968) and dog (Swierstra and Eagen, 1974). The Leydig cells appeared in goat as groups of two, four or even in chain arrangement. Similar group arrangement was reported in domestic animals (Trautmann and Fiebiger, 1957; Nickel *et al.*, 1973) and buffalo calves (Goyal and Dhingra, 1973b). Kirkpatrick (1955) reported clump and chain arrangement of the Leydig cells in the functional testis of fox squirrel. Dellmann and Wrobel (1981) observed that the interstitial cells form well vascularized groups of polyhedral cells which occupy the spaces between the seminiferous tubules in domestic animals. Weaker (1975) observed, in armadillo, that the Leydig cells were surrounded by lymph sinusoids. In seasonal breeding mammals, the Leydig cells were shrunken in appearance in non-breeding period (Clarke and Forsyth, 1964; Short and Mann, 1966; Tsui *et al.*, 1974). The Leydig cells of goat were spherical or irregularly polyhedral in shape. On the basis of nuclear morphology and position of nucleoli three types of Leydig cells were recorded in goats as have been reported in human testis (Mancini *et al.*, 1963). Four types of fibroblasts in the interstitial tissue of human testis were also reported. The cytoplasm of Leydig cells of goat was lightly stained and vacuolated as has been reported in the Leydig cells of man (Copenhaver, 1964; Ham, 1969). McEnery and Nelson (1953) recorded

coarse granules in Leydig cells nuclei of rat testis. The other cellular components like fibrocytes, fibroblasts and undifferentiated cells were distributed at random in the intertubular area in all the seasons. Aughey (1969) observed that the majority of interstitial cells in pre-rut testis of red deer were small and darkly stained with the general appearance of fibroblasts.

Schiff positive reaction was moderate in Leydig cells and weak in fibroblasts and undifferentiated cells of goat. The Leydig cells exhibited lack of PAS reaction in buffalo calves (Goyal and Dhingra, 1973a) and a weak reaction in Guinea pigs (Cavazos *et al.*, 1961). The glycogen was lacking in the Leydig cells, however, fibroblasts and undifferentiated cells exhibited faint reaction in goat. Similar observation was recorded in buffalo calves (Goyal and Dhingra, 1973a) and man (Montagna, 1952). On the other hand glycogen has been reported in the Leydig cells of bull, stallion, cat (Dellmann and Wrobel, 1981), albino mouse (Baillie, 1964). In deer, glycogen is absent in Leydig cells but present in the wall of the arteries and arterioles (Wislocki, 1949), in breeding and non-breeding periods.

The cellular components of the intertubular area exhibited Feulgen reaction in their nuclei. The intensity of reaction was more in type-II and type-III than in type-I Leydig cell nuclei. Similarly nuclei of fibrocytes and endothelial cells demonstrated comparatively intense reaction than those of the fibroblasts and undifferentiated cells. Protein reactive materials in the nuclei followed the same pattern of distribution as that of Feulgen reaction. Protein reaction was also noticed in the cytoplasm particularly in the cell membranes. Nickel *et al.* (1973) described protein crystalloids in the Leydig cells of the domestic animals. Alkaline and acid phosphatase activity was moderate in the Leydig cells. Similar reaction was reported in buffalo calves (Goyal and Dhingra, 1973a). However, no alkaline phosphatase activity has been recorded in Zebu bull (Rollinson, 1954) and both the enzymes are reported to be absent in the Leydig cells of man (Montagna, 1952; Mancini *et al.*, 1963), Wislocki (1949), while working with deer, recorded absence of both the enzymes in the Leydig cells of Fall and June testis.

The lipids were observed in the cytoplasm of the cellular components and intertubular area in all seasons. Lipid accumulation was more in the cytoplasm of Leydig cells and fibroblasts and sparse in undifferentiated cells. Intertubular area exhibited lipid globules of varying sizes in the vicinity of intertubular blood vessels. Lipids in the interstitial tissue of testis have been reported in goat (Guraya, 1968), bull, ram, cat (Dellmann and Wrobel, 1981), domestic animals (Nickel *et al.*, 1973), rat, mouse, guinea-pig, cat, dog, horse (McEnery and Nelson, 1953), albino mouse (Baillie, 1964), man (Ham, 1969) and buffalo calf (Goyal and Dhingra, 1973a). The Leydig cell lipids were more in breeding period and less in non-breeding period of deer (Wislocki, 1949), red deer (Aughey, 1969) and vole (Clarke and Forsyth, 1964). On the contrary the lipid content was low in peak breeding period and high in non-breeding period in masked civet cat (Tsui *et al.*, 1974) and squirrel monkey (Belt *et al.*, 1974).

The ribonucleic acid was demonstrated both in the nucleoli and cytoplasm of the Leydig cells of the testis of goat. The Leydig cell nucleoli were comparatively more pyronin positive in reaction than those of the fibroblasts and undifferentiated cells. The cytoplasmic RNA exhibited granular appearance in the Leydig cells and was sparse in fibroblasts and undifferentiated cells. Mancini *et al.* (1963) reported cytoplasmic basophilic reaction in different type of Leydig cells in man due to the presence of ribonucleoprotein.

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 374—377 (September 1983)

EFFECT OF ROUGHAGE CONCENTRATE RATIO ON THE WATER INTAKE IN MILCH BUFFALOES

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(Received : January 13, 1982; Revised : December 24, 1982)

Voluntary water intake is known to be influenced by age of animal, climate, level of production, type of the animal and type of feed. The type of feed is reported to be a major determinant of the voluntary water intake, the addition of succulent fodder tending to reduce it (Atkeson and Warren, 1934; Salerno and Malossine, 1967). Present studies were undertaken to find out the water intake of old and young buffaloes under different roughage concentrate ratios.

Twenty four lactating Murrah buffaloes, twelve old (completed seven or more lactations) and twelve young (completed up to 5th lactation), were selected on the basis of their milk yield and stage of lactation. Each set of the animals was divided into three sub-groups with four animals in each. The animals of each sub-group were allotted at random to three roughage concentrate ratios (70 : 30, 50 : 50 and 30 : 70 on TDN basis) in a split plot factorial design. The animals were individually tied in loose house and fed as per their requirement (Sen and Ray, 1971). Green berseem and wheat bhusha were fed in the morning and concentrate mixture consisting of 50 parts barley and 50 parts wheat bran supplemented with two parts mineral mixture and one part common salt, was fed both in the morning and evening at the time of milking. Drinking water was made available in the morning and evening. To determine the voluntary water intake, measured quantity of water was offered in plastic buckets at 10.0 a.m. and 4.0 p.m. once in a week and refusals were measured. The experiment was conducted during winter season of 1978 (January to March, 1978). The moisture content of feed offered was estimated by hot air oven method. The total water consumption was calculated by adding the water intake through feed and fodders, metabolic water and voluntary intake of water. The metabolic water (l/kg) was estimated by multiplying with the factors 0.6, 0.4 and 1.07 of digestible carbohydrate, protein and fat, respectively, as reported by Abrams (1961). The data were statistically analysed by standard method (Snedecor and Cochran, 1967).

Old buffaloes consumed 10.29 litres more water than young buffaloes though the difference was statistically non-significant but total water intake was

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TABLE 1

Average daily water intake (litres) from different sources during the experiment

	No. of buffaloes	Average daily DM intake (kg)	Average daily milk yield (kg)	Voluntary water intake	Water from feed and fodders	Metabolic water	Total water intake
Age group							
Old	12	12.01±0.25^{A}	7.17±0.44	46.40±2.31^{a}	15.17±1.60	4.83±0.21	66.40±2.32^{b}
Young	12	10.88±0.30^{B}	6.18±0.38	36.11±2.16^{a}	14.07±1.55	4.02±0.23	54.20±2.59^{a}
Roughage-concentrate ratio							
70 : 30	8	11.98±0.36	6.67±0.59	38.88±3.31^{a}	20.86±0.64	4.67±0.34	64.43±4.02^{a}
50 : 50	8	11.38±0.31	6.62±0.39	39.56±3.03^{a}	14.79±0.41	4.49±0.29	58.85±3.43^{ac}
30 : 70	8	10.99±0.40	6.75±0.64	45.32±3.34^{b}	8.20±0.47	4.12±0.29	56.32±3.07^{bc}

Means with different superscripts differ significantly ($P < 0.05$).

TABLE 2

Average daily water intake per kg dry matter intake and per kg metabolic body size

	No. of buffaloes	Voluntary intake/kg DM intake (l)	Voluntary intake/kg $W^{0.75}$ (ml)	Total water intake/kg DM intake (l)	Total water intake/kg $W^{0.75}$ (ml)
Age group					
Old	12	3.86±0.19	449.53±24.11	5.45±0.15	635.57±26.44
Young	12	3.32±0.18	379.59±22.20	4.97±0.14	569.73±25.61
Roughage-concentrate ratio					
70 : 30	8	3.21±0.20^{A}	390.36±29.96^{a}	5.35±0.19	647.55±33.84
50 : 50	8	3.46±0.21$^{A\,b}$	407.35±28.20^{ab}	5.15±0.21	606.44±30.37
30 : 70	8	4.11±0.22^{B}	445.97±33.65^{b}	5.13±0.20	553.97±31.03

abc means followed by the same or no lower case letters as superscript do not differ significantly ($P < 0.05$).
AB means followed by the same or no upper case letters as superscript do not differ significantly ($P < 0.01$).

significantly ($P < 0.05$) more in old buffaloes as compared to young ones (Table 1). This higher intake of total water may be due to more body weight and more milk yield in old buffaloes. The values of voluntary and total water intake during present studies are practically same as reported by Pal *et al.* (1973) for milch buffaloes during winter. The consumption of water on per kg dry matter intake as well as per kg $W^{0.75}$ basis in old and young buffaloes was not significantly different (Table 2). However, roughage-concentrate ratios had significant ($P < 0.05$) influence on voluntary water and total water intake (Table 1). The animals in 30 : 70 roughage concentrate ratio drank significantly ($P < 0.05$) more water than animals in 70 : 30 and 50 : 50 roughage concentrate ratios. There was no significant difference between 70 : 30 and 50 : 50 ratio. The results were similar ($P < 0.05$) when the voluntary water intake was expressed as a function of dry matter intake or metabolic body size. But total water intake on per kg dry matter intake and per kg metabolic body size (kg $^{0.75}$) basis was not significantly influenced by different roughage-concentrate ratios. This indicated that the higher voluntary intake in 30 : 70 ratio may be due to lesser water given through feeds. The findings of the present experiment are in agreement with those of Singh and Mudgal (1967), Sebastian *et al.* (1970) and Radadia (1979).

The most significant finding of present study is that buffaloes adjust their total water intake to a uniform level by increasing or decreasing the voluntary water intake depending upon the availability of water from other sources. When the voluntary water intake was expressed as function of dry matter intake on metabolic body size there was a significant ($P < 0.05$) difference in intake between different roughage concentrate groups but total water intake did not show such difference. This capacity of the bovine to adjust its total water intake by increasing or decreasing the voluntary water intake is well known in cattle. Perhaps, this is the first similar report in buffaloes.

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 378—379 (September 1983)

EVALUATION OF TROPICAL FORAGES AS SOURCES OF AMINO ACIDS

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(Received : January 13, 1982; Revised : May 4, 1982)

High quality green fodders play a significant role in economic raising of dairy animals. Much emphasis has been laid on the quality of dietary protein for ruminants (Hume, 1970; Miller, 1973). Mepham (1976) showed that amino acid balance of the dietary protein is most important deciding factor for the production performance of animals. The data pertaining to the protein quality in forages especially amino acid content are limited. Hence, an attempt was made to assess the amino acid make up of some important tropical forages.

The samples of **berseem** *(Trifolium alexandrinum)*, cowpea *(Vigna unguiculata)*, **guar** *(Cyamopsis tetragonoloba)*, lucerne (*Medicago sativa)* and oat *(Avena sativa)* were collected at pre-flowering stage from crop research farm. Dry matter contents of these forage samples were determined by drying them in oven. Nitrogen content of the samples was estimated by Kjeldahl's method (AOAC, 1975). For determination of amino acids, known quantity of finely grinded sample was hydrolyzed at 110°C for 24 h with sufficient quantities of 4 N hydrochloric acid in hydrolysing tubes sealed under nitrogen atmosphere. After removing the residue and making the hydrolysate free from hydrochloric acid, its amino acid content was determined with the help of Multichrome-B automatic amino acid analyzer (Backman, W. Germany) using single column, 3-hour protein hydrolysate methodology which elutes the different acidic, neutral and basic amino acids with sodium acetate buffers of pH 3.22, 4.25 and 6.28, respectively.

Data pertaining to amino acid content in different forages are presented in Table 1. Legume forages contained higher concentration of amino acids in comparison to non-legume forages (oats) because of more concentration of nitrogen in the former. When the figures of amino acids were calculated on the basis of per 16 g nitrogen, it was found that lucerne contained more glutamic acid and proline and cowpea was poorest in this regard. The concentrations of all the essential amino acids were comparatively higher in all the legume forages studied.

Amongst the legume forages, lucerne contained the highest amount of lysine, isoleucine, phenylalanine threonine, valine, aspartic acid, glycine, glutamic acid, proline and serine, while **guar** fodder contained highest amounts of arginine (3.14%), histidine (3.46%) and tyrosine

TABLE 1

Amino acid content (g/100 gDM) of forages

Amino acid	Forages				
	Berseem	Cowpea	Guar	Lucerne	Oat
A. **Essential**					
Arginine	0 52(2.31)	0.29(1.21)	0.59 (3.14)	0.72 (2.82)	0.04(0.36)
Histidine	0.24(1.06)	0.12(0.50)	0.65 (3.46)	0.35 (1.37)	0.08(0.72)
Isoleucine	0.46(2.04)	0.20(0.84)	0.35 (1.86)	0.59 (2.31)	0.11(0.98)
Leucine	1.15(5.10)	0.64(2.68)	0.86 (4.58)	1.27 (4.97)	0.27(2.16)
Lysine	0.60(2.66)	0.32(1.34)	0.25 (1.33)	0.83 (3.25)	0.11(0.98)
Methionine	0.11(0.49)	0.28(1.17)	0.06 (0.32)	0.08 (0.31)	—
Phenylalanine	0.54(2.39)	0.28(1.17)	0.43 (2.29)	0.72 (2.82)	0.10(0.89)
Threonine	0.53(2.35)	0.33(1.38)	0.46 (2.45)	0.75 (2.93)	0.12(1.07)
Valine	0.45(1.99)	0.38(1.38)	0.39 (2.07)	0.72 (2.82)	0.13(1.16)
B. **Non-essential**					
Aspartic acid	1.67(7.40)	0.90(3.76)	2.37(12.67)	4.70(18.37)	0.71(6.35)
Cysteine	2.23(9.88)	1.19(4.97)	1.42 (7 55)	2.23 (8.72)	0.49(4.38)
Glycine	0.66(2.93)	0.42(1.76)	0.56 (2.98)	0.84 (3.28)	0.17(1.52)
Glutamic acid	2.03(9.01)	1.52(6.35)	1.44 (7.66)	2.35 (9.19)	0.86(7.69)
Proline	0.62(2.75)	0.53(2.22)	0.61 (3.25)	1.46 (5.71)	0.47(4.20)
Serine	0.57(2.53)	0.40(1.67)	0.54 (2.87)	0.89 (3.48)	0.16(1.43)
Tyrosine	0.32(1.42)	0.09(0.38)	0.30 (1.60)	0.36 (1.41)	0.07(0.63)

Figures in parentheses are g amino acid per 16 g nitrogen contained in the forage.

(1.60%) on per 16 g nitrogen basis. Cowpea forage contained the highest quantities of methionine (1.17%), whereas lucine and cystine contents were highest in berseem. These observations indicate the superiority of protein contained in lucerne forage but the quantity of methionine, most limited essential amino acid in animal rations, was also found to be limiting in lucerne protein.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 380—384 (September 1983)

SYNTHESIS OF 1-ACETYL-3-(2-HYDROXY-5-SUBSTITUTED PHENYL)-5-PHENYL-$\triangle^2$-PYRAZOLINES AND THEIR β-DIALKYLAMINOETHYL ETHERS

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(Received : March 2, 1982 ; Revised : August 26, 1982)

ABSTRACT

2'-Hydroxy-5'-substituted chalkones (*4-6*), prepared by condensation of benzaldehyde with 2-hydroxy-5-substituted acetophenones (*1-3*), on refluxing with hydrazine sulphate in acetic acid in presence of potassium acetate gave the title compounds, 1-acetyl-3-(2-hydroxy-5-substituted phenyl)-5-phenyl-$\triangle^2$-pyrazolines (*7—9*) as an equimolecular mixture of a pair of *d*- and l-enantiomers. The corresponding β-dialkylaminoethyl ethers (*10-17*) of *4-9* were prepared by their alkylation with β-dialkylaminoethyl chloride hydrochloride.

In view of the antibacterial and antifungal activities exhibited by chalkone (Naresh Kumar, 1980) and 4'-substituted 2-hydroxy-5-bromochalkones (Schraufstater and Deutsch, 1948, 1949), it was considered of interest to synthesize the corresponding chalkones with 2'-and 5'-substituents. Further, as pyrazoline ring forms a part of several biodynamic agents (Kelkar *et al.*, 1980; Mittra and Mittra, 1981; Rao and Mittra, 1981; Sangwan and Rastogi, 1981a) and, thus, as a next step in this direction, the α, β-unsaturated keto moiety of these chalkones was converted into a rigid pyrazoline ring for optimization of this activity. Thus, in this paper, the synthesis of 2'-hydroxy-5'-substituted chalkones, 1-acetyl-3-(2-hydroxy-5-substituted phenyl)-5-phenyl-$\triangle^2$-pyrazolines and their corresponding β-dialkylaminoethyl ethers has been described as a part of a broad programme on the development of newer antimicrobial agents.

MATERIAL AND METHODS

Melting points were determined in capillary tubes in Gansons electrical melting point apparatus and were uncorrected. Purity of the compounds was routinely checked on silica gel G TLC plates using benzene or 5% methanol in benzene as the mobile phase. The IR spectra ($\bar{V}$ in cm^{-1}) were recorded in KBr on Perkin-Elmer-137 spectrophotometer and the PMR spectra (chemical shift values in δ units), in $CDCl_3$ or otherwise stated, on Varian EM-390 90 MHz spectrometer using TMS as internal reference. All compounds gave expected spectral characteristics. Only those spectral data have been mentioned which have a direct bearing on the assignment of the structure. All compounds were analyzed within ±0.5% of the calculated values for C, H and N. General methods for the preparation of various compounds are illustrated below and

TABLE 1

Characterization data of various chalkones and Δ^2-pyrazolines

Compound No[a]	R	Z	Molecular formula	Yield (%)	m. p.[b] °C	Analyses					
						Found			Required		
						C	H	N	C	H	N
4	H	—	$C_{15}H_{12}O_2$	89	88[c]	—	—	—	—	—	—
5	Br	—	$C_{15}H_{11}BrO_2$	82	103	59.12	3.48	—	59.43	3.66	—
6	COEt	—	$C_{18}H_{18}O_3$	75	112	77.54	5.32	—	77.12	5.75	—
7	H	—	$C_{17}H_{16}N_2O_2$	80	126	72.36	6.02	10.21	72.84	5.75	9.99
8	Br	—	$C_{17}H_{15}BrN_2O_2$	90	178	57.16	3.98	7.72	56.84	4.21	7.80
9	COEt	—	$C_{20}H_{20}N_2O_3$	80	164	71.82	6.34	8.81	71.41	5.99	8.33
10	H	Me_2N	$C_{19}H_{21}NO_2$	85	Oil	76.86	7.42	5.08	77.26	7.17	4.74
11	H	Et_2N	$C_{21}H_{25}NO_2$	69	Oil	78.35	7.71	4.69	77.98	7.79	4.33
12	Br	Et_2N	$C_{21}H_{24}BrNO_2$	75	Oil	62.84	5.87	3.29	62.69	6.01	3.48
13	COEt	Me_2N	$C_{22}H_{25}NO_3$	80	82	74.83	6.96	4.15	75.18	7.17	3.99
14	COEt	Et_2N	$C_{24}H_{29}NO_3$	79	Oil	76.33	7.49	3.64	75.96	7.70	3.69
15	H	Et_2N	$C_{23}H_{29}N_3O_2$	79	49	72.87	7.47	10.76	72.79	7.70	11.07
16	COEt	Me_2N	$C_{24}H_{29}N_3O_3$	85	111	70.36	7.53	10.72	70.73	7.17	10.31
17	COEt	Et_2N	$C_{28}H_{33}N_3O_3$	80	92	71.89	7.28	9.94	71.69	7.64	9.65

[a]Numbers described in this column refer to those described in scheme 1.

[b]Compounds *4-9* were recrystallized from methanol while the other compounds were purified by column chromatography over silica gel using benzene as eluant.

[c]Literature m. p. is 88-9°C (Heilbron *et al.*, 1965).

their characterization data are listed in Table 1.

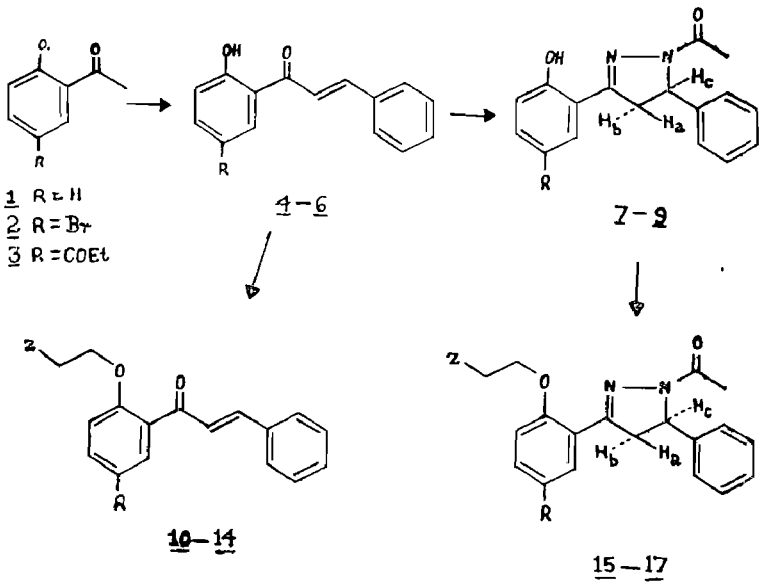
2-hydroxy-5-bromo (or propionyl)—acetophenones (*2*, *3* Scheme 1) were prepared by Fries' rearrangement of the corresponding 4-substituted phenyl acetates according to the reported procedure (Sangwan and Rastogi, 1981b), while 2-hydroxyacetophenone was available commercially.

2'-Hydroxy-5'-propionylchalkone (6, R=COEt)

A mixture of 2-hydroxy-5-propionylacetophenone (*3*, 1.92 g, 10 mmol) and benzaldehyde (1.06 g, 10 mmol) was added to cold (10°) methanolic KOH (4%, 28 ml) solution with stirring. The stirring was continued at room temperature for 48 h. The reaction mixture was diluted with water and acidified with dilute sulphuric acid. The solid, thus, separated was filtered, washed with water, dried and recrystallized from methanol to give 2.3 g of *6*, yield 75%, m. p. 112°; IR : 1695 and 1646 (C=O); PMR(CCl_4) : 1.25 (t, 3H, CH_2CH_3, J= 7 Hz), 2.95 (q, 2H, $COCH_2$, J=7 Hz), 7.05 (d, 1H, *Arom H*, *o*-to OH, J=9 Hz), 13.20(s, 1H, *OH*, D_2O exchangeable).

1-Acetyl-3-(2-hydroxy-5-propionylphenyl)-5-phenyl-Δ^2-pyrazoline (*9*, R=COEt)

A mixture of *6* (1.12 g, 4 mmol), hydrazine sulphate (1.04 g, 8 mmol), potassium acetate (0.98 g, 10 mmol) and acetic acid (10 ml) was refluxed for 8 h. The reaction mixture was cooled and poured on to ice. The separated solid was filtered, washed with water, dried and recrystallized from methanol



SCHEME-1

to give 1.25 g of *9*, yield 80%, m. p. 164°; IR : 1688 and 1681 (C=0); PMR : 2.45 (s, 3H, COC*H*$_3$), 3.42 (dd, 1H, *H*$_a$, J_{ab}=18 Hz, J_{ac}=5 Hz), 3.98 (dd, 1H, *H*$_b$, J_{ab}= 18 Hz, J_{bc}=12 Hz), 5.67 (dd, 1H, *H*$_c$, J_{ac}=5 Hz, J_{bc}=12 Hz), 10.82 (s, 1H, O*H*, D_2O exchangeable).

2′-(β-Dimethylaminoethoxy)-5′ - propionylchalkone (*13*, R=COEt, Z= Me_2N)

A mixture of *6* (0.28 g, 1 mmol), β-dimethylaminoethyl chloride hydrochloride (0.16 g, 1.1 mmol), potassium carbonate (0.3 g 2.2 mmol) and anhydrous acetone (10 ml) was refluxed with stirring for 24 h. The reaction mixture was cooled, diluted with water and extracted with ether. The ether extract was washed with water, dried (sodium sulphate) and concentrated to furnish 0.28 g of *13* yield 80%, m. p. 82°; IR : 1681 and 1653(C=0), PMR : 2.28 [s, 6H, N(C*H*$_3$)$_2$], 2.73 (t, 2H, NC*H*$_2$, J= 6 Hz), 4.23 (t, 2H, OC*H*$_2$, J=6 Hz).

1 - Acetyl - 3 - [2 -(β-dimethylaminoethoxy)- 5-propionylphenyl]-5-phenyl-Δ^2 - pyrazoline (16, R = COEt, Z = Me_2N)

This was prepared from *9* by the method described for *13* in 85% yield, m. p. 111°; IR : 1680 and 1660 (C=0); PMR : 2.24 [s, 6H, N(C*H*$_3$)$_2$], 2.68 (t, 2H, NC*H*$_2$, J=6 Hz), 3.42 (dd, 1H, *H*$_a$, J_{ab}=18 Hz, J_{ac}=5 Hz), 3.95 (dd, 1H, *H*$_b$, J_{ab}=18 Hz, J_{bc}= 12 Hz), 4.17 (t, 2H, OC*H*$_2$, J=6 Hz), 5.61 (dd, 1H, *H*$_c$, J_{ac}=5 Hz, J_{bc}=12 Hz).

RESULTS AND DISCUSSION

Base catalyzed condensation of 2-hydroxyacetophenone (*1*) and 2-hydroxy-5-bromo (or propionyl) acetophenones (*2*, *3*) with benzaldehyde using 4% methanolic-KOH at room temperature gave the corresponding substituted chalkones *4-6* in good yields (Scheme 1). Refluxing of chalkones *4-6* with hydrazine sulphate in acetic acid in presence of potassium acetate gave the title compounds, 1-acetyl-3-(2-hydroxy-5-subtituted phenyl)-5-phenyl-Δ^2-pyrazolines (*7-9*) in excellent yields. Interestingly, in case of the reaction of 5′-propionylachalkone *6*, with hydrazine sulphate, no hydrazone of the 5′-keto group under these reaction conditions was formed even though more than two moles of hydrazine sulphate were used. This was evidenced by the spectral and analytical data of the product *9* obtained in this reaction. However, under similar reaction conditions other ketones form the acethydrazones (Sangwan and Rastogi, 1981a). The C_4-*H*$_2$ protons in Δ^2-pyrazolines *7-9*, adjacent to an asymmetric carbon C_5, showed non-equivalence in their PMR spectra. In case of *9*, the C_4-*H*$_t$ protons, *H*$_a$ and *H*$_b$ (Scheme 1), appeared as doublet of a doublet at δ 3.42 (J=18 and 5 Hz) and 3.98 (J= 18 and 12 Hz), respectively in accordance with the results reported in similar systems (Sangwan and Rastogi, 1979).

This method of preparation of Δ^2-pyrazolines is not stereospecific as under similar reaction conditions α-substituted chalkones gave a mixture of 4, 5-*trans*- and *cis*-Δ^2-pyrazolines (Sangwan and Rastogi, 1979, 1981a). However, the method is described to be highly stereoselective and the *trans*-isomer predominates (Armarego, 1977). This indicates that the nitrogen of hydrazine attacking the β-carbon of chalkone may do so

from the front as well as from the rear side. Thus, there is a possibility of formation of enantiomeric pairs of Δ^2-pyrazolines at C_5. This is supported by the optical rotation studies of the Δ^2-pyrazoline *7* which was found optically inactive and, thus, was an equimolecular mixture of a pair of *d*- and *l*-enantiomers. For the sake of simplicity, only one optical isomer of *7-9* and *15-17* is shown in Scheme 1.

The chalkones *4-6* and Δ^2-pyrazolines *7-9* were alkylated with β-dialkylaminoethyl chloride hydrochloride in refluxing anhydrous acetone in presence of potassium carbonate to furnish the corresponding title ethers, 2'-(β-dialkylaminoethoxy)-5'-substituted chalkones (*10-14*) and 1-acetyl-3-[2-(β-dialkylaminoethoxy - 5 - substituted phenyl] - 5 - phenyl-Δ^2-pyrazolines (*15-17*), respectively.

All these compounds were characterized by their IR and PMR spectra and elemental analyses.

ACKNOWLEDGEMENTS

The authors are thankful to Drs. I. R. Trehan and J. K. Bhatnagar of Punjab University, Chandigarh, for providing PMR and IR spectral facilities and to Dr. Nitya Anand, Director, Central Drug Research Institute, Lucknow, for microanalysis.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 385—388 (September 1983)

RESPONSE OF GRAM TO N, P, K APPLICATION

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(Received : August 5, 1981; Revised : April 17, 1982)

ABSTRACT

Experiments at farmers' fields in district Hissar (Haryana) revealed that gram responded to N and P application significantly. Average response of 20 kg N/ha over control was 2.02 q/ha, with 40 kg P_2O_5/ha over 20 kg N/ha was 4.5 q/ha and with 20 kg K_2O/ha over N_{20} P_{40} was 0.65 q/ha. Application of potassium did not increase the gram yield significantly. Maximum economic return in gram under dryland conditions was obtained with the application of 20 kg N+40 kg P_2O_5/ha.

Gram is one of the main pulse crops of Haryana. The area under gram during 1979-80 was 1063 thousand hectares which constitutes about 19% of the cropped area of the State (Anonymous, 1979-80). About 75% of the area under gram cultivation is rainfed. Average per hectare yield of gram is 9.8 q in this State, but yields of higher magnitude (15-16 q/ha) have been obtained by adopting improved dryland agricultural technology. Balanced fertilization is one of the important inputs advocated for obtaining higher yields. Present investigation was, therefore, undertaken to study the response of gram to fertilizer application.

MATERIAL AND METHODS

Experiments on farmers' fields in Barwala, Bhuna, Fatehabad and Hissar blocks of Hissar district were conducted under All India Coordinated Agronomic Research Project from 1977 to 1980. Five villages in each block were randomly selected and one trial was laid out in each village. The soil of experimental fields was alkaline in reaction (pH 8.4-8.9) and non-saline to saline in salt content with EC (1 : 2) ranging from 0.26 to 1.25 mmhos/cm. The soils were low in organic carbon (0.12-0.35%) and available N (100-156 kg/ha); high in available P (21-40 kg/ha) and K (300-385 kg/ha). Each experimental trial received 10 treatments (Table 1).

Calcium ammonium nitrate, single superphosphate and muriate of potash were used as N, P and K sources, respectively. Drilling of fertilizer and seed was done with the help of two pores behind the plough. Pore through which seed was drilled, was kept 5 cm above the first one. Thus, fertilizer was placed about 10 cm deep and the seed 5 cm above the fertilizer granules. Gram C-214 was the test variety. Sowing was completed in the first week of November each year and the crop was harvested at maturity in the first week of April. All the recommended practices such as bunding,

TABLE 1

Response of N, P and K in gram (C-214) under rainfed conditions

S. No.	Treatments	Yield (q/ha) 1977-78	1978-79	1979-80	Average	Response (q ha) Over control	Per unit response of nutrient(s) (kg/ha)
T_1	$N_0P_0K_0$	10.93	11.95	11.03	11.31	—	—
T_2	$N_0P_{20}K_0$	12.58	13.32	14.99	13.63	2.32	11.60
T_3	$N_0P_{40}K_0$	13.98	14.37	17.69	15.35	4.04	10.10
T_4	$N_{10}P_0K_0$	11.65	12.50	13.14	12.43	1.12	11.20
T_5	$N_{10}P_{20}K_0$	13.71	13.81	16.42	14.65	3.34	11.14
T_6	$N_{10}P_{40}K_0$	15.12	15.60	18.97	16.57	5.26	10.52
T_7	$N_{20}P_0K_0$	12.86	13.12	13.99	13.33	2.02	10.10
T_8	$N_{20}P_{20}K_0$	14.88	14.82	17.77	15.83	4.52	11.30
T_9	$N_{20}P_{40}K_0$	16.53	16.84	20.24	17.87	6.56	10.94
T_{10}	$N_{20}P_{40}K_{20}$	17.19	17.26	21.09	18.52	7.21	9.21
C. D. at 5%		0.75	0.48	1.15			

ploughing and planking after rainfall, deep sowing and weed free cultivation were adopted to conserve the soil moisture. All these operations were completed in October before sowing.

Fifty to 78 mm rainfall was received during September in all the three years. There was no or little rain from October to December and in January only 8-11 mm rainfall was received. February had good rainfall (33-51 mm) in 1977 and 1978, while March had less in 1978-79 but good rainfall during 1977-78 and 1979-80.

RESULTS AND DISCUSSION

Perusal of data in Table 1 reveals that response of gram to N and P application was consistent during 1977-78 and 1978-79 but was of higher order during 1979-80. It was 0.72, 0.55 and 2.11 q/ha with 10 kg N/ha and 1.93, 1.17 and 2.96 q/ha with 20 kg N/ha in the corresponding years. Similar trend was observed with P application also. Response values observed with 20 kg P_2O_5/ha were 1.65, 1.37 and 3.96 q/ha during 1977-78, 1978-79 and 1979-80, respectively and with 40 kg P_2O_5/ha the corresponding values were 3.05, 2.42 and 6.66 q/ha. Gram did not respond significantly to K application. Higher response during 1979-80 may be attributed to lesser moisture content in soil during the critical period of gram growth. The rainfall pattern shows that only 0.6 mm rain was received during February, 1980, while it was 33 and 51 mm during 1977-78 and 1978-79, respectively. Due to low moisture content in soil, the native nutrients were less available and, thus, response to added sources was increased. Although soil test for available P was high, the response due to P indicates that there is need for further calibration of limits in respect to P especially under rainfed conditions.

TABLE 2

Economics of fertilizer use in gram under rainfed conditions

S. No.	Treatments	Average grain yield (q/ha)	Cost of fertilizer (Rs.)*	Value of additional yield (Rs.)	Net profit (Rs.)	Profit per rupee investment
T_1	$N_0P_0K_0$	11.31	—	—	—	—
T_2	$N_0P_{20}K_0$	13.63	140	928	788	5.47
T_3	$N_0P_{40}K_0$	15.35	280	1616	1336	4.77
T_4	$N_{10}P_0K_0$	12.43	64	448	384	6.00
T_5	$N_{10}P_{20}K_0$	14.65	204	1336	1132	5.55
T_6	$N_{10}P_{40}K_0$	16.57	344	2104	1760	5.12
T_7	$N_{20}P_0K_0$	13.33	128	808	680	5.31
T_8	$N_{20}P_{20}K_0$	15.83	268	1808	1540	5.75
T_9	$N_{20}P_{40}K_0$	17.87	408	2624	2216	5.43
T_{10}	$N_{20}P_{40}K_{20}$	18.52	445	2884	2439	5.48

*N Rs. 6.40/kg; P_2O_5 Rs. 6.30/kg; K_2O Rs. 1.85/kg; Grain Rs. 4.00/kg.

Response of gram to N and P application was further increased when applied in combination. Average response due to 40 kg P_2O_5/ha alone was 4.04 q/ha. It was 5.26 and 6.56 q/ha when applied with 10 and 20 kg N/ha, respectively. Though highest yield (18.52 q/ha) was observed with N_{20} P_{40} K_{20}, yet it was not significant over N_{20} P_{40} where the yield obtained was 17.87 q/ha. Yields were increased with increasing levels of P at both the levels of nitrogen (Table 1). The prolific vegetative growth of gram in the presence of N and good root system in the presence of P might have enhanced combined effect of N and P on the grain yield of gram. Higher response of gram to combined application of N and P has also been reported by Shukla (1964), Panwar *et al.* (1977) and Mudholkar and Ahlawat (1979).

Perusal of data in Table 1 also indicates that per unit response of N decreased with the increasing levels of N. At 10 and 20 kg/ha levels, the corresponding per unit increase in grain yield of gram was 11.20 and 10.10 kg/ha. Per unit response of P at 20 kg/ha level was 11.6 kg/ha. Unit increase in grain yield of gram was more with P than N at equivalent levels of application.

Economic studies reveal that phosphorus application in combination with nitrogen increased the net profit (Table 2). Application of nitrogen alone at levels of 10 and 20 kg/ha resulted in the lowest net profit of Rs. 384 and 680. Highest net profit (Rs. 2439) was obtained with N_{20} P_{40} and K_{20} application.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 389—395 (September 1983)

DIRECT, RESIDUAL AND CUMULATIVE EFFECT OF N, P AND K FERTILIZERS ON THE YIELD AND NUTRIENT UPTAKE BY **BAJRA**-WHEAT CROPPING SYSTEM

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ABSTRACT

Field experiments were conducted on 'Coarse Loamy Typic Camborthid' soil of Hissar to study the direct, residual and cumulative effect of fertilizers in **bajra**-wheat rotation. The yield of **bajra** and wheat crops decreased significantly with the reduction in the recommended levels of fertilizer application to both the crops. Bumper crop of **bajra** led to a reduction in the wheat yield even after an application of the recommended dose of fertilizers. The results indicate that the residual response increased linearly with increasing levels of fertilizers to the preceding crop but decreased by increasing the fertilizer dose to the current crop.

Fertilizer being a costly input, it is important to make its proper assessment for different cropping systems rather than of an individual crop. The residual effect of fertilizers applied to the preceding crop, if investigated systematically may help to regulate the demand of nutrients for the succeeding crop. Agronomic researches have been conducted to study the residual effects of phosphatic fertilizers for many crop sequences (Gupta and Kanwar, 1972; Sinha and Rai, 1977; Chaudhry *et al.*, 1979; Khanna *et al.*, 1979). But hardly any work has been carried out to study the residual effect of recommended dose of all the nutrients in a crop sequence. Thus, field experiments were conducted to determine the direct, residual and cumulative effect of different levels of recommended dose in **bajra**-wheat rotation, a common crop rotation of the semi-arid region of Haryana.

MATERIAL AND METHODS

Field experiments were conducted for two years, viz., 1974-75 and 1975-76 keeping **bajra**-wheat rotation (*Pennisetum typhoides* S & H-*Triticum aestivum*). The soil was loam in texture, having pH 8.0, O. C. 0.37 per cent, E. C. 0.28 mmhos/cm and available N, P and K were 104, 20 and 400 kg/ha, respectively. Taxonomically, the soil was classified as 'Coarse Loamy Typic Camborthids'. The following treatment combinations were selected :

S. No.	Percent recommended dose	
	Kharif	Rabi
1.	100	100
2.	75	100
3.	75	75
4.	50	100
5.	50	75
6.	50	50
7.	25	100
8.	25	75
9.	25	50

The recommended dose was 120, 60 and 60 kg/ha of N, P_2O_5 and K_2O, respectively, for both the crops. The hybrid **bajra** varieties sown were 'HB-3' and 'NHB-5' during 1974 and 1975, respectively, and the wheat variety sown during both the years was Kalyan Sona. The rainfall during 1974 and 1975 was 260.5 and 456.3 mm, respectively. Half the dose of N and full dose of P and K were applied at sowing time and rest of the N was applied at first irrigation in both the crops. The experiments were conducted in a randomised block design with three replications.

The yield data of grain and straw were recorded. The plant samples were digested in $HClO_4$ and H_2SO_4 (1 : 9) for the estimation of nutrients. Phosphorus was estimated according to the method of Koenig and Johnson (1942). Nitrogen was estimated by Nessler's reagent (Jackson, 1958). Potassium was determined in the plant digest with the help of flame photometer.

RESULTS AND DISCUSSION

Yield

The grain and straw yield of **bajra** decreased significantly by decreasing the recommended dose of fertilizers during both the years (Table 1). The reduction in grain yield was of the order of 6.6, 23.8 and 32.5 per cent with a reduction of 25, 50 and 75 per cent of the recommended dose, respectively. The yield level was much less during 1975 than obtained in 1974, which could be due to the differential rainfall pattern during both the years. The rainfall in 1975 was 362.1 mm mainly in the months of July, August and September which affected the yield of **bajra** adversely, whereas the rainfall during these months was only 252.0 mm in 1974, hence there was no adverse effect of rainfall on **bajra** yield. In arid and semi-arid areas the depression in the yield of **bajra** straw is of great significance, since it is used as a dry fodder for the cattle of this region. The reduction in the straw yield of **bajra** was only 1.1, 2.5 and 3.5 per cent with 25, 50 and 75 per cent decrease in the recommended dose of fertilizers, respectively. Furthermore, the reduction in the straw yield was less as compared to the grain yield.

The grain and straw yield of wheat reduced significantly by decreasing the recommended dose of fertilizers in **bajra**-wheat crop sequence during both the years (Table 2). It is also apparent that the wheat yield was better during 1975-76 than it was in 1974-75. This is due to the fact that during 1975, the **bajra** yield was much less as compared to 1974, which indicates that a bumper crop of **bajra** led to a depletion of nutrients

TABLE 1

Effect of different fertilizer levels on the yield of **bajra** (q/ha)

Fertilizer dose	Grain yield			Straw yield		
(% recommended)	1974	1975	Mean	1974	1975	Mean
100	37 66	19.23	28.45	112.4	40.9	76.7
75	35.35	17.76	26.56	99.2	37.6	68 4
50	29.08	14.26	21.67	83.8	30.7	57.3
25	26.23	12.19	19.21	75.9	25.4	50.7
Mean	32.08	15.86	23.97	92.8	33.7	63.3
C D. at 5%	1.84	1 34		4.7	2.78	

TABLE 2

Effect of different fertilizer levels on the yield of wheat (q/ha)

Fertilizer dose		Grain yield			Straw yield		
(% recommended)		1974-75	1975-76	Mean	1974-75	1975-76	Mean
Kharif	**Rabi**						
100	100	40.46	52 72	46.59	59.2	81.2	70.2
75	100	36.24	51 08	43.66	55.5	77.0	66.3
75	75	27.23	42.59	34.91	39.7	71.2	55.5
50	100	33.66	48.84	41.25	50.4	69.7	60.1
50	75	26.54	41.34	33.94	39.8	65.5	52.7
50	50	25.24	38.33	30.79	37.5	64.4	51.0
25	100	31.92	44.87	36.40	47.8	57.2	52.5
25	75	23.92	38.76	31.34	34.6	53.5	44.1
25	50	20.05	33.31	26.68	31.0	52.1	41.6
Mean		29.47	43.32	36.40	43.9	65.7	54.8
C D. at 5%		1.46	1.89		2.89	3.40	

and, thus, a reduction in the wheat yield even after an application of recommended dose of fertilizers. It is also evident that the wheat yield decreased when the direct application of fertilizers was reduced. *Thus, the data suggest that* the application of recommended dose of fertilizers for **rabi** crop should not be reduced, as it adversely affects the crop yield. The straw yield of wheat was in line with that of grain during both the years.

In order to determine the residual *effect of the fertilizers* applied to **bajra** crop on the yield of wheat at various levels of recommended dose, the grain yield of wheat when plotted on a graph,

the linear relationship was obtained (Fig. 1). The intercept ('a' value of equation) gave the yield of wheat which was independent of the residual effect of fertilizers applied to **kharif** crop. The difference between the yield at various levels and intercept gave the residual effect of **kharif** fertilization. There was significant reduction in the wheat yield by reducing the recommended dose during both the years. The depression in the grain yield of wheat was 32.4 and 48.6 per cent during 1974-75 and 22.3 and 29.4 per cent during 1975-76 with a reduction of 25 and 50 per cent in the recommended dose, respectively.

The residual effect of per kg nutrient on the wheat grain when calculated at various levels, showed that residual response increased as the recommended dose during **kharif** increased at all the fertilizer levels in the **rabi** crop and also per unit residual response decreased as the direct application of nutrients was increased (Table 3). This indicates that the residual response is dependent upon the direct application of nutrients, meaning thereby that to achieve the highest residual response, the minimum level of fertilizers should be applied to the present crop. Highest per unit residual response was obtained with an application of 75%

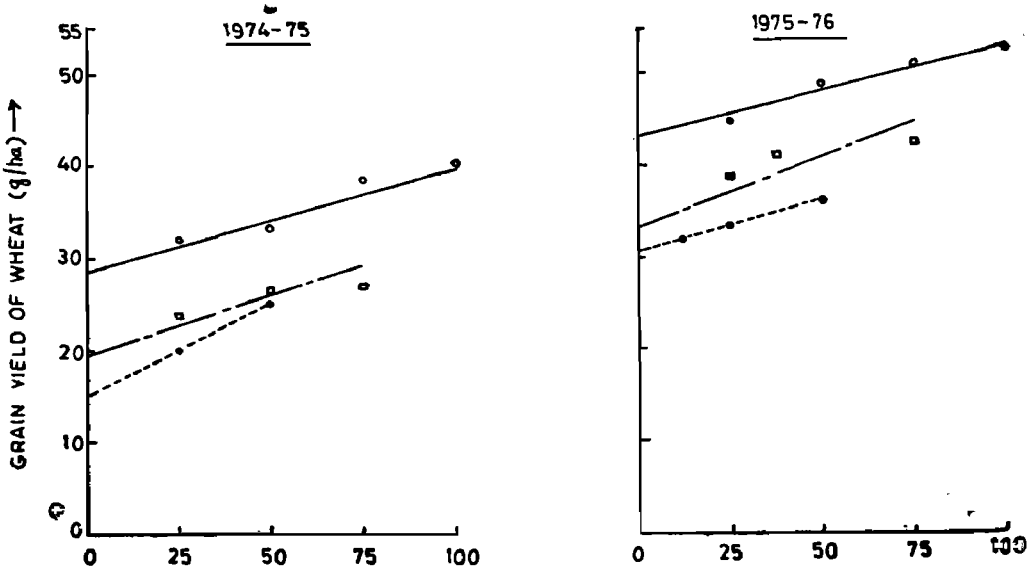


Fig. 1. Residual effect of fertilizers applied to **kharif** on the grain yield of wheat at various fertilizer levels.

TABLE 3

Unit residual response of fertilizers on the grain yield of wheat at different fertilizer levels (response kg grain/kg nutrient)

Fertilizer level during **rabi** (% recommended dose)	Fertilizer level during **kharif** (% recommended dose)											
	25			50			75			100		
	1974-75	1975-76	Mean	1974-75	1975-76	Mean	1974-75	1975-76	Mean	1974-75	1975-76	Mean
50	4.33	2.52	3.43	8.65	5.03	6.84	—	—	—	—	—	—
75	2.58	3.07	2.83	4.03	4.50	4.27	9.97	5.19	7.58	—	—	—
100	1.42	0.81	1.12	2.14	2.46	2.30	3.22	3.40	3.31	4.98	4.08	4.53
Mean	2.78	2.13	2.46	4.94	4.00	4.47	6.60	4.30	5.45	4.98	4.08	4.53

of the recommended dose during each season.

Nutrient Uptake

The uptake of nutrients (N, P, K) by **bajra** under various fertilizer levels decreased significantly by decreasing the recommended dose of fertilizer during both the years (Table 4). The nutrient uptake by **bajra** was lesser during 1975 than in 1974 which could be due to the low yield in 1975 than in 1974. The total removal of N, P and K varied from 36.4 to 85.5, 10.9 to 26.8 and 127.5 to 262.1 kg/ha, respectively. The removal of K by **bajra** was much higher than the total quantity applied which is due to the illitic type of clay mineral in the soil. Nevertheless, a starter dose of this nutrient is a must in a cropping system having 200% intensity. The depression in N, P and K uptake by **bajra** with a decrease of 75% of recommended dose was 57.4, 59.3 and 51.4 per cent, respectively. It is, therefore, evident that the depression was highest in P uptake followed by N and K.

The nutrient uptake of wheat decreased significantly with decreasing levels of fertilizers in **bajra**-wheat rotation during both the years (Table 5). The uptake of nutrients by wheat during 1975-76 was higher as compared to 1974-75 which was in accordance with the yield of wheat during both the years. The total uptake of N, P and K ranged from 54.2 to 104.4, 14.7 to 25.8 and 111.7 to 189.9 kg/ha, respectively. It is also apparent that the N and P uptake by wheat was higher than **bajra**, whereas K uptake had a reverse trend.

Thus, the results indicate that the residual effects of fertilizers are dependent upon the level of fertilizers being applied to the present crop. Nevertheless, the efficiency of the residual nutrients could be increased by reducing the fertilizer application to the succeeding crop. A good crop of **bajra** depletes the soil of its nutrient leading to a significant reduction in the wheat yield even at recommended level of fertilizer application.

\TABLE 4

Effect of different fertilizer levels on the nutrient uptake by **bajra** (kg/ha)

Fertilizer dose	N			P			K		
(% recommended)	1974	1975	Mean	1974	1975	Mean	1974	1975	Mean
100	107.7	63.2	85.5	32.3	21.3	26.8	341.1	183.0	262.1
75	84.2	53.8	69.0	25.3	18.8	22.1	270.5	162.1	216.3
50	58.9	40.6	49.8	17.9	13.4	15.7	211.3	130.2	170.8
25	39.9	32.8	36.4	11.7	10.0	10.9	154.4	100.6	127.5
Mean	72.7	47.6	60.2	21.8	15.9	18.9	244.3	144.0	194.2
C. D. at 5%	4.6	4.0		2.3	1.1		20.1	14.3	

TABLE 5

Effect of different fertilizer levels on the nutrient uptake by wheat (kg/ha)

Fertilizer dose		N			P			K		
(% recommended)		1974-	1975-	Mean	1974-	1975-	Mean	1974-	1975-	Mean
Kharif	Rabi	75	76		75	76		75	76	
100	100	76.8	131.2	104.0	25.3	26.2	25.8	127.1	252.7	189.9
75	100	83.9	129.8	104.4	22.4	23.0	22.7	109.7	243.9	176.8
75	75	77.6	78.7	78.2	17.0	22.0	19.5	73.8	217.7	145.8
50	100	79.6	110.8	95.2	22.6	22.7	22.7	93.0	220.9	157.0
50	75	69.9	82.4	76.2	16.9	19.4	18.2	84.4	207.9	146.2
50	50	62.9	78.1	70.5	15.9	17.2	16.7	78.7	194.5	136.6
25	100	73.8	102.1	88.0	21.4	22.2	21.8	94.2	194.2	144.2
25	75	55.1	75.5	65.3	15.7	19.7	17.7	67.0	175.6	121.3
25	50	47.8	60.6	54.2	12.4	16.9	14.7	63.0	160.4	111.7
Mean		69.7	93.8	81.8	18.8	21.0	19.9	88.0	207.5	147.7
C. D. at 5%		8.8	7.4		1.5	1.9		11.4	14.0	

Based on this experiment it can be safely concluded that for obtaining the optimum yield of wheat a dose of 120 N, 60 P_2O_5 and 60 K_2O has to be applied even though the preceding crop has had the recommended dose of fertilizer. However, it would be worth studying the fertilizer requirement of the succeeding crop as there would be enough residual effect of the relatively immobile nutrients like phosphorus and potash and certain economy could be effected by reducing the doses of these fertilizers.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 396—401 (September 1983)

EFFECT OF COBALT AND PHOSPHORUS ON THEIR AVAILABILITY AND NITROGEN FIXATION BY LEGUMES

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(Received : September 3, 1981; Revised : December 16, 1981)

ABSTRACT

With an addition of 0.0, 0.5, 1.5, 2.5 and 3.5 ppm cobalt to cowpeas *(Vigna unguiculata)* variety FOS-1 and soybean *(Glycine max)* variety Bragg, grown each in Inceptisols and Entisols for 60 days, cowpeas fixed 3.5 and 7.0 per cent higher nitrogen at 1.5 ppm Co while soybean fixed 3.3 and 13.4 per cent more nitrogen at 2.5 and 3.5 ppm Co in former and latter soils, respectively. Further, addition of 100 ppm P with 10 ppm Co to cowpeas increased N fixation by 9% when fertilized with 0.0, 2.5, 5.0 and 10.0 ppm Co in combination with 0, 100 and 200 ppm P in Entisols. Addition of Co decreased the availability of P and vice-versa.

The essentiality of cobalt for the activity of symbiotic nitrogen fixing bacteria has been recently recognised (Reisenauer, 1960; Delwiche *et al.*, 1961; Hallsworth *et al.*, 1965). Though very little is known about the functions and amount of cobalt required in the symbiotic nitrogen fixation mechanism, yet it has been found that cobamide coenzymes are present in nitrogen fixing nodules of several legumes as well as non-legumes (Kliewer and Evans, 1962; Wilson and Hallsworth, 1965). According to Hardy and Knight (1968) the role of cobalt in nitrogen fixation remained to be finalized, but it appeares to have an indirect relationship possibly an effect on synthesis.

Therefore, the present study was undertaken to see the effect of Co and P on their availability and N fixation by cowpeas and soybean grown in cobalt deficient soils.

MATERIAL AND METHODS

Soil. Bulk samples of surface soil (upper 20 cm) from Balopur (Ambala) and Ramrai (Jind) classified as Entisols and Inceptisols, respectively, were chosen for the study. These soils were dried, crushed, passed through 2 mm sieve and mixed thoroughly for the study. Physico-chemical properties of these soils were determined (Table 1) and following two independent pot experiments were conducted :

I. Experiment on simple Co treatment. The treatment consisted of 0.0, 0.5, 1.5, 2.5 and 3.5 ppm Co as cobaltous nitrate solution in each soil of Entisols and Inceptisols. Four kg treated soil was taken in each polyethylene lined enamelled pot of 22 cm dia. to raise crops.

Two crops, cowpeas *(Vigna unguiculata)* variety FOS-1, the fodder variety,

TABLE 1

Physico-chemical properties of soils

Properties	Entisols	Inceptisols
pH (1 : 2)	7.4	8.2
E. C. (mmhos/cm of 1 : 2 soil : water suspension)	0.14	0.32
Walkley & Blacks' organic carbon (%)	0.21	0.42
Texture	Loamy sand	Sandy loam
CEC (me/100 g soil)	2.80	4.30
Av. nitrogen (ppm)	59.89	111.22
Av. phosphorus (ppm)	10.73	10.73
Av. potassium (ppm)	292.50	297.50
Av. cobalt (ppm)	0.10	0.11
Total cobalt (ppm)	7.08	12.50

and soybean *(Glycine max)* variety Bragg, the grain variety, were grown for 60 days as test crops in each soil. A basal dose of 5 and 10 ppm N through urea and 20 and 40 ppm P_2O_5 through KH_2PO_4 solutions was given to cowpeas and soybean, respectively.

Eight seeds of each crop inoculated with *Rhizobium* spp. were sown in each pot. After a week of germination, only 4 seedlings of soybean and 5 of cowpeas, having the same height and vigour, were allowed to grow in each pot. Deionized water was used for irrigation. All necessary plant protection measures were taken to avoid the effect of any extraneous factor.

II. Experiment on Co and P treatment. The treatment consisted of solutions of 0.0, 2.5, 5.0 and 10.0 ppm Co through cobaltous nitrate in combinations with 0, 100 and 200 ppm P through KH_2PO_4. Cowpeas was grown as a test crop for 60 days in Entisols only. A basal dose of 5 ppm N through urea solution was given.

Plant sampling. Plants were harvested after 60 days of germination in both the experiments. After washing the plants with deionized, acidified deionized and glass distilled water in the sequence, these were oven-dried at 60-70° C for 48 h. The samples were grounded by using the stainless steel wiley mill.

Post-harvest soil sampling. After harvesting cowpeas and soybean, composite soil samples from each pot of both the experiments were taken by a stainless steel tube auger and total N was determined. Available Co and P contents were estimated in soil samples collected from experiment II.

Soil analysis. The methods described by Jackson (1958) were used for the determination of Walkley and Black's organic carbon, pH and E. C. (1 : 2 soil : water), Olsen's P (available P), CEC and available K using 1 *N* NH_4OAc and total N adopting modified Kjeldahl's method. Available N was estimated according to Subbiah and Asija (1956). International pipette method was used for determining mechanical analysis.

Available and total Co were determined after extracting the soil with 2.5% acetic acid (pH 2.5) (Alban and Kubota, 1960) and digesting in perchloric and hydrochloric acids (Sandell, 1958), respectively, with the help of atomic absorption spectrophotometer.

Nitrogen fixation. The amount of N fixed by both the crops was taken as

TABLE 2

Effect of cobalt on nitrogen fixation (ppm) by cowpeas and soybean grown in different soils

Treatment Co (ppm)	Entisols						Inceptisols					
	Cowpeas			Soybean			Cowpeas			Soybean		
	N	% N gain over original soil N	% N gain over control	N	% N gain over original soil N	% N gain over control	N	% N gain over original soil N	% N gain over control	N	% N gain over original soil N	% N gain over control
Original soil content	326	—	—	326	—	—	408	—	—	408	—	—
Control	359	10.1	—	365	12.0	—	443	8.6	—	449	10.0	—
0.5	374	14.7	4.2	377	15.6	3.3	451	10.5	1.8	460	12.7	2.5
1.5	384	17.8	7.0	401	23.0	9.9	458	12.2	3.5	461	13.0	2.7
2.5	379	16.2	5.6	410	25.8	12.3	454	11.3	2.5	464	13.7	3.3
3.5	369	13.2	2.8	414	27.0	13.4	443	8.6	0.0	460	12.7	2.5
C. D. at 5%	6	—	—	3	—	—	2	—	—	2	—	—

the difference between total N after the harvest of the crop and the original total N present in soil. The former includes nitrogen uptake by the crop and total N in soil just after the crop, whereas the latter includes the total N in soils before sowing of crop including the nitrogen applied through fertilizer as a basal dose.

Plant analysis. Nessler's method given by Jackson (1958) was used for nitrogen estimation in plant material after digesting it in diacid mixture (9 : 1) of H_2SO_4 and $HClO_4$.

Statistical analysis. Each treatment was replicated thrice in a randomised block design. Statistical analysis of data was conducted according to Snedecor (1961).

RESULTS AND DISCUSSION

Effect of Co on N Fixation

It is evident from Table 2 that addition of Co significantly increased total N fixed over control. The maximum N fixed by cowpeas was 7.0 and 3.5 per cent higher than that of control at 1.5 ppm Co level in Entisols and Inceptisols, respectively. However, soybean had a higher requirement for cobalt as compared to cowpeas and an increase of 3.3 and 13.4 per cent N was noticed by applying 2.5 and 3.5 ppm Co in Inceptisols and Entisols, respectively.

It may be inferred from these data that each crop had a specific requirement for Co to fix N in the soils. Wilson and Reisenauer (1963) reported that a critical level of 1 to 10 parts per trillion Co in the rooting medium of alfalfa was necessary for symbiotic N fixation. Under field conditions, Powrie (1964) recommended 280 g cobalt sulphate/ha for getting 98 and 169 per cent increase in N fixation by soybean and lucerne, respectively.

Effect of Co and P on N Fixation

Not only Co but P too has a role in N fixation as is evident from Table 3. The addition of 100 ppm P increased total N content of soil from 368 to 384 ppm and its higher application decreased N fixation by cowpeas of 60 days, grown in Entisols. Further, it is also clear that 2.5 ppm Co alone boosted N fixation to the extent of 5.4% which is less than that of the above experiment in which cowpeas fixed N to the extent of 7.0% more at 1.5 ppm Co in this soil.

TABLE 3

Effect of cobalt and phosphorus on nitrogen fixation (ppm) by cowpeas in Entisols

Treatments (ppm) P/Co	0.0	2.5	5.0	10.0	Mean
0	355	374	372	370	368
100	381	383	385	387	384
200	331	336	338	332	334
Mean	356	364	365	363	-
C. D. at 5%	P × Co=2.8, P=1.4, Co=1.6				

TABLE 4

Effect of cobalt and phosphorus on available cobalt (ppm) in Entisols

Treatments (ppm) P/Co	0.0	2.5	5.0	10.0	Mean
0	0.14	0.38	0.40	0.82	0.43
100	0.20	0.35	0.33	0.28	0.29
200	0.13	0.14	0.18	0.40	0.21
Mean	0.16	0.29	0.30	0.50	—
C. D. at 5%	P × Co=0.03, P=0.02, Co=0.02				

TABLE 5

Effect of cobalt and phosphorus on available phosphorus (ppm) in Entisols

Treatments (ppm) P/Co	0.0	2.5	5.0	10.0	Mean
0	9	8	6	8	7.7
100	21	17	14	18	17.5
200	71	65	61	69	66.5
Mean	34	30	27	32	—
C. D. at 5%	P × Co=1.5, P=0.8, Co=0.9				

It is further obvious from the data that all combinations of 100 ppm P with Co were superior in N fixation to other treatments, but maximum N to the extent of 387 ppm was found with 100 ppm P and 10 ppm Co and was worked out to be 9% higher than control.

Effect of Co and P on their Availability

A perusal of data in Table 4 reveals the antagonistic effect of P on available Co content in Entisols and the magnitude of decrease was observed from 0.43 to 0.21 ppm. However, an addition of Co led to its significant increase from 0.16 to 0.50 ppm. The maximum available Co (0.82 ppm) was found at 10 ppm Co alone. Similarly, available P increased from 7.7 to 66.5 ppm upon P application (Table 5). The antagonistic effect of Co upto 5 ppm with each P level is quite evident. The reduction in the availability of Co and P, when both added simultaneously, could be due to the formation of low solubility phosphatic compounds of cobalt like $Co_3(PO_4)_2$ and $CoHPO_4$ as supported by Young (1949).

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 402—407 (September 1983)

ESTIMATION OF WATER USE COMPONENTS IN RICE

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(Received : September 16, 1981; Revised : March 26, 1982)

ABSTRACT

A study carried out **in situ** to determine the different water use components at three stages of crop growth in rice revealed that of the total water used, percolation loss accounted for 66.6 and 59.5 per cent at first and second stage, respectively, whereas the transpiration alone accounted for 52.7% at third stage. The total water use for rice was found to be 327 cm in semi-arid regions.

India has the second largest irrigation system in the world but little information is available on water management practices in rice. Out of 40 million hectares under rice, nearly 15 million hectares have adequate irrigation facilities and the estimates show that this area consumes about 45% of the total available irrigation water (Ghildyal, 1972; Swaminathan, 1972). Various investigators have reported that a rice crop requires about 750 to 2500 mm water depending upon the agro-climatic conditions and management practices (Hussain, 1970; Ghildyal, 1972) and the percolation loss ranges from 30 to 75 per cent (Vamadevan, 1967; Hussain, 1970; Swaminathan, 1972; Kanwar, 1975).

To increase the water-use-efficiency in rice, interests have been to quantify the different components of water use. Such information becomes very important for improving water management and ground water hydrological balance as water is scarce for irrigation. Studies in pot culture, and lysimeters have been conducted from time to time by several workers to quantify the water-use components of rice but the reliability of such information is limited in view of the soil disturbances and crop micro-environment. Keeping this in view, the determination of evaporation, transpiration and percolation at different growth intervals in rice crop has been made **in situ** for the year 1976.

MATERIAL AND METHODS

A field experiment was conducted at Soil Research Area, Haryana Agricultural University, Hissar, Haryana, during July to October 1976 in plots of 60 sq cm area. The climate of the region is semi-arid with an average annual rainfall of 425 mm. The surface soil characteristics of the experimental site are as under :

Mechanical composition (%)	0-15 cm	15-30 cm
Sand	49.0	41.4
Silt	21.0	25.0
Clay	29.4	33.6
Textural class	Sandy clay loam	Clay loam
Bulk density (surface layer)		1.43 g/cm³
Hydraulic conductivity (surface layer)		0.23 cm/h
Field capacity (1/3 bar) upto 1 metre depth		18-21%
Wilting point (15 bar) upto 1 metre depth		6.5-8%
pH 1 : 2		7.3
EC 1 : 2		0.27 mmhos/cm

The weather data during the crop season are given in Table 1.

Three to four weeks old IR-8 seedlings were transplanted after puddling on 25th July, 1976. Recommended dose of 120 kg N/ha (half at sowing) and 60 kg P_2O_5/ha was applied to the crop. Submergence and other cultural practices were followed as given in package of practices (Anonymous, 1980).

Evaporation, transpiration and percolation were determined at three stages, viz., I (10-17 days), II (35-45 days) and III (63-73 days) by installing infiltrometers (30 cm ID) having four plants in each. One set of infiltrometers was made air tight by covering with white transparent polythene sheets during the period of determination and the experiment was conducted with three replications. Each day at the same time, for recording observations and air circulation the polythene cover was carefully removed for 10–15 minutes. The water loss from covered infiltrometers was taken as percolation and the care was taken that all the water condensed inside of polythene cover fell back in the infiltrometer. White transparent polythene cover permitted photo synthesis and growth processes. Water loss from uncovered infiltrometers was taken as total loss consisting of evaporation, transpiration and deep percolation. Evaporation was measured within the crop by installing open pan (15 cm ID) evaporimeter. Daily loss of water from infiltrometer as well as in open pan was measured with the help of a scale (±1 mm) fixed in each container. The difference between the uncovered and covered infiltrometer gave the evapo-

TABLE 1

Climatological data during crop season (**kharif** 1976)

Month	Rainfall (mm)	Temperature (°C)		U. S. open pan evaporation (mm/day)	Mean R. H. (%) max./min.	Mean sunshine	Mean wind velocity (km/h)
		Max.	Min.				
July	212.5	36.6	26.3	8.2	83/67	7.4	12.1
August	365.8	32.5	24.6	4.2	87/81	6.5	8.8
September	77.7	33.8	22.2	5.3	87/68	9.4	6.7
October	0.0	34.4	16.1	5.4	82/42	9.9	3.9

transpiration (ET) component. Further, transpiration was estimated by subtracting evaporation from evapotranspiration. The irrigation water was measured with the Parshall Flume and in all 23 irrigations were applied.

RESULTS AND DISCUSSION

Total water-use by a rice crop largely depends on the climatic factors and soil water management practices. In view of the limited availability of surface (51.0 million hectare metre) and ground (26.0 millon hectare metre) water resources of India for irrigation and to meet the increasing demand of the irrigable cultivated land, it is essential that the water-use and the relative proportions of different components in rice which occupy major area, are properly estimated.

The evaporation as measured from the open pan installed in the cropped area shows that it was more or less same at different stages of crop growth. Normally evaporation from U. S. open pan evaporimeter is used for scheduling irrigation and estimating water requirement of crops. However, in practice, the actual open pan evaporation from the cropped area is markedly lower due to lesser solar energy available for evaporation. For this the relationship between the actual open pan evaporation from the cropped area and the U. S. open pan evaporation at different crop growth stages was estimated to 0.47, 0.45 and 0.39 during the first, second and third crop growth stages, respectively. The decrease in this ratio with successive crop growth stage is due to increased crop canopy.

The transpiration component increased with the growth of the crop. The increase was from 1 to 12.6 and 12.6 to 33.4 mm/day from first to second and second to third stage, respectively (Table 2). Since of the total water use, the transpiration amounted to 11.1, 34.0 and 52.7 per cent during the first, second and third crop growth stages, respectively, it is necessary that adequate water supply must be ensured during later crop growth stage to meet the increasing crop water demand.

The percolation component ranged from 6.0 to 27.7 mm per day from first to third crop growth stage. This increase in percolation with crop growth is attributed to decreasing effect of puddling with time and increased root proliferation. How-

TABLE 2

Water-use components in rice at different stages (mm/day)

Water-use	Days after transplanting		
	(10-17) I	(35-45) II	(63-73) III
Evaporation (E)	2.0	2.4	2.1
Transpiration (T)	1.0	12.6	33.4
Evapotranspiration (ET)	3.0	15.0	35.5
Percolation (P)	6.0	22.0	27.7
Total (ET+P)	9.0	37.0	63.2

ever, of the total water use, the percolation component at three different stages was 66.6, 59.5 and 43.9 per cent, respectively. This highest percentage of percolation during first stage is due to lower transpiration requirement of the crop. Daily fluctuations in different water-use components at the three stages have been shown in Fig. 1. As may be seen that variations in the different components of water-use were of relatively greater magnitude at second stage than either first or third stage.

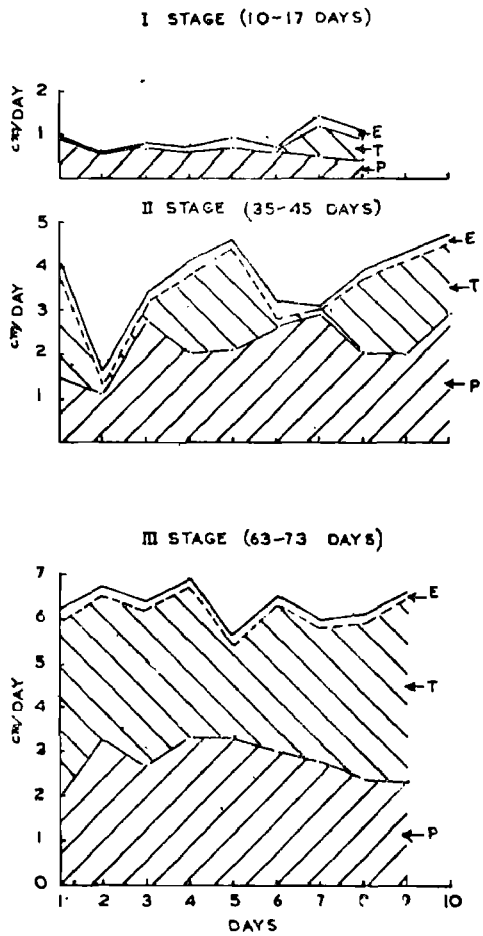


Fig. 1. Daily evaporation (E), transpiration (T) and percolation (P) at different stages of crop growth.

A transplanted rice crop (variety IR-8) required about 90 days period of irrigation. Measurements were made for 8 to 10 days at three different stages of growth to avoid any long term detrimental effect of polythene cover on the crop. Considering the water loss components measured at three stages, each representing the values for first, second and third months, an assessment of water use for the crop season made, reveals that the water-use was 3270 mm. This estimate is on higher side than the values reported by Dastane *et al.* (1966), Ghildyal (1972), Yadav (1972) and Kanwar (1975). The higher values obtained in the present study are attributed to the semi-arid climate and relatively lighter texture of soil in this region. It has been reported by Ghildyal (1972) and Yadav (1972) that submergence of rice crop is essential under arid and semi-arid climatic conditions. Increase in water-use by rice with submergence than maintaining the soil at saturation or near saturation has been reported by several investigators (Bhattacharya, 1972; Yadav, 1972). The average percolation was 56.7% of the total water-use in the present study and this is in agreement with the work of other investigators (Mitra, 1969).

The water-use components at different stages depicted in Fig. 2 show that the maximum loss of water during first (66.6%) and second (59.5%) stages was through percolation, whereas transpiration accounted for maximum water loss (52.7%) at third stage. The percentage of evapotranspiration component was 33.3 and 40.5 at first and second

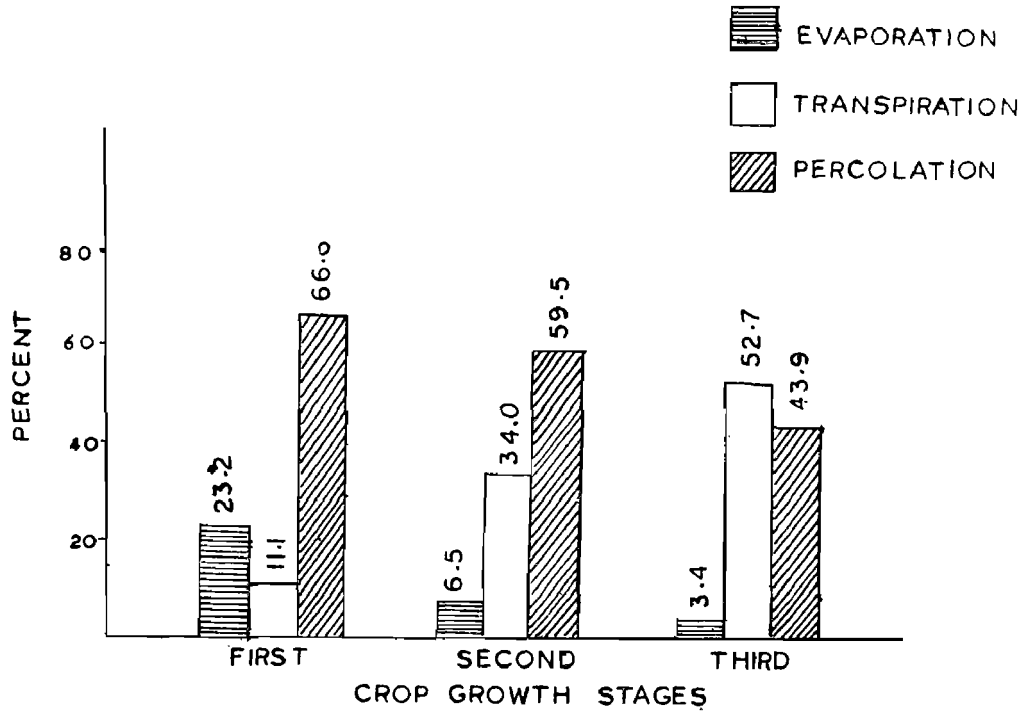


Fig. 2. Water use components (%) at different crop growth stages in rice.

stages but it increased to 56.1% at the third stage. Increased evapotranspiration in later stages has been reported by Ahmed (1968) and Bhattacharya (1972).

The results of the present study suggest that the water-use by a rice crop is on higher side in semi-arid region and the transpiration losses account maximum at third stage. Supply of greater quantum of water for irrigation is required at later stages for better crop growth and yield.

ACKNOWLEDGEMENTS

The assistance provided by Dr. M. L Chaudhary, Soil Chemist for conducting these studies is thankfully acknowledged. Authors are thankful to Professor and Head, Department of Soils, and Director of Research for their interest in this investigation.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 408—412 (September 1983)

GENETIC VARIABILITY AND SCOPE OF IMPROVEMENT OF QUALITY TRAITS IN TOMATO *(LYCOPERSICON ESCULENTUM* MILL.*)*

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(Received : September 3, 1981; Revised : January 18, 1983)

ABSTRACT

Genetic variability studies in 84 genotypes of tomato revealed significant differences for all the characters under study. The genotypes viz., Roma, Sel. 152, Cherry, Pusa Red Plum and HS-102 exhibited highest values for dry matter content, reducing sugars, acidity, ascorbic acid content and yield, respectively. Ascorbic acid content, reducing sugars and dry matter content showed higher genetic gain values alongwith higher heritability values.

Tomato is one of the important vegetable crops popularly grown in the world. It is a rich source of minerals and vitamins (Gould, 1974). As a processing crop it ranks first among vegetables. Certain compositional factors as total solids, sugars, ascorbic acid, acidity and lycopene alongwith yield are important for processing. For successful breeding for high yielding, quality and processing varieties requisite information on the nature and magnitude of variation available in the material and the role played by the environment in the expression of quality characters are important. Since, the information available on quality characters in tomato is limited, the present investigation was opined to study the extent of variability in 84 genotypes of tomato.

MATERIAL AND METHODS

Eighty four genotypes of tomato were transplanted in August, 1976 in a randomised block design in three replications at the Vegetable Research Farm of Haryana Agricultural University, Hissar. All the cultural practices were followed during the course of investigation. Five randomly selected plants were tagged in each genotype for recording data on yield per plant and to determine ascorbic acid content (mg/100 g), acidity (g of citric acid/100 ml of juice), reducing sugars (%) and dry matter content (%).

Acid content of the extracted tomato juice was determined by titrating 5 ml of tomato juice against N/10 NaOH using phenolphthalein as an indicator. Reducing sugars were determined by phenol-sulphuric acid method suggested by Dubois *et al.* (1956) and ascorbic acid content was determined by 2,6 dichlorophenol indophenol titration method (AOAC, 1960).

Genetic variability (Cochran and Cox, 1957; Panse and Sukhatme, 1967),

TABLE 1

Mean performance of 84 genotypes of tomato for quality characters and yield

S. No.	Genotypes	Dry matter content (%)	Reducing sugars (%)	Acidity (g of citric acid/100 ml juice)	Ascorbic acid content (mg/100 g)	Yield/ plant (kg)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	Pusa Early Dwarf	5.077	1.98	0.763	14.388	0.945
2.	Pusa Ruby	7.370	2.00	0.774	15.651	0.987
3.	Pusa Red Plum	8.267	3.61	0.774	28.265	0.815
4.	Pusa Lal Meeruti	6.317	0.92	1.103	12.040	0.798
5.	Sioux	6.283	1.23	1.095	16.376	0.738
6.	Sl.120	8.900	3.31	0.638	12.683	1.050
7.	Roma	10.950	3.45	0.603	10.616	1.177
8.	Best of All	7.100	3.83	0.860	16.423	0.735
9.	Monarch	8.427	1.60	1.080	7.389	0.910
10.	Red Top	6.200	1.26	0.835	12.609	0.552
11.	Growthens Globe	7.983	2.77	0.383	8.422	0.984
12.	Improved Meeruti	6.900	1.74	1.070	11.337	0.957
13.	Hallow-2	4.800	1.68	0.898	15.930	0.565
14.	Hallow-4	5.927	2.94	0.855	10.053	0.560
15.	Hallo 1403-2	4.383	3.58	0.771	9.632	0.813
16.	G-2	8.050	2.26	1.020	16.178	0.893
17.	Hybrid pink	6.687	1.59	0.899	10.420	0.993
18.	B-17	6.300	4.05	0.511	15.850	0.547
19.	Venus	4.217	2.32	0.776	12.698	0.718
20.	Mikado	3.650	1.66	0.899	8.527	0.838
21.	Mikado Pink	4.357	1.95	0.520	13.679	0.852
22.	Globe. 1	7.817	1.50	1.114	13 673	1.003
23.	Robinson	4.950	2.50	0.824	10.430	0.877
24.	Chamboli Red Plum	5.033	2.05	0.999	20.022	0.820
25.	Cherry	6.800	2.10	1.614	27.380	0.547
26.	Creole	4.100	3.29	0.963	12.607	0.922
27.	Pritchard	6.450	2.50	1.062	13.853	1.020
28.	New Yorker	4.450	1.90	1.090	11.023	0.755
29.	HS-101	8.433	2.36	0.899	17.242	1.397
30.	HS-102	6.617	3.42	0.912	18.653	1.653
31.	HS-103	8.533	1.76	0.997	13.937	0.877
32.	HS-106	6 033	2.24	0.643	15.385	1.000
33.	HS-108	5.833	2.43	0.760	17.353	0.865
34.	HS-110	7.733	3.83	0.694	14.157	1.173
35.	S-12	10.283	2.18	0.915	21.039	1.075
36.	Punjab Tropic	7.450	2.57	0.993	13.060	0.928
37.	Punjab Chhuhara	7.550	3.40	0.635	10.350	1.150
38.	Kalyanpur Angurlata	6.317	3.25	0.502	25.533	0.803
39.	Kalyanpur T-1	7.517	2.51	0.628	12.583	0.737
40.	Chiku Grande	7.100	3.73	0.592	15.567	0.760
41.	Sel-152	5.633	3.89	0.648	12.600	0.858

(1)	(2)	(3)	(4)	(5)	(6)	(7)
42.	Sweet-72	6.333	3.02	0.749	14.433	1.043
43.	63-VF	7.500	3.19	0.901	19.790	0.905
44.	VL-9-1	7.067	1.06	1.360	8.943	0.813
45.	VL-9-1-2	4.683	1.12	1.001	9.793	0.697
46.	VL-9-1-3	4.100	1.92	0.980	13.333	0.633
47.	VL-11-1	3.133	1.62	1.218	16.243	0.838
48.	VL-11-2	5.983	2.28	1.089	8.803	0.593
49.	Collection No. 1	4.567	2.75	0.892	8.497	0.885
50.	Collection No. 2-3	4.500	3.39	0.759	10.055	0.922
51.	Sel No. 3	6.617	3.00	1.008	9.100	0.822
52.	Sel. No. 4	7.367	2.12	1.272	9.410	0.950
53.	Sel. No. 23	5.120	2.12	0.994	10.055	1.010
54.	Sel. 2-1	5.233	1.84	0.983	9.140	0.918
55.	Sel. 13-1	6.000	3.93	0.539	8.635	1.017
56.	Sel. 6-1	5 717	3.14	0.809	9.778	0.997
57.	Sel. 73-1	6.933	2.28	1.024	12.705	0.793
58.	No. 7	6.100	3.55	0.854	12.103	0.712
59.	No. 9	4.833	3.14	1.023	14.673	0.580
60.	No. 26	6.583	2.88	0.792	9.967	0.870
61.	E. C. 35379	5.817	2.36	0.900	8.651	0.957
62.	E. C. 35498	4.483	3.29	0.770	10.335	0.845
63.	E. C. 35501	4.317	3.66	0.532	14.100	0.782
64.	E. C. 35524	5.433	3.18	0.664	14.710	0.952
65.	E. C. 37201	4.650	3.16	0.760	8.632	0.803
66.	E. C. 37205	7.550	3.06	0.757	12.987	0.930
67.	E. C. 37212	8.633	2.51	0.771	15.943	0.617
68.	Heinz 1370-14-15	5.410	2.78	0.901	10.810	0.833
69.	E. C. 1153	4.367	3.33	0.828	12.947	0.657
70.	E. C. 3239	6.683	3.33	0.683	11.197	1.123
71.	E. C. 7403	4.800	2.73	1.002	8.748	1.157
72.	E. C. 9994	6.267	2.52	1.085	15.670	1.003
73.	E. C. 16278	6.917	3.04	0.874	16.610	0.353
74.	E. C. 16788	4.867	2.18	0.997	10.800	0.700
75.	E. C. 16788-1	6.377	2.89	1.104	10.077	0.908
76.	E. C. 35367	3.953	3.08	0.737	13.679	0.943
77.	E. C. 45064	6.167	1.97	1.075	13.733	0.748
78.	E. C. 52060-1	3.693	3.46	0.642	14.927	1.023
79.	E. C. 52062	3.727	3.32	0.540	7.570	0.732
80.	E. C. 52062-1	8.407	3.23	0.628	7.198	0.693
81.	E. C. 52399-1	4.957	2.18	1.027	15.485	0.827
82.	E. C. 76102-9	3.583	2.40	0.595	11.960	0.692
83.	E. C. 76104	5.237	2.88	0.894	13.338	0.990
84.	E. C. 76109	5.063	3.56	0.635	11.360	0.623
General Mean		6.055	2.638	0.865	12.999	0.867
C. D. at 1%		0.466	0.378	0.087	1.575	0.253
C. D. at 5%		0.355	0.288	0.051	1.199	0.192

coefficients of genotypic and phenotypic variability (Burton and DeVane, 1953), heritability (broad sense) and genetic advance (Allard, 1960) were worked out.

RESULTS AND DISCUSSION

Statistical analysis revealed highly significant differences among the genotypes for all the characters under study. Average values in respect of five characters are presented in Table 1. Genotype HS-102 came out to be the highest yielder with 1.653 kg fruit per plant followed by HS-101 (1.397 kg), Roma (1.177 kg) and HS-110 (1.173 kg). Highest dry matter content was found in tomato cultivar Roma (10.95%) followed by S-12 (10.28%) and E. C. 37212 (8.63%). Highest amount of reducing sugars (4.05%) was recorded in B-17 followed by Sel. 152 (3.89%) and HS-110 (3.89%). Lowest acidity in the form of citric acid was observed in Growthens Globe (0.383%) and highest in Cherry (1.614%), while Pusa Red Plum was found the richest source of ascorbic acid (vitamin C) with a value of 28.265 mg/100 g of tomato fruits closely followed by Cherry (27.380 mg/100 g).

A wide range of variation was observed for all the characters studied (Table 2). The quality characters such as ascorbic acid content, reducing sugars, dry matter content and acidity had shown a wide range variation and also exhibited high phenotypic variation, and therefore, suggest scope of improvement for these characters.

The estimates of phenotypic coefficient of variability (PCV), genotypic coefficient of variability (GCV), heritability (broad sense), genetic advance and genetic advance as per cent of mean are also given in Table 2. Highest phenotypic and genotypic coefficient of variability was recorded for ascorbic acid content and reducing sugars. Dry matter content, acidity, reducing sugars, ascorbic acid content and yield which exhibited high heritability suggest that

TABLE 2

Estimates of phenotypic coefficient of variability (PCV), genotypic coefficient of variability (GCV), heritability (broad sense) and genetic advance for quality characters and yield

S. No.	Characters	Mean±S. E.	PCV	GCV	Heritability	Genetic advance	Genetic advance as per cent of mean
1.	Dry matter content	6.055±0.181	25.540	25.280	97.94	0.52	8.59
2.	Reducing sugars	2.638±0.181	29.570	28.770	94.69	0.58	21.99
3.	Acidity	0.865±0.026	24.530	24.250	97.71	0.49	56.65
4	Ascorbic acid content	12.999±0.611	31.550	31.020	96.67	0 63	4.35
5	Yield	0.867±0.050	22.500	21.360	90.11	0.42	48.44

selection will be more effective, but contrary to this Swarup and Chugale (1962) have suggested that genotypic coefficient of variation or heritability alone is not sufficient to determine the amount of variation which is heritable and heritable variation can be determined with greater accuracy when heritability alongwith genetic advance is studied. Johnson *et al.* (1955) have also emphasized the importance of high heritability estimates alongwith high genetic advance than heritability alone. In the present study, ascorbic acid content reducing sugars and dry matter content, gave comparatively high heritability estimates and genetic advance. This may be attributed due to the action of additive genes (Panse, 1957) and the selection for these characters will be more effective than the remaining characters.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 413—415 (September 1983)

NITROGEN AND PHOSPHORUS NUTRITION IN SEED PRODUCTION OF ROUND MELON *(PRAECITRULLUS VULGARIS* WATT.*)*

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(Received : September 16, 1981; Revised : June 11, 1982)

ABSTRACT

Out of four levels of nitrogen (0, 25, 50 and 75 kg/ha) and two levels of phosphorus (0 and 30 kg/ha) maximum length of vine, number of fruits, diameter of fruits, seed yield and 1000-seed weight were recorded with 75 kg/ha nitrogen and 30 kg/ha phosphorus application. The interaction of these two factors was also significant for most of the characters and a combination of 75 kg N and 30 kg P_2O_5 produced 4.58 q/ha of seed as against 2.33 q/ha in untreated control.

The non-availability of quality seed has been a stumbling block in boosting round melon production. Out of various factors influencing the seed yield of round gourd N and P fertilization is considered to be of vital importance. In most of the Indian soils nitrogen is the main limiting factor. Besides, phosphorus plays a key role in root development and photosynthesis. In India, owing to lack of relevant information on nutrition of vegetable seed crop, the seed production has not been commercialised. Keeping in view the importance of N and P, an experiment was planned to study their effect on seed production of round melon *(Tinda)*.

MATERIAL AND METHODS

To study the effect of N and P on seed production of round melon, an experiment was conducted at Vegetable Research-cum-Seed Production Centre, Kaul during 1977-78 with four levels of N (0, 25, 50 and 75 kg/ha) and two levels of P (0 and 30 kg/ha) making a total of eight treatment combinations. The experiment was replicated three times in randomised block design. The soil was sandy loam with 8.02 pH, 0.26% organic carbon and 20 and 460 kg available P and K, respectively. The sowing of *Praecitrullus vulgaris* Watt. variety Hissar Sel. 1 was done on 26 March each year at a distance of 50 cm between plants in rows at 150 cm apart with a plot size of 4m × 3m. The data on length of vine, fruits per plant, diameter of fruit, seed yield and 1000-seed weight were recorded during both the years. Seed extraction was done as suggested by Nath (1976).

RESULTS AND DISCUSSION

It was observed that increasing levels of N increased vine length, number of fruits, diameter of fruits, seed yield and

TABLE 1

Effect of nitrogen, phosphorus and their interaction on seed production in round melon

Treatment (kg/ha)	Length of vine (cm)			Number of fruits per plant			Diameter of fruit (cm)			Seed yield (q/ha)			1000-seed weight (g)		
	1977	1978	Mean	1977	1978	Mean	1977	1978	Mean	1977	1978	Mean	1977	1978	Mean
N_0	136.9	138.4	137.6	2.5	3.3	2.9	5.5	5.5	5.5	2.38	2.55	2.46	91.7	91.8	91.7
N_{25}	147.1	147.7	147.4	2.9	3.8	3.3	6.9	6.8	6.8	3.20	3.23	3.21	93.6	93.7	93.6
N_{50}	153.2	157.5	155.3	3.1	4.2	3.6	8.1	8.1	8.1	3.83	3.91	3.87	94.0	94.4	94.2
N_{75}	164.2	165.9	165.0	4.0	4.5	4.2	8.8	8.9	8.8	4.31	4.58	4.44	95.0	94.9	94.9
C. D. at 5%	0.91	0.83	—	0.4	0.6	—	0.14	0.13	—	0.135	0.191	—	0.84	0.83	—
P_0	148.4	150.5	149.4	3.1	3.8	3.4	7.2	7.1	7.1	3.30	3.39	3.34	93.3	93.5	93.4
P_{20}	152.5	154.3	153.4	3.2	4.0	3.6	7.5	7.3	7.4	3.56	3.75	3.65	93.9	93.9	93.9
C. D. at 5%	0.64	0.61	—	NS	NS	—	0.10	0.09	—	0.121	0.135	—	0.60	0.59	—
N_0P_0	153.3	136.4	135.8	2.5	3.4	2.9	5.4	5.4	5.4	2.27	2.40	2 33	91.5	91.6	91.5
N_0P_{20}	138.5	140.3	139.4	2.6	3.3	2.9	5.7	5.7	5.7	2.50	2.70	2.60	92.0	91.9	91.9
$N_{25}P_0$	145.5	145.5	145.5	2.8	3.6	3.2	6.7	6.6	6.6	3.10	3.13	3.11	93.4	93.6	93.5
$N_{25}P_{20}$	148.7	149.9	149.3	3.0	4.0	3.5	7.1	7.1	7.1	3.30	3.33	3.31	93 7	93.8	93.7
$N_{50}P_0$	151.4	155.7	153.5	3.1	3.8	3.4	8.0	7.8	7.9	3.63	3.60	3.61	93.3	93.9	93.6
$N_{50}P_{20}$	155.1	159.4	157.2	3.2	4.6	3.9	8.2	8.4	8.3	4.03	4.23	4.13	94.8	94.9	94.8
$N_{75}P_0$	161.4	164.4	162.9	4.0	4.6	4 3	8.6	8.8	8.7	4.20	4.43	4.31	94.8	94.9	94.8
$N_{75}P_{20}$	168.0	167.5	167.7	4.1	4.5	4.3	9.1	9.1	9.1	4.43	4.73	4.58	95.2	95.0	95.1
C.D. at 5%	1.29	NS	—	NS	NS	—	NS	0.132	—	0.241	0.271	—	NS	NS	—

1000-seed weight (Table 1). The maximum length of vine (164.2 and 165.9 cm), number of fruits (4.0 and 4.5), diameter of fruit (8.8 and 8.9 cm), seed yield (4.31 and 4.58 q/ha) and 1000-seed weight (95.0 and 94.9 g) were recorded with the application of 75 kg N followed by 50 kg N application during both the years and minimum values for these characters were recorded in control. All the characters were significantly influenced by N application. Similar findings have also been reported by Dhesi *et al.* (1966) in bittergourd and Padda *et al.* (1969) in muskmelon.

The application of P exhibited significant effect on all the characters except number of fruits per plant. The maximum length of vine (152.5 and 154.3 cm), number of fruits per plant (3.2 and 4.0), diameter of fruit (7.5 and 7.3 cm), seed yield (3.56 and 3.75 q/ha) and 1000-seed weight (93.9 and 93.9 g) were recorded with 30 kg P application during both the years and the minimum values for these characters were recorded in control. P has also been reported beneficial in increasing growth and yield in several other vegetable crops (Dhesi *et al.*, 1966; Padda *et al.*, 1969; Ivanov and Surlekov, 1975).

Interaction between N and P levels was significant for seed yield during both the years, but for length of vine during first year and diameter of fruit during second year. Application of 75 kg N in combination with 30 kg P produced maximum length of vine, diameter of fruit, seed yield and 1000-seed weight, whereas least values were recorded under unfertilized control during both the years (Table 1). Maximum average seed yield on two years basis (4.58 q/ha) was given by the treatment combination of 75 kg N and 30 kg P_2O_5 as against 2.33 q/ha in unfertilized control. These results are in conformity with the findings of Ivanov and Surlekov (1975) and Tolmach (1977).

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 416—419 (September 1983)

DECIPHERING OF SHALLOW WATER TABLE AREAS THROUGH LAND SAT IMAGERY IN LOWER GHAGGAR BASIN—HARYANA

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(Received : November 19, 1981; Revised : April 29, 1982)

ABSTRACT

Groundwater depth maps based on water table fluctuation data from 1974 through 1977 from 290 observation wells spread over an area of approximately 11 thousand sq. km in lower Ghaggar basin of Haryana, have been drawn. By interpolation of imagery maps over the isobath maps, it has been concluded that fairly good correlation exists between these maps. Land Sat Imagery, which gives a synoptic view of the area, can be used to ameliorate the problem by quick assessment of shallow water table areas.

The common method to ascertain the areal extent of sub-surface shallow groundwater involves measuring of water table depths over a period in the observation wells spread over the area, drawing isobath map and working out the area under different groundwater regimes by planimeter. This method is pretty laborious, time consuming and costly as it involves installation of observation wells, recording monthly water level data and maintenance of observation wells, transport, etc. Cost estimates for observation net work through observation wells at Lower Ghaggar basin with an area of 11,000 sq. km (290 observation wells) and through Remote Sensing Technique are Rs. 27.50 and 2.25 per sq. km of Land Sat Imageries and conducting of ground truth survey. Culleding of this information as test case from the repeated Land Sat Imageries of Lower Ghaggar basin—Haryana State and comparing it with information obtained through Isobath maps which were prepared from actually measured water table data obtained from Haryana State Minor Irrigation and Tubewell Corporation (HSMITC) has been tried.

MATERIAL AND METHODS

Water table data from 1974 through 1977 from 290 observation wells spread over an area of approximately 11,000 sq. km in Lower Ghaggar basin were procured from H S M I T C (Singh, 1981). The data were used to draw Isobath maps (depth to water table maps) in respect of post monsoon period (month of October) and per cent area under different water table depth ranges was worked out using planimeter. Thereafter, False Colour Composite Imageries of Land Sat I & II of relevant period and season covering the above cited area were visually analysed. The areas of the imagery, bearing light blue to reddish blue indicating shallow water table areas, were demarcated and map was prepared (Dallam *et al.*, 1975; Thiruvengadachari, 1978).

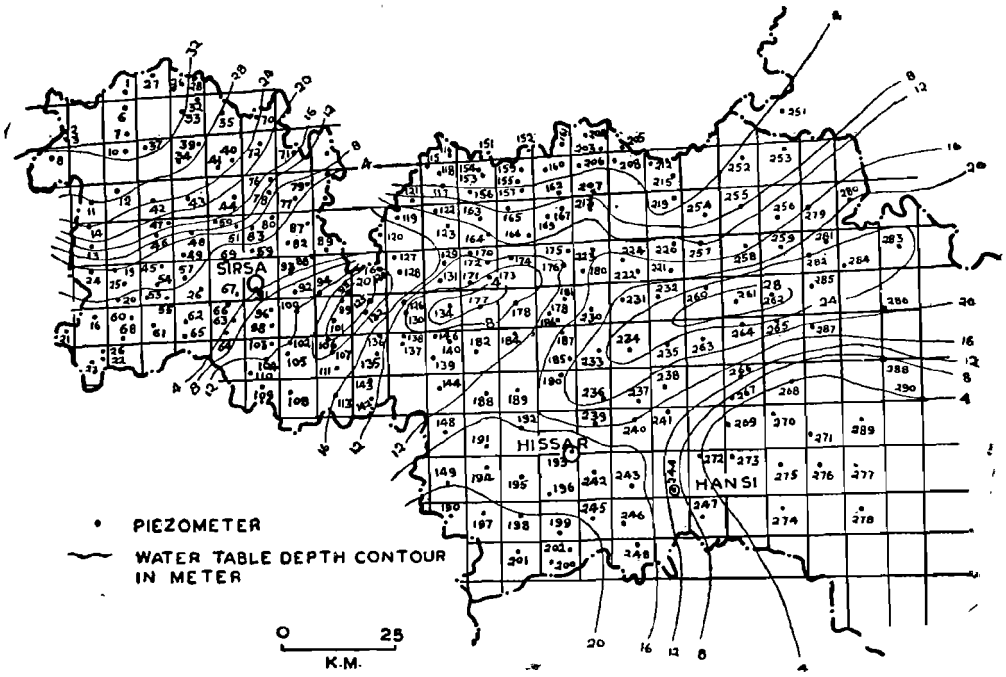


Fig. 1. Isobath map of part of Lower Ghaggar Basin (October 1977).

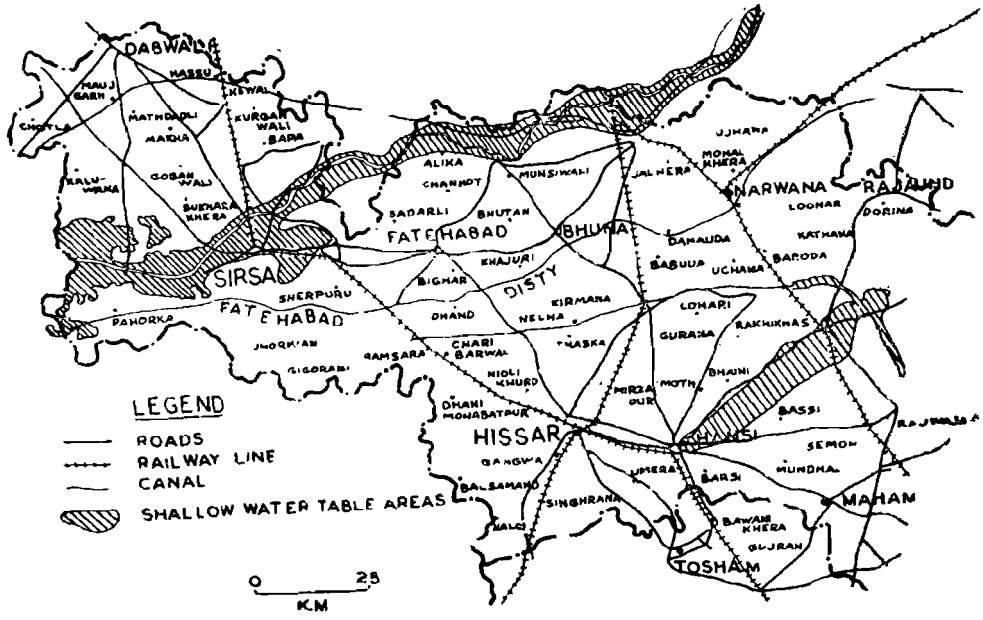


Fig. 2. Shallow water table areas from land Sat Imagery (October 1977).

TABLE 1

Per cent and absolute area of shallow water table deciphered from Land Sat Imagery and Isobath map

Year	Isobath map (actually observed area)		Imagery		% variation from actually observed area
	% area of the total	Absolute area (sq. km)	% area of the total	Absolute area (sq. km)	
1974	3.87	425.7	3.55	390.5	8.27
1975	6.45	709.5	5 68	624.8	11.94
1976	11.85	1303.5	10.64	1170.4	10.21
1977	14.86	1634.6	12.57	1382.7	15 71

RESULTS AND DISCUSSION

Isobath maps of post monsoon period from 1974 through 1977 were drawn which show the area under different water table regimes. The latest Isobath map (October 1977) is shown in Fig. 1. Similarly, shallow water table areas were demarcated from Land Sat Imagery and latest map for the post monsoon period of 1977 is shown in Fig. 2. There is proximity between the areal location of shallow water table observed from isobath map and imagery. Areas under less than 4m water table depth were assumed to be shallow water table areas. The per cent and absolute areas estimated under shallow water table are given in Table 1.

The extent of shallow water table areas ascertained from F. C. C. imageries of different periods is also shown in Table 1. During 1974, the variation between actually observed and imagery shallow water table area was 8.27%, whereas during 1977 it was 15.71 per cent. The area under shallow water table depth ascertained from imagery was found to be less than the actual observed area from isobath maps, in all cases. It may be because the area having marginal water table depth might have not been depicted in the imagery. It may be concluded from Table 1 that Land Sat Imageries can be used for quick ascertaining the shallow water table area with 10-15% accuracy. However, the use of Remote Sensing Technique for detailed groundwater studies is in a nascent stage and a lot of effort remains to be undertaken to develop and operationalise different applications.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 420—423 (September 1983)

SCREENING OF GUAVA CULTIVARS FOR WINE AND BRANDY MAKING

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(Received : November 28, 1981; Revised : October 20, 1982)

ABSTRACT

Five cultivars of guava were screened for preparation of wine and brandy. It was observed that wine with 3.83 to 5.81 per cent alcohol can be prepared. The recovery of wine obtained from different cultivars of guava varied from 60.3 to 76.0 per cent, minimum being in case of Banarsi surkha. The recovery of alcohol in brandy from guava wine ranged from 63.8 to 74.2 per cent, maximum being in Lucknow-49.

Guava (*Psidium guajava* L.) is one of the important fruit crops of Haryana and is also cultivated commercially in other parts of the country. The fruit is very nutritious and rich in vitamin C, minerals, etc. This fruit is mainly used for table purpose and very little utilized for processing. However, products like jam, jelly, toffy, etc. can be prepared from it with great success. The wine prepared from guava fruit gives a characteristic flavour (Bardiya *et al.*, 1974). Therefore, five guava cultivars were studied for making wine and brandy.

MATERIAL AND METHODS

Five guava cultivars viz., Apple colour, Allahabad safeda, Banarsi surkha, Lucknow-49 and Seedless were taken from the Experimental Orchard of the Haryana Agricultural University, Hissar. Ripe fruits of different cultivars were harvested and washed out thoroughly. The fruit was crushed in a pulper. Sulphur dioxide in the form of potassium metabisulphite was added at the rate of 100 ppm to prevent the growth of undesirable microorganisms and browning reactions. Commercial pectinase enzyme obtained from CFTRI, Mysore was added @ 5 ml/kg of pulp and allowed to react for 24 h. Juice was extracted with the help of a wooden basket press. The juice was extracted with the yeast *Saccharomyces cerevisiae* var. ellipsoideus and allowed to ferment at 25–30°C till the completion of fermentation. The wine was decanted and filtered through seitz filter. The bot tling was done after adding sulphur dioxide at the rate of 50 ppm. The fermented material was then distilled to recover brandy.

Total reducing sugars from wine and brandy were estimated by the method of Hulme and Naraine (1931). Alcohol, aldehydes, esters, total and volatile acidity, higher alcohol and vitamin C were estimated by the methods of AOAC (1970).

RESULTS AND DISCUSSION

The chemical composition of juice from five aforesaid guava cultivars is presented in Table 1. It is evident from the data that maximum recovery of juice (70.0%) was obtained from the cultivar Seedless followed by Lucknow-49 (67.5%) and Banarsi surkha (65.0%). Total soluble solids and total reducing sugars were highest in Allahabad safeda and lowest in Lucknow-49.

The pH of the guava juice varied from 4.10 to 4.35. Total acidity ranged from 0.49 to 0.87 per cent. Vitamin C content was highest in Allahabad safeda followed by Lucknow-49.

The chemical composition of wine prepared from guava is shown in Table 2. The alcohol content was highest in Allahabad safeda (5.81%) and lowest in Lucknow-49 and Seedless (3.83% each). Volatile acids in wine varied from 0.014 to 0.024 per cent. Ester content ranged from 35.2 to 61.6 mg/l wine. The aldehyde content was highest in Seedless (352.0 mg/l) and lowest in Allahabad safeda (74.6 mg/l). The percentage of residual sugars varied from 1.12 to 1.80 per cent. The highest recovery of wine was obtained from Allahabad safeda (76.0%) and lowest from Banarsi surkha (60.3%).

TABLE 1

Chemical composition of guava juice

Cultivars	Juice (%)	T. S. S. (%)	Total acidity (%)	pH	Vitamin C (mg/100 ml)	Reducing sugars (%)
Apple colour	60.0	12.5	0.57	4.35	142.74	10.88
Allahabad safeda	50.0	14.7	0.87	4.10	263.52	12.21
Banarsi surkha	65.0	13.8	0.64	4.30	122.00	11.28
Lucknow-49	67.5	11.2	0.67	4.20	219.60	9.52
Seedless	70.0	12.2	0.49	4.35	145.18	10.24

TABLE 2

Chemical composition of wine

Cultivars	Total acidity (%)	Volatile acidity (%)	Alcohol (%)	Esters (mg/l)	Aldehydes (mg/l)	Residual sugar (%)	Yield of wine (%)
Apple colour	0.85	0.015	4.18	35.2	148.0	1.46	73.6
Allahabad safeda	1.09	0.024	5.81	52.8	74.6	1.12	76.0
Banarsi surkha	0.87	0.016	5.21	35.2	220.4	1.12	60.3
Lucknow-49	0.94	0.019	3.83	52.8	136.0	1.80	65.7
Seedless	0.85	0.014	3.83	61.6	352.0	1.32	65.4

TABLE 3

Recovery of brandy from wine

Cultivars	Volume of wine (l)	Volume of brandy (l)*	V/V alcohol in wine (%)	Per cent recovery of alcohol in brandy
Apple colour	2.74	0.287	4.18	63.8
Allahabad safeda	2.30	0.310	5.81	70.0
Banarsi surkha	2.30	0.330	5.21	71.6
Lucknow-49	2.90	0.305	3.83	74.2
Seedless	2.70	0.275	3.83	69.7

*Alcohol strength adjusted to 42.8%.

TABLE 4

Chemical composition of guava brandy

Cultivars	Volatile acids (as % acetic acid)	Higher alcohol (g/100 l)	Aldehyde (as acetal-dehyde) (mg/l)	Esters (as ethyl acetate) (mg/l)	Vitamin C (mg/100 ml)
Apple colour	0.198	248.0	589.6	70.4	1.75
Allahabad safeda	0.192	262.0	594.0	70.4	0.25
Banarsi surkha	0.330	120.0	774.4	79.2	0.25
Lucknow-49	0.408	208.0	704.0	79.2	2.50
Seedless	0.384	336.0	827.2	70.4	0.25

The data on recovery of brandy from guava wine are given in Table 3. Maximum recovery of alcohol in brandy was obtained from the wine prepared from Lucknow-49 (74.2%) followed by Banarsi surkha (71.6%). In other guava cultivars it ranged from 63.8 to 70.0 per cent.

The chemical composition of guava brandy is given in Table 4. The volatile acidity ranged from 0.192 to 0.408 per cent. The aldehydes content was highest in Seedless (827.2 mg/l) and lowest in Apple colour (589.6 mg/l). The values for ester varied from 70.4 to 72.2 mg/l. Higher alcohol content was highest in brandy from the cultivar Seedless (336.0 mg/l) and lowest in Banarsi surkha (120.0 g/100 l). The retention of ascorbic acid was negligible which varied from 0.25 to 2.50 mg/100 ml of brandy.

ACKNOWLEDGEMENT

The authors wish to thank Dr. K. S. Chauhan, Professor & Head, Department of Horticulture, for providing necessary facilities to carry out this research.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 424—428 (September 1983)

RECURRENT SELECTIONS IN PEARL MILLET

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(Received : December 8, 1981; Revised : June 25, 1982)

ABSTRACT

The efficiency of various intra-population recurrent selection procedures for grain yield in pearl millet was compared. Four methods $-S_2$, full-sib, half-sib (PT) using parental testers and half-sib (URT) using unrelated testers, were studied over three environments. Mean of the original population ($\bar{X}_o$), selected line ($\bar{X}_s$), selection differential, heritability and genetic advance were worked out. Analysis of variance showed significant treatment differences for grain yield in all the four sets of data. The highest selection differential was observed in S_2 followed by half-sib (PT), half-sib (URT) and full-sib. Estimates of heritability and genetic advance were also higher in S_2 followed by full-sib in both the environments. The net realized gain was highest in S_2. Thus, among intra-population selection procedures, S_2 appears to have an edge over full-sib and half-sib methods.

Recurrent selection procedures provide effective random-mating which breaks the undesirable linkages, ultimately after selection it gives better population than the original one. Various selection procedures viz., S_2, full-sib and half-sib have been suggested for intra-population improvement in cross pollinated crops. Effectiveness of these methods has been emphasized in maize by several workers (Horner *et al.*, 1969; Burton *et al.*, 1971; Moll and Stuber, 1971; Eberhart *et al.*, 1973). However, in pearl millet *(Pennisetum typhoides* (Burm) Stapf et Hubb.) a little work has been conducted on these aspects. The present investigation was undertaken to compare the various intra-population selection procedures for the improvement of grain yield in pearl millet.

MATERIAL AND METHODS

The experimental material for the present investigation was developed from a synthetic pearl millet variety HS-1. Two thousand half-sibs were selected during **kharif**, 1976, which were evaluated during **kharif**, 1977, for grain yield and other agronomic attributes. Again 200 S_1 plants were selected and grown in the off-season nursery (Summer, 1978) at the ICRISAT Farm, Patancheru, Hyderabad. One hundred lines were selected from this nursery to produce S_2 (each line was sibbed), full-sib, half-sib (PT) (individual line was crossed with the bulk pollen of HS-1) and half-sib (URT) (individual line was crossed with the bulk pollen of WC-C 75 composite).

Four sets of trials comprising 100 entries of each S_1, half-sib (PT) and half-sib (URT) and 50 entries of full-sib were grown at two locations by creating three environments at the Experimental Farms of Haryana Agricultural University, Hissar (E_1=Early sown, E_2=Late sown) and Bawal (E_3) during **kharif** (July-October), 1978. The S_1 and half-sibs were planted in simple lattice design and full-sibs in randomized block design consisting of two replications. In each plot there were two rows of 3 m length, spaced 45 cm apart. Care was taken to maintain equal plant population for all the treatments in all the four sets of trials. These experiments were conducted in the same field and the crop was sown on the same date at each location. Grain yield was recorded on plot basis which was converted into q/ha. The best seven entries from each set of experiments were further selected and crossed with bulk pollen of the selected lines. The lines showing consistent performance over the environments from each site were intermated and the same were further grown during 1979 in a randomised block design with two replications of two rows of 5 m length and 50 cm apart at Hissar and Bawal. However, owing to acute drought no worthwhile data were recorded at Bawal.

Analysis of variance for all the sets of experiments was done following randomised block design. Due to small plot size, block differences were non-significant in simple lattice. Mean of the original population ($\bar{X}_o$), selected lines ($\bar{X}_s$), and selection differential were worked out for all the sets of experiments for both the years. Heritability and genetic advance were worked out following Sprague (1966) and Empig *et al.* (1972) procedures. The numerators used for calculating genetic advance were for S_2, $\sigma^2 g = K(3/2)\ \sigma^2 A$; for full-sib $\sigma^2 g = K(1/2)\ \sigma^2 A$ and for half-sib $\sigma^2 g = K(1/4)\sigma^2 A$.

RESULTS AND DISCUSSION

Analysis of variance for grain yield of all the trials conducted during 1978 are presented in Table 1. The differences between the treatments for all the four sets of data at both the locations i. e. Hissar (E_1, E_2) and Bawal (E_3) were significant. This indicates that there was sufficient genetic variability in the base population and selected lines. Mean grain yield of the original lines ($\bar{X}o$) indicated that half-sib (URT) and S_1's were better in E_1 and E_2 (Table 2). However, in E_3 full-sib was better. Similar results were also obtained from the mean yield of selected lines ($\bar{X}s$). Highest selection differential was observed in S_2 followed by half-sib (PT), half-sib (URT) and full-sib. The estimates of heritability and genetic advance were highest for S_2 followed by full-sib under both the environments. However, estimates of heritability and genetic advance in both the half-sibs were quite low.

The lines showing consistent performance over the locations were further intermated and grown during **kharif**, 1979. The mean performance, heritability and genetic advance of different progenies (Table 3) indicate that maximum grain yield, heritability and genetic advance was realized from the S_2 progenies followed by fullsib. However, except S_2 none of the methods could outyield the check HS-1 base populations.

TABLE 1

Analysis of variance for grain yield of S_2, full-sib, half-sib (PT) and half-sib (URT) populations of pearl millet grown over three environments during 1978

Source	Environment	d. f.	Population mean squares			
			S_2	Full-sib	Half-sib (PT)	Half-sib (URT)
Replication	E_1	1	0.0033	0.0588	3.3610	0.1818
	E_2	1	0.0026	0.0007	0.3750	0.5390
	E_3	1	0.0007	0.0001	0.0411	0.0400
Treatment	E_1	99	0.1489	0.1073	7.1462	9.1960
	E_2	99	0.0796*	0.1656*	0.0610*	0.0460*
	E_3	99	0.0216*	0 0163*	0.0100*	0.0129*
Error	E_1	99	0.1472	0.0312	0.3928	11.2619
	E_2	99	0.0220	0.0124	0.0299	0.0260
	E_3	99	0.0007	0.0029	0.0021	0.0021

*Significant at 5% level.
d. f.=49 for treatment and error in full-sib.

TABLE 2

Mean yield of original lines ($\bar{X}_o$), selected lines ($\bar{X}_s$), selection differential ($\bar{X}_o - \bar{X}_s$), heritability and genetic advance in S_2, full-sib and half-sib population of pearl millet during 1978

Selection procedure	Environment	Mean of original lines (q/ha)	Mean of selected lines (q/ha)	Selection differential (q/ha)	Heritability (%)	Genetic advance (%)
S_2	E_1	32.65	54.42	11.77	49.35	38.66
	E_2	18.36	31.01	12.66	76.00	17.33
	E_3	8.66	17.10	8.24	93.93	5.75
Full-sib	E_1	42.55	51.06	8.51	54.43	21.94
	E_2	11.26	16.00	4.74	92.00	12.03
	E_3	12.54	20.18	7.59	84.45	1.07
Half-sib (PT)	E_1	34.04	46.13	12.09	1.88	1.01
	E_2	11.92	25.20	13.28	13.00	0.37
	E_3	8.48	15.50	7.02	20.29	0.09
Half-sib (URT)	E_1	34.61	50.83	16.22	9.05	3.94
	E_2	24.51	34.90	10.39	7.52	0.15
	E_3	8.70	16.16	7.90	23.24	0.14

TABLE 3

Mean performance of the progeny of selected lines, heritability and genetic advance in S_2, full-sib and half-sib families of pearl millet during 1979 at Hissar

Selection procedure	Mean performance of the progenies (q/ha)	Heritability (%)	Genetic advance (%)
S_2	25.37	70.90	38.05
Full-sib	23.05	33.68	0.83
Half-sib (PT)	23.52	18.23	0.02
Half-sib (URT)	23.18	6.86	0.04

The efficiency of any selection procedures depends on two factors, firstly, genetic variability in the base population and secondly, the type of gene effects involved in the material. The results presented here reveal that there was enough variability in the original population. Considering selection procedure, S_2 appears to be the best followed by full-sib. Theoretically also, on per cycle basis, S_2 is the most efficient selection procedure because the coefficient of additive genetic variances in the numerator of the expected gain is higher. Although, the phenotypic variance in the denominator could also be somewhat larger, homozygosity tends to raise genotype × environments interaction. Mass selection does not readily permit precise testing under large population stress and phenotypic variance in this method is likely to be high. The S_2 testing offers better precision for estimating family mean than half-sib and full-sib method with consequent rapid genetic gain (Rachie and Gardner, 1975). Though, the results presented here are based on only one cycle of selection, they provide sound basis to believe that among intra-population selection procedures, S_2 is most efficient in pearl millet. Gupta and Andrews (1978) also made similar observations.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 429—432 (September 1983)

RELATIVE ENERGY PRODUCTION AND ECONOMIC PERFORMANCE OF MUSTARD, CHICKPEA AND BARLEY UNDER CONSERVED MOISTURE AND SUPPLEMENTAL IRRIGATION

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(Received : January 6, 1982; Revised : October 18, 1982)

ABSTRACT

Soil moisture conservation with ploughing showed extra returns of Rs. 317.08, 714.36 and 723.30 and production of Kcal by 7.59, 22.58 and 23.19 per cent higher during 1979-80 over gramoxone, goal and mulch treatments, respectively. Application of one irrigation increased the net income to the extent of Rs. 149.36 and 1067.72/ha and production of Kcal to the tune of 3304×10^4 and 19971×10^4/ha during 1978-79 and 1979-80, respectively. Among crops, mustard gave maximum income and energy during both the years. The next in merit was chickpea with regard to net income and barley with regard to energy.

Mustard *(Brassica juncea* Coss.*)*, chickpea *(Cicer arietinum)* L. and barley *(Hordeum vulgare* L.*)* are the major rainfed winter crops and are planted on the stored soil moisture received from the monsoon. These crops give poor yields if winter rain is insufficient or no supplemental irrigation is applied. However, their success on farmer's field depends on the input-output prices and net returns from different crops. Thus, it is of paramount importance to work out the economics of different crops on the present input-output prices. Since the cost of input and output varies from year to year and as these crops have different potential while comparing different crops, having large differences in their price structure, relative net returns in terms of calories perhaps is better criterion to judge their relative suitability under different sets of conditions. So a field experiment was conducted to compare the net returns and energy production by mustard, chickpea and barley under conserved moisture and supplemental irrigation.

MATERIAL AND METHODS

Field experiments were conducted at the Agronomy Research Farm of Haryana Agricultural University, Hissar, during 1978-79 and 1979-80. The soil of the experimental plot was sandy loam in texture, low in organic and available nitrogen contents and medium in phosphorus, rich in potash and slightly alkaline in reaction.

Experiments were laid out in split plot design with four replications. There were 24 treatment combinations in main plots viz., (i) conventional tillage, (ii) Gramoxone @ 0.24 kg a.i./ha+one ploughing, (iii) Goal (RH 2915) @ 0.25 kg a.i./ha

+one ploughing, and (iv) mulching with sunnhemp; two irrigation levels in sub-plots viz., (i) no irrigation and (ii) one supplemental; and three crops in ultimate plots viz., mustard, chickpea and barley. The ultimate plot size was 8 m×3 m. Details of various operations are given in Table 1.

The economics of treatments has been worked out by taking into consideration the cost of cultivation/production of different crops. Cost of cultivation was based on package of practices for **rabi** 1979 and 1980 (Anonymous, 1979, 1980). However, the price of gramoxone was taken as Rs. 80/l and that of Goal Rs. 100/l. To find out the net gain, the cost of the treatment was subtracted from the gross value of the produce. In order to compare three potentially different crops, the grain yields were converted into energy by using energy data for different crops given by Aykroyd (1963).

The rainfall recorded (from July to September) during **kharif**, 1978 (538.3 mm) was higher than **kharif**, 1979, (320 mm). Weather conditions during the two crop seasons differed considerably and were more favourable for crop growth in 1978-79 than 1979-80. Rainfall was higher (84.10 mm) and better distributed during **rabi** 1978-79 than 1979-80 (30.50 mm).

RESULTS AND DISCUSSION

Energy Production

Soil moisture conservation practices did not affect the energy production during 1978-79 (Fig. 1). However, significant differences were observed during 1979-80. Ploughing treatment produced 68552×10^4 kcal/ha which was significantly higher as compared to gramoxone, goal and mulch to the extent of 7.59, 22.58 and 23.19 per cent, respectively. Gramoxone was next in merit. Applications of goal and mulch were proved at par. One supplemental irrigation recorded significantly higher production of energy over no irrigation during both the years. The response to irrigation was higher during 1979-80 (19971×10^4 Kcal/ha) than in 1978-79 (3304×10^4 Kcal/ha).

TABLE 1

Details of various operations

Operations	Mustard	Chickpea	Barley
Sowing	8.10.78	8.10.78	8.10.78
	15.10.79	15.10.79	15.10.79
Row spacing	30 cm	30 cm	25 cm
Variety	Parkash	H-208	C-138
Fertilizer	40 kg N+20 kg P_2O_5/ha	15 kg N+40 kg P_2O_5/ha	30 kg N+15 kg P_2O_5/ha
Seed rate	5 kg/ha	37.5 kg/ha	87.5 kg/ha
Harvesting	15.3.79	24.4.79	20.3.79
	18.3.80	18.4.80	25.3.80

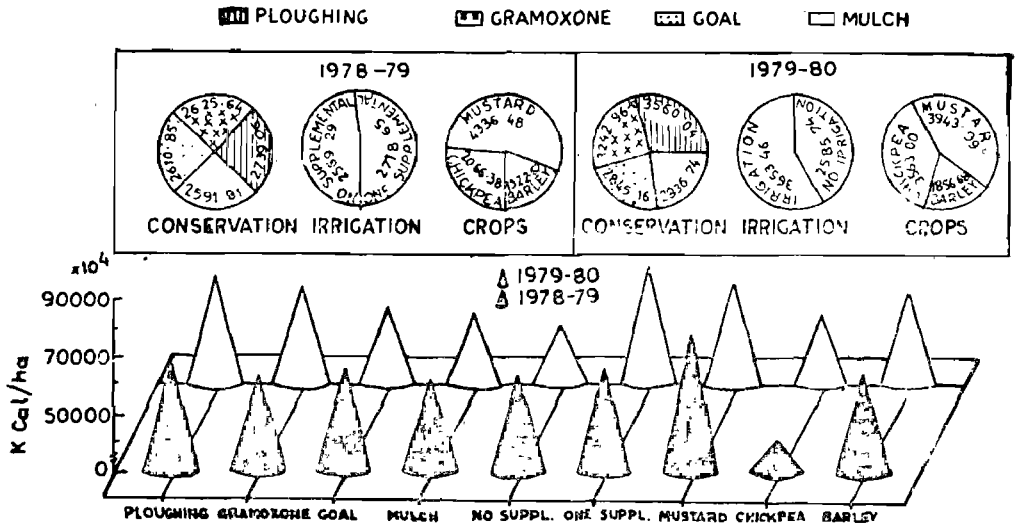


Fig 1. Economics (Rs./ha) and calories (Kcal) as affected by different treatments.

In general, energy production by different crops was more during 1978-79 than in 1979-80 except in chickpea. The reason being that irrigation instead of increasing the yield of chickpea resulted in lowering of its yield (Table 2). During 1978-79 highest energy (87808×10^4 kg/ha) was produced by mustard closely followed by barley (65288×10^4 kg/ha). The lowest energy was produced by chickpea (41094×10^4 kg/ha), thereby indicating double the energy with mustard than chickpea. During 1979-80, mustard and barley crops were at par but both recorded significantly more energy as compared to chickpea. Better performance of barley than chickpea in terms of energy is attributed to the higher yield of barley than chickpea (Table 2). Singh and Rama Krishana (1977) also found that out of selected dry land crops grown on conserved soil moisture, barley proved to be more efficient in terms of better yields.

Economics of Treatments

Net income was almost similar due to different soil moisture conservation practices during 1978-79 (Fig. 1). Whereas in 1979-80 ploughing treatment showed extra returns of Rs. 317.08, 714.88 and 723.30 over gramoxone, goal and mulch, respectively. With one supplemental irrigation the net income increased by Rs. 149.36 and 1067.72 over no irrigation during 1978-79 and 1979-80, respectively. This was due to the fact that high rainfall took place during 1978-79 as compared to 1979-80 which nullified the effect of irrigation and resulted in lower yield differences (Table 2).

Out of different crops tried, maximum net income of Rs. 4336.48 and 3943.99 was obtained by mustard during 1978-79 and 1979-80, respectively. Further, the increase in net profit by mustard over chickpea and barley was Rs. 2270.10

TABLE 2

Grain yield of mustard, chickpea and barley as affected by soil moisture conservation practices and supplemental irrigation

Treatments	Grain yield (q/ha)					
	Mustard		Chickpea		Barley	
	1978-79	1979-80	1978-79	1979-80	1978-79	1979-80
Soil moisture conservation practices						
Ploughing	17.55	13.44	10.30	15.97	20.32	22.52
Gramoxone + one ploughing	16.40	12.17	10.25	15.36	19.74	20.83
Goal + one ploughing	15.37	11.17	12.72	15.08	19.26	15.79
Mulch	15.20	11.24	12.39	14.20	18.39	16.37
S. Em. ±	0.50	0.49	0.48	0.51	1.0	1.69
C. D. at 5%	1.41	1.44	1.42	1.50	NS	4.96
Irrigation level						
No irrigation	15.29	10.59	12.05	13.62	18.48	13.89
One supplemental	16.96	13.42	10.77	16.68	20.38	23.86
S. Em. ±	0.36	0.34	0.34	0.36	0.70	1.19
C. D. at 5%	1.05	1.02	1.02	1.05	NS	3.50

and 2813.81; Rs. 380.99 and 2087.31 during first and second year, respectively. The lowest net return from barley was mainly due to low market price of the crop. Singh and Sharma (1981) found that mustard was most remunerative crop under limited water availability condition followed by chickpea, taramira and barley.

ACKNOWLEDGEMENT

The senior author is thankful to the Council of Scientific and Industrial Research, New Delhi, for awarding senior research fellowship.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 433—438 (September 1983)

STUDIES ON THE STORAGE BEHAVIOUR OF A WHITE ONION (*ALLIUM CEPA* L.) VARIETY AS INFLUENCED BY LEVELS OF N, P AND K

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(Received : June 11, 1980; Revised : January 14, 1981)

ABSTRACT

Investigations conducted to study the influence of various levels of N (0, 40, 80, 120, 160 and 200 kg/ha), P_2O_5 (0, 30, 60 kg/ha) and K_2O (0, 30 and 60 kg/ha) on the storage behaviour of a white onion variety, Punjab 48, revealed that higher levels of N had an adverse influence on storage behaviour under ordinary and cold storage conditions, whereas P and K (60 kg/ha each) improved it. P and K also alleviated the adverse effect of N. Interaction of N × P × K was found to be non-significant.

The storage of onion under ordinary conditions poses a great problem due to excessive rotting, sprouting and rooting. Under cold storage the losses are comparatively less. The storage behaviour is influenced by genetic as well as cultural practices. Generally, excess N application increases the yield of bulbs, but it is reported that excess N application lowers the storage quality while P and K improve it (Singh and Kumar, 1969; Bottcher and Kolbe, 1975b). Most of the studies were conducted on coloured varieties of onion and recommended 112 kg/ha dose of N and 50 kg/ha of P_2O_5 and K_2O each (Singh and Kumar, 1969; Singh *et al.*, 1972). The present investigations were undertaken to study the storage behaviour of white onion variety, Punjab 48, as influenced by the levels of nitrogen, phosphorus and potash.

MATERIAL AND METHODS

The studies were undertaken on a white onion (*Allium cepa* L.) cultivar, Punjab 48, during 1976-77 and 1977-78. The fertilizer treatments consisted of six levels of nitrogen (0, 40, 80, 120, 160 and 200 kg/ha), three levels of phosphorus (0, 30 and 60 kg/ha P_2O_5) and three levels of potash (0, 30 and 60 kg/ha K_2O) in all possible combinations arranged in a split plot design with three replications. The N levels were kept in main plots, whereas P and K in sub-plots. The subplot measured 4.5 × 1.5 m and planting was done at 15 × 7.5 cm spacing. Uniform 60 days old seedlings were transplanted on 4th January each year. The cultural practices were uniform for all the treatments. The sources of N, P and K were calcium ammonium nitrate (25% N),

superphosphate (16% P_2O_5) and muriate of potash (60% K_2O), respectively. Whole dose of P and K and half of N was applied before transplanting while remaining half dose of N was top-dressed after 30 days of transplanting.

The crop was harvested in May each year and samples comprising 10 kg cured bulbs per treatment per replication were put in wooden crates. One lot was kept at room temperature, whereas the other in cold storage (32±2°F and 80% RH). The observations on rotting and sprouting were recorded after four months of storage. The data for both the years were pooled and analysed.

RESULTS AND DISCUSSION

Influence of Nitrogen

Higher levels of N were found to have an adverse influence on the storage behaviour of onion both under ordinary conditions (Tables 1 and 2) and cold storage conditions (Tables 3 and 4). Both sprouting and rotting increased with N levels higher than 80 kg/ha. These findings corroborate the reports of Hawthorn (1941) and Bottcher and Kolbe (1975a). However, Sypian *et al.* (1973) observed best bulb quality and storeworthy with 150 kg/ha of N applied before transplanting. The reason may be that excessive N tends to increase water content as well as size. According to Karmarkar and Joshi (1941) and Fosket and Peterson (1950), bulb size and water content have inverse relationship with storage quality.

Influence of Phosphorus

Phosphorus application improved the storage quality of onion bulbs both under ordinary and cold storage conditions. Increasing the levels of P_2O_5 to 60 kg/ha caused a significant decrease in losses due to sprouting as well as rotting. These results are similar to those of Bottcher and Kolbe (1975a) who observed a decl-

TABLE 1

Sprouting (%) under ordinary storage as influenced by various levels of N and P (data pooled for 1975-76 and 1976-77)

	Nitrogen (kg/ha)						
	0	40	80	120	160	200	Mean
Phosphorus(kg/ha)							
0	61.30	62.20	68.51	72.06	72.79	73.90	68 46
30	61.48	62.39	67.43	70.27	70.58	72.09	67.37
60	61.43	62.08	66.71	69 66	70.37	71.67	66.98
Potash (kg/ha)							
0	62.69	63.40	68.96	72.58	73.51	74.13	69.21
30	60.94	61.87	67.33	70.33	70.53	72.30	67.22
60	60.60	61.39	66.36	69.09	69.69	71.16	66.39
Mean	61.41	62.22	67.55	70 66	71.24	72.55	67.81
C. D. at 5%			N=2.38		NP=NS		
			P=0.67		NK=NS		
			K=0.67		NPK=NS		

TABLE 2

Rotting (%) under ordinary storage as influenced by various levels of N and P (data pooled for 1975-76 and 1976-77)

	Nitrogen (kg/ha)						
	0	40	80	120	160	200	Mean
Phosphorus (kg/ha)							
0	21.88	22 65	24.85	25.40	25.99	27 04	24.64
30	20.91	21.21	23.51	23.78	24.50	25.62	23.25
60	20.48	20.97	22.47	23.50	24.13	24.80	22.72
Potash (kg/ha)							
0	21 94	22.72	24.87	25.39	25.97	27.08	24.66
30	20.85	21.15	23.20	23.72	24.68	25.41	23.13
60	20.49	20.97	22.76	23.57	24.19	24.97	22.83
Mean	21.09	21.61	23 61	24.23	24.87	25.82	23.54
C.D. at 5%			N=0.60	NP=NS			
			P=0.87	NK=NS			
			K=0.87	NPK=NS			

TABLE 3

Sprouting (%) under cold storage as influenced by various levels of N and P (data pooled for 1975-76 and 1976-77)

	Nitrogen (kg/ha)						
	0	40	80	120	160	200	Mean
Phosphorus (kg/ha)							
0	4.83	6.26	7.33	8.49	9.22	9 35	7.58
30	4.43	5.52	6.52	7.38	8.23	8.26	6.72
60	4.50	5.48	6.20	7.37	8.03	8 01	6.60
Potash (kg/ha)							
0	4.92	6.62	7.61	8.67	9.53	9.53	7.81
30	4.59	5.60	6.53	7.58	8.33	8.37	6.83
60	4.25	5.05	5.91	6 98	7.63	7.72	6.26
Mean	4.69	5.75	6.68	7.74	8.50	8.54	6.97
C. D. at 5%		N=0.550		NP=0.345			
		P=0.139		NK=0.340			
		K=0.139		NPK=NS			

ine in the sprouting and rotting with 39.3 kg/ha of P_2O_5. The decrease in sprouting and rotting with higher levels of P_2O_5 may be due to increase in bulb size and dry matter (Madan and Sandhu, 1980).

Influence of Potash

Like phosphorus, increasing the levels of potash resulted in the improvement of storage quality. Both the levels of K viz.,

30 and 60 kg/ha significantly lowered the losses from sprouting and rotting. The findings corroborate the results of Tsang (1972), Bottcher and Kolbe (1975a) and Petkov *et al.* (1976). Under ordinary conditions of storage, minimum sprouting and rotting was observed with 60 kg/ha of K_2O. The improvement in storage behaviour by K_2O may be explained on the basis of increased TSS and dry matter content in onions as a result of K_2O application (Fosket and Peterson, 1950).

Interaction Effects

Minimum sprouting and rotting was observed in treatments with 60 kg/ha of either P_2O_5 or K_2O in the absence of N. The inclusion of either phosphorus or potash with nitrogen alleviated the adverse influence of N on the storage behaviour of onion bulbs under ordinary (Tables 1 and 2) and cold storage conditions (Tables 3 and 4). These results are in confirmity with the findings of Corenjo (1957) and

TABLE 4

Rotting (%) as influenced by various levels of N and P after 150 days of storing in cold storage (data pooled for 1975-76 and 1976-77)

	Nitrogen (kg/ha)						
	0	40	80	120	160	200	Mean
Phosphorus (kg/ha)							
0	5.54	6.35	7.00	7.96	8.90	10.38	7.69
30	5.08	5.93	6.48	7.45	8.37	9.87	7.20
60	4.85	5.53	6.05	7.15	8.16	9.66	6.90
Potash (kg/ha)							
0	5.70	6.48	7.06	8.12	9.01	10.62	7.83
30	5.26	6.01	6.46	7.48	8.44	9.85	7.25
60	4.52	5.32	6.01	6.96	7 98	9.45	6.71
Mean	5.16	5.94	6.51	7.52	8.48	9.97	7 26

C. D. at 5%

N=0.58 NP=NS
P=0.91 NK=NS
K=0.91 NPK=NS

TABLE 5

Sprouting (%) under ordinary storage as influenced by various levels of P and K (data pooled for 1975-76 and 1976-77)

	Phosphorus (kg/ha)			
	0	30	60	Mean
Potash (kg/ha)				
0	70.69	68.88	68.06	69.21
30	67.69	66.97	66.99	67.22
60	67.01	66.26	65.89	66.39
Mean	68.46	67.37	66.98	67.61

C. D. at 5% PK=NS

TABLE 6

Rotting (%) under ordinary storage as influenced by various levels of P and K (data pooled for 1975-76 and 1976-77)

Potash	Phosphorus (kg/ha)			
(kg/ha)	0	30	60	Mean
0	24.85	24.70	24.43	24.66
30	24.66	22 64	22.09	23.13
60	24.41	22.42	21.65	22.83
Mean	24.64	23.25	22.72	23.54
C. D. at 5%	PK=0.36			

TABLE 7

Sprouting (%) under cold storage as influenced by various levels of P and K (data pooled for 1975-76 and 1976-77)

Potash	Phosphorus (kg/ha)			
(kg/ha)	0	30	60	Mean
0	8.27	7.73	7.43	7.81
30	7.46	6.37	6.67	6.83
60	7.00	6.06	5.70	6.26
Mean	7.58	6.72	6.60	6.97
C. D.at 5%	PK=0.24			

TABLE 8

Rotting (%) as influenced by various levels of P and K after 150 days of storing in cold storage (data pooled for 1975-76 and 1976-77)

Potash	Phosphorus (kg/ha)			
(kg/ha)	0	30	60	Mean
0	8.13	7.85	7.51	7.83
30	7.62	7.10	7.03	7.25
60	7.31	6.66	6.16	6.71
Mean	7.69	7.20	6.90	7.26
C. D. at 5%	PK=0.16			

Singh and Kumar (1969). Both P and K are known to increase the dry matter accumulation as a result of increased photosynthetic rates. Phosphorus helps in energy transfer reactions, whereas potash is known to influence the action of various photosynthetic enzymes (Davlin, 1969).

The results on the interaction between phosphorus and potash show a positive interaction (Tables 5 to 8). The minimum percentage of rotting was, thus, recorded with $P_{60} \times K_{60}$ interaction. The role of K in improving the keeping quality seemed to be more than that of P on sprouting at room temperature which agrees with Bottcher and Kolbe (1975a). These results are, however, contrary to the results of Wayre (1967) who reported that phosphorus and potash had no effect on keeping quality of onion bulbs.

It was found that minimum losses from rotting and sprouting were observed with 120 kg N, 60 kg P_2O_5 and 50 kg K_2O per ha. The results, however, fell short of level of significance.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 439—446 (September 1983)

WEED CONTROL STUDIES IN OKRA (*ABELMOSCHUS ESCULENTUS* (L.) MOENCH)

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(Received : September 16, 1981; Revised : April 7, 1982)

ABSTRACT

Each herbicide supplemented with one hand or two hand weedings produced *Cyperus rotundus* more in number than herbicide alone. Fluchloralin 0.5 kg a.i./ha controlled the weed population most effectively except broad leaved weed like amaranthus. Fluchloralin application at 1 kg a.i./ha + one hand weeding at 45 days produced maximum number of fruits per plant and highest yield of green pods/ha.

Okra *(Abelmoschus esculentus* (L.) Moench), commonly called as **bhindi**, is one of the important vegetable crops of subtropical and tropical regions. It is grown all over India during the spring and rainy seasons. The okra crop is infested by a wide spectrum of broad leaved grassy herbs which germinate and flourish much earlier than the okra seedlings. Agronomic practices like wider spacing, liberal supply of organic manures and fertilizers, frequent irrigation with canal and sewage water and poor cultivation of land due to intensive cropping are responsible factors for higher weed intensity in vegetable growing areas. The cost of production of vegetables increases with the number of weedings as the vegetable growers have to depend on manual labour which is becoming costlier as well as scarce. Though manual weeding is effective, yet it is a time consuming, costly and laborious method. Sometimes it proves injurious to root and shoot system leading to loss of moisture at a critical phase of crop growth, especially in areas where water supply is limited and results in low yields. In rainy seasons, crop weeds are the major problem because with every shower of rain there is resurgence of weed and requires repeated hand weeding, thereby increasing the cost of production. Weeds have a higher initial growth rate and remove more N, P and K from the soil earlier than the crop (Hewson, 1971). Guzman (1955-56) and Murphy (1964, 65) obtained better yield of **bhindi** pods for table purposes with the application of weedicides during **kharif** season. The present investigation was carried out to find out the efficacy of two weedicides, independently as well as in combination with one hand weeding as compared to hand weedings alone, in controlling weeds in okra and also their effect on the yield.

MATERIAL AND METHODS

The experiment was conducted at the Vegetable Research Farm, Haryana Agricultural University, Hissar during the rainy

season of 1979 and 1980 on sandy loam soil having 8.5 pH and moderate fertility. During both the years, okra variety 'Pusa Sawani' was sown. Sowing was done on July 23 during 1979 and July 9 during 1980. The treatments consisted of four doses of Fluchloralin, i.e., 0.5, 1.0, 1.5 and 2.0 kg a.i./ha and two doses of Nitrofen, i.e., 2.0 and 2.5 kg a.i./ha and one hand weeding followed at 45 days after sowing with each weedicide treatment and compared with hand weeding at 15 and 45 days after sowing, weed free (repeated weeding) and weedy check (control). The experiment was laid out in a randomized block design with three replications. Plot size was 4.0×2.5 m and the planting distance was 45×30 cm. Recommended package of practices were followed during the course of experimentation. Weedicides were sprayed with Knap sack sprayer fitted with flat fan nozzle at 1000 l/ha. Fluchloralin was used at preplant weedicide two days before sowing and incorporated into the soil by thorough raking, whereas Nitrofen was applied one day after sowing as pre-emergence weedicide. Data were recorded on spectrum, number, fresh and dry weight of weeds/m^2, germination percentage, height of plants, number of branches/plant, number of nodes at which first flower appeared, number of fruits/plant and yield of fruits of okra. Data on weed spectrum and their fresh and dry weight were recorded 70 days after sowing. Harvesting of fruits was done in 8 and 10 pickings during 1979 and 1980 and last pickings were done on 26th and 9th October, respectively.

RESULTS AND DISCUSSION

The main weed species prevalent in the okra crop were *Amaranthus viridis, Cynodon dactylon, Dactyloctenium aegyptium, Cyperus rotundus, Euphorbia microphylla, Trianthema monogyna* and *Vioca indica* (Table 1).

The data in Table 2 reveal that, in general, the weed population was more during 1979 as compared to 1980 which might be due to variation in weather and farm yard manure. Though during both the years there were significant differences among the treatments, yet the number of weeds/m^2 under chemical treatments was statistically at par except under Nitrofen in 1980. Both the concentrations of Nitrofen supplemented with hand weeding gave significantly higher number of weeds than control during both the years, which was because of *Cyperus rotundus* which sprouted more in number after the weeding (Table 1). It was interesting to note that each herbicidal treatment supplemented with hand weeding produced more number of *Cyperus rotundus*/m^2 than under the chemical treatments alone (Table 1). It might be due to the reason that by the date of weeding (45 days after sowing) chemical might have lost the weed killing capacity. Average of two years showed that Fluchloralin 0.5 kg a.i./ha was more effective to minimise the weed population during both the years (Table 2). But this treatment was inaffective to control broad leaf weeds like *Amaranthus viridis*. The population of *Cyperus rotundus* was minimised in the plots where broad leaved weeds like *Amaranthus viridis* and *Trianthema monogyna* prevailed due to their spreading growth habit and covering the plot surface. In hand weeded plots, all the types of weeds were minimum except *Cyperus rotundus* which frequently sprouted after weeding and was actually res-

TABLE 1

Effect of weed control treatment on number of weeds of different species/m² at the time of harvesting

Treatments (kg a.i./ha)	*Amaranthus viridis*		*Cynodon dactylon*		*Dactyloctenium aegyptium*		*Cyperus rotundus*		*Euphorbia microphylla*		*Trianthema monogyna*		*Vioca indica*	
	1979	1980	1979	1980	1979	1980	1979	1980	1979	1980	1979	1980	1979	1980
1. Weedy check (control)	33.30	28.34	—	—	28.34	19.72	—	—	—	1.22	9.34	4.92	—	—
2. Hand weeding at 15 and 45 days after sowing	1.22	1.22	8.62	—	1.22	1.22	50.54	24.64	1.22	20.94	1.22	—	—	1.22
3. Weed free (repeated weeding)	8.62	6.00	—	—	—	3.70	56.72	20.00	1.22	4.92	—	2.43	—	—
4. Fluchloralin 0.5	29.30	20.34	1.22	—	6.14	9.84	2.44	—	—	—	1.22	3.70	—	—
5. ,, 1.0	14.80	14.80	—	—	1.22	1.22	23.46	10.03	1.22	9.12	4.92	2.00	—	—
6. ,, 1.5	8.62	14.80	9.84	3.70	4.92	3.70	28.34	20.94	2.44	3.70	—	3.70	—	3.70
7. ,, 2.0	7.40	8.62	3.70	2.44	—	—	82.62	8.62	4.92	6.14	—	7.40	—	3.70
8. ,, 0.5*	11.10	18.50	1.22	2.44	3.70	7.40	433.14	4.92	1.22	7.40	20.94	25.90	—	—
9. ,, 1.0*	1.22	13.54	1.22	—	1.22	3.70	140.60	19.72	—	3.70	1.22	6.14	—	2.44
10. ,, 1.5*	2.44	7.40	1.22	1.22	—	3.70	117.14	41.92	2.44	3.70	—	7.40	—	1.22
11. ,, 2.0*	—	12.44	9.84	—	—	4.58	104.82	30.82	—	—	1.22	3.43	—	—
12. Nitrofen 2.0	25.90	12.32	16.02	—	8.62	12.52	3.70	1.22	1.22	2.44	—	10.20	—	—
13. ,, 2.5	14.80	7.40	16.02	—	14.80	3.70	6.14	1.22	6.14	70.30	—	13.54	—	3.70
14. ,, 2.0*	7.40	—	7.40	6.14	—	1.22	98.64	65.34	—	33.60	—	2.44	—	—
15. ,, 2.5*	3.70	1.22	6.14	—	—	1.22	123.32	136.90	—	22.60	—	1.22	—	—

*Treatments supplemented by one hand weeding at 45 days after sowing.

TABLE 2

Effect of weed control treatments on number of weeds, and fresh and dry weight of weeds at the time of harvesting

Treatments (kg a. i./ha)		Number of weeds/m²			Fresh weight of weeds/m² (g)			Dry weight of weeds/m² (g)		
		1979	1980	Average	1979	1980	Average	1979	1980	Average
1.	Weedy check (control)	71.48	54.20	62.34	1529.33	1282.67	1406.00	559.93	323.13	441.53
2.	Hand weeding at 15 and 45 days after sowing	64.04	49.24	56.64	351.50	423.03	387.26	234.33	226.93	230.63
3.	Weed free (repeated weeding)	66.56	37.05	51.81	198.57	213.37	205.97	118.40	127.03	122.71
4.	Fluchloralin 0.5	40.62	33.88	37.25	284.90	923.77	604.33	119.63	319.43	219.53
5.	,, 1.0	45.62	37.17	41.40	208.43	849.77	529.10	122.10	297.23	209.67
6.	,, 1.5	54.16	54.20	54.18	686.97	933.63	810.30	357.67	300.93	329.30
7.	,, 2.0	98.64	37.00	67.82	305.87	764.67	535.27	171.43	300.93	236.18
8.	,, 0.5*	81.40	66.56	73.98	315.73	753.57	534.65	176.37	278.73	227.55
9.	,, 1.0*	145.53	49.24	97.39	218.30	852.23	535.26	150.47	240.50	195.48
10.	,, 1.5*	127.90	66.56	97.23	212.13	293.53	252.83	123.33	173.90	148.61
11.	,, 2.0*	115.93	41.27	78.60	283.67	254.07	263.87	144.30	131.97	138.04
12.	Nitrofen 2.0	55.50	37.30	46.50	1089.03	1006.40	1047.71	421.80	246.57	334.18
13.	,, 2.5	57.97	99.86	78.92	1298.70	1523.17	1410.93	516.77	316 97	416.87
14.	,, 2.0*	113.44	106.36	109.90	1298.70	525.40	912.05	413.17	220.77	316.97
15.	,, 2.5*	127.02	163.16	145.09	657.37	604.33	630.85	352.73	220.00	287.36
C. D. at 5%		56.42	30.73	—	285.77	209.37	—	162.39	117.44	—

*Treatments supplemented by one hand weeding at 45 days after sowing.

ponsible to increase the count of weeds/m^2 as compared to weedicidal treatments.

It is also evident from Table 2 that during both the years the fresh weight of weeds/m^2 was significantly higher in weedy check (control) plots and the lowest fresh weight was recorded in weed free plots. The highest fresh weight of weeds/m^2 under weedy check was possible because of no disturbance to the growth of weeds, whereas in weed free plots frequent removal of weeds checked the growth and resurgence of weeds resulting in the lowest fresh weight of weeds. The same trend was observed in dry weight of weeds/m^2. The excellent range of efficacy of Fluchloralin (Basalin) against weeds has also been demonstrated in pea (Singh *et al.*, 1974), cotton (Ertle, 1974), brinjal (Leela, 1976) and onion (Randhawa and Kooner, 1977).

Germination of okra seed had some differences, but significant differences among various weedicidal treatments were not seen (Table 3). No phytotoxic effect was noticed on the crop under the influence of any weedicide treatment. Singh (1978) reported that Fluchloralin and Nitrofen did not have any adverse effect on germination and no phytotoxicity was seen with the treatment in okra crops.

The differences in plant height amongst the treatments were significant only in 1980 (Table 3). However, the average of two years showed the maximum height of plants with the weedicide Fluchloralin 0.5 kg a.i./ha just followed by Fluchloralin 1.0 kg a.i./ha and Nitrofen 2.5 kg a.i./ha. The minimum height of plants during both the years was observed in the plots kept for hand weeding at 15 and 45 days after sowing. The maximum height of plants with Fluchloralin 0.5 and 1.0 kg a.i./ha might be due to lesser weed competition (Table 3). The results are in agreement with the findings of Singh (1978). The minimum height of plants with two hand weeded plots appeared probably due to weedings and hence the crop plants faced almost no competition with weeds and rather received more sunlight at early stage making the plants stoughty with thick stem and more number of branches per plant resulting the check on the height of the plants (King, 1966).

The differences in the number of branches per plant were significant during both the years (Table 3). The maximum branches per plant were found in weed free plots, followed by Nitrofen 2.0 kg a.i./ha+one hand weeding at 45 days after sowing, whereas the least branches per plant were found in control plot. The reason for maximum and minimum number of branches/plant under weed free and weedy check (control) plots, respectively, might be due to the weed population in the plots which directly affected the branching of the plants.

Significant differences were observed in node at which first flower appeared. The lowest node was found on the plants where Fluchloralin @ 1.0 kg a.i./ha was used. Number of fruits per plant were influenced significantly by weed control treatments (Table 3). The average of two years depicted the highest number of fruits per plant with the application of Fluchloralin 1.0 kg a.i./ha and supplemented with one hand weeding at 45 days after sowing and followed by weed free, and Nitrofen 2.5 kg a.i./ha+one hand

weeding, whereas lowest number of fruits was obtained in control plot. The higher number of fruits per plant under above treatments might be due to lower population of weeds like *Amaranthus viridis*, *Cynodon dactylon* and *Trianthema monogyna* which due to their spreading nature of growth cover the space and compete with crop plants for light and nutrition faster than the weed like *Cyperus rotundus*. The second reason for better fruiting appears to be the better height of plants under these treatments. Saghir and Markaullis (1974) and Singh, (1978) also reported increased yield in potato and okra, respectively, under Fluchloralin application.

Fluchloralin 1.0 kg a.i./ha+one hand weeding at 45 days after sowing produced the highest fruit yield during both the years which was significantly higher than the yield obtained from control and hand weeded twice. The highest yield could be due to lesser competition of weeds from sowing to the harvesting stages of the crop, thus, resulting in better utilization of soil moisture, nu-

TABLE

Effect of weed control treatments on germination, height of plant, number of fruits per plant and

Treatments*	Germination (%)			Height of plant (cm)			No. of branches/ plant		
	1979	1980	Average	1979	1980	Average	1979	1980	Average
1.	57.67	40.94	49.31	114.33	63.60	88.97	0.94	0.60	0.77
2.	60.34	35.35	47.85	101.53	59.30	80.42	2.67	1.53	2.10
3.	68.00	34.96	51.48	100.80	76.10	88.45	2.47	4.00	3.24
4.	59.00	40 66	49.83	124.40	72.40	98.40	1.94	1.20	1.57
5.	59.34	39.56	49.45	127.33	64.70	96.02	2.14	1.86	2.00
6.	60.34	41.08	50.71	104.86	67.90	86.88	1.40	1.20	1.30
7.	54.67	35.12	44.90	116.73	66.40	91.57	1.74	1.13	1.44
8.	63.34	38.18	50.76	106.86	68.00	87.43	2.87	3.06	2.97
9.	64.34	37.72	51.02	118.60	70.00	94.30	2.34	3.06	2.70
10.	61.00	40.14	50.57	112.20	68.60	90.40	2.67	2.13	2.40
11.	60.34	39.68	50.01	101.66	69.20	85.43	1.94	3.86	2.90
12.	61.34	36.46	48.90	119.26	59.50	89.38	1.14	0.86	1.00
13.	60.00	35.20	47.60	113.60	78.70	96.15	0.67	0.93	0.80
14.	64.67	37.38	51.03	116.00	60.10	88.05	2.80	3.33	3.07
15.	59.00	38.52	48.76	122.20	64.60	93.40	1.40	2.73	2.07
C. D. at 5%	NS	NS	—	NS	4.59	—	1.05	0.81	—

*Detail of treatments as in Table 1.

trients and space. The taller plants were also observed to have broader leaves inducing more photosynthesis and having more number of buds, flowers and ultimately resulting in higher yield. The lowest yield was recorded in control plots, may be due to more competition of weeds to crop plants and, thus, producing the minimum number of branches and fruits per plant. The yield obtained during 1979 was higher than that of 1980 due to uniform distribution of rains as well as timely irrigation in 1979, whereas during 1980 irrigation could not be given timely due to breakdown of electricity and canal during late fruiting stage. In brinjal crop similar findings have also been reported by Leela (1976) who found Basalin (Fluchloralin) 2.0 kg a.i./ha to be the best treatment giving 28.8% increase in yield over the hand weeded control followed by Basalin 3.0 kg a.i./ha which gave 18.1% increase over control. Samdyan (1977) also found that Basalin 1.25 kg/ha not only induced early flowering and ripening of tomato but also increased number and weight of fruits per plant.

3

branches per plant, number of node at which first flower appeared, number of yield of fruits in okra

No. of node at which first flower appeared			No. of fruits/ plant			Yield of fruits (q/ha)		
1979	1980	Average	1979	1980	Average	1979	1980	Average
11.34	10.86	11.10	5.78	2.65	4.22	38.55	9.63	24.90
10.67	12.46	11.57	7.26	4.99	6.14	51.60	11.94	31.77
10.40	10.75	10.57	9.19	8.15	8.67	59.25	63.72	61.49
10.87	11.46	11.17	7.59	3.69	5.64	42.60	19.08	30.84
9.67	10.26	9.97	10.56	5.37	7.97	32.89	36.37	34.63
10.51	11.46	11.00	9.65	3.57	6.61	68.85	33.53	51.19
11.27	11.33	11.30	7.74	3.54	5.64	41.55	25.97	33.76
11.14	10.93	11.04	7.62	7.51	7.57	46.50	31.46	38.98
9.67	12.53	11.10	10.82	7.10	8.96	77.45	65.93	71.69
10.20	12.00	11.10	10.49	4.89	7.69	71.55	56.34	63.95
10.07	12.00	11.04	7.87	5.85	6.86	59.10	69.66	64.38
10.40	11.46	10.93	9.01	2.90	5.96	57.75	22.95	40.35
10.54	11.60	11.07	6.02	4.85	5.44	45.15	33.21	39.18
10.34	12.33	11.34	8.51	4.77	6.64	62.40	45.57	53.99
9 67	10.93	10.30	10.30	5.80	8.05	68.40	46.12	57.26
1.028	0.68	—	1.827	2.27	—	12.74	27.22	—

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 447—453 (September 1983)

AN APPROACH TO CONTROL COLLAR-ROT OF INDIAN MUSTARD

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(Received : September 24, 1981; Revised : April 21, 1982)

ABSTRACT

Out of 19 fungicides tested *in vitro*, only six viz., carbendazim, carboxin, thiophanate-methyl, captafol, mancozeb and agrosan GN were found effective at all concentrations (0.05, 0.1, 0.15 and 0.2 per cent a. i.) against *Rhizoctonia bataticola*, the incitant of collar-rot of Indian mustard. Seed treatments with 11 selective fungicides indicated that carbendazim, carboxin and panoram checked the disease completely under greenhouse conditions. In soil drench method, in addition to above fungicides, benomyl was also found equally effective, panoram (0.2% a. i.) was found phytotoxic as soil drench and seedling growth retardant as seed treatment under controlled conditions.

Collar-rot of Indian mustard (*Brassica juncea* (L.) Czern. and Coss.) caused by *Rhizoctonia bataticola* (Taub.) Butler is becoming a major pathological constraint, because in Haryana State this crop is grown under the soil moisture stress and comparatively high temperature, which are the ideal conditions for the development of *R. bataticola* (Rana and Tripathi, 1981). This disease takes maximum toll at seedling stage as compared to later stages.

The disease is characterised by the appearance of a light brown small spot at collar region of newly emerged seedlings. Lateron, this spot girdles the entire stem and the colour changes to black. The disease moves upward more rapidly than downward, with the result the seedlings collapse. *R. bataticola* being a notorious soil borne pathogen, several attempts have been made to control the disease caused by it on various crop plants by seed treatment as well as soil drench abroad (Lewin and Natarajan, 1971; Shanmugam and Govindaswamy, 1973; Sivaprakasam *et al.*, 1975; Elewa *et al.*, 1977; Rai and Srivastava, 1978). However, no attempt has been made so far to control the collar-rot of Indian mustard caused by *R. bataticola*. Therefore, a systematic approach was made to control this disease.

MATERIAL AND METHODS

Inoculum. *Rhizoctonia bataticola* was isolated from collar-rot affected stem of Indian mustard. Koch's postulates were established and the culture was maintained on Sabourand's agar medium

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at 10±2°C in BOC incubator for further studies. To check the attenuation, organism was subjected to reinoculation and reisolation from host after an interval of three months.

Effect of fungicides on the growth under soil environment. Nineteen systemic and non-systemic fungicides were screened for their efficacy by slightly modified 'soil mix' technique as described by Zentmyer (1955). Calculated amount of fungicides was mixed with weighed, sterilized sandy loam soil separately so as to give the concentrations of 0.05, 0.1, 0.15 and 0.2 per cent (a. i.). Soil containing a specific dose of a given fungicide was kept in 5 cm long vials having 2.5 cm diameter in 4 replicated sets. Two mycelial discs of 4 mm diameter cut from the margins of three days old culture (grown on Sabourand's agar medium) were placed in each vial in between the treated soil and were saturated with sterilized water and incubated at 30±1°C for 24 h.

The inoculum bits were taken out aseptically and placed on freshly prepared Sabourand's agar medium in 9 cm petri plates separately. Thus. seeded petri plates were also incubated at 30± 1°C. The radial growth was measured after 24 and 48 h and compared with control in which bits were placed only in between sterilized sandy loam soil contained in same type of vials under similar conditions. Per cent growth inhibition was calculated after deducting the per cent growth from 100 (which was considered as 100% inhibition).

Seed treatment. *R. bataticola* was grown aseptically on sand oat meal medium for 10 days and then mixed with sterilized sandy loam soil in the ratio of 30 : 70. This soil was kept in 10 cm diameter earthen pots for 5 days for stabilization. During this period, pots received normal irrigation. Uninoculated soil was also filled in four pots of same size to serve as check.

Eleven fungicides, selected on the basis of their performance *in vitro* and on the basis of their previous recommendations, were used to treat the seeds of Indian mustard (cv. Parkash) @ 0.2% (W/W a. i.). Panoram was used ass lurry treatment. Fifty seeds treated with specific fungicides were sown in each pot with 4 replications. In control, untreated seeds were sown in inoculated sterilized soil as well as in uninoculated soil. Diseased and healthy seedlings were counted at alternate days upto 20 days of sowing because maximum disease was recorded during this period.

Soil drench. The eleven fungicides, used as seed treatment, were also used for soil drench. Fungicidal suspensions were prepared with sterilized water @ 0.2% W/V (a. i.), except panoram where V/V was used. Fifty seeds of Indian mustard (cv. Parkash) were sown in each 10 cm earthen pot containing sterilized inoculated sandy loam soil. Fungicidal suspension (100 ml/pot) was added separately in each pot in four replicated sets, when seedlings started emerging out. Diseased and healthy plants were counted in each pot after 15 days of fungicide application and disease intensity was recorded on the basis of control set.

RESULTS AND DISCUSSION

Seed treatment is blankly advocated in most of the diseases caused by *R. bataticola* or other soil inhabiting organisms, although some workers suggest the soil drench with the fungicides. Obviously the reason is that, in this country opinions are sought when the disease has already taken its toll. Among the systemic fungicides tested, only benomyl, carbendazim, thiophanate-methyl and carboxin were found to inhibit 100% growth of *R. bataticola* isolates from different crops (Grover and Chopra, 1970; Ilyas *et al.*, 1975; Menten *et al.*, 1976). Among the non-systemic, non-metalic fungicides, captafol and mancozeb were found highly toxic. Panoram and zineb inhibited the growth at 0.05% concentration by 34.3 and 3.1 per cent, respectively (Table 1). However, increased doses were responsible for 100% growth inhibition. Tripathi *et al.* (1977) have also noted that captafol, mancozeb and zineb were toxic to sesamum isolate of *R. bataticola*. Panoram is a new fungicide, therefore, its performance could not be compared. Agrosan GN was highly toxic among the metalic, non-systemic fungicides, however, it proved better against the other isolates of this fungus (Tripathi *et al.*, 1977). Performance of thiram, quintozene and captan has been recorded better against *R. bataticola* isolates (Singh *et al.*, 1973; Ilyas *et al.*, 1975; Menten *et al.*, 1976), but in present investigations these fungicides inhibited growth at 0.2% (a. i.) concentration by 43.7, 25.0 and 43.7 per cent, respectively (Table 1). These differences between the present and previous observations may be attributed to the differences in the isolates/pathological races. Some non-systemic fungicides like bayleton, bayton, panolil and rovral were tried for the first time against *R. bataticola*, their efficacy did not come up to the satisfactory level.

Carbendazim, carboxin and panoram checked the incidence of collar-rot of Indian mustard when used as seed treatment, although panoram delayed the germination of the seedlings by six days. Grover and Chopra (1970) have found that carbendazim and carboxin were superior in controlling the root-rot of okra caused by *R. bataticola*. Benomyl has been advocated by several workers (Jain and Khare, 1972; Petkar *et al.*, 1977; Sinha and Khare, 1977) as the best fungicide, but it came next to above three fungicides in order of merit because there was 4.6% collar-rot in benomyl treated pots (Table 2). This difference may be either due to host or isolate behaviour. Among the non-systemics agrosan GN and quintozene protected seedlings by 91.1 and 79.0 per cent, respectively (Table 2). There was 70.4 and 69.7 per cent final stand when seeds were treated with thiram and captafol, respectively. These fungicides were oftenly used by various workers against the diseases caused by *R. bataticola* (Masih *et al.*, 1970; Singh *et al.*, 1973; Tripathi *et al.*, 1977). No doubt non-systemic ranked next to systemics because of their immobile nature in plant system and since this disease attacks at collar-region mobilization in appropriate concentration is required to control it.

Soil drench with fungicidal suspension is another method to protect seed-

TABLE 1

Effect of fungicides on the per cent growth inhibition of *R. bataticola* after 48 h

Common name	Chemical name	Concentrations (%)			
		0.05	0.1	0.15	0.2
Benomyl	50% Methyl 1-(butylcarbamoyl)-2 benzimidazole carbamate	100	100	100	100
Carbendazim	50% Methyl-1-1-1-benzimidazole-2-ylcarbamate	100	100	100	100
Bayleton	25% 1-(4-Chlorophenoxy)-3-3-dimethyl-1-1 (TH-1, 2, 4-Triazole-1 ethanol	1.5	25.0	34.3	34.3
Baytan	15% B-(4-Chlorophenoxy)-2 (1-1 demethylethyl)-TH-1-2,4-Triazole-1 ethanol	3.5	25.0	31.2	32.8
Thiophanate-methyl	70% 1, 2-di-(3-methoxy carbonyl-2 thioureido) benzene	100	100	100	100
Carboxin	75% 5-6 dihydro-2-methyl-1-1, 4-oxathiin-3 carboxynilide	100	100	100	100
Oxycarboxin	75% 5-6-dihdro-2-methyl-1, 4-oxathiin-3-carboxanilide 4-4-dioxide	3.8	3.8	30.7	61.5
*Guazatine	33% 9-aza-1, 17-diguanidino hept adecance salt (either sulphate or acetate)	7.6	11.5	26.9	38.4
*Panolil	40% Guanidated 9-aza-1, 17-dia minohept-adecane acetate	3.1	9.3	24.5	51.2
*Panoram	40% 2 methyl-Furan-3-Carboxanilide	34.3	100	100	100
Captafol	80%Cis-N-(1, 1, 2-tetrachlore-ethylthio)-4-cyclohexene-1, 2-dic-arboximide	100	100	100	100
Captan	50% N-trichloromethyl-thio-4-cyclo-hexene-1, 2-dicarboximide	6.2	9.4	8.7	43.7
Thiram	75% tetramethyl thiram disulphide	12.5	21.0	31.2	43.7
Zineb	75% Manganese ethylene-bisdithio-carbamate	3.1	100	100	100
Mancozeb	78% Manganese ethylene-bisdithio-carbamate	100	100	100	100
Quintozene	75% Pent achloro nitrobenzene	5.9	15.6	21.0	25.0
Rovral	50% 3-(3, 5-dichlorophenyl) 1-isopropyl carbamoylhdantion	6.8	23.4	28.7	37.5
Copper-oxy-chloride	50% copper oxychloride	10.9	18.7	28.1	37.5
Agrosan GN	1% Hg. Phenyl mercury acetate+ thyl mercury chloride	100	100	100	100
Control	—	0	0	0	0

*Formulations available in liquid form, while others are in wettable powder form.

**Average of 8 bits, which constitutes 8 replications.

TABLE 2

Effect of seed treatment with fungicides on the incidence of collar-rot of Indian mustard caused by *R. bataticola*

Fungicides*	Per cent collar-rot incidence**		Per cent final stand
	Pre-emergence mortality	Post-emergence mortality	
Benomyl	0.0	4.6(12.2)***	95.4
Carbendazim	0.0	0.0	100
Thiophanate-methyl	2.3(0.6)	23.0(20.5)	74.7
Carboxin	0.0	0.0	100
Panoram	0.0	0.0	100
Captafol	3.5(10.6)	26.8(31.1)	69.7
Captan	12.6(20.7)	28.0(31.8)	59.4
Quintozene	0.0	21.0(27.2)	79.0
Thiram	1.2 6(20.7)	17.0(24.2)	70.4
Zineb	13.7(21.6)	33.3(35.4)	42.5
Agrosan GN	0.0	0.9(17.2)	91.1
Control	13.7(21.6)	46.0(42.6)	40.3
LSD at 5% level	(2.34)	(3.24)	—

*Fungicides were used @ 0.2% (a. i.) w/w except panoram (v/w) for seed treatment.

**Average of 4 replications.

***Figures in parentheses are transformed values.

lings from soil borne diseases. When seedlings, raised in *R. bataticola* infected soil in pots under greenhouse conditions, were drenched with the same eleven fungicides it was found that benomyl, carbendazim and carboxin completely protected the seedlings from this disease. Quintozene was found best among the non-systemic fungicides, where 5.0% collar-rot was recorded as compared to 46% in control (Table 3). There were no significant differences between thiophanate-methyl (TPM), captan and thiram. Panoram, a potential chemical as seed treatment, proved phytotoxic when used as soil drench because all the seedlings collapsed after 24 h of application. Our observations on the efficacy of these fungicides as soil drench are in accordance with the findings of Shanmugam and Govindaswamy, 1973; Singh *et al.*, 1973; Rai and Srivastava, 1978, except panoram which was used for the first time against *R. bataticola* of Indian mustard.

Nevertheless, there were lot of variations in the efficiency of these fungicides against the diseases caused by *R. bataticola*. This may be attributed to the biophysical/biochemical differences in the host as well as the role played by isolate of *R. bataticola* in micro-climate around the host. Soil environment and status of available nutrients to host and pathogen and interaction is the modification of

TABLE 3

Effect of soil drench on the incidence of collar-rot of Indian mustard caused by *R. bataticola*

Fungicides*	Per cent collar-rot** incidence	Per cent final stand
Benomyl	0.0	100.0
Carbendazim	0.0	100.0
Thiophanate methyl	12.0	88.0
Carboxin	0.0	100.0
Panoram	0.0	0.0****
Captafol	27.3(31.41)***	72.7
Captan	14.6(22.3)	85.4
Quintozene	8.5(16.8)	91.5
Thiram	13.0(20.9)	87.0
Zineb	32.1(34.4)	67.9
Agrosan GN	25.7(30.3)	74.3
Control-1	46.0(42.6)	54.0
Control-2	0.0	100.0
LSD at 5% level	(3.31)	

*Fungicides were used @ 0.2% (a. i.) w/v except panoram (v/v) for soil drench.

**Average of four replications.

***Figures in parentheses are transformed values.

****Toxic to seedlings.

toxicity of a specific chemical (Kataria and Grover, 1976).

No doubt, seed treatment being economical can be advocated. In case of small trials, to save the precious material, soil drench may be a boon, where seed treatments were omitted knowingly.

ACKNOWLEDGEMENTS

Authors are thankful to Dr. J. N. Chand, Prof. & Head, Department of Plant Pathology, Dr. T. P. Yadav, Project Leader (Oilseeds) for providing necessary facilities and Dr. R. K. Grover for the valuable suggestions he made at the time of preparation of this manuscript.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 454—457 (September 1983)

CORRELATION AND PATH COEFFICIENT ANALYSIS OF YIELD AND YIELD COMPONENTS IN WHEAT VARIETY KALYAN SONA

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(Received : November 13, 1981; Revised : November 22, 1982)

ABSTRACT

The relationship of yield with yield attributing characters was studied by means of simple correlation coefficient with the data from all the treatment combinations averaged over two years. A positive and highly significant correlation was observed between grain yield and yield attributing characters under consideration. The yield components were also positively and highly correlated among themselves. The results of path coefficient analysis indicated that number of grains per ear had the maximum direct effect on grain yield of wheat variety Kalyan Sona. Higher values for direct effect of number of effective tillers per metre row length and 1000-grain weight came via number of grains per ear. Data on mean grain yield and yield attributing characters and result of path analysis suggest that the treatment(s) which result in higher values of yield attributes also result in higher grain yield.

To evaluate the relative influence of agronomic characters on yield, path coefficient analysis is a standardised partial regression analysis which permits the separation of correlation coefficients into the measures of direct and indirect effects. In the present study, an attempt was made to analyse the grain yield and its attributing characters of dwarf wheat (Kalyan Sona) by the method of path coefficient analysis.

MATERIAL AND METHODS

The experiment was conducted with an objective to study the effect of different inputs, singly and in combination, on wheat production during rabi seasons of 1974-75 and 1975-76 at the farm of Haryana Agricultural University, Hissar. The treatments comprised three input factors viz., irrigation (optimum), manuring (optimum) and weeding (optimum) and their possible combinations alongwith an absolute control. The treatments were replicated thrice in a randomised block design. Kalyan Sona variety of wheat was sown on 28th November and 11th November after applying pre-sowing irrigation and was harvested on 20th April and 15th April in the first and second year, respectively. Observations on various yield attributing characters were taken from one metre row length, selected at random and marked (at two places) in each plot (Harbir Singh *et al.*, 1978). The grain yield and three other characters viz., number of effective tillers per metre row

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length; number of grains per ear; and 1000-grain weight which are thought to be associated with grain yield, were considered. Path coefficient analysis was done on mean values of two years according to the method given by Dewey and Lu (1959). The correlation coefficients were drawn on the assumption that there is no difference between the treatment regression coefficient of one character on the other and error regression coefficient (environmental or the true measure of the regression coefficient).

RESULTS AND DISCUSSION

It is apparent from Table 1 that correlation between grain yield and yield attributes was positive. This indicates that increase in any of these characters increases the grain yield. The correlation coefficient values among different yield attributing characters were also positive and highly significant.

In view of the difficulty of unravelling the casual relationship by a study of correlation only, it was decided to undertake a path coefficient analysis. The results of this analysis are given in Table 2.

Examination of these components (Table 2) reveals that number of grains per ear had positive and maximum association with grain yield (r=0.9355) over other yield attributing characters. This component had a maximum value in its direct effect (0.6812). Indirect effect of this character on grain yield through number of effective tillers per metre row length and test weight was found to be minimum.

It is interesting to note that although the correlation between number of effective tillers per metre row length and grain yield per ha was found to be positive and significant (r=0.8658), yet this component had a small value (0.2109) in its direct effect. Most of the positive effect of this character probably came through its indirect effect via number of grains per ear.

Considering the association between 1000-grain weight and grain yield, it is clear from the path coefficient analysis that this component, though positively correlated (r=0.8949) with grain yield per ha, had a very small value (0.0783) in its direct effect. This component had a bearing on grain yield through its indirect effect via number of grains per ear (0.6324).

TABLE 1

Correlation coefficients between grain yield and yield attributing characters (mean of 1974-75 and 1975-76 seasons)

	Number of effective tillers/ metre row length	Number of grains per ear	1000-grain weight	Grain yield
Number of effective tillers/ metre row length	1.0000	0.8610**	0.8732**	0.8658**
Number of grains per ear		1.0000	0.9284**	0.9355**
1000-grain weight			1.0000	0.8949**
Grain yield				1.0000

**Significant at 1% level.

TABLE 2

Path coefficients

(a)	Number of effective tillers per metre vs grain yield	r=0.8658
	direct effect	0.2109
	indirect effect via number of grains per ear	0.5865
	indirect effect via 1000-grain weight	0.0684
(b)	Number of grains per ear vs grain yield	r=0.9355
	direct effect	0.6812
	indirect effect via number of tillers per metre	0.1816
	indirect effect via test weight	0.0727
(c)	Thousand grain weight vs grain yield	r=0.8949
	direct effect	0.0783
	indirect effect via number of tillers per metre	0.1842
	indirect effect via number of grains per ear	0 6324
(d)	Effect of residual factor	0.3317

TABLE 3

Effect of different treatments on grain yield and yield components of wheat variety Kalyan Sona (mean of 1974-75 and 1975-76 seasons)

S. No.	Treatments	Grain yield (q/ha)	Effective tillers per metre	Number of grains/ear	1000-grain weight (g)
1.	Absolute control	16.29	42.3	40.9	33.7
2.	Irrigation only	20.21	60.3	44.4	36.7
3.	Manuring only	24.65	71.8	46.1	38.7
4.	Weeding only	17.38	59.4	42.6	37.1
5.	Irrigation+manuring	31.29	69.3	47.1	39.8
6.	Irrigation+weeding	27.65	60.3	49.0	39.7
7.	Manuring+weeding	27.49	68.6	49.8	40.4
8.	Irrigation+manuring+weeding	36 52	89.9	53.8	41.4

From the results of path analysis, it appears that number of grains per ear is the most cordial component for grain yield which had a high and positive direct influence on grain yield. Indirect effects of other characters on grain yield through number of grains per ear were also high.

The effect of the residual factors over the grain yield (+0.3317) suggests that there might be a few more components other than those studied in this investigation, which might have been responsible to influence the grain yield.

A close perusal of the data presented in Table 3 reveals that the values of mean grain yield and associated characters were higher under the treatment combination of optimum irrigation+manuring+weeding. The path analysis and the observations on mean grain yield and yield attributes clearly indicate that those treatments which result in higher values of yield attributes also result in higher grain yield.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 453–463 (September 1983)

EFFECT OF ETHREL ON THE STORAGE LIFE OF CITRUS FRUITS

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(Received : November 28, 1981; Revised : April 22, 1982)

ABSTRACT

The effect of ethrel on the storage behaviour of fruits of Pearl tangelo and Dancy tangerine varieties of citrus, kept at room temperature, was studied. It was found that the former variety has better storage life and lesser loss in weight than the latter. The loss in weight under storage was enhanced by ethrel application. There were varietal differences in TSS content due to ethrel application. Acidity and ascorbic acid contents were decreased under storage and ethrel application in both the varieties. The quality of fruits and their storage life were better with 500 ppm ethrel treatment.

Pearl tangelo and Dancy tangerine cultivars of citrus are promising for high yield, juiciness and good quality fruits and are best suited to semi-arid regions of north India. But colour in these cultivars develops very late and by that time the fruits become granulated, their juice content lessens and the fruits fetch very low price in the market. When they are stored after harvest at green stage, the proper colour development does not take place. Ethrel has been reported to help in the colour development in citrus fruits (Chundawat *et al.*, 1973). However, the effect of ethrel application on storage life of these fruits is not known. The present study was, therefore, undertaken to see the effect of various concentrations of ethrel on the colour development and changes in the quality of fruits during storage, so that the fruits can be marketed accordingly.

MATERIAL AND METHODS

Fruits of Pearl tangelo and Dancy tangerine cultivars of citrus were harvested at green mature stage when the fruits were containing high amount of juice of optimum quality. The fruits were then washed, cleaned and dipped in ethrel solution of 0, 250, 500, 750 and 1000 ppm concentrations for 5 min. The fruits were then surface dried and packed in ventilated wooden box with 3 kg fruits, taking four boxes in each treatment as replicates and kept at room temperature (25±5°C) for 30 days. The shean of the fruits, weight loss and changes in T. S. S., acidity (as citric acid) and ascorbic acid content by 1, 6-dichlorophenol indophenol method, during storage, were determined at 10 days interval by taking four fruits in each sample. The organoleptic scoring was also recorded through a panel of judges on each sampling date.

RESULTS AND DISCUSSION

Shean of the Fruit

The best colour development was observed in fruits dipped in 750 ppm ethrel solution followed by 500 ppm on 10th

day of storage. Though colour developed in fruits dipped in 1000 ppm was highly dense, it gave dull appearance. But not much difference in colour was observed in fruits treated with 250 ppm and control. On 20th day of storage, the shean was lost on the fruits dipped in higher concentrations as compared to control and 250 ppm treatment. The shean of all the fruits was, however, lost considerably on 30th day of storage, irrespective of the treatment. However, it remained much better in Pearl than Dancy fruits throughout the storage period and with all ethrel concentrations. Similar degreening in grapefruits was reported by Chundawat *et al.* (1973), when ethrel, at 500 ppm and higher concentrations, applied to fruits still on the trees resulted in drop of fruits. This may be due to the degradation of chlorophyll (Edgerton and Blanpied, 1968; Bamore, 1975).

Weight Loss

The physiological loss in fruit was variable with regard to ethrel concentrations used and the cultivars (Table 1). The weight loss of fruit in both the cultivars increased with the increase in storage period and concentrations of ethrel. The differences in increased loss in weight among various concentrations upto 10th day of storage were not markable, whereas on 20th and 30th day of storage there was a marked increase in weight loss with the increased concentration of ethrel except on 20th day of storage, where no marked increase was observed than control. The increase in weight loss with the increase in storage period is obvious, but the increase in weight loss with the use of increased concentrations of ethrel could be due to the ethylene gas released from ethrel

TABLE 1

Cummulative loss (%) in weight during storage

Cultivar	Ethrel (ppm)	Days in storage		
		10	20	30
Pearl	Control	4.33	8.80	18.33
	250	4.13	8.87	19.47
	500	5.13	11.60	21.67
	750	5.07	13.20	26.00
	1000	6.13	14.80	33.53
	Mean	4.96	11.45	23.80
Dancy	Control	5.67	13.43	28.17
	250	6.00	13.00	30 20
	500	7.00	16.43	36.27
	750	6.33	17.33	42.93
	1000	6.30	18.20	46.87
	Mean	6.23	15.08	36.89

C. D. at 5% for variety = 0.540
Treatment = 0.860
Days = 0.665

which manifested the intracellar organisation to break down and with the disorganisation of cells the rind became loose thereby increasing the rate of transpiration from the fruit. The weight loss was markedly higher in Dancy tangerine as compared to Pearl tangelo and this trend was maintained throughout the storage period and in all the ethrel concentrations. This might be due to the loose skin character of the former cultivar.

Quality

No consistent trend was observed in the total soluble solids (T. S. S.) of the fruits during storage in both the cultivars (Table 2). However, there was a reduction in T. S. S. with the increase in concentration of ethrel. There was an increase in T. S. S. in both the cultivars upto 10th day of storage in all the concentrations, whereas on prolong storage there was a decrease in T. S. S. except in Dancy cultivar, where these contents were on the increase upto 20th day of storage as compared to control and 250 ppm treatments. In Pearl, the T. S. S. contents were markedly decreased at 1000 ppm concentration than control, whereas in Dancy it decreased markedly at all higher concentrations than control and 250 ppm ethrel application.

There was a reduction in acidity and ascorbic acid contents of juice in both the cultivars with the increase in storage period (Tables 3 and 4). This reduction was marked on 20th and 30th day of storage. Though there was further decrease in both the constituents with the increase in ethrel concentrations, the marked reduction was observed only in ascorbic acid. However, the acidity and ascorbic acid contents in Dancy fruits were markedly higher than in Pearl fruits and this lead was maintained throughout the storage period.

TABLE 2

T. S. S. variations during storage (Brix at 20°C)

Cultivar	Ethrel (ppm)	Days in storage				Mean
		0	10	20	30	
Pearl	Control	8.94	8.95	8.55	8.25	8.67
	250	8.94	8.87	8.47	8.00	8.56
	500	8.94	9.20	8.77	8.20	8.79
	750	8.94	8.95	8.35	7.88	8.51
	1000	8.94	8.95	8.25	7.40	8.39
	Mean	8.94	8.98	8.48	7.89	
Dancy	Control	7.86	8.18	8.37	7.65	8.02
	250	7.86	8.15	8.37	7.45	7.96
	500	7.86	8.00	7.58	6.80	7.53
	750	7.86	8.05	7.38	6.40	7.44
	1000	7.86	8.22	6.50	5.70	7.08
	Mean	7.86	8.12	7.64	6.80	

C. D. at 5% for variety = 0.065
Treatment = 0.285
Days = 0.190

TABLE 3

Acidity variations during storage (w/v in % anhydrous citric acid)

Cultivar	Ethrel (ppm)	Days in storage				Mean
		0	10	20	30	
Pearl	Control	1.19	1.06	0.91	0.87	1.01
	250	1.19	0.88	0.84	0 79	0.92
	500	1.19	0.92	0.87	0.81	0.95
	750	1.19	0.86	0.73	0.69	0.87
	1000	1.19	0.86	0.71	0.70	0.86
	Mean	1.19	0.92	0.81	0.77	
Dancy	Control	1.84	1.71	1.23	1.02	1.45
	250	1.84	1.47	1.23	1.00	1.38
	500	1.84	1.57	1.15	0.98	1.38
	750	1.84	1.55	0.81	0.67	1.21
	1000	1.84	1.60	0.82	0.60	1.21
	Mean	1.84	1.58	1.05	0.85	

C. D. at 5% for variety = 0.25
Treatment = NS
Days = 0.35

TABLE 4

Vitamin C variations during storage (mg/100 ml of juice)

Cultivar	Ethrel (ppm)	Days in storage				Mean
		0	10	20	30	
Pearl	Control	35.84	32.00	29.00	21.00	29.50
	250	35.84	30.30	25.60	18.90	27.57
	500	35.84	31.90	24.40	17.80	27.60
	750	35.84	30.10	20.60	15.40	25.47
	1000	35.84	29.50	18.50	11.60	23.80
	Mean	35 84	30.76	23.62	16.94	
Dancy	Control	43.75	41.60	36.50	32.80	38.62
	250	43.75	41.20	37.30	28.50	37.75
	500	43.75	40.80	36.20	27.80	37.00
	750	43.75	38.50	30.20	22.40	34.00
	1000	43.75	32.90	23.60	18.90	29.55
	Mean	43.75	39.01	32.76	26.08	

C. D. at 5% for variety = 0.69
Treatment = 0.98
Days = 1.14

TABLE 5

Organoleptic scoring

Cultivar	Ethrel (ppm)	Days in storage			
		0	10	20	30
Pearl	Control	80.0	75.4	79.3	65.5
	250	80.0	76.3	82.4	62.6
	500	80.0	85.8	78.5	60.8
	750	80.0	87.6	70.3	52.2
	1000	80.0	81.7	65.6	50.6
Dancy	Control	70.0	73.6	72.6	62.1
	250	70.0	75.9	71.5	60.4
	500	70.0	80.3	69.9	50.6
	750	70.0	82.5	65.7	42.8
	1000	70.0	76.5	55.6	32.8

The organoleptic scoring revealed that the quality of fruits was improved upto 10th day of storage (Table 5). It was further improved with the increased concentrations of ethrel. Not much improvement was observed in fruits dipped in 250 ppm compared to control. However, the quality of fruits was decreased with further increase in the storage period. But the fruits in control and 250 ppm dip remained in acceptable state upto 20th day of storage. Whereas fruits were below average beyond 20th day of storage irrespective of any treatment. The deterioration in organoleptic quality was much higher in Dancy fruits than Pearl fruits throughout storage period and also in all the ethrel applications.

The increase in T. S. S. and organoleptic scoring upto 10th day of storage might be due to continuous process of building up of sugars through metabolism, low rate of degradation and loss of water through transpiration to some extent. The further increase with the increase in ethrel concentration might also be due to increased transpiration rate. However, the rapid deterioration in organoleptic quality with prolonged storage can be attributed to the fact that there was a rapid degradation of T. S. S. and also the reduction in the acidity and ascorbic acid contents of fruits, which are the major constituents affecting the quality. The decrease in the organoleptic rating with the increased concentrations of ethrel further suggest that ethrel caused the deorganisation of intracellular structure, with the result the activities of degrading forces increased in the fruits. Decreased acidity as a result of ethephon application in grapes was also reported by Singh *et al.* (1977). They attributed this reduction as a result of increase in the membrane permeability which permitted the acids stored in cell vacuoles to respire at a faster rate.

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 464—467 (September 1983)

EFFECT OF SHADING AND METHODS OF PLANTING ON THE PERFORMANCE OF TOMATO (*LYCOPERSICON ESCULENTUM* MILL.) VARIETIES DURING SUMMER SEASON

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(Received : July 13, 1981; Revised : February 25, 1982)

Non-availability of tomatoes due to poor fruit set at higher temperature during the summer months is the most important problem in the sub-tropical regions of the country. If this period can be reduced by some means, it would be quite beneficial to the farmers of the region.

Foliar application of growth regulators and micro-nutrients increase fruiting and improve early and total yield in tomatoes (Pandita *et al.*, 1979). Considerable differences in the yield of tomato have been observed from shading (Cooper, 1964) and direct sowing vs transplanting (Sullivan and Wilcox, 1971) of tomato crop. The present investigation was, therefore, conducted at the Vegetable Research Farm, Haryana Agricultural University, Hissar during summer of 1973-74 on five tomato varieties viz., HS-101, HS-102, HS-110, Pusa Ruby and S-12 to study the effect of shading/non-shading and direct sowing/transplanting. The experiment was laid out in a split plot design in four replications with two main plot treatments, i.e. shading of tomato plants with maize and non-shading. The ten sub-plot treatments included five tomato varieties each with two methods of planting, i.e. 'direct sowing' of seeds (DS) and 'transplanting' (T). Each experimental plot measured 3.6 m × 2.0 m having two beds 3.6 m long and 1.0 m apart. The direct sowing of tomato seeds and transplanting of seedlings were done on 6th May, 1973 and 6th June, 1973, respectively. The seeds of maize var. Hybrid Ganga No. 101 were sown on one side of the raised beds at a distance of 30 cm, whereas the tomato seed and seedlings were respectively sown and transplanted on the other side of the raised beds 45 cm apart, having a total of 16 plants per treatment in two beds. Since the maize is an exhaustive crop, 50% higher dose of fertilizer recommended for tomato crop was applied as band placement on both sides of the beds where maize and tomato crops were planted. The monthly mean maximum and minimum temperatures under shading and non-shading conditions during the period of investigation were recorded (Table 1).

The observations were recorded on the survival percentage (at the final

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TABLE 1

The average maximum and minimum temperature (°C) during the experimental period of 1973-74

Month	Shading		Non-Shading	
	Max. temp.	Min. temp.	Max. temp.	Min. temp.
May	No shading effect		40.5	23.0
June	41.7	29.0	40.3	28.1
July	39.3	27.9	37.7	27.1
August	36.6	25.8	34.0	25.3
September	38.0	24.0	35.1	23.5

harvest) and number of fruits per plant from early and total yields. Yield from pickings made upto 22nd August, 1973 was considered as early yield, whereas total yield was regarded as sum of all the pickings made upto 15th October, 1973.

Survival percentage was highest under non-shading as compared to shading (Table 2). Maximum survival of plants was noticed in HS-101 (DS) and Pusa Ruby (DS) while least was observed in HS-102 (T). The interactions between shading and methods of planting were not significant. Least survival of plants under maize shading might be due to higher temperature (Table 1) and smothering effect on tomato plants.

Number of fruits per plant from early yield was significantly higher in plants grown without shade than in the crop raised under shade (Table 2). Pusa Ruby (T) gave the maximum number of fruits per plant from early yield followed by HS-102 (T) both under non-shading, while shaded crop of HS-110 (T) gave least number of fruits per plant.

Shading had no effect on overall total number of fruits per plant. S-12 (DS) resulted in highest number of fruits per plant, while least number was harvested in HS-110 (DS) when both were grown under shade. Direct seeding of HS-101, HS-102 and S-12 gave highest number of total fruits per plant than transplanting which may be attributed to quick establishment and better development of plants under this treatment.

Early yield of tomato under shade was significantly less (0.59 kg/plant) as compared to unshaded crop (0.80 kg/plant) which confirmed the earlier findings of Young (1962) who obtained reduced early yield by shading the tomato plants than non-shading. Higher early yield (0.96 kg/plant) was recorded in HS-102 (T), whereas HS-110 (T) gave the lowest early yield (0.40 kg/plant). HS-102 (T) gave the maximum early yield (1.08 kg/plant) under non-shading, while least early yield (0.32 kg/plant) was observed from HS-110 (T) under shading. Thus, HS-102 could be singled out as the most outstanding genotype for earliness and maximum early yield (Arora *et al.*, 1975)

TABLE 2

Effect of shading and methods of planting on survival percentage, number and weight of fruits from early and total yields in five varieties of tomato during summer season

Varieties	Treatments	Survival percentage		Number of fruits per plant from early yield		Total number of fruits per plant		Early yield (kg/plant)		Total yield (kg/plant)	
		Shading	Non-shading	Shading	Non-shading	Shading	Non-shading	Shading	Non-shading	Shading	Non-shading
HS-101	DS	81.2	96.9	17.2	30.5	51.3	75.5	0.49	0.89	1 45	1 69
HS-101	T	84.3	84.4	12.7	28.5	49.0	65.5	0.70	0.93	1.41	1.63
HS-102	DS	78.1	78.1	25.7	40.2	66.1	87 8	0.63	0.92	1.61	1.78
HS-102	T	65.6	59.4	31.0	54.5	58.0	85.8	0.83	1.08	1.78	2.25
HS-110	DS	78.5	84.0	9.2	13.0	25.1	33.6	0.34	0.51	1.21	1.34
HS-110	T	59.3	78.1	8.2	12.6	32.3	33.8	0.32	0.47	1.05	1.24
Pusa Ruby	DS	84.3	93.8	20.7	55.2	95.9	106.3	0.54	0.85	1.98	2.13
Pusa Ruby	T	68.7	81.3	33.2	55.4	106.7	116.7	0.66	0.87	2.11	2.22
S-12	DS	78.1	78.1	31.0	35 7	119.8	115.9	0.69	0.72	2.39	1.93
S-12	T	81.2	81.3	31.0	37.5	93.3	118.2	0.68	0.75	1.89	2.07
Average		75.6	81.6	22.0	36.3	69.8	83.9	0.59	0.80	1.69	1.83
C. D. at 5% level											
Shading/non-shading (S)			=4.30		3.18	NS		0.16		NS	
Methods of planting (M)			=11.8		0.28	1.90		0.22		0.44	
Interaction (S × M)			=NS		0.36	4.50		0.30		0.64	

even at higher temperature (Table 1) which had least survival percentage (Table 2).

Shading of tomato plants did not improve the total yield significantly (Table 2). S-12 (DS) gave highest total yield (2.39 kg/plant), whereas least total yield was recorded in HS-110 (T) (1.05 kg/plant), both under shading. Similarly, plants grown without shade HS-102 (T) gave the highest total yield (2.25 kg/plant), while least in HS-110 (T) (1.24 kg/plant). However, Nandpuri *et al.* (1975) also reported some tomato varieties showing good performance under high temperature. The reduction in the yield under shade was due to higher temperature (Table 1) as compared to unshaded plots which caused reduction in survival percentage and increased flower and fruit drop. Direct seeding of HS-101, HS-110 and S-12 gave higher total yields than their transplantings which confirmed the earlier reports of Sullivan and Wilcox (1971).

From the present observations it is clear that transplanting of HS-102 and Pusa Ruby performed better than their direct seeding which confirms the previous reports of Korneev (1971) who observed considerable higher total yields by transplanting as compared with direct sowing.

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 468—470 (September 1983)

GENETICS OF FORAGE CHARACTERS IN SORGHUM

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(Received : November 4, 1981; Revised : February 23, 1982)

The understanding of genetic architecture of fodder yield is essential for formulating a suitable breeding strategy for its improvement. The present investigation was, therefore, undertaken to study the gene effects governing fodder yield and its components in sorghum.

The experiment consisting of parents, F_1, F_2 and F_3 generations of four crosses was laid out in a randomised block design having three replications. The sowing of the material was done by dibbling two seeds per hill at a distance of 10 cm in three metre row plot spaced 30 cm apart. Parents and F_1 were sown in single rows, whereas F_2 and F_3 were raised in five rows. Randomly selected five plants from parents and F_1 and 25 plants from F_2 and F_3 were used for recording data on six morphological characters. The gene effects were estimated according to the procedure given by Hayman (1958).

The gene effects like additive (d'), dominance (h), additive × additive (i) and dominance × dominance (L) interaction components were present in a sizeable proportion (Table 1). In most of the crosses, dominance (h) gene effect was more, but additive component (d') was also significant in some crosses. Moreover, the additive × additive (i) as well as dominance × dominance (L) interactions were also found to be significant in some of the crosses. However, the amount of additive × additive component was, in general, higher than dominance × dominance component for most of the characters in all the crosses. It is evident from the results that plant height, leaf breadth and number of leaves per plant were controlled by more of additive (d') type of gene effects. Additivity for these characters is further supported by indication of complementary type of epistasis. These results are in confirmity with the findings of Chandra *et al.* (1971), Saini and Paroda (1975), Dangi and Paroda (1978) and Lodhi *et al.* (1978) in forage sorghum. However, green fodder yield and dry matter yield were controlled more by dominance (h) than additive (d') component, though the latter was also present in a sizeable proportion. Additive × additive and dominance × dominance type of epistatic components were present in considerable amount for both these traits in all the crosses, but the former was larger than the latter for leaf length. Additive component of variance was more important in all the crosses but dominance was observed for two crosses only. Dominance component could be exploited

TABLE 1

Estimates of gene effects for different characters in forage sorghum

Characters	Gene effect	Cross			
		IS 6090×*S. roxburghii*	HFS 566×*S. roxburghii*	HFS 566×PJ7R	IS 6090×PJ7R
Plant height	d'	20.55±9.24*	23.60±8.94**	0.25±4.34	—2.80±4.93
	h	39.73±30.60	—33.00±39.19	34.73±33.26	33.33±37.03
	l	22.93±95.26	58.40±98.84	93.07±82.90	177.86±88.80
	i	—5.32±32.45	—72.20±34.15*	—49.98±27.96	—60.52±31.08
	Epistasis	Complementary	Duplicate	Complementary	Complementary
Leaf length	d'	—10.25±1.85**	—13.15±1.16**	—13.65±2.05**	—10.75±2.50**
	h	17.20±10.86	26.13±9.47**	43.53±5.95**	13.27±7.04
	l	—22.40±24.30	—39.46±29.11	—150.67±22.60**	—20.53±17.79
	i	11.65±9.02	13.77±9.27	43.69±6.95**	13.11±7.02
	Epistasis	Duplicate	Duplicate	Duplicate	Duplicate
Leaf breadth	d'	0.10±0.33	0.00±0.38	—0.55±0.27**	—0.45±0.19*
	h	0.53±1.10	1.00±1.13	—0.20±1.44	0.33±2.35
	l	0.53±3.67	0.80±3.31	0.80±3.71	2.93±5.26
	i	—0.76±1.19	—0.50±1.18	—1.25±1.31	—0.61±1.81
	Epistasis	Complementary	Complementary	Duplicate	Complementary
Number of leaves/ plant	d'	—0.75±0.28**	—0.75±0.39	—1.30±0.60	—1.30±0.54*
	h	1.53±3.44	4.80±3.03	2.00±3.89	2.93±6.69
	l	2.93±11.93	4.80±9.85	—11.20±9.11	—4.27±15.17
	i	—1.61±3.73	0.25±3.12	2.50±3.18	2.94±5.19
	Epistasis	Complementary	Complementary	Duplicate	Duplicate
Green fodder yield/plant	d'	—4.60±3.36	—9.75±1.53**	—109.20±3.48**	—104.05±4.59**
	h	156.33±24.98**	306.20±40.65**	286.47±46.00**	—188.53±51.97**
	l	—611.47±78.49**	—442.40±117.95**	—686.13±142.89**	511.47±144.21**
	i	60.94±25.75*	79.95±37.89*	178.46±45.36**	—240.49±47.25**
	Epistasis	Duplicate	Duplicate	Duplicate	Duplicate
Dry matter yield/plant	d'	—16.70±5.22**	—9.70±4.72*	—8.85±4.32*	—15.80±4.87**
	h	23.00±27.06	96.67±13.00**	56.80±25.69*	—19.20±11.40
	l	—188.00±94.16*	—142.93±40.98**	—227.20±52.00**	124.80±33.65**
	i	45.30±29.97	63.96±14.09**	57.20±19.03**	—46.30±12.90**
	Epistasis	Duplicate	Duplicate	Duplicate	Duplicate

*, **Significant at 5 and 1 per cent level, respectively.

through heterosis breeding, whereas additive and additive × additive components could be utilized through biparental crossing in F_2 generation of these populations to obtain a variety having large number of desirable gene combinations.

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 471—472 (September 1983)

SCREENING OF GUAR GERMPLASM AGAINST BACTERIAL BLIGHT DISEASE

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(Received : December 10, 1981 ; Revised : August 2, 1982)

Guar *(Cyamopsis tetragonoloba* (L.) Taub.) is one of the most important fodder crops in Haryana and is also grown for its gum content. Bacterial blight caused by *Xanthomonas compestris* PV *cyamopsidis* (Patel *et al.*, 1953; Dye *et al.*, 1980) is a serious disease causing damage over 60% in susceptible varieties (Srivastava and Rao, 1963a). The pathogen is seed borne in nature (Srivastava and Rao, 1963b). It is, therefore, necessary to identify resistant cultivars so as to minimize the losses and to check the further spread of the pathogen to new areas.

One hundred and fifty five varieties/lines of **guar** maintained by Department of Plant Breeding, Haryana Agricultural University, Hissar were screened under artificial inoculation conditions in the field. The varieties/lines were sown in the field in rows during the first week of July keeping 40 cm row to row distance. Agra local, a most susceptible variety, was sown around and in between the rows of each variety/line to ensure maximum inoculations. One month old plants were inoculated by spraying bacterial cell suspension (2×10^6 cells/ml) in the evening. The climatic conditions during crop growth period were favourable for the development of disease and resulted in the severe infection on susceptible varieties. Disease intensity was recorded periodically beginning from first appearance of the symptoms, on 50 randomly selected plants. All the 50 plants were examined carefully to calculate the percentage of infection. The varieties/lines were graded according to the following scale. 1-5% leaf area infected—resistant, 6-20% leaf area infected—moderately resistant, 21-40% leaf area infected—moderately susceptible, 41-60% leaf area infected and lesions on stem—susceptible, 61-100% leaf area infected and lesions and cracking of stem—highly susceptible. The experiment was conducted twice during 1979 and 1980.

None of the varieties/lines screened was found immune or resistant to disease. However, HFG 647, Ic 9065, HFG 710, DSG-1J, HFG 75, HFG 312, HFG 314, HFG 53, HFG 765, PLG 85, D39-1, DSP 25, HFG 556, NCK Sel, DSE-2J, HFG 421, HFG 441, HFG 182, HFG 795, HFG 796, HFG 783, HFG 513W, HFG 476B and HFG 464 B were found moderately resistant. Rest of the varieties/lines behaved as moderately susceptible to highly susceptible. Durgapur safed and B 19-1-55 reported to be resistant by Paroda *et al.* (1977) were found to be

susceptible, while FS 277 and HFG 236 observed to be moderately resistant by Gandhi *et al.* (1978) were moderately susceptible under artificial conditions of inoculation. No source of resistance was located in the present investigation. Therefore, extensive work needs to be carried out to find resistant source to bacterial blight for further breeding programme.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. J. N. Chand, Prof. and Head, Department of Plant Pathology for providing facilities during the course of investigation and to Prof. and Head, Department of Plant Breeding for supply of seeds of different germplasm.

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 473—475 (September 1983)

EVALUATION OF PROMISING INSECTICIDES AGAINST RED-HAIRY CATERPILLAR, *AMSACTA MOOREI* BUTLER ON COTTON

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(Received : December 10, 1981; Revised : April 1, 1982)

Red-hairy caterpillar, *Amsacta moorei* Butler (Arctiidae : Lepidoptera) is a regular pest on cotton and other **kharif** crops in sandy tracts of Sirsa district of Haryana State. The damage by this pest extends from the second fortnight of July to the first week of August. Of late, the recommended insecticides, viz., methyl parathion and endosulfan (Anonymous, 1981; Verma *et al.*, 1972) have been found to be rather ineffective against the pest. It was, therefore, felt necessary to screen some promising insecticides against this pest.

The experiments were conducted during first week of August, 1980 and 1981 at farmer's fields near Sirsa. Ten insecticides viz., endosulfan (Thiodan) 35 EC, methyl parathion (Metacid) 50 EC, fenitrothion (Folithion) 50 EC, dichlorvos (Nuvan) 76 EC, phosalone (Zolone) 35 EC, chlorpyriphos (Dursban) 20 EC, phenthoate (Elsan) 50 EC, quinalphos (Ekalux) 25 EC, monocrotophos (Nuvacron) 36 WSC and carbaryl (Sevin) 50 WP, were evaluated against the 6th instar caterpillars of the pest. The insecticidal emulsions/ suspensions were sprayed on the insect infested cotton plants with the help of rocking sprayer fitted with a hallow-cone nozzle. The spraying was done upto 'run-off' stage.

For each treatment a plot measuring 30 × 4 m, comprising seven crop rows, was used. Between two plots a buffer crop strip of one metre width was provided. After the sprayed plants in a plot were dry, 100 caterpillars, mostly in the 6th instar, were collected in three battery jars (22 × 15 cm) and offered sprayed leaves from that very plot. Thus, each jar contained 33-34 caterpillars. These jars were covered with muslin cloth pieces, held in position with the help of rubber bands and kept at room temperature. Mortality counts were taken 24, 48 and 72 h after treatment when leaves from the respective sprayed plots were offered to the surviving caterpillars. Mortality data were subjected to analysis of variance.

The data on insect mortality obtained for each insecticidal treatment during the

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TABLE 1

Effectiveness of some insecticides against the 6th instar caterpillars of *A. moorei*

Treatment (% spray material)	Per cent mortality of caterpillars (h-after treatment)					
	1980			1981		
	24	48	72	24	48	72
Monocrotophos 0.04	96 9(81 8)*	100.0(90 0)	100.0(90.0)	73.2(60.1)	90.0(85.5)	100.0(90.0)
Quinalphos 0.05	76 0(60.8)	79.0(62.9)	88.0(70.9)	88.8(70.8)	96.0(80 6)	99.3(87.2)
Dichlorvos 0 C6	74.6(60 3)	76.9(61.7)	85.5(67.7)	59.1(50.3)	67.3(55.2)	93.2(76.4)
Endosulfan 0.07	41.4(40.0)	71.8(59.5)	91.9(73.9)	17.2 24.4)	43.5(41.2)	86.1(68.2)
Methyl-parathion 0.05	35.4(36.4)	53 6(46.9)	73.2(59.0)	—	—	—
Methyl-parathion 0.075	—	—	—	18.9(25.5)	44.4(41.7)	84.8(67.1)
Chlorpyriphos 0.04	46.9(43.2)	71.8(59.5)	92.0(77.6)	23.8(29.1)	48.5(44 1)	79.0(62.8)
Carbaryl 0.1	48.9(44.4)	64.0(53.3)	78.7(63.1)	10.1(17.8)	26.3(30.7)	55.6(48.3)
Fenitrothion 0.1	16.7(23.9)	42.8(40.9)	72.3(58.5)	2.0(6.6)	9.7(18.0)	54.4(47.5)
Phosalone 0.07	12.3(20.2)	27.7(31.2)	59.0(50.3)	3.0(8.1)	9.0(17.3)	47.9(43.8)
Phenthpate 0 1	14 0(15.3)	15.9(23.8)	44.7(41.9)	6.3(14.2)	7.0(15.3)	47.0(43.2)
Control	3.0(10.0)	14.1(22.0)	15.1(22.9)	0.0(0.0)	5.1(13.0)	17.5(24.5)
'F' test	Sig.	Sig	Sig.	Sig.	Sig.	Sig.
SE ±	(4 3)	(6.4)	(6.3)	(5.5)	(3.9)	(3.4)
C.D. at 5%	(8.9)	(13.4)	(13.1)	(11.5)	(8.1)	(7.1)

*Figures in parentheses are angular transformed values in three replications.

years 1980 and 1981 are given in Table 1.

Both during 1980 and 1981, 0.1% fenitrothion, 0.1% phenthoate and 0.07% phosalone, at most of the testing intervals, did not prove better than the control. Among the insecticidal treatment compared at all the testing intervals, 0.04% monocrotophos during 1980 and 0.04% monocrotophos and 0.05% quinalphos during 1981 proved the most effective treatments. In the next effective group of treatments only 0.06% dichlorvos gave consistently good results during both the years. Endosulfan gave fairly good results during 1980 but not during 1981. Methyl-parathion both at the recommended and the enhanced dose, never gave encouraging results.

Monocrotophos proved very effective against this pest in earlier studies (Verma *et al.*, 1972). Since this chemical was not commercially available at that time, it was not recommended against this pest. The present findings are, thus, in conformity with the findings of earlier workers. Quinalphos also proved very effective in the present studies but this has been tried for the first time against this pest.

Dichlorvos, used as 0.06% spray, was also found quite promising against the hairy caterpillars. In studies conducted by Venkataraman *et al.* (1970) and Srivastava *et al.* (1971), 0.11% dichlorvos gave effective control of this pest infesting groundnut and sunnhemp. Dichlorvos 76 EC at 500 ml/ha has been recommended against this pest on cotton in Punjab (Anonymous, 1980).

The quantity of spray material required for spraying the cotton crop upto run-off stage during end of July (period coinciding with maximum activity and damage by *A. moorei*) worked out approximately to 625 litres per hectare. Based on this, the quantities of the most effective insecticides required per hectare worked out to 625 ml monocrotophos, 36 WSC, 1.25 litres quinalphos 25 EC and 500 ml dichlorvos 76 EC. Monocrotophos, being systemic in nature, is also effective against sucking pests. In case moderate to severe infestation of sucking insect pests (jassid, aphid, whitefly) is also to be encountered at the time of controlling red-hairy caterpillar, it is advisable to select monocrotophos amongst the three most effective insecticides.

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 476—477 (September 1983)

EFFECT OF NUTRITION AND TEMPERATURE ON SPORE GERMINATION OF *MYROTHECIUM RORIDUM* TODE EX FR.

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(Received : January 29, 1982; Revised : June 9, 1982)

Leaf spot of guar caused by *Myrothecium roridum* Tode ex Fr. has become a major disease during the last few years in Haryana. The disease was first reported in India by Arya (1956). Most of the cultivated varieties of guar are susceptible to this disease. Studies reported herein were initiated to determine some of the factors affecting spore germination of *M. roridum*.

To study the effect of nutrition on spore germination, spore suspension was prepared in host extract, potassium nitrate (1%), tap water, distilled water, glucose (2%) and sterilized water from one week old culture grown on PDA. Drops of spore suspension were placed in triplicate on glass slides and incubated from 6-48 h at 25°C (±0.5°C). Droplets of spore suspension prepared in tap water were placed on glass slides and incubated at 5, 10, 15, 20, 25, 30, 35 and 40°C (±5° C). Data were recorded on spore germination after 8-48 h of incubation. Humidity was maintained in all the cases in petriplates lined with moist blotting sheets. Maximum and minimum spore germination percentage was recorded in 2% glucose solution and distilled water, respectively (Table 1). Spore germination in host extract was inhibited to a considerable extent. Potassium nitrate (1%) was second best nutrition for spore germination of *M. roridum*. Similar results were obtained by Munjal (1960).

The temperature range of 25-30°C was optimum for spore germination (Table 2). Maximum spore germination was recorded

TABLE 1

Effect of nutrition on spore germination of *Myrothecium roridum*

Source of nutrition	Per cent spore germination hours after incubation*					
	6	12	18	24	36	48
Sterile water	4.4	12.3	25.0	35.5	50.5	60.0
Distilled water	4.4	10.0	15.5	21.0	24.8	26.7
Tap water	8 5	16 4	29.0	40.5	52.5	65.0
Glucose solution (2%)	13.0	22.5	35 5	54.0	72.4	85 5
Potassium nitrate solution (1%)	90	17.5	30.2	48.4	72.3	80.0
Host extract solution	6 5	12.5	18.4	24.0	31.3	40.0

*Average of 5 replications.

TABLE 2

Effect of temperature on spore germination of *Myrothecium roridum*

Temperature (°C)	Per cent germination hours after incubation*					
	8	12	18	24	36	48
5	0	0	0	0	0	0
10	0	0	15.0	29.0	38.0	40.0
15	0	10.0	18.4	30.5	43.4	52.5
20	0	14.0	20.8	35.5	50.3	65.5
25	20 5	47.7	63.0	76.0	85.0	92.5
30	0	18.5	30.0	53.6	82.0	95.0
35	0	12.0	21.5	36.5	43.6	57.3
40	0	0	0	5.5	13.3	20.0

*Average of 5 replications.

at 25°C, where 20.5% spores germinated after 8 h and 92.5% after 48 h. Minimum spore germination percentage was recorded after 48 h of incubation. There was no germination at 5°C.

These studies indicate that 10°C and 40°C temperatures are required respectively for minimum and maximum spore germination of *M. roridum*. Minimum period of incubation to start germination is 6 h. Maximum germination of spores can be achieved at 25°C by incubating them for 48 h.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 478—482 (September 1983)

POPULATION EDUCATION IN RURAL DEVELOPMENT—KNOWLEDGE OF RURAL FUNCTIONARIES

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(Received : November 13, 1981; Revised : May 5, 1983)

ABSTRACT

Study reveals that knowledge of rural development functionaries was poor. In general, the inadequacy of knowledge of population education and contraceptives seemed to be greatest in the respondents from Agriculture department and least in the respondents from Health and Family Welfare department. There was positive relationship between the knowledge level, age and service experience. Maximum knowledge scores were of graduates and respondents from nuclear family. There was no association between the knowledge level of respondents and family education

To create awareness about population problem among rural people, it is necessary to use rural functionaries because they have been working in rural areas for long time and have established contacts and rapport with local people. Moreover, it is easier and convenient to motivate rural people on population problems while implementing rural development programmes rather through an independent family planning programme (Karan Singh, 1976). This is possible when functionaries themselves know about population education.

Population education in the present paper is used to include awareness of the relationship between family size and family well being, population explosion and its consequences, small family norm, measures for population control, methods and techniques of family planning/birth control.

This study was opined to :

(i) identify and know the background of different rural development functionaries;

(ii) assess their knowledge towards population education.

METHODOLOGY

The study was undertaken in Hansi Block I in district Hissar, Haryana. Eight different development departments viz., Revenue, Agriculture, Cooperative, Health and Family Welfare, Animal Husbandry, Development and Panchayat, and Industry and Education were in operation. A list of field functionaries was obtained from the different departments.

In the selection of the respondents, stratified random sampling technique was used considering the department as a

stratum. Forty per cent of respondents were taken from each stratum (department) at random. From those departments where there was only one functionary, the same was taken as such to cover all the departments of the block. Total respondents, thus, selected were 117.

RESULTS AND DISCUSSION

A comprehensive inventory of NES Block Hansi I was prepared by consulting different departments. It was found that Patwari, Kanungo, Agricultural Sub-Inspector, Agriculture Development Officer, Lady Circle Supervisor, Art and Craft Teacher, Mahila Mandal Organizer, Mukhya Sevika, Gram Sachiv, Social Education and Panchayat Officer, School Teachers, Block Level Extension Officer, Veterinary Surgeon, Stockman, Stock Assistant, Mini-Bank Manager, Block Level Cooperative Inspector, Extension Officer, Land Valuation Officer, Multipurpose Health Worker, Health Supervisor, Auxiliary Nurse-Midwife, Sanitary Inspector, and Medical Officer were the functionaries who were working in the field and could be involved in population education (Sharma *et al.*, 1978).

Out of 117 respondents, 98.29% mentioned that India was over-populated. Consequences as unemployment, overcrowding, poverty, food problems, clothing and housing problems, inflation, educational problems and health problems of increasing population were mentioned. Measures to control the population e.g. late mrriages, use of contraceptives, abortions and operations were mentioned by the respondents. Techniques like abstinence, condom, diaphragm, vasectomy, tubectomy, abortion, I. U. D. pills, jellies, foam tablets, herbal extracts and aurvedic medicines were known to them and on an average two or three devices were mentioned by each respondent.

Population education scores were given to every right answer and calculated for each department; scores were calculated separately for family planning techniques (Sharma *et al.*, 1978). Scores obtained by functionaries of different departments given in Table 1 clearly indicate that out of total respondents average scores of functionaries of Health and Family Welfare department were the highest in both population education (91.1) and family planning techniques (100). This is due to their specialization in this work. They were followed by functionaries of Industry and Animal Husbandry departments, but no inference could be drawn as their sample was very small. Revenue department functionaries had 60 knowledge scores in population education and 50 in family planning techniques. Among others, the scores of functionaries from Development and Panchayat, Education, Cooperation and Agriculture for population education were 56.0, 53.5, 51.5 and 47.5, respectively. But scores for family planning techniques next to functionaries from Health and Family Welfare department were of Education department (57.5) followed by Development and Panchayat (52.5), Revenue (50.5), Cooperative (45.0) and Agriculture (42.5) It was noted that the functionaries from Agriculture were ranked lowest both in overall scores in population education and family planning techniques.

TABLE 1

Knowledge of functionaries about population education and family planning techniques

S. No.	Departments	Frequency	Percentage	Population education scores (M. M. 100)	Family planning techniques (M. M. 100)
1.	Industry	1	0.85	62.0	50.0
2.	Health and Family Welfare	3	2.56	91.0	100.0
3.	Revenue	47	40.17	60.0	50.0
4.	Agriculture	6	5.12	47.5	42.5
5.	Development and Panchayat	7	5.98	56.0	52.5
6.	Cooperative	6	5.12	51.5	45.0
7.	Education	45	38.46	53.5	57.5
8.	Animal Husbandry	2	1.70	65.0	50.0
	Total	117	100.0	100.0	

Relationship between background of functionaries and their population education scores (Table 2) shows that functionaries with 1-10, 11-20, 21-30 and 31-40 years service experience had 58.0, 62.0, 63.5 and 60.0 scores, respectively in population education. But the inference could not be drawn from the functionary with 31-40 years service experience as the number was only one.

Relationship with age shows that the respective knowledge scores of functionaries with age groups of 21-30, 31-40, 41-50 and 51-60 years were 58.5, 61.5, 61.5 and 60.0, respectively. Further, relation of qualification with knowledge scores reveals that maximum knowledge scores were in graduates (64), followed by matriculates (61.5) and post-graduates (56.5). It may be due to the fact that graduates were B.Sc. and B.V.Sc. and in post-graduates majority was M.A. (Table 2).

The relation of family education with knowledge scores indicates that functionaries having highest family education upto matric had 54.5%, graduates 56.5% and post-graduates 65.0 per cent. The functionaries having education in family upto M.B.B.S. had 56.5, R.M.P. 80.0, LL. B. 65.5 and I.A.S. 62.5 per cent knowledge scores of population education (Table 2).

The knowledge scores of population education of functionaries in joint family were 55.0, whereas in nuclear family corresponding scores were 57.5. The knowledge scores of Hindus were 63.0 and of Sikhs 58.5 per cent (Table 2).

Thus, knowledge of the rural development functionaries in general was poor. The inadequacy of knowledge of population education and contraceptives seemed to be greatest in the respondents from department of Agriculture and least in the respondents from department of

TABLE 2

Knowledge scores of population education with background of functionaries

	Frequency	Percentage	Population education scores (M.M. 100)
Length of experience (years)			
1-10	35	29.93	58.0
11-20	47	40.17	62.0
21-30	34	29.05	63.5
31-40	1	0.85	60.0
Age (years)			
21-30	30	25.64	58.5
31-40	41	35.04	61.5
41-50	45	38.46	61.5
51-60	1	0.85	60.0
Qualification			
Matric	95	81.19	61.5
Graduation	18	15.39	64.0
Post-graduation	4	3.41	56.5
Family education			
Upto matric	55	47.00	54.5
Upto graduation	47	40.17	56.0
Upto post-graduation	9	7.69	65.0
M. B. B. S.	2	1.70	56.5
R. M. P.	1	0.85	80.0
L L. B.	1	0.85	65.5
I. A. S.	2	1.70	62.5
Type of family			
Joint	32	27.35	55.0
Nuclear	85	72.63	57.5
Religious status			
Hindu	111	94.87	63.0
Sikh	6	5.13	58.5
Total	117	100.0	

Health and Family Welfare. The differences in the levels of knowledge are entirely due to the specialization of work. Knowledge scores of the respondents in the reproductive age group and with long service experience were more than those of the younger and less experienced respondents. Thus, there was positive relationship between the knowledge level and age and service experience. Know-

ledge scores of the respondents from nuclear family were more than the respondents from joint family. Maximum knowledge scores were of graduates. Knowledge scores of Hindu functionaries were more as compared to Sikhs. There was no association between the knowledge level of respondents and family education.

It would be possible to integrate population education concept into working situations of the village level functionaries. Training in population education appears to help the village level functionaries to develop new outlook towards various programmes of rural development in the context of population education. Periodic refresher courses in population education seem to help in developing a systematic approach for solving population problems at the community level on the principle of self-help (Chaudhary, 1978). The job description of all functionaries in the field of rural development and extension should be reviewed and amended to include population education as an integral part of their respective jobs. The functionaries should be provided with relevant literature and material to keep them informed about current trends in population education. The programmes should be reviewed periodically with a view to coordinate and integrate the activities of various government departments and voluntary agencies promoting small family norm.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 3, pp. 483—486 (September 1983)

HEALTH STATUS OF RURAL CHILD LABOURERS IN MOHINDERGARH DISTRICT OF HARYANA

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(Received : March 4, 1982; Revised : December 12, 1982)

ABSTRACT

Majority of the child labour was between 12-14 years, among them boys outnumbered the girls. Main mode of earning of the parents and their children was agriculture. Most of the parents and the child workers were illiterate. The diet consumed by the child labour was deficient in proteins, calories and vitamins; thus, retarding physical and mental development of the child labour who has to work for longer hours per day and throughout the year.

The tragedy of child labour is highest in India than elsewhere in the world. In India, young children constitute about 1/3 of the total population. According to 1981 census, 255 million children below 14 years of age form single largest segment (39%). Among them 16.5 million children are working as labourers. Due to over population, poverty and low education of the parents, children are compelled by poor parents to earn something and cease to be a burden on them. Bhagoliwal (1976) reported that the economic necessity for wage earning to support family deprives the child of opportunity for education, wholesome play and recreations, stunts his physical growth, interferes with the normal development of his personality and waste his preparation for adult responsibility.

Health problems in such children are more acute, particularly in rural areas where the poor nutrition is coupled with factors like unhealthy working and living conditions, long hours of working at a tender age, and parents different attitude towards them. George (1964) reported that working of children under such conditions interferes with their physical development. Working of children at lower age or for unreasonable hours under unhygienic conditions multiplies health problems.

The overall condition of the child labour in India is as bad as it was about 50 years ago. This has been found by the official committee headed by Mr. Gurupadaswamy which submitted its report to the Government of India in Dec. 1979 at the end of the International Year of the Child. So more health care is needed in our country where million of these children die at a very tender age due to neglect and malnutrition (Anonymous, 1980). Devdas (1973) observed that the quantity and adequacy of the diet children receive will be reflected in the rate of their physical and mental development.

Protein-calorie malnutrition is probably one of the most pressing nutrition problems in India especially among children. Mamoria and Doshi (1966) said that child labour is directly related to child health and exerts a negative effect upon it.

METHODOLOGY

The study was conducted in four purposively selected villages, viz., Manethi, Padla, Mazra and Bhalkhi of Mohindergarh district in Haryana. A sample of 200 families sending 402 children for work, was selected on the basis of purposive and random sampling procedure. A well structured interview schedule was administered for collecting information. The respondents were heads of the families.

RESULTS AND DISCUSSION

Majority of the child workers (47 5%) were in the age group of 12-14 years, followed by 9-11 years (33.1%) and 6-8 years (19.4%). The child labour constituted 70.6% boys and 29.4% girls. Education level of their parents was quite low. About 89% parents were illiterate, 6% could read only and 4.5% could read and write. As regards their own education, only 6% were studying and majority (79%) never went to school. Of all, 15% child labourers were school drop-outs due to severe economic reasons.

Castewise, they belonged to Harijans (19%), Yadavs (26%), Rajputs (13%), Khatis (9%), Guwariyas (8%) and other castes (4.5%). The main occupation of their parents was agriculture (96%) and only 4% were engaged in business. Out of all the child workers, 63.7% were engaged in agricultural activities, whereas rest in the slate stone activities.

As far as per day calorie requirement of the child labourers is concerned, it is apparent from Table 1 that about 75% of the children consumed calorie deficient diet. Among them 63.8% were from the age group of 12-14 years alone. Tragi-

TABLE 1

Calorie and protein intake by the child labour

Age	No. of children	Calorie intake per day (I. U.)			Protein intake (g/day)		
		Recommended	Sufficient	Deficient	Recommended	Sufficient	Deficient
6-8	78 (19.4)	1500	53 (51 7)	25 (8.2)	22	16 (14.0)	62 (19.4)
9-11	133 (33.1)	1800	49 (48.3)	84 (28.0)	33	39 (34.8)	94 (33 1)
12-14	191 (47 5)	2100	—	191 (63.8)	41	57 (51.2)	134 (47.5)
—	402 (100.0)	—	102 (25.0)	300 (75 0)	—	112 (27.9)	290 (72.1)

Figures in parentheses indicate percentages.

cally, among remaining 25% children none in the age group of 12-14 years consumed calorie sufficient diet. Similar trend was observed in case of protein intake also. Only 27.9% children consumed protein sufficient diet, whereas 72.1% consumed protein deficient diet.

Thus, perusal of the facts reveals that children of 12-14 years of age are the worst victims of undernutrition. Ghosh (1977) reported that if the calorie intake is inadequate, some protein will be used for energy purposes and so the protein available for tissue building will be reduced.

So these child labourers attain poor physical and mental health which have adverse effect on their development. The health problem of these tender aged children becomes more acute when their nutritionally deficient diet couples with long working hours throughout the year.

Table 2 educes that the largest proportion, i. e. 47.5% of child labour is in the age group of 12-14 years. Among them the majority (64.9%) have to work for a maximum period of 7-8 h per day. Qureshy (1979) reported that children had to work hard varying from 10-15 h a day and most of them in the 7-14 years age group under unhealthy conditions.

Further, it is apparent from Table 2 that 66.6% of child labour of all the three age groups had to work throughout the year, whereas 27.4% worked seasonally. Only 6% children used to go for work after school time as part time job to supplement their family income. The largest number of children who were working around the whole year belonged to higher age categories of 12-14 and 9-11 years. Thus, majority of the children had to work throughout the year and for long hours. This shows the acute hardship to which these children are exposed at a very tender age. Caste and education did not appear to have any bearing on child labour. Due to economic hardship these child labourers were severely undernourished. Consequently, it had dir-

TABLE 2

Age-wise working hours and yearly work distribution of child labour

Age	No. of children	Working hours			Yearly work distribution		
		4 h/day	5-6 h/day	7-8 h/day	Throughout the year	Seasonally working	Part-time after school
6-8	78	12	24	42	50	17	11
	(19.4)	(15.4)	(30.8)	(53.8)	(64.1)	(21.8)	(14.1)
9-11	133	14	36	83	89	35	9
	(33.1)	(10.5)	(27.1)	(62.4)	(66.9)	(26.3)	(6.8)
12-14	191	7	60	124	129	58	4
	(47.5)	(3.7)	(31.4)	(64.9)	(67 5)	(30.4)	(2.1)
Total	402	33	120	249	268	110	24
	(100.0)	(8.2)	(29.9)	(61.9)	(66.6)	(27.4)	(6.0)

Figures in parentheses indicate percentages

ectly affected their physical and mental development.

Following suggestions can be remedial for the problem :

1. Trade and commerce based income generating activities should be introduced to develop abilities, skills like production of jute goods, slate making, growing of vegetables, making handicrafts to increase children's interest in studies. This will also supplement their family income without subjecting the children to unscrupulous child labour.

2. Parents, particularly mothers, should be imparted trainings in preparing foods with various combinations of cereals and pulses to enhance the nutritional value of the diet, use of locally available seasonal inexpensive edibles in daily diet, saving the nutrients of food through proper cooking methods, knowledge about the diseases caused by nutritionally deficient food and their dietary treatments, preservation of seasonally available cheap fruits and vegetables.

3. Mid-day meals should be provided to the children to reduce nutritional deficiency. Efforts should be made to grow vegetables in kitchen gardens which will go a long way to make available more nutritious and balance food.

4. More consumer co-operative stores should be opened in remote villages to provide less expensive basic items like food, clothing and other items of daily use.

5. Parents and employers need to be educated about the existing laws governing various aspects of agricultural labour like minimum wages, duration of work, prohibition to employ children below 15 years. Moreover, parents should be educated to adopt small family norm which will help to reduce the number of members to be fed with available resources.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 4, pp. 487—496 (December 1983)

EFFECT OF HATCHING SEASON AND SEX ON BODY WEIGHTS IN TURKEYS

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(Received : March 23, 1982; Revised : September 10, 1982)

ABSTRACT

Male turkey poults were significantly heavier than females at all ages and during all the seasons. The birds hatched and reared till 12 weeks age during warmer months and 20-30 weeks during colder months performed the best. Accordingly, the birds hatched in March, April, September and October were heavier than those which hatched in November, December, January and February.

In recent years the demand for turkey has been increasing due to constantly changing food habits of the population. Since in India the performance of turkeys is not similar to as in foreign countries, there is need to standardise the managemental practices for efficient turkey production in this country. The hatching season is one of the factors affecting the body weight (growth) of birds to a considerable extent. The present study was undertaken to find out the effect of hatching season on the performance of turkeys of different sexes and to know the existence of sexual dimorphism and sex × season interactions in turkeys.

MATERIAL AND METHODS

This study was undertaken on 342 turkeys hatched in 9 hatches from February, 1978 to January, 1979. Only those birds which survived upto 30 weeks of age, in each hatch, were studied. The birds of each hatch were raised, separately, on floor from day old to 30 weeks of age following standard managemental practices best known till now. They were provided the same feed and similar managemental conditions throughout the experiment. The birds were weighed individually at day old and fortnightly intervals during 8-30 weeks of age. Data were subjected to analysis of variance and pair-wise comparisons of means were made following Duncan's Multiple Range test (Kramer, 1957). The growth rate was calculated as gm of growth per bird per day and expressed as regression of cumulative weight gain on initial body weight from day old to 30 weeks of age. The number of observations for different sexes and seasons has been presented in Table 1.

RESULTS AND DISCUSSION

The body weights at different ages alongwith their standard errors for the birds hatched during different months

TABLE 1

Number of observations under different seasons and sexes

Hatching month	Male	Female	Combined sex
February, 1978	24	24	48
March, 1978	21	26	47
April 1, 1978	25	22	47
April 15, 1978*	19	27	46
September, 1978	24	20	44
October, 1978	26	16	42
November, 1978	12	17	29
December, 1978	7	14	21
January, 1979	7	11	18
Total	165	177	342

*Hatching suspended till September, 1978 because of non-availability of air conditioning facilities in the hatchery.

have been presented in Tables 2-5, whereas the analysis of variance showing the effect of sex and hatching season has been presented in Tables 6 and 7. Data in Table 7 indicate that highly significant differences existed between body weights of different sexes at all ages of measurements. Males were heavier to females at all ages and in all seasons (Tables 2-5). This observation is in agreement with the findings of Albuquerque *et al.* (1978), Todorova (1978), Andryushchenko (1979), Belukha (1979) and Kriz *et al.* (1979). The gm of growth per bird per day expressed as regression of cumulative weight gain on age in weeks between day old to 30 weeks of age has been presented in Table 8. The growth rate in males was about 1.5 to 2 times more than that of females in all the hatches. Further, the males were conclusively heavier than females at all ages and during all seasons.

Significant effects of season of hatching on body weights at different ages were obtained for males, females and pooled sexes (Tables 6 and 7). At 8 weeks age the body weights in different seasons varied between 623 to 1241 g, 654 to 1137 g and 646 to 1193 g in males, females and on the combined sex basis, respectively. Body weights at this age were heaviest in those birds which hatched in February, March or April followed by those hatched in September and October. The lowest minimum body weights were observed for the birds hatched in November, December and January.

The 10 weeks body weights for males, females and pooled sexes varied between a minimum of 1297, 1073 and 1148 g in poults hatched in December to a maximum of 1898, 1577 and 1720 g for the birds hatched in March. The birds

hatched in February, March or April had higher body weights than those which hatched from September to January. The birds hatched in September or January weighed heavier to those hatched in October, November or December.

At 12 weeks age the trend was almost similar to that reported for 10 weeks body weight. The birds hatched in February, March or April were the heaviest and the birds which hatched in September, October, November and December had lower body weights than those hatched in other months. The birds hatched in January showed a little different trend than at 8 or 10 weeks of ages. It appeared that growth rate in these birds was higher during this fortnight (March/April) and after compensating for low body weight the birds attained a weight almost equal to those hatched in March or April. Small number of observations during January may be another reason for variable performance of January hatched birds.

From the foregoing discussion it appears that, in most of the cases, birds hatched in February, March or April were heaviest, while those hatched in September or October had higher body weights at 8, 10 and 12 weeks of ages as compared to those which hatched in November and December. This may be due to the fact that early brooding period is very critical for poults and they will perform better if colder months are avoided during this stage.

At 14 weeks of age no significant differences were observed in body weights of birds hatched during February, March, April and November. The birds hatched during these months had the highest body weight. The birds hatched in January were amongst the heavier birds at 10 and 12 weeks of age but recorded the lowest body weights at 14 weeks of age.

At 16 weeks of age the males hatched during April, September and November had the highest and those hatched during February and March had the lowest body weights. This trend was just opposite to that observed for 8 to 14 weeks of ages. For females and on a combined sex basis the heaviest 16 weeks body weight was observed in the birds hatched in November. A hatch × sex interaction was evident for growth at this stage. The males hatched in September and October ranked third and sixth in body weights compared to seventh and second for the females hatched during these months, respectively. The females hatched in December and January were lowest in weight. It was hard to conclude the superiority of a particular month over the other because of differential performance of sexes at this age.

At 18 weeks of age the birds had heaviest body weights when hatched during September. The hatching months of December, January, February and March resulted in poorest body weights.

From 20 to 30 weeks of age, it was observed in most of the cases that birds hatched in March, April, September and October had the highest body weights and the birds hatched from November to February showed poor growth. In a few cases the birds hatched during January (particularly at 20 and 22 weeks of ages) performed better than those

TABLE

Means (g) and standard errors (within parentheses) showing the effect of month of

Month of hatching	8 weeks weight		
	Male	Female	Combined
Feb. 78	1228^{d} (74)	1135^{a} (34)	1182^{a} (41)
March 78	1154^{cd}(50)	1018^{b} (29)	1079^{b} (29)
1 April 78	1241^{d} (35)	1137^{a} (38)	1193^{a} (27)
15 April 78	1187^{d} (27)	990^{bc}(27)	1071^{b} (24)
Sep. 78.	1028^{c} (51)	909^{cd}(31)	974^{c} (32)
Oct. 78	873^{b} (47)	858^{d} (37)	868^{d} (32)
Nov. 78	751^{ab}(46)	681^{e} (18)	710^{e} (22)
Dec. 78	700^{ab}(57)	654^{e} (37)	670^{e} (31)
Jan. 79	623^{a} (84)	660^{e} (58)	646^{e} (47)

Superscripts in common (within a column) do not differ significantly at 5% level of

TABLE

Means (g) and standard errors (within parentheses) showing the effect of month of

Month of hatching	14 weeks weight		
	Male	Female	Combined
Feb. 78	2884^{ab}(124)	2470^{ab}(70)	2677^{a}(76)
March 78	3083^{a}(80)	2491^{ab}(53)	2756^{a}(63)
1 April 78	3102^{a}(61)	2558^{a}(64)	2848^{a}(59)
15 April 78	3158^{a}(73)	2381^{abc}(60)	2702^{a}(75)
Sep. 78	2996^{a}(98)	2255^{c}(68)	2659^{ab}(83)
Oct. 78	2619^{b}(138)	2297^{bc}(87)	2496^{bc}(94)
Nov. 78	3185^{a}(134)	2562^{a}(44)	2820^{a}(83)
Dec. 78	2814^{ab}(125)	2243^{c}(75)	2433^{c}(87)
Jan. 79	2543^{d}(203)	1882^{d}(108)	2139^{d}(126)

Superscripts in common (within a column) do not differ significantly at 5% level of

2

hatching (season) on fortnightly body weights of turkeys from 8-12 weeks of age

10 weeks weight			12 weeks weight		
Male	Female	Combined	Male	Female	Combined
1745^{ab}(100)	1568^{a} (45)	1657^{a} (56)	2331^{abc}(109)	2098^{a} (62)	2215^{a} (65)
1898^{a} (74)	1577^{a} (38)	1720^{a} (45)	2435^{ab} (73)	1920^{b} (51)	2150^{a} (57)
1729^{a} (49)	1509^{a} (45)	1626^{ab}(37)	2342^{abc} (55)	1993^{ab} (61)	2179^{a} (48)
1745^{ab} (39)	1368^{b} (27)	1524^{bc}(36)	2517^{a} (57)	1904^{b} (51)	2157^{a} (59)
1475^{c} (66)	1352^{bc} (46)	1419^{cd}(42)	2233^{bc} (103)	1685^{cd} (64)	1984^{b} (75)
1333^{c} (71)	1225^{cd} (46)	1292^{ef} (47)	1761^{d} (106)	1609^{cd} (69)	1703^{c} (71)
1387^{c} (74)	1197de (27)	1276^{ef} (38)	2169^{bcd}(101)	1799^{bc} (43)	1952^{b} (59)
1297^{c} (91)	1073^{e} (68)	1148^{f} (58)	1963^{c} (93)	1547^{d} (76)	1686^{c} (73)
1457^{bc}(123)	1290^{bcd}(87)	1356de(72)	2229^{abc}(155)	1914^{ab}(106)	2036^{ab}(93)

probability.

3

hatching (season) on fortnightly body weights of turkeys from 14-18 weeks of age

16 weeks weight			18 weeks weight		
Male	Female	Combined	Male	Female	Combined
3471^{c}(129)	2922^{bc}(89)	3197^{cd}(87)	4020^{c}(147)	3190^{cd}(89)	3605de(104)
3647^{bc}(103)	2883^{bc}(59)	3224^{bcd}(79)	4316^{bc}(136)	3329^{bcd}(65)	3770^{cd}(101)
3954^{ab}(87)	3020^{ab}(76)	3517^{a}(90)	4658^{b}(128)	3334^{bcd}(81)	4038^{b}(124)
4168^{a}(93)	2907^{bc}(73)	3428^{ab}(111)	4789^{b}(121)	3476^{ab}(80)	4018^{b}(121)
3992^{ab}(158)	2720^{c}(104)	3414^{abc}(137)	5252^{a}(107)	3715^{a}(112)	4553^{a}(140)
3698^{bc}(174)	3028^{ab}(100)	3443^{ab}(124)	4652^{b}(207)	3422^{bc}(131)	4183^{b}(165)
4050^{ab}(149)	3224^{a}(65)	3566^{a}(105)	4575^{b}(157)	3535^{ab}(56)	3966^{bc}(120)
3703^{abc}(161)	2716^{c}(106)	3045^{d}(135)	4164^{bc}(126)	3085^{d}(95)	3445^{e}(136)
3650^{abc}(131)	2714^{c}(124)	3078^{d}(142)	4321^{bc}(168)	3345^{bcd}(127)	3725^{cde}(152)

probability.

TABLE

Means (g) and standard errors (within parentheses) showing the effect of month of

Month of hatching	20 weeks weight		
	Male	Female	Combined
Feb. 78	4622^{b}(170)	3462^{b}(90)	4042de(127)
March 78	4845^{c}(138)	3612^{b}(81)	4252^{cde}(129)
1 April 78	5150^{b}(120)	3739^{ab}(113)	4489^{bc}(132)
15 April 78	5226^{ab}(186)	3687^{ab}(81)	4447^{bc}(162)
Sep. 78	5677^{a}(108)	3897^{a}(101)	4868^{a}(154)
Oct. 78	5181^{b}(206)	3715^{ab}(94)	4623^{ab}(172)
Nov. 78	4721^{b}(218)	3471^{b}(67)	3988de(151)
Dec. 78	4871^{b}(119)	3524^{b}(100)	3973^{e}(161)
Jan. 79	5229^{ab}(229)	3805^{ab}(131)	4358^{bcd}(204)

Superscripts in common (within a column) do not differ significantly at 5% level of

TABLE

Means (g) and standard errors (within parentheses) showing the effect of month of

Month of hatching	26 weeks weight		
	Male	Female	Combined
Feb. 78	6533^{b}(246)	4108^{c}(134)	5321^{c}(225)
March 78	7557^{a}(122)	4352^{bc}(117)	5779^{b}(250)
1 April 78	7606^{a}(150)	4616^{ab}(121)	6206^{a}(240)
15 April 78	7653^{a}(173)	4730^{a}(83)	5920^{b}(233)
Sep. 78	7894^{a}(218)	4525^{ab}(133)	6363^{a}(288)
Oct. 78	7715^{a}(219)	4321^{bc}(137)	6445^{a}(295)
Nov. 78	6679^{a}(235)	4485^{ab}(106)	5393^{c}(233)
Dec. 78	6564^{b}(151)	4204^{bc}(102)	4990^{c}(262)
Jan. 79	6671^{b}(391)	4400^{abc}(178)	5283^{c}(323)

Superscripts in common (within a column) do not differ significantly at 5% level of

4

hatching (season) on fortnightly body weights of turkeys from 20-24 weeks of age

22 weeks weight			24 weeks weight		
Male	Female	Combined	Male	Female	Combined
5142^{d}(168)	3531^{b}(117)	4336^{d}(155)	5823^{c}(205)	3900^{c}(143)	4861^{e}(187)
5905^{bc}(141)	3818^{ab}(103)	4751^{bc}(175)	6819^{ab}(143)	4183^{bc}(124)	5361^{d}(214)
5812^{bc}(157)	3948^{a}(124)	4939^{b}(170)	6666^{ab}(141)	4509^{a}(121)	5656^{bc}(184)
6095^{b}(148)	3963^{a}(83)	4843^{b}(174)	6976^{a}(147)	4305^{ab}(79)	5409^{cd}(226)
6583^{a}(148)	4002^{a}(119)	5410^{a}(218)	7112^{a}(162)	4443^{ab}(105)	5899^{ab}(214)
5996^{b}(218)	3968^{a}(84)	5224^{a}(206)	7008^{a}(214)	4425^{ab}(139)	6024^{a}(241)
5387^{cd}(236)	3832^{ab}(88)	4476^{cd}(181)	6004^{c}(232)	4218^{abc}(89)	4957^{e}(198)
5286^{cd}(119)	3689^{ab}(83)	4221^{d}(181)	5943^{c}(134)	3918^{c}(96)	4593^{e}(227)
5721^{bcd}(261)	4091^{a}(165)	4725^{bc}(237)	6164^{bc}(312)	4241^{abc}(163)	4989^{e}(273)

probability.

5

hatching (season) on fortnightly body weights of turkeys from 26-30 weeks of age

28 weeks weight			30 weeks weight		
Male	Female	Combined	Male	Female	Combined
7404^{c}(209)	4298^{b}(111)	5851^{c}(255)	7904^{bc}(209)	4438^{a}(136)	6171^{a}(281)
8140^{b}(123)	4558^{ab}(118)	6159^{b}(276)	8978^{a}(121)	4938^{a}(117)	6744^{a}(308)
8226^{b}(154)	4864^{a}(125)	6652^{a}(267)	8934^{a}(157)	5029^{a}(141)	7106^{a}(306)
8253^{ab}(167)	4846^{a}(84)	6253^{b}(264)	8789^{a}(211)	4954^{a}(88)	6538^{a}(299)
8779^{a}(186)	4675^{a}(96)	6914^{a}(330)	9247^{a}(190)	5032^{a}(104)	7332^{a}(339)
8190^{b}(246)	4840^{a}(104)	6914^{a}(298)	8113^{b}(241)	4748^{a}(101)	6845^{a}(295)
7121^{c}(241)	4679^{a}(127)	5690^{c}(258)	7325^{cd}(196)	4618^{a}(81)	5738^{a}(268)
6878^{c}(121)	4275^{b}(88)	5143^{d}(283)	6936^{d}(144)	4539^{a}(136)	5338^{a}(272)
7161^{c}(460)	4600^{ab}(180)	5606^{c}(366)	7929^{bc}(534)	4959^{a}(205)	6114^{a}(421)

probability.

TABLE 6

Mean squares from analysis of variance of different traits in male and female turkeys

Traits	Males		Females	
Body weight at the age of (weeks)	Between hatches (8)*	Error (156)*	Between hatches (8)*	Error (168)*
8	786655**	558791	658188**	22388
10	843924**	109807	575456**	40099
12	1159308**	177196	621413**	76484
14	840959**	245104	648672**	91126
16	1041795**	387336	481753**	144974
18	2826945**	482803	661665**	166096
20	2385521**	561841	427556**	180400
22	3955540**	577918	567117**	283915
24	4685980**	688913	925226**	285745
26	5473775**	868745	801254**	298493
28	6205747**	834106	975972**	258625
30	9051324**	870414	1031506	8503293

*Degrees of freedom.

**Significant at 1% level of probability.

TABLE 7

Mean squares from analysis of variance of different traits in turkeys (pooled)

Body weight at the age of (weeks)	Between sexes (1)*	Between hatches (8)*	Error (332)*
8	1108320**	1447627**	37368
10	4004586**	1343417**	73718
12	12145106**	1416111**	130749
14	27567434**	1252061**	167006
16	69958764**	1079622**	260059
18	122948843**	4106374**	296022
20	190406813**	3460879**	339072
22	337713629**	5580713**	368941
24	482189197**	8344278**	402443
26	731759123**	9049321**	492400
28	962069252**	11982582**	407116
30	1122406381**	13375814	18588798

*Degrees of freedom.

**Significant at 1% level of probability.

TABLE 8

Average growth(g) and standard errors (in parentheses) per bird per day, expressed as regression of cumulative weight gain on initial body weights, in turkeys from day old to 30 weeks age

Month of hatching	Males	Females	Pooled
Feb. 78	44^{d}(0.76)	21^{a}(1.26)	32^{d}(0.41)
March 78	51^{bc}(2.42)	25^{a}(1.26)	36^{bc}(0.41)
1 April 78	51^{bc}(0.84)	26^{b}(1.41)	39^{b}(0.55)
15 April 78	51^{b}(0.78)	27^{b}(1.38)	37^{bc}(1.02)
Sep. 78	56^{a}(1.33)	27^{b}(1.96)	43^{a}(1.48)
Oct. 78	53^{ab}(2.06)	27^{b}(1.92)	43^{a}(1.80)
Nov. 78	53^{d}(1.89)	26^{ab}(2.29)	33^{cd}(2.11)
Dec. 78	43^{d}(1.81)	25^{ab}(1.75)	31^{d}(1.72)
Jan. 79	47^{cd}(1.41)	28^{b}(1.86)	35^{cd}(1.67)

hatched in March, April, September or October. This may be due to small number of observations in January, 1979. The birds hatched in March, April, September and October passed through a comparatively warm season during brooding stage and through a colder part of the year during 20-30 weeks of age which resulted in higher body weights. On the other hand, the birds hatched during November, December, January and February passed through a cold season during brooding stage and through a warm season during 20-30 weeks of age.

To sum up, it may be inferred that growth of birds was highest in birds which were hatched and brooded during warm season upto 12 weeks of age and increasing cold after 20 weeks age. Except for the month of January, 1979 where number of observations were small, Table 8 also gave an indication and trend of growth similar to the one reported above. Therefore, the turkeys should be hatched during March, April, September and October months as they will reach to the prime age during December or April at Christmas and Easter time, respectively. This will give an added advantage to the producers because of high demand of turkeys on these occasions.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 4, pp. 497—504 (December 1983)

EFFECT OF HOUSING AND FEEDING SYSTEMS ON THE PRODUCTION OF MURRAH BUFFALOES DURING RAINY SEASON

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(Received : February 12, 1982; Revised : August 17, 1982)

ABSTRACT

Experiment conducted to find out the effect of two housing systems (loose housing vs conventional-tie-barn) and two feeding systems (80 : 20 and 60 : 40 roughage concentrate ratios) on the milk yield of 12 lactating Murrah buffaloes revealed that the daily dry matter and voluntary water intakes were not significantly influenced by two housing conditions. The average daily milk yield, 6% fat-corrected and solids-corrected milk yield was significantly ($P<0.05$) more in loose house than conventional barn group. Buffaloes fed 60 : 40 ratio consumed significantly ($P<0.05$) more dry matter and TDN daily. Similarly, buffaloes given 60 : 40 roughage concentrate ratio produced significantly ($P<0.05$) more milk than 80 : 20 ratio. The fat, SNF and T S contents in milk were not significantly influenced by housing and feeding systems. The feed cost of milk production was 16 paise more in 60 : 40 ratio as compared to 80 : 20 roughage : concentrate ratio.

About 80% of the calving in Murrah buffaloes occurs during July to November (Bhatnagar *et al.*, 1961). During this season, the temperature and humidity are very high putting buffaloes in great heat stress, and thus, adversely affecting their milk production. This heat load of the animals can be reduced by providing proper housing and feeding higher proportions of concentrate in the daily diet. The present investigation was, therefore, undertaken to study the effect of two major housing systems and two levels of concentrate feeding on the daily milk yields of lactating Murrah buffaloes.

MATERIAL AND METHODS

Twelve lactating Murrah buffaloes, in early stage of lactation, were distributed randomly in following four treatments with three animals each on the basis of their milk yield :

A. Loose housing—roughage : concentrate ratio of 80 : 20 on TDN basis;

B. Loose housing—roughage : concentrate ratio of 60 : 40;

C. Conventional barn—roughage : concentrate ratio of 80 : 20; and

D. Conventional barn—roughage : concentrate ratio of 60 : 40.

The loose house had a covered area with simple asbestos cement sheet roofing and a brick paved open area surrounded by a 1.5 m high wall on three sides. The conventional barn was a completely enclosed structure having an asbestos sheet roofing with individual stalls.

The experiment was conducted in a 2×2 completely randomised factorial switch over design. The animals were given one week of adjustment period and 15 days of experimental period in such a way that cycle was completed by three switch overs. The layout plan of switch overs is given in Table 1.

TABLE 1

Layout plan showing the three switch overs

Periods	Treatments			
P_1	A	B	C	D
P_2	B	A	D	C
P_3	D	C	B	A
P_4	C	D	A	B

All the buffaloes were fed individually according to their requirement for maintenance and production (Sen and Ray, 1971). The green jowar was used as roughage and the concentrate mixture containing 22.5% DCP and 71.0% TDN (henceforth designated No. 1) was given to buffaloes fed roughage concentrate ratio of 80 : 20, while concentrate mixture having 12.5% DCP and 73.0% TDN (henceforth designated No. 2) was given to buffaloes in the ratio of 60 : 40. The ingredients used in both the concentrate mixtures were crushed maize, crushed barley, wheat bran, groundnut cake, mineral mixture and common salt.

Management conditions were similar for all the groups except treatments. The buffaloes in conventional-tie-barn house were remained tied throughout day and night, while these were tied only at the time of feeding and milking in loose house. Daily observations on minimum and maximum temperature and dry and wet bulb temperature were recorded separately in both type of houses. The relative humidity percentage and temperature humidity index (THI) were calculated by the equations of William and Charles (1976) and McDowell (1972), respectively. These observations have been presented in Table 2.

Respiration rate, pulse rate and rectal temperature were recorded at 9.00 a.m. and 3.00 p. m. in the beginning, middle and at the end of each experimental period.

Milk production was recorded in the morning and evening. The amount of milk consumed by the calves was determined by the method of Thomas *et al.* (1978). The 6% fat-corrected milk and solids-corrected milk yield were calculated by the formulae given by Rice *et al.* (1970) and Tyrrell and Reid (1965), respectively. The samples of milk were tested weekly for fat percentage by standard Gerber's method. Total solids were determined by gravimetric method (Anonymous, 1972). Solids-not-fat percentage was determined by subtracting fat percentage from total solids percentage. Feed cost of milk production was calculated on farm based prices of feeds and fodders.

RESULTS AND DISCUSSION

The average daily dry matter, DCP and TDN and water consumption in buffaloes are given in Table 3. The dry matter consumption, as per expectation, was almost same in buffaloes maintained in two types of houses. However,

TABLE 2

Average ambient temperature, relative humidity and temperature humidity index in loose house and barn during four switch over periods

Housing system	Ambient temperature (°C)			Relative humidity (%)		Temperature humidity index (THI)		
	Maximum	Minimum	Mean	Morning	Evening	Morning	Evening	Mean
Loose house								
P_1	39.00	29.56	34.28	63	58	66.90	74.63	70.76
P_2	38.86	28.46	33 66	64	59	68.42	76.82	72.62
P_3	39.13	25.86	32.49	58	29	66.96	73.28	70.12
P_4	34.00	22.50	28.25	51	38	62.12	70.53	66.32
Average	37.74	26.59	32.17	59	46	66.10	73.81	69.95
Barn								
P_1	38.43	29.63	34.05	68	57	71.15	75.90	73.52
P_2	36.83	27.93	32.38	68	51	71.07	75.37	73.22
P_3	36.16	26.06	31.11	56	39	68.94	73.74	71.34
P_4	32.56	23.73	28.14	62	55	65 99	69.42	67.70
Average	35.99	26.83	31.41	63.50	50.50	69.28	73.60	71.44

TABLE 3

Average daily dry matter, DCP, TDN and water consumption in experimental buffaloes

Variables	Housing system		Feeding system (Roughage : concentrate ratio)	
	Loose house	Barn housing	80 : 20	60 : 40
Total dry matter intake/day (kg)	11.68 ±0.288	11.61 ±0.221	11.40[a]±0.295	11.89[b]±0.199
Dry matter intake/100 kg body weight (kg)	2.51 ±0.047	2.52 ±0.035	2.47[a]±0.049	2.56[b]±0.029
Dry matter intake/kg $W^{0.75}$ (g)	116.82 ±2.660	116.78 ±1.853	113.75[a]±2.750	119.86[b]±1.462
Dry matter intake kg 6% FCM yield (kg)	1.35[a]±0.044	1.42[b]±0.034	1.41[a]±0.039	1.36[b]±0.041
Daily DCP intake (kg)	0.672[a]±0.018	0.652[b]±0.014	0.657 ±0.017	0.668 ±0.015
Daily TDN intake (kg)	7.21 ±0.189	7.15 ±0.158	6.78[a]±0.173	7.58[b] ±0.128
Voluntary water intake/day (litres)	59.58 ±2.563	60.08 ±1.946	59.87 ±2.386	59.79 ±2.161
Voluntary water intake/kg DM (litres)	5.22 ±0.186	5.18 ±0.126	5.28 ±0.172	5.12 ±0.145
Daily body weight gain (kg)	0.177 ±0.079	0.158 ±0.017	0.055 ±0.187	0.280 ±0.188

[a] — The means with different superscripts (within a particular system) differ significantly ($P<0.05$).

[b] — The means without any superscripts do not differ significantly ($P<0.05$).

buffaloes fed 60 : 40 roughage : concentrate ratio consumed significantly ($P<0.05$) more dry matter than those fed 80 : 20 ratio. This was as per norms because the animals in 60 : 40 ratio had more concentrate than roughage to meet their requirements (Sen and Ray, 1971). This fact is further strengthened by the figures of body weight gain (Table 3), which was not significantly effected by the housing and feeding system in buffaloes during experimental period. Therefore, it can be said that all the animals received proper amount of nutrients for their requirements.

The voluntary water intake in buffaloes was not significantly influenced by two housing and two feeding systems during rainy season (Table 3). These observations are contradictory to the findings of Misra *et al.* (1963), Tomer *et al.* (1969), Pal *et al.* (1973) and Singh *et al.* (1976). They reported higher water intake in buffaloes kept unprotected during summer. It can be inferred from the present findings that water requirement of buffaloes is not significantly influenced by the housing conditions. This may be due to feeding of succulent green **jowar** without any dry fodder.

Water intake of cattle is a function of dry matter intake and ambient temperature. The water intake maintains direct relationship with dry matter intake within the range of thermoneutrality of cattle, and beyond this it is not a function of dry matter only but of the ambient temperature also. The total voluntary intake is dependent upon water contents of the forages and ambient temperature.

The data on average daily milk yield, 6% fat-corrected and solids-corrected milk yield and milk composition are given in Table 4. The daily milk production in buffaloes maintained in loose house was significantly ($P<0.05$) more (5.14%) than the buffaloes kept in conventional-tie-barn. The similar trend was also observed in FCM and SCM yields. The daily 6% fat-corrected and solids-corrected milk yield were significantly ($P<0.05$) more in loose house than conventional-tie-barn group (0.48 and 0.58 kg, respectively). The higher milk yield in loose house may be due to higher relative humidity and higher ambient temperature in the conventional barn as compared to loose house during rainy season which in combination exert more heat stress on the animals. This was in corroboration with the data on ambient temperature, relative humidity and temperature humidity index given in Table 2, which clearly indicate that average maximum ambient temperature in loose house was 1.75°C more than barn but minimum temperature was almost same in both types of houses. The relative humidity was 4.5% more in barn than loose house in the morning and evening. When temperature and humidity were taken together it was observed that barn had 3.18 more THI value than the loose house in the morning but during evening the figures were almost same. Thus, animals in loose house were relatively comfortable than conventional barn.

Matassino *et al.* (1976) and Speight *et al.* (1980) also reported a significant ($P<0.05$) increase in milk yield of cows kept in loose house as compared to conventional barn. But Thomas *et al.* (1978) did not observe significant effect on milk yield in buffaloes and crossbred cows during winter. It is also clear from Table 4

TABLE 4

Average daily milk yield and composition as influenced by two systems of housing and two systems of feeding

Variables	Housing system		Feeding system (Roughage : concentrate ratio)	
	Loose house	Barn housing	80 : 20	60 : 40
Milk yield (kg)	$8.18^{a}\pm0.330$	$7.78^{b}\pm0.306$	$7.80^{a}\pm0.313$	8.27 ± 0.318
6% FCM yield (kg)	$8.79^{a}\pm0.360$	$8.31^{b}\pm0.352$	$8.19^{a}\pm0.381$	$8.91^{b}\pm0.354$
Sold-corrected milk yield (kg)	$11.09^{a}\pm0.427$	$10.51^{b}\pm0.456$	$10.40^{a}\pm0.448$	$11.20^{b}\pm0.437$
Fat (%)	6.55 ± 0.182	6.45 ± 0.116	6.42 ± 0.135	$6\,58\pm0.166$
SNF (%)	9.55 ± 0.142	9.33 ± 0.192	9.37 ± 0.175	9.61 ± 0.163
Total solids (%)	16.11 ± 0.236	15.78 ± 0.231	15.79 ± 0.234	16.09 ± 0.233

Means with different superscripts differ significantly ($P<0.05$).

TABLE 5

Average feed cost of milk production in different treatments (based on farm prices)

	Treatments			
	A	B	C	D
Average daily feed cost/animal (Rs.)	4.77	6.53	4.57	6.47
Average feed cost/kg of milk (Rs.)	0.60	0.78	0.60	0.80
Average feed cost/kg 6% FCM (Rs.)	0.57	0.71	0.57	0.75
Average feed cost/kg SCM (Rs.)	0.45	0.57	0.45	0.59
Total return over feed cost from sale of milk (Rs.)	809.78	769.96	783.60	733.18
Feed cost/kg 6% FCM (Rs.) from				
Jowar	0.19	0.14	0.19	0.15
Concentrate	0.38	0.57	0.38	0.60

Prices of green jowar, concentrate mixture I and II were Rs. 10.00, Rs. 137.35 and Rs. 119.45/q. Milk was sold @ Rs. 2.30/kg.

that average daily milk yield as well as 6% fat-corrected and solids-corrected milk yield were significantly ($P<0.05$) more in 60 : 40 roughage : concentrate ratio than 80 : 20 ratio. Jackson and Gupta (1971) and Shukla *et al.* (1972) reported more milk yield in buffaloes with the increased level of the concentrate in the ration, but Singh *et al.* (1972) and Nahm *et al.* (1975) did not observe any significant effect of level of concentrate on the milk yield in cattle.

The two housing systems and two feeding systems have no significant influence on fat, solids-not-fat and total solids content of milk (Table 4). These results are in agreement with Konggaard (1977), who also reported that housing system has no effect on the composition of milk in cattle. Jackson and Gupta (1971), Singh *et al.* (1972) and Gupta (1980) also reported no effect of level of concentrate in the ration on fat, SNF and TS in buffaloes milk.

The feed cost of milk production based on farm prices is given in Table 5. The average feed cost per kg of FCM was 4 paise less for animals in loose house than in conventional barn. Similarly, feed cost per kg FCM was 16 paise more in 60 : 40 roughage : concentrate ratio than 80 : 20 ratio. This was due to higher level of concentrate in this ratio. Gupta (1980) also reported that feed cost of milk production in buffaloes increased as the level of concentrate increased in the ration.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 4, pp. 505—511 (December 1983)

EFFECT OF LEVELS AND DURATIONS OF RESTRICTING THE FEED INTAKE OF GROWING PULLETS ON GROWTH, FEED CONSUMPTION AND UTILIZATION OF FEED

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(Received : April 7, 1982; Revised : November 18, 1982)

ABSTRACT

A trial with 280 day-old chicks of a commercial layer strain was conducted to find the effect of feed restriction. Both the level and duration of feed restriction adversely affected the body weights of chicks at 24 weeks of age. The lowest weights were recorded for chicks fed 70% of **ad lib.** feeding for 18 weeks. Allowing 6 or 12 weeks **ad lib.** feeding period after restricting the diet did improve the body weights, but these were not comparable to those fed **ad lib.** for the entire period of study.

The chicks on restricted diets consumed lesser feed than those on the control diet ($P < .01$). The smallest feed was consumed by chicks on 70% of **ad lib.** feeding for 18 weeks duration. The maximum efficiency of feed utilization was observed in chicks fed 80 and 70 per cent of **ad lib.** feeding for 18 weeks.

Feed restriction has been used as means of improving the performance of layer bird in terms of various traits. There are varying reports on this subject. MacIntyre and Aitken (1959), Reddy *et al.* (1974) and Vaidya and Sathe (1974) have reported decrease in feed consumption at the end of restriction period. However, Fuller and Dunahoo (1962) reported contrary to the aforesaid reports. Singh *et al.* (1975) reported significantly smaller body weights due to feed restriction. According to Gowe *et al.* (1960) and MacIntyre and Gardiner (1964), feed restriction reduced the body weight which improved rapidly after the restoration of full feeding, but the body weights were not comparable to those of the full fed groups.

The efficiency of feed utilization which is also an important parameter in animal studies needs investigation. Therefore, the present investigation was undertaken to study the effect of different levels and durations of feed restriction on body weights and feed utilization in commercial egg type pullets.

MATERIAL AND METHODS

Two hundred and eighty day-old chicks of a commercial layer strain were reared in battery brooders for 4 weeks and were later transferred to floor pens. The chicks were wing banded, weighed and divided into 20 groups of 14 birds for ten dietary treatments each with two replicates. At the age of 6 weeks, 12

chicks were retained for each group discarding those with extreme body weight. The treatments were then allotted randomly to these groups. All chicks were offered starter mash **ad lib.** upto the age of 6 weeks. After this, the effects of treatments (3 levels×3 durations of feed restriction+control) were studied (Table 1). The feed restriction was practised on the basis of the quantity of feed consumed by the control group on the previous day. Half of the daily calculated feed allowance was offered at 9.00 a.m. and the other half at 2.00 p.m.

TABLE 1

Treatment description

Treatment code	Level of feeding (per cent of **ad lib.** feeding)	Duration of feed restriction (weeks)
T_1	Full fed (100%)	Throughout the experiment
T_2	90	6-12
T_3	90	6-18
T_4	90	6-24
T_5	80	6-12
T_6	80	6-18
T_7	80	6-24
T_8	70	6-12
T_9	70	6-18
T_{10}	70	6-24

The composition of the rations was as given by Sharma and Sharda (1980).

Body weight and feed consumption were recorded. Feed conversion ratios for different dietary treatments were subsequently worked out.

RESULTS AND DISCUSSION

The mean body weights, feed consumption and feed conversion ratios (FCR) of pullets on different levels and durations of restriction are presented in Tables 2 and 3.

Body Weights

The mean body weights of different groups of pullets at 6 weeks of age were not different ($P< .01$). A perusal of data at 12 weeks of age reveals a significant reduction in the body weight due to increasing levels of feed restriction ($P< .01$). The highest body weight (673 g) was found in pullets on **ad lib.** feeding followed by those on 90, 80 and 70 per cent of **ad lib.** feeding. The chicks on T_2, T_5 and T_8 treatments showed some improvement in body weights at 18 weeks after 6 weeks of **ad lib.** feeding following 6 weeks of restricted feeding, but they could not attain body weights comparable to the control groups. The body weights of these chicks, however, were significantly higher than those still on restricted feeding at 18 weeks. At 24 weeks of age, even 12 weeks of **ad lib.** feeding following 6 weeks restricted feeding failed to bring the body weights of chicks on treatments T_2, T_5 and T_8 to that of the control group ($P< .01$). The performance of these chicks with regard to this trait, however, was better than those allowed 6 weeks of **ad lib.** feeding following 12 weeks of restriction (T_3, T_6 and T_9) and those allowed no **ad lib.** feeding following feed restriction (T_4, T_7 and T_{10}) ($P< .01$).

These results are in agreement with the reports of Gowe *et al.* (1960) and MacIntyre and Gardiner (1964). Contrary to this, Hollands and Gowe (1961) and Narahari *et al.* (1975) reported that the body weights of feed restricted birds

TABLE 2

Mean body weights and feed conversion ratios during the period of feed restriction

Treatments		Body weights (g) after weeks				Feed conversion ratios after weeks				
		6	12	18	24	6-12	12-18	18-24	6-24	0-24
T_1		295	673^{d}	1039^{e}	1326^{h}	3.96^{c}	6.81^{d}	10.20^{a}	6.71^{cde}	5.93^{cd}
T_2		300	634^{c}	1010^{d}	1244^{g}	3.95^{c}	6.57^{cd}	11.63^{c}	6.87^{e}	5.98^{d}
T_3		290	630^{c}	988^{c}	1228^{f}	3.90^{c}	6.21^{bcd}	11.44^{c}	6.71^{cde}	5.89^{cd}
T_4		291	640^{c}	988^{c}	1215^{ef}	3.86^{c}	6.29^{bcd}	11.56^{c}	6.69^{cde}	5.89^{cd}
T_5		301	621^{b}	990^{c}	1209^{e}	3.66^{ab}	6.54^{cd}	12.60^{d}	6.86^{e}	5.97^{d}
T_6		290	610^{b}	952^{b}	1195^{d}	3.67^{b}	5.78^{ab}	11.37^{bc}	6.53^{bc}	5.76^{bcd}
T_7		293	612^{b}	947^{b}	1163^{c}	3.69^{b}	5.92^{abc}	10.82^{b}	6.32^{b}	5.54^{b}
T_8		290	577^{a}	954^{b}	1175^{c}	3.59^{ab}	6.33^{bcd}	11.90^{c}	6.84^{de}	5.95^{cd}
T_9		296	582^{a}	906^{a}	1149^{b}	3.60^{ab}	5.33^{a}	11.60^{c}	6.55^{bcd}	5.72^{bc}
T_{10}		292	581^{a}	902^{a}	1107^{a}	3.56^{a}	5.40^{a}	9.98^{a}	5.90^{a}	5.22^{a}
C. D. at 1%		NS	13	15	16	.100	.633	.566	.304	.239
Mean of levels	90%	294	633^{a}	995^{a}	1229^{a}	3.90^{a}	6.43^{a}	11.54^{b}	6.59^{a}	5.92^{b}
	80%	295	615^{b}	963^{b}	1189^{b}	3.67^{b}	6.07^{a}	11.41^{a}	6.57^{a}	5.75^{a}
	70%	293	580^{c}	921^{c}	1144^{c}	3.58^{c}	5.68^{b}	11.15^{a}	6.43^{a}	5.63^{a}
C. D. at 1%		NS	7	9	8	.061	.371	.325	.174	.136
Mean of duration (weeks)	6-12	297	611^{a}	985^{a}	1209^{a}	3.73^{a}	6.46^{a}	11.86^{c}	6.85^{c}	5.96^{c}
	6-18	291	607^{a}	949^{b}	1191^{b}	3.72^{a}	5.77^{b}	11.46^{b}	6.59^{b}	5.78^{b}
	6-24	292	609^{a}	946^{b}	1162^{a}	3.70^{a}	5.86^{b}	10.78^{a}	6.30^{a}	5.54^{a}
C. D. at 1%		NS	7	9	8	.06	.371	.325	.174	.136

Means carrying one or more common superscripts in a column do not differ significantly.

TABLE 3

Average feed consumption per bird during the growing period

Treatments	Feed consumption (g) after weeks						Actual level of ad lib. feeding (%) after weeks	
	0-6	6-12	12-18	18-24	6-24	0-24	6-24	0-24
T_1	782	1494	2489^{d}	2932^{b}	6915^{f}	7697^{g}	100.0	100.0
T_2	743	1324	2437^{d}	2720^{c}	6480^{e}	7222^{f}	93.7	93.8
T_3	732	1324	2228^{c}	2741^{cd}	6292^{de}	7024^{ef}	91.0	91.3
T_4	768	1324	2228^{c}	2629^{c}	6182^{cd}	6950^{de}	89.4	90.3
T_5	774	1176	2413^{d}	2541^{c}	6229^{cd}	7002^{ef}	90.1	91.0
T_6	754	1176	1980^{b}	2753^{cd}	5908^{b}	6663^{c}	85.4	86.6
T_7	742	1176	1980^{b}	2337^{b}	5493^{a}	6234^{b}	79.5	81.0
T_8	735	1029	2394^{d}	2628^{c}	6051^{bc}	6785^{cd}	87.6	88.2
T_9	780	1029	1732^{a}	2818^{c}	5579^{a}	6359^{b}	80.7	82.5
T_{10}	777	1029	1732^{a}	2045^{a}	4806^{g}	5582^{a}	69.5	72.5
C. D. at 1%	NS	NS	133	128	148	224	—	—
Mean for 90%	—	1324	2298^{c}	2697^{c}	6317^{c}	7065^{d}		
levels 80%	—	1176	2124^{b}	2577^{b}	5876^{b}	6633^{b}		
70%	—	1029	1953^{a}	2497^{a}	5478^{a}	6242^{a}		
C. D. at 1%	NS	NS	77	74	85	130		
Mean for 6-12	—	1176	2415^{b}	2663^{b}	6253^{c}	7003^{c}		
durations 6-18	—	1176	1980^{a}	2771^{c}	5926^{b}	6682^{b}		
(weeks) 6-24	—	1176	1980^{a}	2337^{a}	5493^{a}	6255^{a}		
C. D. at 1%	NS	NS	77	74	85	130		

Means carrying one or more common superscripts do not differ significantly.

were comparable to that of full fed group following the restoration of full feeding programme.

Feed Consumption

The feed consumption of chicks of different groups was similar upto 6 weeks of age ($P < .01$) and ranged from 732 to 782 g per bird. The total feed consumption was not adversely affected by restricting the feed intake of chicks from 6-12 weeks of age at 90, 80 and 70 per cent of **ad lib.** feeding. From 12-18 weeks of age, the feed intake of chicks of **ad lib.** feeding and those on 6 weeks restricted feeding followed by 6 weeks of **ad lib.** feeding (T_2, T_5 and T_8) was not different ($P < .01$). The feed intake of chicks still on restricted feeding during this period was, however, smaller than the above groups of chicks ($P < .01$).

The feed intake of chicks on 12, 6 and 0 weeks of **ad lib.** feeding following 6, 12 and 18 weeks of restriction, respectively, from 18-24 weeks of age was smaller than those on **ad lib.** feeding throughout the experimental period ($P < .01$). The lowest feed intake (2337g) during this period was of chicks on 80% of **ad lib.** feeding for 18 weeks and 70% restriction for 18 weeks (2045 g) compared to 2932 g for those on **ad lib.** feeding throughout.

These results indicate that the feed consumption of chicks of the control group was larger than those on restricted feeding for the entire period of study i.e. 6-24 weeks of age ($P < .01$). Among the different levels of feed restriction from 6-24 weeks of age, the highest feed intake was for those on 90% of **ad lib.** feeding (6317 g) followed by those on 80 (5876 g) and 70 (5478 g) per cent of **ad lib.** feeding. Similarly, among the different durations of feed restriction, the highest feed intake was for those on 6 weeks restriction (6253 g) followed by those on 12 (5926 g) and 18 weeks (5493 g) restriction. The same trend was observed when treatments were considered separately. The differences among the treatment means were found to be statistically significant ($P < .01$). The lowest feed consumption was for chicks on 70% of **ad lib.** feeding from 6-24 weeks of age.

Further, these results indicate the inability of restricted groups to compensate the feed intake that was reduced during feed restriction period even 12 weeks after their being restored on full feeding programme. These results are in agreement with the findings of MacIntyre and Aitken (1959), Walter and Aitken (1961) and Reddy *et al.* (1974).

Feed Conversion Ratio

The feed conversion ratio (FCR) decreased with the increase in the level of feed restriction ($P < .01$) during 6-12 weeks feeding period. The efficiency of feed utilization was similar for the control and 90% restricted groups, whereas it was lower for 80 and 70 per cent restricted groups.

The FCR during 12-18 weeks period presents a slightly different picture to the above. The FCR of chicks on control diet was not different from those on 90% of **ad lib.** feeding for the three periods and 80 and 70 per cent of **ad lib.** feeding for 6 weeks period only ($P < .01$). The

efficiency of feed utilization was improved by 80 and 70 per cent of **ad lib.** feeding.

During 18-24 weeks feeding period, the FCR was significantly larger for restricted groups as compared to the chicks on control diet except those on 70% of **ad lib.** feeding for 18 weeks (T_7 and T_{10}).

For the entire period of study the FCR of chicks was 6.71, 6.87, 6.71, 6.69, 6.86, 6.53, 6.32, 6.84, 6.55 and 5.90 for treatments T_1 to T_{10}, respectively. The best FCRs were for chicks fed 80 and 70 per cent restricted diets for 18 weeks period. These results are in confirmation with the reports of Milby and Sherwood (1956), MacIntyre and Aitken (1959), Vaidya and Sathe (1974) and Narahari *et al.* (1975).

These results indicate the potentiality of feed restriction in improving the efficiency of feed utilization in pullets. The feed restriction from 6-24 weeks of age at 70% of **ad lib.** feeding improved the utilization of the feed significantly ($P < .01$). The pullets fed **ad lib.** for 12 and 6 weeks following feed restriction for 6 and 12 weeks, respectively, did not attain body weights comparable to that of full fed groups and they consumed less feed. However, lesser body weights of the feed restricted birds did not affect the egg production and egg size as reported by Sharma and Sharda (1980).

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Haryana agric. Univ. J. Res., Vol XIII, No. 4, pp. 512—518 (December 1983)

HISTOMORPHOLOGICAL STUDIES FOLLOWING EXTERNAL AND INTERNAL IMMOBILIZATION OF METACARPAL FRACTURES IN CONJUCTION OF ALLOGENIC BONE GRAFTS IN BOVINE

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(Received : July 30, 1982 ; Revised : February 21, 1983)

ABSTRACT

Histomorphological studies were conducted to assess the healing process of metacarpal fractures following external and internal immobilizations in conjuction of allogenic frozen and autoclaved bone grafts in 30 calves. Results showed comparatively better bone healing following internal than external immobilization. Microscopically, frozen grafts resulted in more amount of new bone formation than autoclaved grafts.

Incidence of metacarpal and metatarsal fractures has been rated high in bovine (Singh *et al.*, 1982). Various techniques to repair the fractures of these bones have been tried with varying success (Gill and Tyagi, 1972; Khan and Ahmed, 1977; Singh and Nigam, 1979). However, these reports were based mainly on the clinical and radiographic findings. It appears that microscopic studies to assess the rate of fracture healing following different techniques of immobilization are limited. The present report was, therefore, intended to study histomorphologically the process of fracture healing following internal and external immobilizations of metacarpal fractures and to observe the effect of frozen and autoclaved bone grafts on the process of bone healing in bovine.

MATERIAL AND METHODS

Studies were conducted on 30 apparently healthy young male buffalo calves of 1-1½ years of age. The animals were divided into five groups of six animals each as mentioned below :

Group A : Simple coaptation; Group B : Stainless steel plate+autoclaved cancellous bone chips; Group C : Stainless steel plate+ frozen cancellous bone chips; Group D : Allogenic cortical onlay bone plate+cancellous bone chips; Group E : Allogenic cortical onlay bone plate+ autoclaved cancellous bone chips.

The allogenic cortical onlay bone plates were prepared from the macerated metacarpal and metatarsal bones of adult buffaloes as reported earlier (Singh and Nigam, 1979).

The allogenic cancellous bone was collected aseptically from the proximal extremity of the tibia of fresh cadavers. The bone was cut into small pieces, washed in normal saline solution and in 1% aqueous solution of Neomycin and

Bacitracin. The cancellous bone chip grafts were kept in sterile glass stoppered bottles and were frozen at —20°C for 15-30 days prior to use. Some of the cancellous bone pieces were autoclaved before their use as autoclaved bone graft.

The overnight fasted animals were anaesthetized by intravenous administration of 6% chloralhydrate and secured on operation table in left lateral recumbency. The medial side of right metacarpal region was prepared for aseptic surgery. The metacarpus was exposed through a full length longitudinal skin incision made on the medial surface of the bone. The periosteum was incised and reflected back. A complete midshaft fracture of diaphysis of metacarpus was created with a chisel and hammer. The fractured fragments were manipulated manually, distracted and then immobilized with one of the techniques mentioned above. In animals of group A, after closing the skin incision, the fractured limb was immobilized with application of simple plaster bandage. Pliable aluminium splints were incorporated in plaster cast for additional reinforcement.

In animals of groups B and C, fractures were stabilized with standard venable metallic plates, fixed on the medial surface of the bone using minimum of two screws in each fragment. Before fixation of the plates in groups B and C, autoclaved cancellous bone chips and frozen cancellous bone grafts were packed in and around the fracture gaps, respectively.

In calves of groups D and E, the fractures were immobilized by internal fixation of allogenic onlay bone plates instead of metallic plates. The frozen and autoclaved cancellous bone grafts were used in groups D and E, respectively.

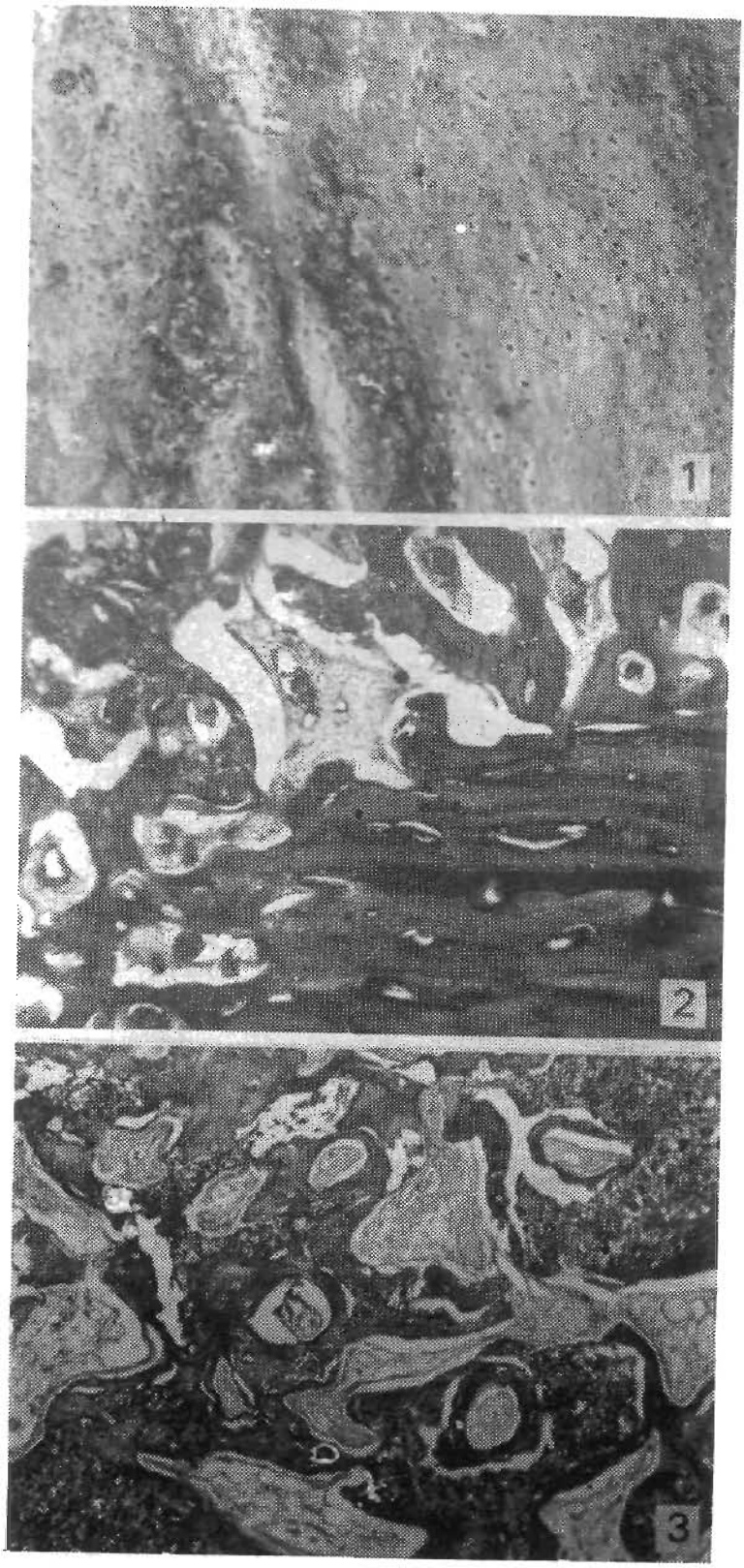
The surgical wound was bathed with one million unit of procain benzyle penicillin and closed in routine manner in all the animals. To provide an additional external support in calves of groups B, C, D and E, the operated limb was plastered alongwith aluminium splint.

The calves were maintained upto 9 weeks postfracture. Three animals of each group were euthanized at 6 and 9 weeks. After removal of the plates and screws a 3 cm long segment of the bone from the fracture site was collected and fixed in formalsaline. The collected bone pieces were split longitudinally in four parts and decalcified as per the method described by Culling (1963). The decalcified bone tissues were processed and paraffin embedded sections of 5 to 6 micron thick were cut. The sections were stained with Mayer's haemotoxylin-eosin (Luna, 1968) for histomorphological studies.

RESULTS AND DISCUSSION

Group A

The fracture gap was observed to be filled with proliferating fibrovascular and chondroblastic tissues at 6th week. Appearance of newly formed osteoblastic cells, close to the osteogenic layer of the periosteum, and initiation of trabeculae formation were observed. Marked osteoblastic activity with definite trabeculae formation in certain area was seen by 9th


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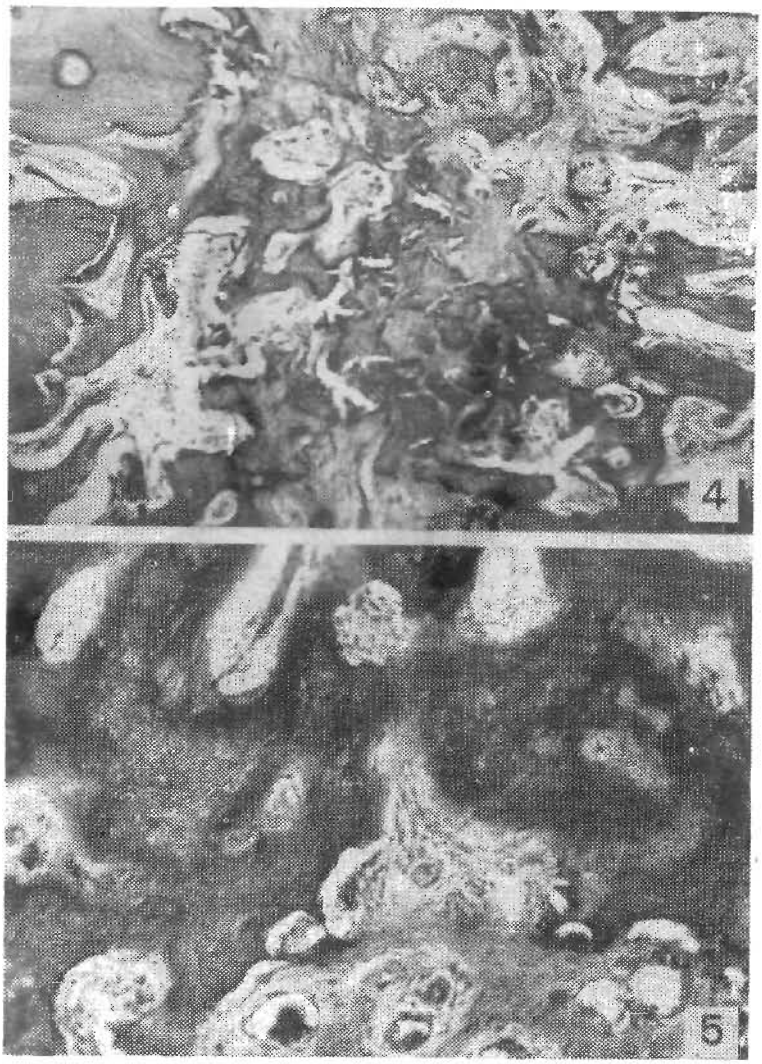


Fig. 1. Microphotograph at 9th week postfracture following simple coaptation showing fibrocartilagenous nature of callus (H & E, 100 X).

Fig. 2. Microphotograph at 9th week postfracture after stainless steel plating in conjuction of allogenic autoclaved bone grafts. Note some new cancellous bone formation adjacent to the fracture (H & E, 100 X).

Fig. 3 Microphotograph at 9th week postfracture stainless steel plating in combination of allogenic frozen bone grafts. Note marked osteoblastic and chondroblastic activities around the grafts (H & E, 100 X).

Fig. 4. Microphotograph at 9th week postfracture after allogenic onlay bone plating in combination of frozen bone grafts. Note the extensive new cancellous bone formation close to the fracture ends (H & E, 100 X).

Fig. 5 Microphotograph at 9th week postfracture after allogenic onlay bone plating in conjuction of autoclaved bone grafts, showing marked chondroblastic activities with scanty osteoblastic proliferation (H & E, 100 X).

week. The deposition of calcium in pericellular spaces was in progress (Fig. 1).

Group B

There was massive proliferation of fibrovascular connective tissue at the fracture site. Newly formed bony spicules were scanty and scattered. Hyalinized cancellous chip grafts were encapsulated with proliferating fibrous connective tissues. There was no evidence of induced osteoblastic activity around the chip grafts. Substantial amount of fibrovascular, chondroblastic and chondro-osteoid activities were seen at 9th week. The trabecular bone formation, though evident, was seen only in certain areas (Fig. 2).

Group C

The histomorphological observations revealed marked proliferation of chondroblasts and osteoblasts adjacent to the periosteum with negligible fibrovascular activities at 6th week. The fracture gap was filled with newly formed cancellous bone. The dark, hyalinized bone grafts showed some degree of osteoblastic activity. The newly formed cancellous bone was fused with the fracture ends (Fig. 3). The observations were similar at 9th week except that the trabeculae were better organized and more compact. Lamellar bone formation and Haversion canals were well appreciated at this interval. The remanents of the grafts appeared to be completely embedded and fused within newly formed trabecular network.

Group D

At 6th week, areas of chondroblastic and osteoblastic activities were clearly evident in this group. The bone graft chips embedded in newly formed osteogenic and chondrogenic tissues were united with newly formed cancellous bone. At the stage of fracture healing, the changes observed in this group were almost similar as in group C. By 9th week, marked osteoblastic activity and substantial amount of cancellous bone formation were observed. In certain areas the cancellous bone appeared to be compact. There was evidence of slight osteoblastic activity in the vicinity of the bone grafts (Fig. 4).

Group E

In this group, the predominance of fibrovascular activities with scanty osteoblastic proliferation was seen at 6th week. The bone grafts were dead and there was no evidence of osteoblastic activity. The trabecular formation was irregular and scanty. At 9th week, excessive amount of fibrovascular connective tissue filling the fracture gap was discernible. The trabecular formation was scarce and scattered (Fig. 5).

These studies reveal differences in the pattern and progress of fracture healing in different groups. The nature of bridging callus was predominantly fibro-cartilagenous in group A, whereas it was chondro-osteoid in nature in other groups.

Though no significant differences were observed with frozen and autoclaved grafts, however, predominance of osteoid tissues was invariably observed in animals with frozen grafts. Furthermore, no osteoblastic activity was seen around the autoclaved grafts, while it was clearly

discernible in the vicinity of the frozen grafts.

Microscopically, the stages of endochondral ossification were evident at the periosteal side in calluses of all the groups, however, intramembranous ossification was observed predominantly in groups C and D. This agrees with the report of Chawla (1980). However, contrary to these observations, Kumar (1977) observed healing to be intramembranous in nature during long bone healing in calves. Excessive cartilage formations observed in groups A, B and E might be due to any of the following factors. Cartilage formation occurs wherever cellular proliferation outspaces the vascular regeneration (Braden and Brinker, 1976). It also forms when oxygen tension is low and oxygen is inadequates, bone is formed per primum (Cruess and Dumont, 1975). Further, cartilage formation depends upon the degree of stability at the fracture site. It also depends upon vascularization, being more in unstable fractures (Braden and Brinker, 1976).

The marked osseous tissue formation seen in groups C and D could be attributed to osteoinductive property of the frozen grafts because the degree of stabilization at the fracture sites was same in all the groups except group A. The merits of frozen over autoclaved grafts have also been reported earlier (Reynold *et al.*, 1951; Burwell, 1966; Singh *et al*, 1978). The amount of cartilage present in relation to the osteoid tissues and the absence of intramembranous ossification in the callus of group A clearly indicates a slow rate of healing in these animals. Further, the presence of predominant cartilagenous callus with scanty osseous tissue in group A shows that the healing process in these calves was far from complete. When groups with frozen and autoclaved cancellous bone grafts were compared among themselves it was observed that healing in groups C and D had an edge over that of groups B and E. The compactness of osseous callus and formation of the Haversion system in animals with frozen grafts in contrast to lack of formation of Haversion system and less compactness of osseous tissue with the presence of cartilagenous strips in groups with autoclaved grafts clearly shows accelerated healing response in former groups. This agrees with the previous investigations (Heiple *et al.*, 1963; Burwell, 1966; Singh *et al.*, 1977, 1978). Freezing markedly impaired the antigenicity of the grafts without effecting osteoinductive property (Burwell, 1966), and this could be attributed for better healing following frozen grafting in this study. Autoclaving used to result in coagulation of soft tissue in Haversion canals, denaturation of the collagen in the bone and lowers the bone inducing ability of the bone grafts (Burwell, 1963). These factors might be responsible, to some extent, for comparatively poor bone formation following autoclaved bone chips grafting.

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Haryana agric. Univ. J. Res., Vol XIII, No. 4, pp. 519—521 (December 1983)

RESEARCH NOTE

EVIDENCE OF LEPTOSPIRA ANTIBODIES IN THE CASES OF ABORTIONS IN DOMESTIC ANIMALS

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(Received : September 29, 1982; Revised : March 31, 1983)

Leptospira infections are known to cause abortion in different species of animals. There are a number of reports (Adinarayan *et al.*, 1960; Sawhney and Saxena, 1967; Chandiramani, 1968; Tripathy, 1977) regarding serological evidence of leptospira infection with different serotypes in apparently healthy and animals slaughtered for food purposes. However, only a few reports (Paragaonkar, 1964; Arora and Baxi, 1978) are available regarding serological evidence of leptospira infection in aborted animals. Keeping in view the wide range of multiplicity of serotypes of this organism, the present study was conducted by employing the pooled leptospiral antigens to examine the evidence of infection, if any, so that subsequent studies could be conducted using antigens prepared from individual serotypes.

Sera samples from different species of animals with a history of abortion in first gestation in late stages were collected within 3 to 6 weeks of abortion and were screened initially for brucella infection by standard tube agglutination test. Serum samples which were found negative for brucella infection, were employed in the present study. A total number of 161 (50 cows, 47 sheep, 42 goats and 22 mares) brucella negative serum samples (Table 1) were subjected to rapid plate agglutination test by using Bacto-leptospira pool antigens. Each serum sample was tested against all the five antigen pools as per the procedure of Galton *et al.* (1958), keeping positive serum and saline controls.

Among sheep, only 2 (4.25%) of the 47 samples were found positive against antigen pool 1, 2 and 3. Both these samples originated from Central Sheep Breeding Farm, Hissar. While among mares, 3 (13.63%) of the 22 samples were found positive against all the five antigen pools, and these 3 samples were from Equine Breeding Stud, Babugarh (U. P.). No serum sample from cows and goats was positive against any of the five antigen pools.

Arora and Baxi (1978) tested a limited number of sera from aborted animals and recorded 8 (34.78%) of the 23 cows, 4 (57.14%) of the 7 goats and 1 (20.0%) of the 5 sheep positive against leptospira antigen prepared from individual serotypes. They also observed one serum sample from a sheep to be positive against

TABLE 1

Results of rapid plate agglutination test* on brucella negative sera from aborted animals against leptospira pool antigens**

Species	Source	No. tested		No. positive with antigens				
				Pool 1	Pool 2	Pool 3	Pool 4	Pool 5
Cow	Govt. Livestock Farm, Hissar	26						
	Deptt. of Animal Breeding, HAU, Hissar	5	50	Nil	Nil	Nil	Nil	Nil
	Krishi Gyan Kendra, Ambala	19						
Sheep	Central Sheep Breeding Farm, Hissar	32						
	Deptt. of Animal Breeding, HAU, Hissar	15	47	2 (4.25)	2 (4.25)	2 (4.25)	Nil	Nil
Goat	Central Sheep and Wool Research Instt., Avikanagar	28						
	Deptt. of Animal Breeding, HAU, Hissar	14	42	Nil	Nil	Nil	Nil	Nil
Mare	Equine Breeding Stud, Babugarh (U.P.)	8		3	3	3	3	3
	Equine Breeding Stud, Hissar	14	22	(13.63)	(13.63)	(13.63)	(13.63)	(13.63)

Figures in parentheses indicate percentages.

*Only 4^+ and 3^+ agglutination reaction were considered as positive.

**Pool 1 contains *L. icterohemorrhagiae*, *L. canicola* and *L. ballum* serotypes.

Pool 2 contains *L. pyrogenes*, *L. bataviae* and *L. grippotyphosa* serotypes.

Pool 3 contains *L. pomona*, *L. wolfii* and *L. antumnalis* serotypes.

Pool 4 contains *L. australis*, *L. hyos* and *L. georgia* serotypes.

Pool 5 contains *L. cynopteri*, *L. celledoni* and *L. javanica* serotypes.

three serotypes, viz., *L. pomona*, *L. pyrogenes* and *L. grippotyphosa*. In the present study also 2 positive samples of sheep reacted with pool 2 antigen which contained *L. pyrogenes* and *L. grippotyphosa* and pool 3 which contained *L. pomona*. There seems to be no report on serological evidence against leptospira infection in aborted mares from India. However, there is a number of such reports from other countries. Roberts *et al.* (1952) observed a thorough bred mare which had foaled two weeks prematurely to be positive against *L. pomona* by complement fixation test. Jackson *et al.* (1957) found 2 out of 3 mares aborted near the termination of pregnancy, positive for agglutination test against *L. pomona*. They, have in one case, also demonstrated leptospira organisms in a smear of abdominal fluid of a foetus by dark field microscope. Topacio *et al.* (1971) also found 8 of the 44 aborted mares serologically positive for *L. pyrogenes*, *L. pomona*, *L. cynopteri*, *L. canicolo*, *L. javanica* and *L. icterohemorrhagiae*. In the present report it is interesting to observe that all these serotypes are contained in antigen

pool 1, 2, 3 and 5. While pool 4 which contains *L. australis*, *L. hyos* and *L. georgia* serotypes seems to have not been reported elsewhere. It may be possible that any of the serotypes contained in pool 4 be prevalent in this country for which more studies need to be conducted.

Leptospira antibodies were not detected in samples from aborted cows and goats, however, further investigations need to be carried out by screening large number of serum samples from animals with history of abortion so that the evidence of infection, if any, can be detected.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 4, pp. 522—530 (December 1983)

DRAINAGE COEFFICIENTS FOR DIFFERENT AGRO-CLIMATIC LOCATIONS OF HARYANA

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ABSTRACT

For estimating drainage coefficients rainfall, probability analysis using more than 22 years of daily point rainfall data for different agro-climatic locations in Haryana was made for 1 to 4 consecutive days maximum rainfall on 5, 10 and 20 years return period basis. For medium, light and very light textured soils, no drainage problems were encountered for 1-day rainfall on 5-year return period basis. However, in heavy soils of different locations the drainage coefficient values for 1-day rainfall and 5-year return period basis ranged from a minimum of 3 mm/day at Hissar to a maximum of 55 mm/day at Karnal. For 3-day rainfall only Karnal and Gurgaon areas experienced drainage problems of 6.0 and 0.7 mm/day, respectively. There were no drainage problems for 4-day rainfall in the State.

For maintenance of sustained production from irrigated agriculture, removal of excess water from agricultural lands is essential through drainage system and, thus, drainage is an integral part of the water management. The most vital part of drainage system is estimation of drainage coefficient or drainage requirement for designing and installation of a particular type of drainage system. It is defined as the rate (mm/day/ha) of removal of excess water per unit time per unit area in order to ensure optimum soil aeration and soil temperature for optimum plant growth. Grable (1966) presented extensive review on soil aeration and plant growth and Van't Woudt and Hagan (1957) reviewed the literature on crop response under excessive soil-water conditions. The effect of drainage on crop production was extensively reviewed and discussed by Van Schilfgaarde (1974). Drainage coefficient is mainly affected by rainfall and its distribution, agroclimatological and soil factors. Gupta *et al.* (1969) made tentative estimations for drainage coefficients on very large area basis for different parts in India for grain crops and vegetable crops based on rainfall and soil and recommended that regional values of drainage coefficient need to be calculated. Sarkar (1980) estimated drainage coefficient of 7.6 mm/h for the maximum rainfall intensity based on 1-year return period for maize crop in Delhi region assuming that 100 per cent of the rainfall reappears as run off. Russel (1952) also reviewed the literature on various aspects of excess water problems. Joshi and Dastane (1965, 1966) studied the effect of different durations of flooding at different stages of crop growth and excess water tolerance of summer cereals under conditions of North India.

In this paper, drainage coefficients for different regions of Haryana have been calculated so that the design discharge rate of removal by surface drainage can be fixed such that the excess water is cleared out of the cropped area within the tolerance period of crops.

MATERIAL AND METHODS

The probability analysis of daily point rainfall data obtained from I. M. D. Pune for the monsoon period (July to September) of more than 22 years for seven different places of Haryana (Lat. 27°39′ to 30°55.5′N, Long. 74°27.8′ to 77°36.5′ E with general slope from North to South and East to West) was made. Hazen (1914), Weibull (1939), Gumbel (1941), Powell (1943) and Benson (1962) have suggested different methods of probability analysis of rainfall. Chow (1964) has made a review of these different methods in general and for hydrological data in particular. In this study, the most commonly used Weibull (1939) formula has been used for probability analysis for maximum rainfall values of 1, 2, 3 and 4 consecutive days on 5, 10 and 20 years return period basis and is given below :

$$P = \frac{m}{n+1} \times 100 \text{ or } T = \frac{n+1}{m}$$

Where

P = per cent probability of occurrence of rainfall of particular magnitude;

T = return period or recurrence interval in years;

m = rank number (1, 2, 3.....n) of the rainfall magnitude arranged in descending order;

n = number of years of rainfall record for analysis.

The observed rainfall data corresponding to the computed probability were plotted on normal probability paper and rainfall probability curves were prepared for different consecutive days for different locations. The rainfall magnitudes were interpolated from these curves for 1 to 4 consecutive days rainfall on 5, 10 and 20 years return period basis for different places under study. Pai and Hukkeri (1979) have proposed rainfall analysis based on 5-years return period for agricultural drainage and the same has been used for estimating the drainage coefficients.

The drainage coefficients were estimated by subtracting the average depth of water infiltered from the rainfall amount for a particular duration. The change in soil moisture storage, portion of the rainfall intercepted by vegetation and evaporation or evapotranspiration have been assumed to be small in comparison with total rainfall and, thus, neglected. This assumption may provide a safety factor in drainage design procedure.

Duggal (1970) has given a detailed textural classification soil map of Haryana. The annual rainfall pattern and the seven locations included in the study have been superimposed on soil textural map (Fig. 1). The soils in Haryana have formed over an alluvial base in the plains, over detrital sediments in the northern sub-mountain tract and over crystalline rocks in the southern Aravalli hill regions. Although alluvium is the parent material of these soils, there is wide variation in texture. About 30% surface soil in the State is loamy sand, 55% sandy loam, 10% clay loam and only 5% is sandy. The available water storage capacities range from 7.0 to

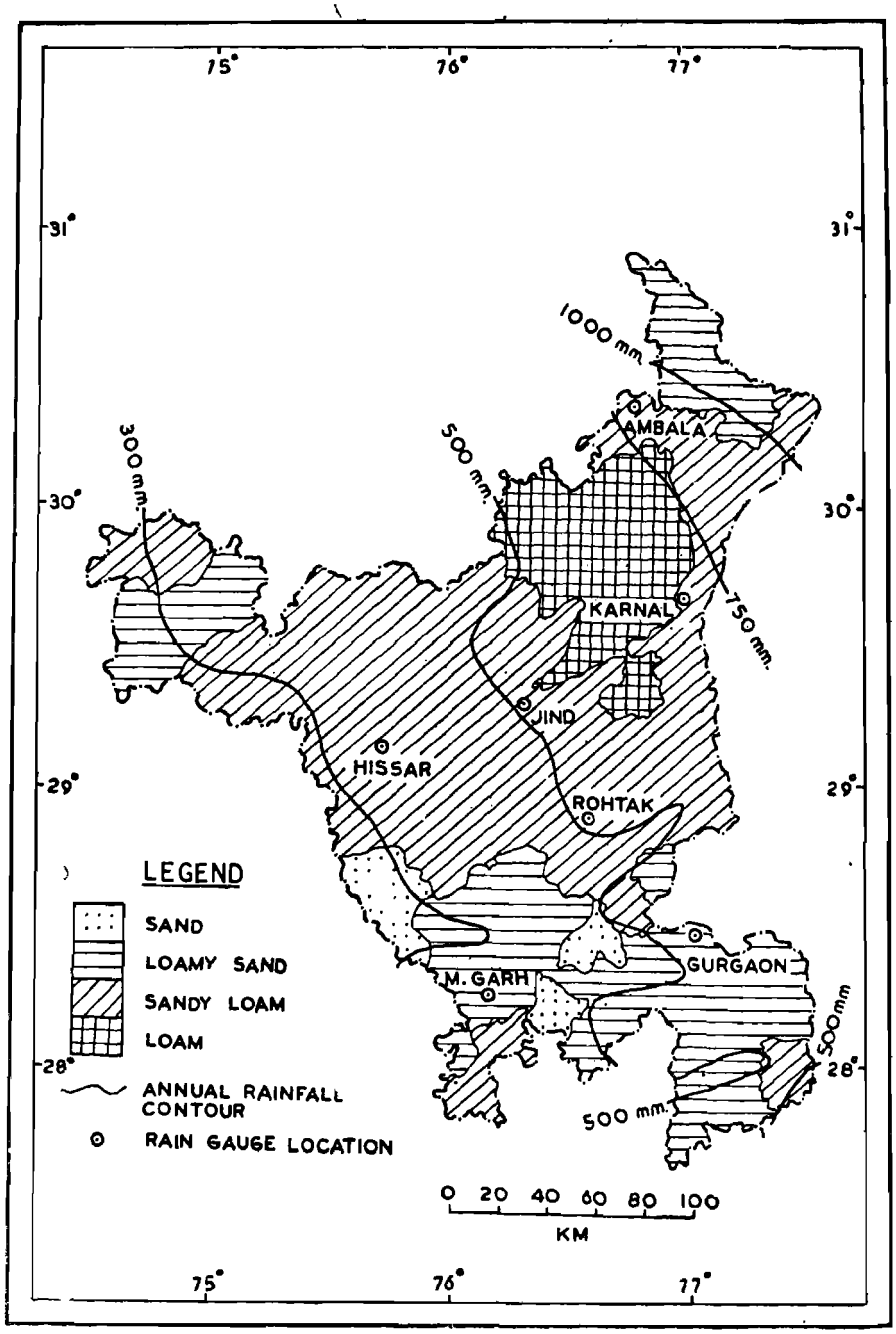


Fig. 1. Soil texture and annual rainfall map of Haryana.

35.4 cm for 150 cm depth of soil. Soil pH ranges from 6.5 to 9.5, calcium carbonate from 0.16 to 2.30 per cent and organic matter from 0.23 to 1.0 per cent.

For estimation of basic infiltration rates several tests were conducted in different soil types and the values ranged from 1.5-2.5, 2-5, 5-20 and more than 25 mm per hour for heavy, medium, light and very light textured soils, respectively. The average values of infiltration rates were used for estimation of drainage coefficients. During **kharif** season the crops which suffer most due to absence of drainage system are arhar, maize, **urd, moong, til, guar** and cotton. The package of practices for the cultivation and management of **kharif** crops for the period under study were followed (Anonymous, 1980).

RESULTS AND DISCUSSION

Statistically computed maximum rainfall magnitudes for 1 to 4 consecutive days for different return periods in respect of different places of Haryana are shown in Table 1.

The probability-rainfall curves for rainfall of different consecutive days for 5-years return period in respect of Hissar and Karnal have been given in Figs. 2-5

TABLE 1

Maximum rainfall magnitudes (mm) for 1 to 4 consecutive days for return period of 5, 10 and 20 years for different places in Haryana

Locations	No. of years of rainfall data analysed	Return period (years)	Maximum rainfall magnitudes (mm) for different consecutive days			
			1	2	3	4
Rohtak	26(1950-75)	5	75	92	104	130
		10	124	132	150	184
		20	132	184	221	250
Gurgaon	22(1954-75)	5	92	125	146	160
		10	120	157	177	202
		20	145	186	213	235
Jind	22(1954-75)	5	78	103	119	130
		10	105	131	141	165
		20	135	165	172	212
Mohindergarh	22(1954-75)	5	67	86	95	117
		10	80	123	126	150
		20	112	161	170	207
Hissar	29(1950-78)	5	51	81	91	94
		10	64	102	119	135
		20	102	130	146	158
Karnal	26(1950-75)	5	103	143	162	168
		10	134	188	208	216
		20	168	231	253	265
Ambala	26(1950-75)	5	100	113	125	140
		10	125	146	170	190
		20	142	184	215	245

because these two locations represent extreme agro-climatic conditions. The value of maximum rainfall magnitude for 1-day period on 5-years return period basis ranged from the lowest (51 mm) for Hissar to a maximum (103 mm) for Karnal (Table 1). Similar trend was observed for 2, 3 and 4 consecutive days period for the same return period. For 10-years return period the rainfall values for 1 to 4 consecutive days period ranged from 134-64, 188-102, 208-119 and 216-135 mm, respectively, the highest values being at Karnal and the lowest at Hissar. For 20-years return period the rainfall values for 1 to 4 consecutive days ranged from 168-102, 231-130, 253-146 and 165-158 mm, respectively, the highest being at Karnal and the lowest at Hissar.

Drainage coefficients of different places in heavy soils for rainfall period of 1 to 4 days on 5-years return period basis are given in Table 2. For medium, light and very light soils the drainage coefficients were zero based on 5-years return period, indicating no drainage problems even for such crops which are susceptible to excess water conditions even for a day.

However, if the drainage system was designed on a 10-years return period

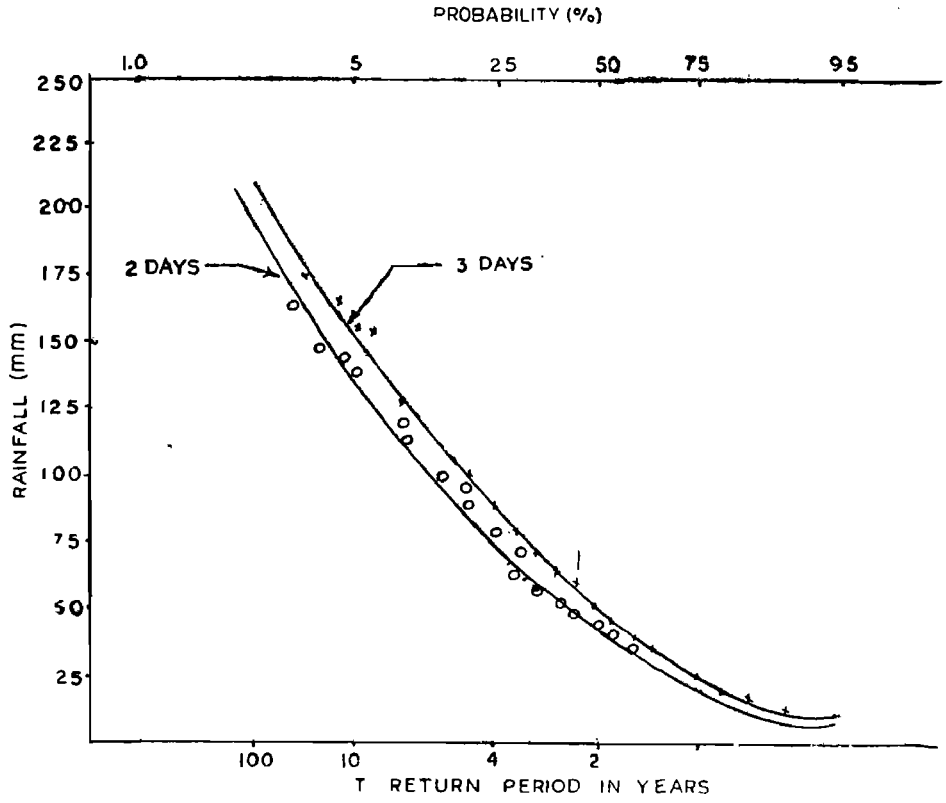


Fig. 2. Rainfall occurrence in 2 and 3 consecutive days (Hissar).

TABLE 2

Drainage coefficients (mm/day) for different places in Haryana for heavy soils for maximum rainfall magnitudes of 1 to 4 days duration based on 5-years return period

Locations	Drainage coefficients (mm/day) for different consecutive days			
	1	2	3	4
Rohtak	27.0	—	—	—
Gurgaon	44.0	24.5	0.70	—
Jind	30.0	3.5	—	—
Mohindergarh	19.0	—	—	—
Hissar	3.0	—	—	—
Karnal	55.0	23.5	6	—
Ambala	52.0	8.5	—	—

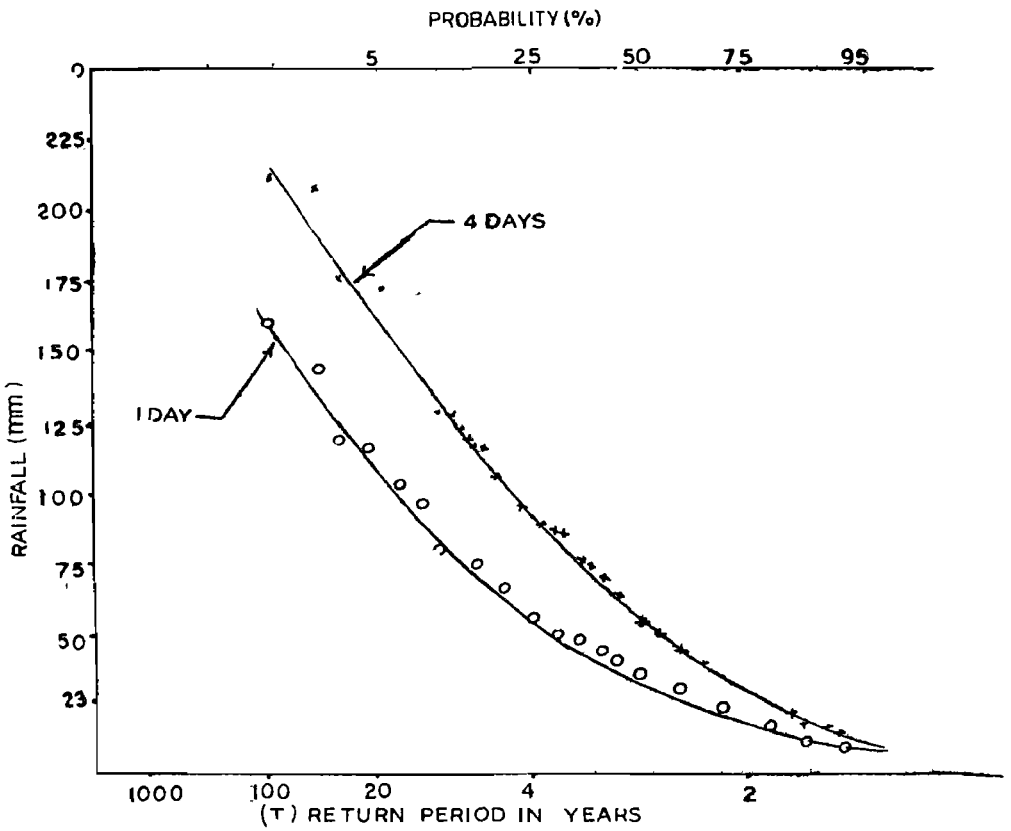


Fig. 3. Rainfall occurrence in 1 and 4 consecutive days (Hissar).

basis, then drainage problems were encountered even in medium soils of areas of Karnal (50 mm/day), Ambala (41 mm/day), Rohtak (40 mm/day), Gurgaon (36 mm/day) and Jind (21 mm/day) for 1 day maximum rainfall. For the same return period only medium soil areas of Karnal experienced drainage problem of magnitude of 20 mm/day for 2 days maximum rainfall period.

As is evident from the analysis, the problem of drainage was experienced only in heavy textured soils and generally for such crops which were unable to tolerate excess water conditions for more than 1 to 2 days. For heavy soils of Karnal, which are of generally flat terrain and of impervious nature due to alkali and salinity conditions, the drainage coefficients values were higher for 1 and 3-days rainfall (35 mm/day and 6 mm/day, respectively) and for 2 days rainfall, heavy soils of Gurgaon had the maximum value (24.5 mm/day). The heavy soils of Gurgaon, Karnal, Ambala and Jind had drainage problems in descending order for 2-days rainfall. Drainage problems for 1-day rainfall were maximum in the areas of Karnal, Ambala and Gurgaon and of moderate nature in the areas of Rohtak and Jind. The areas of Hissar have mini-

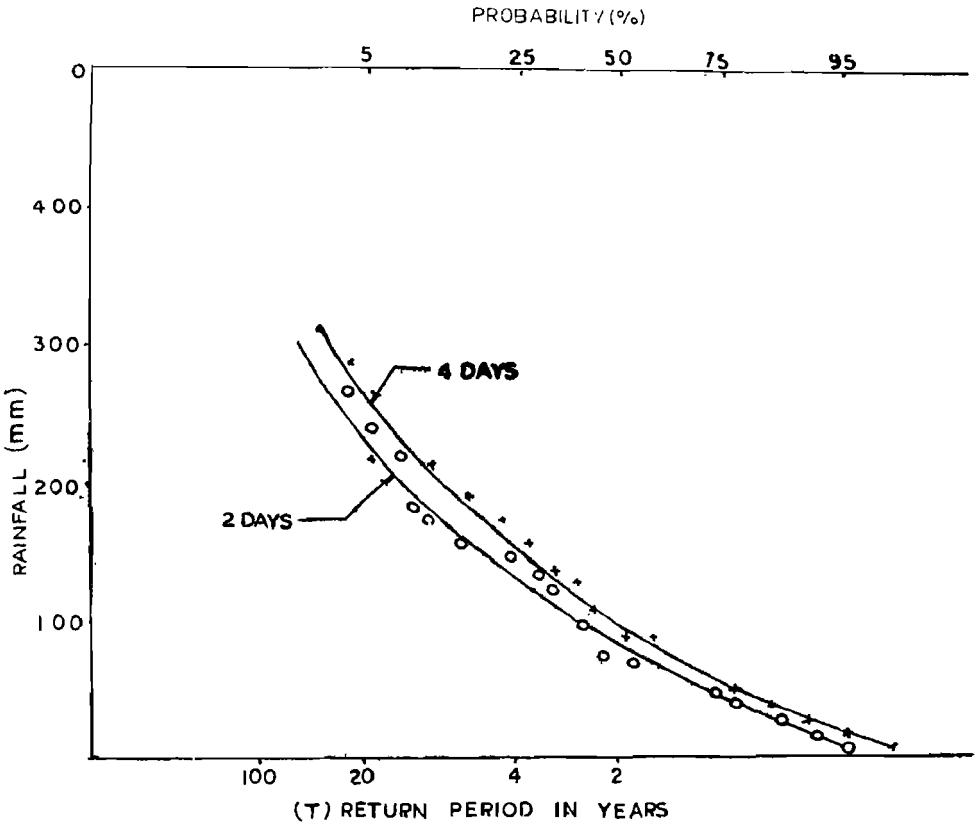


Fig. 4. Rainfall occurrence in 2 and 4 consecutive days (Karnal).

mum (3 mm/day) drainage coefficient for one day rainfall. There were no drainage problems throughout the State for agricultural lands for 4-days rainfall and areas of Karnal and Gurgaon only experienced some drainage problems for 3-days rainfall.

It is evident from the study that excess water conditions prevail in different areas of the State for short periods during the growth of the **kharif** crops. Prompt efforts should be made to drain the fields at the earliest opportunity after heavy rainfall to break the continuity of the excess water as continuous presence of excess water might result in oxygen deficiency and accumulation of toxic gases in the root zone. These conditions may result in reduction in water and nutrient uptake, root respiration and build up of toxins. Amongst **kharif** crops arhar and maize (during early stage) are most sensitive to excess water, requiring drainage within 24 h. Other crops like cotton, **urd, moong, til** and **guar** require drainage of excess water within 48 h, whereas **jowar, bajra** and groundnut are relatively more tolerant to excess water. Drainage systems designed and installed in different areas of the State, based on these computed values of drainage coefficients, would function smoothly without noticeable damage to the crops.

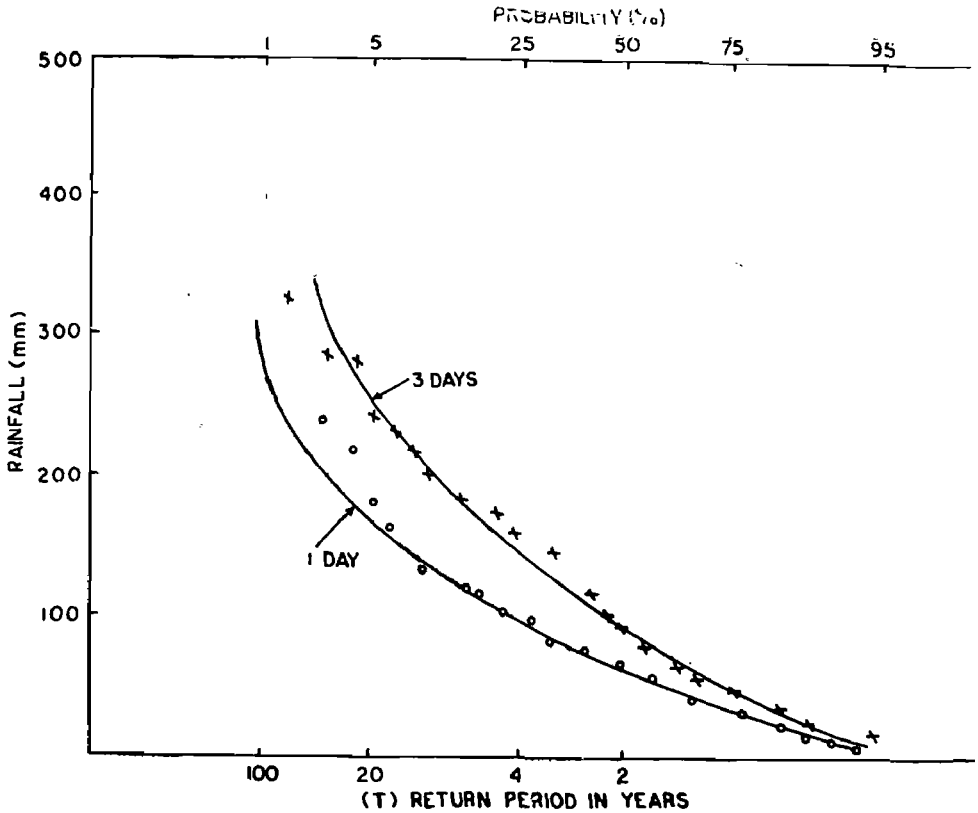


Fig. 5. Rainfall occurrence in 1 and 3 consecutive days (Karnal).

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Haryana agric. Univ. J. Res., Vol. XIII, No. 4, pp. 531—536 (December 1983)

INFLUENCE OF APPLIED Cu, Fe AND $CaCO_3$ ON DTPA EXTRACTABLE Cu AND Fe IN TEXTURALLY DIFFERENT SOILS

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(Received : October 23, 1981; Revised : March 11, 1982)

ABSTRACT

The study on the DTPA extractable Cu and Fe in the presence and absence of $CaCO_3$ in texturally different soils was conducted in laboratory. The sandy loam soil contained much higher DTPA extractable Cu and Fe (0.62 and 4.05 ppm, respectively) than the sandy soil (0.19 and 1.17 ppm). The increasing soil application of Cu from 0 to 10 ppm increased the DTPA extractable Cu but decreased the Fe content in both the soils. The soil application of Fe from 0 to 20 ppm increased the DTPA extractable Fe but decreased the Cu content in both the soils. The application of lime (2% $CaCO_3$) decreased both the DTPA extractable Cu and Fe contents. The DTPA extractable soil Cu and Fe decreased with the increase in incubation period.

The availability of micronutrient cations may be affected by various soil factors like soil texture, organic carbon, pH, major nutrients, fertility status, temperature and moisture. Moreover, the availability of micronutrients is markedly affected by the addition of lime in a soil. In growth medium the proportion of available nutrients is important than the absolute amount of that particular nutrient. Some information is available on the interactions of some micronutrients like Fe-Mn and Cu-Zn in soil system but the information is very scanty with regard to Cu and Fe when both present in variable amounts in soils of variable texture. Keeping this in view, the present study was undertaken to find out the effects of Cu and Fe on DTPA extractable Cu and Fe in texturally different soils under variable $CaCO_3$ content.

MATERIAL AND METHODS

Two representative soils from Rawalwas and H. A. U. Farm, Hissar (Table 1) were used for this study. One hundred g portion of each of the soil was treated with 0, 10 and 20 ppm of Fe through $FeSO_4.7H_2O$ and 0, 5 and 10 ppm Cu through $CuSO_4.5H_2O$ in 150 ml capacity incubating containers. $CaCO_3$, free of Cu and Fe, was added at the rate of 0 and 2 per cent in powder form. The moisture was added in order to bring the moisture of the soils to their respective field capacities. All treatments were kept in duplicate. The samples were incubated at constant temperature (28±1°C) for 42 days keeping moisture level constant throughout. The sampling was done at 3, 7 and 42 days of intervals. The moist samples were extracted immediately with

DTPA taking moisture content into consideration and analysed for Cu and Fe on varian techtron Model A-120 Atomic Absorption Spectrophotometer.

TABLE 1

Physico-chemical properties of two soils used for incubation study

Properties	Location	
	HAU Farm	Rawalwas
pH	8.20	7.90
E. C. (mmhos/cm)	1.05	0.24
Sand (%)	60.40	89.80
Silt (%)	23.20	6.20
Clay (%)	16.40	4.00
Textural class	Sandy loam	Sandy
Organic carbon (%)	0.56	0.12
CEC (me/100 g)	11.91	2.75
DTPA Cu (ppm)	0.62	0.19
DTPA Fe (ppm)	4.05	1.17

RESULTS AND DISCUSSION

DTPA Extractable Soil Cu

The increasing application of Cu in both the soils significantly increased the DTPA extractable Cu while the content was more in unlimed than in limed soil samples at 3rd day of incubation (Table 2) but the recovery of added Cu from both the soils was low. It indicated that $CuSO_4.5H_2O$ was transformed into insoluble salts depending upon Cu concentration in soil (Lehr, 1972). The presence of $CaCO_3$ activated this reaction due to increase in pH by hydrolysis of $CaCO_3$ as was also observed by Singh (1971) while $CaCO_3$ may have adsorbed/fixed the Cu (Mishra and Tiwari, 1966).

DTPA extractable soil Cu decreased with increased rates of Fe application in both the soils at all the intervals (Table 2). This may be attributed to the formation of hydroxides and carbonates of Fe, i.e. $Fe(OH)_2$ and $Fe_2(CO_3)_3$ which may normally coprecipitate and immobilize Cu (Krauskopf, 1972) in which isomorphic substitution of Cu readily occurs (Lehr, 1972). This is more effective in neutral and higher pH range soils where some of the Cu may also adsorb on the surface of hydroxides of Fe which lead to more decrease of soil Cu with increasing levels of added Fe. The DTPA extractable Cu was higher in sandy loam soil than in sandy soil (Table 1). With the advancement in time of incubation to 42 days, there was reduction in the DTPA extractable Cu content at all the levels of $CaCO_3$, Fe and Cu but the decrease was more pronounced in sandy loam than in sandy soil (Table 2) which may be due to high clay+silt and $CaCO_3$ contents in the former soil. DeMumbrum and Jackson (1958) reported adsorption of Cu in montmorillonite clay beyond its cation-exchange capacity near neutral or alkaline pH. There was effect of ageing on DTPA extractable Cu which was fixed or precipitated due to slow oxidation or formation of insoluble compounds in due course of time.

DTPA Extractable Soil Fe

The DTPA extractable Fe increased significantly in both the soils with the increased level of Fe from 0 to 20 ppm while the content was more in unlimed than in limed soils at 3rd day of incubation (Table 3) but the recovery of added Fe from both the soils was very low. The decrease in DTPA extractable Fe in the limed soil samples might be due to oxida-

TABLE 2

Effect of Cu and Fe on DTPA Cu (ppm) at 0 and 2% $CaCO_3$ (value in parenthesis) in soils

Fe levels (ppm)	Incubation period (days) and Cu levels (ppm)											
	3				7				42			
	0	5	10	Mean	0	5	10	Mean	0	5	10	Mean
Sandy soil (S_1)												
0	0.25 (0.20)	2.13 (1.80)	3.37 (3.25)	1.92 (1.75)	0 25 (0.20)	2.06 (1.80)	3.30 (3.20)	1.87 (1.73)	0.18 (0.16)	1.40 (1.35)	2.45 (2.38)	1.34 (1.25)
10	0.20 (0.18)	1.75 (1.60)	3.25 (3.12)	1.74 (1.64)	0.20 (0.18)	1.70 (1.56)	3.28 (3.10)	1.72 (1 61)	0.16 (0.16)	1.20 (1.20)	2.36 (2.20)	1.24 (1.18)
20	0.16 (0.14)	1.70 (1.55)	3.16 (3.00)	1 68 (1.57)	0.18 (0.16)	1.60 (1.40)	3.18 (3.00)	1.65 (1.58)	0.18 (0.12)	1.20 (1.10)	2.30 (2.30)	1.23 (1.17)
Mean	0.21 (0.16)	1.86 (1.65)	3.26 (3.13)		0.21 (0.19)	1.78 (1.50)	3.24 (3.10)		0.17 (0.15)	1.26 (1.21)	2.37 (2.29)	
Sandy loam soil (S_2)												
0	0.53 (0.47)	2.40 (2.20)	4.40 (4.08)	2.19 (2.04)	0.50 (0.45)	2.30 (2.10)	4.28 (4.05)	2.36 (2.20)	0.37 (0.30)	1.65 (1.56)	2.55 (2.35)	1.45 (1.40)
10	0.50 (0.43)	2.20 (2.00)	3.60 (3.50)	2.44 (2.25)	0.45 (0.40)	2.15 (1.90)	3.60 (3.42)	2.06 (1.91)	0.37 (0.32)	1.43 (1.40)	2.45 (2.35)	1.41 (1.35)
20	0.45 (0.43)	2.10 (1.92)	3.60 (3.36)	2.10 (1.97)	0.45 (0.36)	2.10 (1.80)	3.52 (3.30)	2.02 (1.82)	0.37 (0.30)	1.40 (1.30)	2.30 (2.20)	1.35 (1.26)
Mean	0.49 (0.45)	2.23 (2.04)	3.86 (3.64)		0.46 (0.40)	2.18 (1.93)	3.80 (3.59)		0.37 (0.31)	1.49 (1.42)	2.36 (2.30)	

LSD (0.05)					
S_1	3	Cu or Fe=0.054	$CaCO_3$=0.036	Cu × Fe=0.111	Cu × $CaCO_3$ or Fe × $CaCO_3$=0.078
	7	=0.055	=0.038	=0.113	=0.079
	42	=0.041	=0.029	=0.086	=0.058
S_2	3	=0.063	=0.042	=0.126	=0.085
	7	=0.070	=0.043	=0.140	=0.087
	42	=0.081	=0.052	=0.163	=0.106

TABLE 3

Effect of Cu and Fe on DTPA Fe (ppm) at 0 and 2% $CaCO_3$ (value in parenthesis) in soils

Fe levels (ppm)	Incubation period (days) and Cu levels (ppm)											
	3				7				42			
	0	5	10	Mean	0	5	10	Mean	0	5	10	Mean
Sandy soil (S_1)												
0	1.24 (1.09)	1.07 (1.00)	1.01 (1.01)	1.10 (1.03)	1.13 (1.05)	0.95 (0.90)	0.95 (0.85)	1.01 (0.93)	1.09 (1.00)	1.00 (0.90)	0.92 (0.90)	1.00 (0.93)
10	1.87 (1.50)	1.76 (1.48)	1.70 (1.49)	1.77 (1.49)	1.86 (1.46)	1.46 (1.40)	1.42 (1.20)	1.58 (1.35)	1.10 (1.00)	1.30 (1.15)	1.06 (1.04)	1.15 (1.09)
20	2.41 (1.95)	2.02 (1.85)	2.00 (1.83)	2.14 (1.87)	2.08 (1.90)	1.70 (1.78)	1.66 (1.60)	1.81 (1.76)	1.30 (1.15)	1.13 (1.01)	1.20 (1.10)	1.32 (1.15)
Mean	1.84 (1.51)	1.61 (1.44)	1.57 (1.44)		1.69 (1.47)	1.37 (1.36)	1.34 (1.21)		1.28 (1.19)	1.13 (1.01)	1.06 (1.01)	
Sandy loam soil (S_2)												
0	3.9 (3.1)	3.28 (3.00)	3.19 (3.00)	3.45 (3.03)	3.43 (3.00)	3.20 (2.90)	3.00 (3.00)	3.21 (2.96)	3.00 (2.90)	2.80 (2.46)	2.72 (2.44)	2.84 (2.60)
10	4.26 (3.63)	3.74 (3.59)	3.69 (3.40)	3.89 (3.54)	3.82 (3.70)	3.69 (3.30)	3.70 (3.56)	3.73 (3.52)	3.20 (3.00)	3.16 (2.80)	3.14 (2.74)	3.16 (2.84)
20	4.49 (3.75)	3.89 (3.78)	3.79 (3 65)	4.05 (3.62)	4.37 (3.88)	3.84 (3.84)	3.77 (3.64)	3.99 (3.78)	3.28 (3.16)	3.20 (2.96)	3.20 (2.92)	3.22 (3.01)
Mean	4.21 (3.48)	3.63 (3.45)	3.55 (3.35)		3.87 (3.52)	3.57 (3.34)	3.49 (3.40)		3.16 (3.02)	3 05 (2.74)	3.02 (2.70)	

LSD (0.05)		Cu or Fe	$CaCO_3$	Cu × Fe	Cu × $CaCO_3$ or Fe × $CaCO_3$
S_1	3	=0.063	=0.043	=0.137	=0.094
	7	=0.051	=0.032	=0.103	=0.065
	42	=0.065	=0.049	=0.123	=0.098
S_2	3	=0.132	=0.092	=0.266	=0.187
	7	=0.125	=0.084	=0.252	=0.164
	42	=0.068	=0.048	=0.139	=0.097

tion of soluble added or native Fe through direct reaction of $CaCO_3$ as :

$$Fe^{++} + CaCO_3 = FeCO_3 \downarrow + Ca^{++}$$

$$4FeCO_3 + O_2 + Ca(HCO_3)_2 = 2Fe_2(CO_3)_3 + Ca(OH)_2$$

$$Fe_2(CO_3)_3 + 3H_2O = Fe_2O_3 + 3H_2CO_3$$

(Thorne and Wallace, 1944) and also through the effect of increased pH due to hydrolysis of $CaCO_3$ (Singh and Dahiya, 1975) which might have oxidised some Fe to higher oxides and hydroxides.

The DTPA extractable Fe decreased with increased application of Cu in both the soils (Table 3). The time of incubation under optimum moisture and temperature conditions resulted in decrease of DTPA extractable Fe because some of added soluble Fe might have changed to such higher oxides or hydroxides which could not be extracted with DTPA solution. Norvell (1972) for the reaction of $Fe^{3+} + 3OH = Fe(OH)_3$ (S) reported equilibrium constant value of 39.4 (—log of activity) which he extrapolated to zero ionic concentration. On addition of soluble salt, this value changed to 38.6 and slowly returned to 39.4 in a period of 1 month. Since these are the values of constant for —ve log, the value 38.6 indicates higher solubility of Fe which reduced to 39.4 due to oxidation. Evidently, the same situation was true in present case due to oxidation of soluble Fe into insoluble Fe as indicated by decrease in DTPA extractable Fe with the time of incubation. The amount of DTPA extractable Fe was higher at higher rate of added Fe due to longer time taken for oxidation and hydration of higher amount of Fe.

From the data on Fe and Cu, it appears that immobilization of Fe is more than Cu at similar pH values. Follet and Lindsay (1971) reported that small application of Cu and Zn fertilization remains labile and available in soil for much longer time than do similar application of more abundant of Fe and Mn.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 4, pp. 537—548 (December 1983)

AGRO-PEDOLOGICAL INVESTIGATIONS IN BLOCK RANIA, DISTRICT SIRSA (HARYANA). I. SOIL CHARACTERIZATION

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(Received : November 6, 1981; Revised : April 28, 1982)

ABSTRACT

Four important soil series occurring in the hot and semi-arid areas of Rania are reported. Dudhianwali series (Typic Torripsamments) comprised of very deep, excessively well drained, calcareous, sandy soils of undulating upland plains dotted with sand dunes. Pirkhera series (Typic Camborthids) represented well drained, calcareous, coarse-textured soils of almost flatland surfaces. Rampur kheri series (Ustic Torrifluvents) was somewhat poorly drained, finer textured, dark yellowish brown soil of Ghaggar flood plains. Harnikhurd series (Aquic Torriorthents) comprised of very poorly drained, saline-alkali soils of depressional areas.

Out of the four series, Dudhianwali was most extensive and occupied about 57% area, next was Pirkhera with 24% and remaining two were not much extensive and each covered about 8% area.

Soils in the area were very low to low in available nitrogen, low to medium in phosphorus and medium to high in potassium. They differed widely in their capacity to retain available moisture.

Towards the effort of maintaining accelerated agricultural production, a sound and scientific knowledge of primary agricultural resource, soil, is a must. Basic and fundamental information about the various characteristics and qualities of soils, comes from their study both in the field and laboratory.

In this study, agro-pedological investigations in National Extension Service Block of Rania were undertaken with a view to characterise the important soil occurring in the area, and then to make land evaluation for them. In this paper, only important soil series identified in the area are reported.

MATERIAL AND METHODS

General Description of the Area

(a) **Extent and location.** The study area lies between latitude 29°16.5′ to 29°42.8′ N and longitude 74°30.15′ to 74°55.10′ E and comprised of 84 villages with an area of about 480 sq. miles. On south-western side the area is bounded by Rajasthan State (Fig. 1).

(b) **Geology and physiography.** The area forms a part of monotonus alluvial plains. At places contiguous to Rajasthan State, there are deposits of course aeolian material resulting in undulating topography. Ghaggar river traverses through

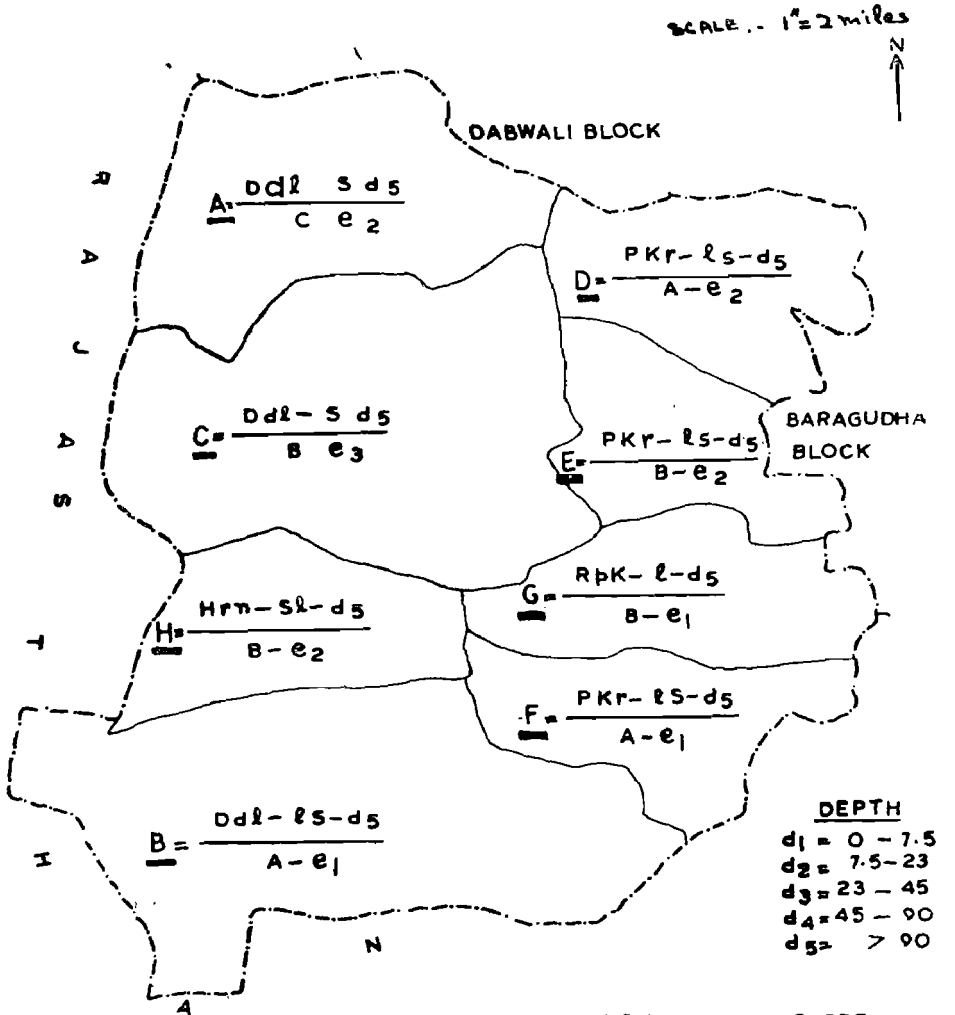


Fig. 1. Soil map of Rania block, district Sirsa.

the study area and its flood plains are characterized by deposits of finer textured sediments. The alluvial deposits range in age from Pleistocene to the Recent times.

(c) **Rainfall and temperature.** The area experiences hot and semi-arid monsoonic climate, with mean annual rainfall <300 mm and mean annual temperature 24.8°C. Mean summer and mean winter temperatures differ by>5°C and are 32.9°C and 14.5°C, respectively.

(d) **Vegetation and agriculture.** Natural vegetation in the area was scanty and consisted of thorny bushes (**Ber Jhar** *Zizyphus nummularia*) and some species of xerophyte trees (**Babul** *Acacia arabica* and **Kair** *Capparis* spp.). Crop husbandry was the main occupation of people in area. Main harvests consisted of cotton, **bajra, guar** and paddy in **kharif** and wheat, gram, barley and sarson in **rabi.**

Methodology

Toposheets (1" to 1 mile) were used during the course of reconnaissance survey as base material and about 250 augerholes and eight representative soil profiles were studied in the field and laboratory. Profile morphology and the general site characters were recorded as per procedure described in Soil Survey Manual (Soil Survey Staff, 1951). For other routine physico-chemical analyses, procedures outlined in U. S. D. A. Handbook No. 60 (Richards, 1954), were followed. For the estimation of available N, P and K, methods suggested by Subbiah and Asija (1956), Olsen *et al.* (1954) and Jackson (1958), respectively, were followed.

RESULTS AND DISCUSSION

During the course of investigation on soils of Rania, four major important soil series, viz. Dudhianwali, Pirkhera, Rampur kheri and Harnikhurd were identified. A detailed description of these is given below. Some of the important features about them are shown in Table 1 and data presented in Table 2 are of typifying pedon of each series.

1. Dudhianwali Series

This series is a member of calcareous, mixed, hyperthermic family of Typic Torripsamments. Typically, these are excessively drained, calcareous, slightly-alkaline, light olive brown in colour sandy soils of hot and semi-arid upland plains with aeolian deposits (dunes). This series is most extensive, covering about 288 sq. miles nearly 57.2% of the block area.

Morphology of the typifying pedon is described below :

Typifying pedon : **Dudhianwali sand**

(colours are for moist soil unless otherwise noted)

A_p	0-25 cm	Light olive brown (2.5 Y 5/4) sand; single grain, non-coherent; loose (dry), friable (moist), non-sticky and non-plastic (wet); few coarse and many fine roots; effervesces moderately; calcareous; gradual smooth boundary; pH 8.2.

A_{12}	25–55 cm	Light olive brown (2.5 Y 5/4) sand; single grain, hard (dry), friable (moist), non-sticky and non-plastic (wet); few fine roots; effervesces moderately; calcareous; gradual smooth boundary; pH 8.2.
C_1	55–85 cm	Light olive brown (2.5 Y 5/4) sand; massive; hard (dry), friable (moist), non-sticky and non-plastic (wet); no roots; effervesces moderately; calcareous; diffuse smooth boundary; pH 8.3.
C_2	85–145 cm	Light olive brown (2.5 Y 5/4) sand; massive and hard (dry); effervesces strongly, carbonate coating on sand grains; calcareous; pH 8.3.

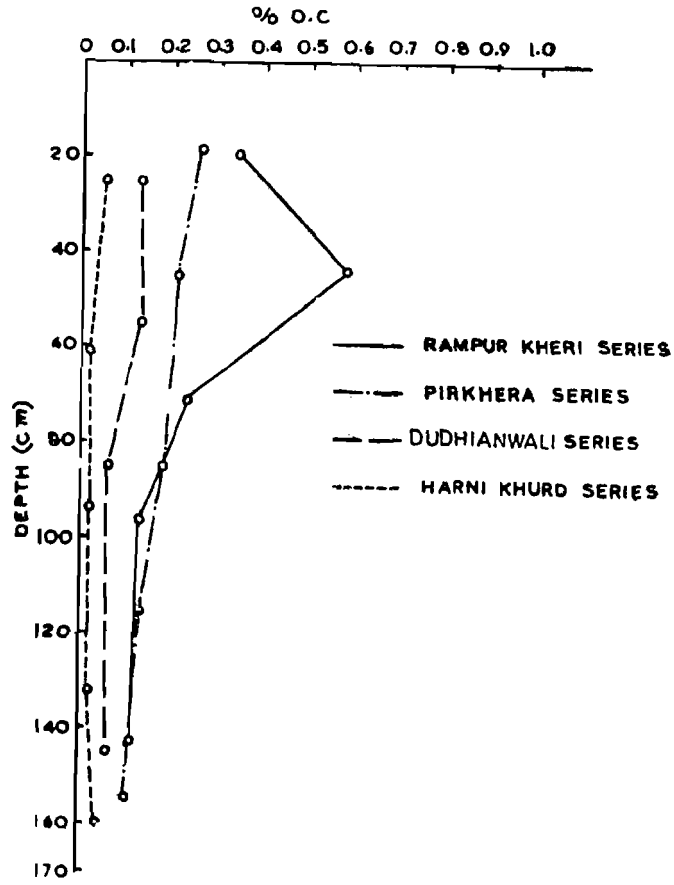


Fig. 2. Distribution of organic carbon in typifying pedon of different soil series.

TABLE 1

Important features of various soil series in block Rania, district Sirsa

Soil series	Type location	Setting	Drainage and permeability	Use and vegetation	Distribution and extent
Dudhianwali	Near water works of village Dudhianwali	Gently sloping landscape to highly undulating upland plains dotted with sand dunes	Somewhat excessively drained with no to little runoff and rapid permeability	Shifting sand dunes devoid of any vegetation; cultivated for rainfed crops of **bajra** in **kharif** and gram in **rabi**	Most extensive, distributed over the villages of Dudhianwali, Fridpur, Bharatwali, Nodeka, Kalana, Beihir, Nattor, Nemarkhera, Kherwala, Bani, Bohia, Haripura Sadewala, Jiwan-nagar Hariwala and Bhonlia; covers about 57.6% area
Pirkhera	On the north-eastern outskrit of village Pirkhera in the field of Hakim Singh	Almost flat to gently sloping upland plains	Well drained with slow run-off and moderately rapid permeability	Good arable lands; extensively used for growing cotton in **kharif** and wheat in **rabi** with irrigation. Under rainfed conditions used for **guar** and gram crops	Second most extensive series, distributed over the villages of Pirkhera, Bhudinari, Mena Khera, Chaka, Bhoonia, Khai Shergarh, Bhogsar, Morawali, Daryawala, Balsar, Manuna, Kulan and Hamakhera; covers about 120 sq miles nearly 24.1% area
Rampur kheri	About 1 km away from Ghaggar river, in field adjacent to Rampur kheri–Jiwan Nagar road	Flood plains of river Ghaggar on either side	Somewhat poorly drained with medium run off and slow permeability	Extensively used for cultivation of paddy and wheat	Not much extensive; distributed along either bank of river Ghaggar in the villages of Rampur kheri, Ottue, Nigrana, Nalcrora, Firozabad and Rania; covers about 40 sq miles nearly 8% area
Harnikhurd	About 2 km away from right bank of Ghaggar in the village of Harnikhurd	Depressional areas having concave slopes	Very poorly drained with slow permeability	Mostly barren (waste) lands; only at some places paddy in **kharif** is grown	Mapped in and around the villages of Harnikhurd, Thobria, Jagmelera, Talwara Khurd, and Mirzapur; covers about 40 sq miles nearly 8% area

TABLE 2

Data on important soil characteristics of typifying pedons of different soil series

S. No.	Depth (cm)	pH (1 : 2)	EC × 10^3	$CaCO_3$ (%)	O. C. (%)	Sand (%)	Silt (%)	Clay (%)	CEC (me/ 100 g)	ESP	Available nutrients (kg/ha)			Hyd. cond. (cm/ h)	Av. water by wt. (1/3-15 atm.)	Av. HC for 150 cm soil depth
											N	P_2O_5	K_2O			
						1. **Dudhianwali Series**										
1.	0-25	8.2	0.10	1.55	0.13	89.7	6.1	4.2	3.8	11.0	86	33.7	218	4.98	6.18	16.1
2.	25-55	8.2	0.10	2.32	0.13	84.3	10.1	5.6	3.8	11.0	97	19.2	148	3.01	6.12	
3.	55-85	8.3	0.14	2.25	0.06	86.8	8.3	4.9	4.3	10.0	58	18.5	170	2.97	6.61	
4.	85-145	8.4	0.17	2 37	0.06	86.3	8.4	5.3	4.5	10.0	49	15.8	170	2.04	5.59	
						2. **Pirkhera Series**										
1.	0-18	8.2	0.14	Nil	0.26	86.3	6.3	7.4	6.2	5.0	103	25.4	382	2.88	5.74	28.9
2.	18-45	8.2	0.28	Nil	0.21	68.5	20.0	12.5	8.6	7.0	100	23.4	300	0.12	11.44	
3.	45-85	8.3	0.17	Nil	0.18	63.5	19.0	17.5	11.2	5.0	84	26.1	294	0.96	12.17	
4.	85-115	8.3	0.14	Nil	0.13	64.7	17.3	18.0	10.4	3.0	75	19.3	274	0.92	11.88	
5.	115-150	8.3	0.18	Nil	0.10	69.3	15 2	15.3	9.2	3.0	72	19 6	260	0.84	10.76	
						3. **Rampur kheri Series**										
1.	0-19	8.1	1.40	2.17	0.34	50.7	28.5	20.8	11.6	6.0	108	28.9	440	1.22	16.63	57.1
2.	19-44	8.2	0.77	1.80	0.58	39.8	22.0	38.2	20.4	66.0	89	23.4	320	1.14	24.97	
3.	44-71	8.2	0.77	Nil	0.23	34.8	26.2	39.0	20.4	6.0	53	25 5	324	0.98	22.12	
4.	71-96	8.2	0.18	1.37	0.13	53.4	16.4	30.2	17.2	8.0	53	25.5	328	0.84	23.32	
5.	96-143	8.1	0.13	2.60	0.11	72.2	17.5	10.3	9.6	10.0	50	26.8	240	0.73	24.38	
						4. **Harnikhurd Series**										
1.	0-25	8.6	1.86	Nil	0.05	62.0	19.5	18.5	11.2	50.0	44	25.4	350	0.52	15.22	39.81
2.	25-61	9.3	2.17	2.95	0.04	59.0	22.6	19.4	11.8	38.0	37	28.2	288	0.48	16.75	
3.	61-94	9 6	2.31	1.25	0.02	48.7	28.9	22.4	14.7	74.0	25	19.6	284	0.92	16.63	
4.	94-132	9.5	1.75	0.92	0.02	44.5	28.0	27.5	15.1	86.0	22	29.1	266	1.20	14.97	
5.	132-160	9.6	2.10	0.75	0.02	35.5	31.8	32.7	15.7	85.0	28	29.5	260	1.34	9.71	

Range in characteristics. These are soils with A C profiles, having light olive brown colour to pale brown colour, non-coherent sandy A horizon, which is slight to moderately alkaline. The soils are calcareous throughout without any horizon with pronounced enrichment. These are normal soils without any appreciable amount of soluble salts as E. Ce for surface soils ranged from 0.64 to 0.84 mmhos/cm. The soils were very low to low in organic carbon (0.13 to 0.23 per cent) which decreased with depth (Fig. 2).

Dudhianwali soils were deficient in available N, low to medium in available P and medium in available K. The contents of available N, P_2O_5 and K_2O in surface soil of Dudhianwali sand were 86.0, 33.71 and 218.0 kg/ha, respectively.

The soils were also very poor in available moisture supplying capacity and its value for the typifying pedon of Dudhianwali sand was only 16.1 cm/150 cm soil depth (Table 2).

The other important features of the Dudhianwali series like setting, use and

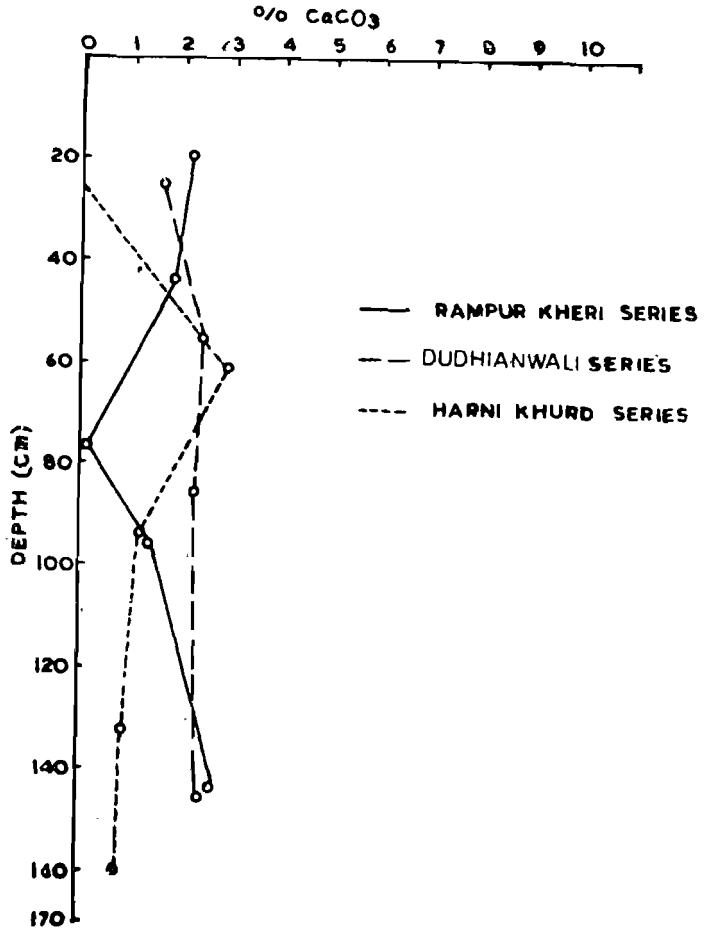


Fig. 3. Distribution of calcium carbonate in typifying pedon of different soil series.

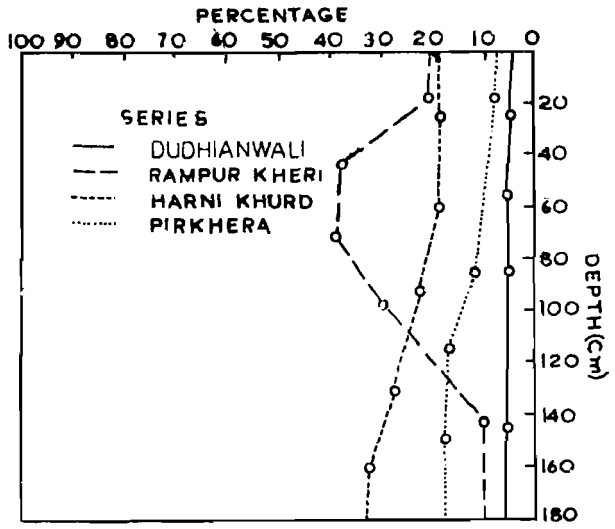


Fig. 4. Distribution of clay in typifying pedon of different soil series.

vegetation, and distribution and extent are depicted in Table 1.

2. Pirkhera Series

This series is a member of coarse loamy, calcareous, mixed hyperthermic family of Typic Camborthids. Typically, these are well drained calcareous, coarse textured soils of almost flat arable land-surfaces, in hot and semi-arid areas. This series is second most extensive, covering about 120 sq. miles nearly 24.1% of the block area.

Morphology of the typifying pedon is described below :

Typifying pedon :		**Pirkhera loamy sand** (colours are for moist soil unless otherwise noted)
A_p	0-18 cm	Light olive brown (2.5 Y 5/4) loamy sand; structureless, single grain to very weak fine sub-angular blocky; friable (moist), non-sticky and non-plastic (wet), many fine and very fine roots; very porous, effervesces weakly; calcareous; clear smooth boundary; pH 8.2.
B_{21}	18-45 cm	Brown (10 YR 4/3) sandy loam; massive breaks into medium moderate sub-angular blocky; very hard (dry), firm (moist) and slightly sticky and non-plastic (wet); many interstitial and few tubular pores of discontinuous nature; many fine and many very fine roots; effervesces weakly; calcareous; clear smooth boundary; pH 8.2.

B_{22}	45–85 cm	Yellowish brown (10 YR 5/4) sandy clay loam; moderate, medium sub-angular blocky; hard (dry), firm (moist), slightly sticky and slightly plastic (wet); few tubular pores and many fine to very fine pores; few very fine roots; effervesces moderately; calcareous; diffuse smooth boundary; pH 8.3.
C_1	85-115 cm	Yellowish brown (10 YR 5/4) sandy loam; weak to moderate, fine to medium sub-angular blocky; friable (moist), slightly sticky and slightly plastic (wet); no roots; few fine soft $CaCO_3$ concretions; effervesces moderately; diffuse smooth boundary; pH 8.3.
C_2	115-150 cm	Same as C_1 except no $CaCO_3$ concretions.

Range in characteristics. Soils in this series are characterized with A(B) C profiles. The solum is thick enough. The light olive brown to dull yellowish brown loamy sand. A-horizon is 15 to 23 cm thick lies directly over a structural (B), i.e. cambic of dull yellowish colour to brown colour and sandy loam to sandy clay loam in texture with moderate, medium sub-angular blocky structure between the depths of 15 to 87 cm. The underlying C, which is presumed to be the parent material for the solum in these soils is free from any rock structure but contain few fine, soft $CaCO_3$ concretions embeded here and there and is of calcareous nature.

The soils were low in organic carbon (0.28 to 0.32 %), which decreased with depth (Fig. 2). pH in surface soils ranged from 8.1 to 8.4 and electrical conductivity of saturation extract remained between 0.36 to 1.06 mmhos/cm. The content of clay increased in B horizon and then again decreased in C (Fig. 4).

The available nutrient status of these soils was low, medium, and medium to high with respect to nitrogen, phosphorus and potassium, respectively.

The soils were also low in available moisture holding capacity. Pirkhera loamy sand retained 28.9 cm of water per 150 cm of soil (Table 2).

3. Rampur Kheri Series

This series is a member of fine loamy calcareous, mixed, hyperthermic family of Ustic Torrifluvents. Typically, these are well drained to somewhat poorly drained calcareous, fine textured dark yellowish brown soils of flood plain areas of river Ghaggar. This series is not much extensive and covers about 40 sq. miles nearly 8% of the block area.

Morphology of the typifying pedon is described below :

Typifying pedon :		**Rampur kheri loam**
		(colours are for moist soil unless otherwise noted)
A_p	0–19 cm	Dark yellowish brown (10 YR 4/3) loam; weak to moderate, fine to medium sub-angular blocky; hard

		(dry), firm (moist), slightly sticky and slightly plastic (wet); many fibrous roots; many fine and few tubular pores; effervesces moderately; calcareous; clear smooth boundary; pH 8.1.
C_1	19–44 cm	Brown (7.5 YR 5/4) clay loam; massive structureless; very hard (dry), very firm (moist), very sticky and very plastic (wet); common fine roots; common fine and very fine pores; effervesces strongly; calcareous; abrupt smooth boundary; pH 8.1.
C_2	44–71 cm	Reddish brown (5 YR 4/4) clay loam; massive structureless; very hard (dry), very firm (moist), very sticky and very plastic (wet); common fine distinct dark grayish brown (10 YR 4/2) and very few fine brownish yellow (10 YR 6/6) mottles; effervesces strongly; calcareous; clear smooth boundary; pH 8.2.
C_3	71–96 cm	Dark brown (7.5 YR 4/4) sandy clay loam with common fine faint dark grayish brown (10 YR 4/2) and also few fine distinct (10 YR 6/6) mottles; very few water born favna shell; effervesces moderately; calcareous; abrupt smooth boundary; pH 8.5.
C_4	96–143 cm	Light olive brown (2.5 Y 5/4) loamy sand; loose single grain; non-sticky and non-plastic (wet); effervesces strongly, calcareous; pH 8.1.

Range in characteristics. The surface Ap horizon is 15 to 22 cm thick, dull yellowish brown to dark-yellowish brown in colour (10 YR 5/3 to 10 YR 4/3) and sandy loam to loam in texture. The underlying layers of stratification have textures of loamy sand to sandy clay loam to clay loam. Usually four to five deposits are there within 150 cm of the profiles. Sub-surface soils are characterized with the presence of faint to distinct mottles of yellowish brown to dark yellowish brown.

These soils were low to medium in organic carbon, which decreased irregularly with depth (Fig. 2). The soils were calcareous but there were wide variations in the content of calcium carbonate. They had appreciable amounts of water soluble salts at the surface, but did not qualify the limits for saline soils.

Like soils of the other two series, these too were low in available nitrogen, medium in phosphorus and high in potassium. The figures for Rampur kheri loam surface soil are 108, 28.8 and 640 kg/ha for available N, P_2O_5 and K_2O, respectively.

Being finer textured soils, these had good available moisture supplying capa-

city. Rampur kheri loam retained as high as 57.1 cm of water per 150 cm soil.

4. Harnikhurd Series

This series is a member of fine loamy, calcareous, mixed, hyperthermic family of Aquic Torriorthents. Typically, this series comprises of very poorly drained, medium textured, yellowish brown to brown colour soils of depressional areas with concave slopes. These are typically saline-alkali soils of hot and semi-arid areas and display white salts encrustation at surface during hot and dry summer months. This series is not very extensive and covers about 8% area.

Morphology of Harnikhurd sandy loam is described below :

Typifying pedon :		**Harnikhurd sandy loam**
		(colours are for moist soil unless otherwise noted)
A_p	0-25 cm	Brown (10 YR 5/3) sandy loam; weak fine to medium sub-angular blocky; hard (dry), slightly firm (moist), sticky and plastic (wet), few fine and very fine pores; no roots; effervesces weakly; calcareous; gradual smooth boundary; pH 8.7.
A_{12}	25-61 cm	Mixed matrix colours of brown (10 YR 5/3) and dark yellowish brown (10 YR 4/4), the former being of finer material in the sandy loam; weak fine sub-angular blocky; slightly firm (moist), sticky and plastic (wet); effervesces moderately; calcareous; gradual smooth boundary; pH 9.1.
AC	61-94 cm	Dark yellowish brown (10 YR 4/4) 90% and rest brown (10 YR 5/3) loam; moderate, medium sub-angular blocky; few fine distinct olive brown (2.5 Y 4/4) mottles of coarse material; effervesces moderately; calcareous; gradual smooth boundary; pH 9.5.
C_1	94-132 cm	Dark brown (7.5 Y 4/4) silty clay loam with brown (10 YR 5/3) sandy pockets and streaks of olive brown (2.5 YR 4/4); few fine iron and manganese concretions; few patchy thin flood coatings on grains; effervesces strongly; calcareous; gradual smooth boundary; pH 9.5.
C_2	132-160 cm	Dark brown (10 YR 4/3) clay loam; massive breaks into sub-angular to angular blocky; hard (dry), very firm (moist), sticky and very plastic (wet); few firm iron and manganese concretions; effervesces strongly; calcareous; pH 9.6.

Range in characteristics. The surface horizon in these soils is consisted of unploughed layer of 18 to 25 cm thick sandy loam usually capped with white salt encrustation in hot and dry months of summer. Sub-surface soils have variegated colours of brown (10 YR 5/3) and dark yellowish brown (10 YR 4/4) and textures of loam and silty clay loam. Sub-surface soils are also characterized by the presence of few fine black colour concretions of iron and manganese.

Being saline-alkali soils these had very low content of organic carbon and had high pH ranging between 9.4 to 10.2 with very high ESP.

These were very poor in available nitrogen, low to medium in phosphorus and medium to high in potassium. With respect to available moisture, these were medium.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 4, pp. 549—553 (December 1983)

HETEROSIS IN MUSKMELON *(CUCUMIS MELO* L.)

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(Received : November 6, 1981; Revised : July 28, 1983)

ABSTRACT

The extent of heterosis over better parent was 46.70 for yield, 54.30 for number of fruits, 39.70 for weight of fruit, 18.50 for thickness of flesh, —12.30 for length of cavity, —27.90 for width of cavity, 26.10 for total soluble solids and —29.70 for node of first hermaphrodite flower. Crosses Pusa Sharbati × Sarada Melon and Pusa Sharbati × Punjab Sunehari for yield, Punjab Sunehari × Sel-1 and Arka Jeet × Durgapura Madhu for number of fruits, Arka Jeet × Sarada Melon and Arka Jeet × Durgapura Madhu for total soluble solids and Durgapura Madhu × Sarada Melon for early hermaphrodite flower appearance exhibited high heterosis over better and best parent.

Utilization of hybrid vigour in muskmelon holds great promise but its feasibility at commercial level is still lacking. Munger (1942), Foster (1967, 1968), Lippert and Legg (1972 a, b), Nandpuri *et al.* (1974) and Pandey and Kalloo (1976) have reported considerable degree of heterosis for yield and other characters in muskmelon. The present investigation was made for further study of heterosis in muskmelon.

MATERIAL AND METHODS

Twentyeight F_1 hybrids alongwith their parents were sown in randomized block design with three replications in February 1980. The rows and plants were spaced at 1.5 m and 50 cm, respectively. All the normal cultural practices were followed during experimentation. Observations were recorded on five randomly selected plants for total yield per plant (kg), number of fruits per plant, weight of fruit (g), length and width of cut fruit (cm), thickness of flesh (cm), length of cavity (cm), width of cavity (cm), total soluble solids (%), node of first hermaphrodite flower and length of vines (cm). Heterosis was determined as percentage increase or decrease in F_1 over better and best parent.

RESULTS AND DISCUSSION

Superior heterotic crosses, hybrid mean and parental mean for characters under study are given in Table 1. Only five or six best crosses are given in this table.

High magnitude of heterosis for yield was observed in the crosses Pusa Sharbati × Sarada Melon (46.70), Arka Jeet × Pusa Sharbati (38.60), Pusa Sharbati × Punjab Sunehari (38.10), Durgapura Madhu × Sel-1 (34.40) and S-445 × Punjab Sunehari (30.30) over better parent and Pusa Sharbati × Punjab Sunehari (38.10), Pusa Sharbati × Sarada Melon (36.70), Arka Jeet × Pusa Sharbati

TABLE 1

Superior heterotic crosses, hybrid mean and parent mean for characters under study in muskmelon

Characters	Crosses	Heterosis per cent over		Hybrid mean	Parental mean	C. D. at 5% level
		Better parent	Best parent			
1	2	3	4	5	6	7
Total yield per plant (kg)	Arka Jeet × Pusa Sharbati	38.60*	35.60*	2.110	1.552 × 1.450	
	Durgapura Madhu × Sel-1	34.40*	29.60*	2.016	1.493 × 1.500	0.451
	S-445 × Punjab Sunehari	30.30*	30.30*	2.027	1.542 × 1.556	
	Pusa Sharbati × Punjab Sunehari	38.10*	38.10*	2.149	1.450 × 1.556	
	Pusa Sharbati × Sarada Melon	46.70**	36.70*	2.127	1.450 × 1.445	
Number of fruits per plant	Arka Jeet × Durgapura Madhu	51.30**	51.30**	3.833	2.533 × 1.900	
	Durgapura Madhu × Pusa Sharbati	48.90*	17.50	2.977	1.900 × 2.00	0.771
	Arka Jeet × Sel-1	31.60*	31.60*	3.333	2.533 × 1.900	
	Durgapura Madhu × Sel-1	43.50*	8.60	2 750	1.900 × 1.916	
	Pusa Sharbati × Punjab Sunehari	43.40*	13.20	2.868	2.00 × 1.933	
	Punjab Sunehari × Sel-1	54.30**	17.80	2.983	1.933 × 1.916	
Weight of fruit (g)	Arka Jeet × S-445	37.90*	12.80	948.52	600.59 × 688.01	
	Arka Jeet × Pusa Sharbati	39.70**	26.20*	1061.37	600.59 × 760.00	204.181
	S-445 × Punjab Sunehari	6.70	—	875.16	688.01 × 805.03	
	S-445 × Sarada Melon	7.00	—	806.35	688.01 × 752.88	
	Pusa Sharbati × Sarada Melon	21.60	9.90	924.42	760.00 × 753.88	
Length of cut fruit (cm)	Hara Madhu × Punjab Sunehari	10.10	—	12.21	10.93 × 11.09	
	Hara Madhu × Sel-1	1.20	—	12.32	1.36 × 1.46	1.541
	Arka Jeet × Pusa Sharbati	15.60	—	9.88	7.17 × 8.55	
	Durgapura Madhu × Sarada Melon	2.30	2.30	15.07	14.73 × 14.16	
	S-445 × Punjab Sunehari	6.50	—	11.81	9.27 × 11.09	
Width of cut fruit (cm)	Hara Madhu × Arka Jeet	23.30**	18.50**	14.76	11.97 × 10.85	
	Arka Jeet × Pusa Sharbati	24.90**	8.30	13.55	10.85 × 9.97	1.428
	Arka Jeet × Punjab Sunehari	12.00	—	12.15	10.85 × 10.77	
	Arka Jeet × Sel-1	12.40*	—	12.19	10.85 × 10.43	
	Pusa Sharbati × Sel-1	27.00**	5.90	13.25	9.97 × 10.43	

1	2	3	4	5	6	7
Thickness of flesh (cm)	Hara Madhu × Punjab Sunehari	8.50	3.20	3.20	2.95 × 2.85	
	Hara Madhu × Sarada Melon	7.50	2.30	3.17	2 95 × 2.86	0.688
	S-445 × Sel-1	4.20	4.20	3.23	2.79 × 3.10	
	Pusa Sharbati × Sarada Melon	18.50	9.40	3.39	2.78 × 2.86	
	Punjab Sunehari × Sel-1	11.90	11.90	3.47	2.85 × 3.10	
Length of cavity (cm)	Hara Madhu × Sel-1	−4.40	—	6.45	6.75 × 10.74	
	Arka Jeet × S-445	−2.60	−2.60	5.31	5.45 × 5.66	1.705
	Arka Jeet × Sarada Melon	−12.30	−12.30	4.78	5.45 × 10.21	
	Durgapura Madhu × Sel-1	−11.50	—	8.89	10.40 × 10.04	
	Sel-1 × Sarada Melon	− 2.40	—	9.80	10.04 × 10.21	
Width of cavity (cm)	Hara Madhu × Sel-1	−18.60*	—	6.10	7.49 × 7.50	
	Arka Jeet × Durgapura Madhu	−19.90*	—	5.72	7.17 × 7.14	1.207
	Arka Jeet × Sarada Melon	−27.90**	−9.50	7.51	7.17 × 7.32	
	Durgapura Madhu × Sel-1	−17.50**	—	5.89	7.14 × 7.50	
	Sel-1 × Sarada Melon	−23.90*	−2.50	5.57	7.50 × 7.32	
Total soluble solids (%)	Arka Jeet × Durgapura Madhu	18.20**	18.20*	12.41	9.28 × 10.50	
	Arka Jeet × Sarada Melon	26.10**	11.40	11.70	9.28 × 7.44	1.634
	Durgapura Madhu × Sel-1	14.50	14.50	12.02	10.50 × 8.38	
	S-445 × Punjab Sunehari	20.80*	—	9.11	7.54 × 7.44	
	S-445 × Sel-1	25.90**	0.50	10.55	7.54 × 8.38	
Node number of first female flower	Hara Madhu × Sarada Melon	−20.20*	—	6.33	8.87 × 7.93	
	Arka Jeet × Sel-1	−8.50	−2.20	5.67	6.20 × 6.60	1 576
	Durgapura Madhu × Pusa Sharbati	−14.70	−20.30*	4.62	6.07 × 5.93	
	Durgapura Madhu × Sel-1	−25.40*	−21.90*	4.53	6.07 × 6.60	
	Durgapura Madhu × Sarada Melon	−29.70*	−26.40*	4.27	6.07 × 7.93	
Length of vine (cm)	Arka Jeet × Sel-1	17.60	14.30	178.52	138.22 × 151.80	
	S-445 × Punjab Sunehari	11.60	—	154.60	93.13 × 138.52	38.43
	S-445 × Sarada Melon	55.60**	16.30	181.53	93.13 × 116.67	
	Pusa Sharbati × Sel-1	10.30	7.20	167.44	130.1 × 151.80	
	Pusa Sharbati × Sarada Melon	55.10**	29.20	201.74	130.10 × 116.67	

*, ** Significant at 5 and 1 per cent level, respectively.

(35.60), S-445 × Punjab Sunehari (30.30) and Durgapura Madhu × Sel-1 (29.60) over best parent. The high degree of heterosis for yield was attributed to increased number of fruits and weight of fruit. Some of the crosses exhibiting high heterosis for yield also exhibited high degree of heterosis for number of fruits and weight of fruit. Low × low and high × low mean values of parents exhibited high heterosis which may be due to additive and over dominance gene actions, respectively. The findings of Lippert and Legg (1972b) and Nandpuri *et al.* (1974) were also similar.

High heterosis for number of fruits was observed in crosses, Punjab Sunehari, × Sel-1 (54.30), Arka Jeet × Durgapura Madhu (51.30), Durgapura Madhu × Pusa Sharbati (48.90), Durgapura Madhu × Sel-1 (43.50), and Pusa Sharbati × Punjab Sunehari (43.40) over better parent and Arka Jeet × Durgapura Madhu (51.3), Arka Jeet × Sel-1 (31.60) and Durgapura Madhu × Pusa Sharbati (17.50) over best parent. Low × low and high × high mean values of parents gave high heterosis. This may be due to additive or over dominance gene action. Heterosis for this character has also been reported by Nandpuri *et al.* (1974). For fruit weight, range of heterosis over better parent and best parent varied from 0.60 to 39.70 and 1.20 to 26.20, respectively and superior heterotic crosses were Arka Jeet × Pusa Sharbati (39.70) and Arka Jeet × S-445 (37.90) over better and best parent, respectively. Low × high mean values of parents gave high heterosis. The present results are in conformity with the findings of Lippert and Legg (1972b) in muskmelon.

Heterosis for thickness of flesh ranged from 0.60 to 18.50 and 0.60 to 11.90% over better and best parent, respectively and Pusa Sharbati × Sarada Melon and Punjab Sunehari × Sel-1 exhibited best heterosis. The range of heterosis for length of cavity varied from −1.20 to −12.30 and −2.60 to −12.30 over the better and the best parent, respectively. Best negative (favourable) heterosis for length of cavity was found in Arka Jeet × Sarada Melon (−12.30) and Durgapura Madhu × Sel-1 (−11.50) over better parent and in Arka Jeet × Sarada Melon (−12.30) over best parent. The range of heterosis for T. S. S. varied from 0.40 to 26.10 and 0.40 to 18.20 over the better and best parent, respectively. The high heterotic crosses were Arka Jeet × Sarada Melon (26.10), S-445 × Sel-1 (25.90) and S-445 × Punjab Sunehari (20.8) over better parent and Arka Jeet × Durgapura Madhu (18.20) over best parent. None of the hybrid was significant over better parent or best parent for flesh thickness.

Crosses showing high heterotic values for characters can be utilized as such and such crosses are Pusa Sharbati × Punjab Sunehari and Pusa Sharbati × Sarada Melon.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 4, pp 554—559 (December 1983)

EFFECT OF PRUNING AND PLANT SPACING ON PRODUCTIVITY OF MUSKMELON VARIETIES

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(Received : November 13, 1981; Revised : June 4, 1983)

ABSTRACT

Four varieties of muskmelon (Hara Madhu, Punjab Sunehari, Punjab Hybrid and Madhuras (during 1980) and Hara Madhu, Pusa Sarbati, Punjab Hybrid and Madhuras (during 1981), two plant spacings (30 and 45 cm) and two pruning treatments (control and pruning) were tried with respect to maturity, yield and T.S.S. content of muskmelon. Varieties differed from each other in maturity and variety Punjab Sunehari and Punjab Hybrid matured earlier as compared to other varieties. Maturity was enhanced under wide spacing (45 cm) as compared to closer spacing. Pruning improved earliness by a weeks time as compared to control plants in all varieties. Pruning and wider plant spacing (45 cm) improved the yield of all varieties significantly as compared to unpruned plants and narrow plant spacing (30 cm). Fruit yield increased by about 30 and 55 q/ha during 1980 and 1981, respectively, with pruning as compared to control plants. T.S.S. content varied according to varieties and significantly higher T.S.S. content (11.70%) was recorded in variety Hara Madhu as compared to other varieties. Wider plant spacing (45 cm) improved sweetness (T.S.S.) as compared to closer spacing. T.S.S. content significantly improved in the fruits harvested from pruned plants as compared to unpruned plants.

Manipulation for higher yield, early maturity and better quality through pruning has been reported in several cucurbits. Wikesjo and Nilsson (1972) and Mangal and Yadava (1979) in cucumber, and Eccher and Zerbini (1970) and Mangal and Pandita (1979) in melons have reported a significant increase in fruit yield in pruned plants as compared to unpruned control. But response of some new commercial varieties of muskmelon to the pruning is not fully known. Useful effect of optimum plant spacing on yield and quality is also well known in several cucurbits (Borisov *et al.*, 1976; Mangal and Yadava, 1979), but information on this aspect for various varieties of muskmelon is scanty. Present investigation was, therefore, undertaken to study the response of muskmelon varieties to pruning and plant spacing with respect to maturity, yield and quality.

MATERIAL AND METHODS

The experiments were conducted at the Research Farm of the Department of Vegetable Crops during 1980 and 1981. The soil of the experimental plot was sandy loam having uniform fertility. Experiment was planted in split plot

design in three replications with four varieties, viz. Hara Madhu, Punjab Sunehari, Punjab Hybrid and Madhuras during 1980, and Hara Madhu, Pusa Sarbati, Punjab Hybrid and Madhuras during 1981 and two plant spacings (30 and 45 cm) as main plot treatments and two pruning treatments (control and pruning) in sub-plots. There were 16 treatment combinations in all.

Muskmelon is an andromonecious having male flowers on main stem and hermaphrodite flowers on secondary branches. The first hermaphrodite flower is generally borne on the secondary branch arising from eighth node in case of variety Hara Madhu, fourth node in case of Punjab Sunehari, fifth node in case of Punjab Hybrid and Madhuras and seventh node in case of Pusa Sarbati. Hence, the secondary branches and regenerated growth upto 7th, 3rd, 4th, 4th and 6th node in case of Hara Madhu, Punjab Sunehari, Punjab Hybrid, Madhuras and Pusa Sarbati, respectively, were pinched off at their emergence and subsequent ones were allowed to develop. The secondary branches were also detached at two leaves after the first perfect flower. The pruning operation was done at three days interval and continued throughout experimentation.

Plot size was kept 4.5×1.5 m. Genetically pure seeds were sown on 4.3.1980 and 11.3.1981. Three seeds were sown per hill and after germination only one plant was allowed to develop per hill. The normal method of cultivation was followed for raising the healthy crop.

The data on yield per plant, yield per hectare (plot basis), fruit maturity and fruit quality (T.S.S. per cent) were recorded. T.S.S. was measured by hand refractometer at the time of harvesting.

RESULTS AND DISCUSSION

Maturity

Data in Table 1 reveal that fruits of variety Punjab Sunehari and Punjab Hybrid matured earlier, i.e , in 28.96 and 30.17 days, respectively, as compared to other varieties. No statistical difference in the duration of maturity of these two varieties was recorded during 1980. Maturity duration for variety Hara Madhu and Madhuras was statistically at par during 1980 but during 1981, fruit maturity was significantly delayed in Hara Madhu as compared to Madhuras. However, the fruits of varieties Hara Madhu and Pusa Sarbati matured almost in same duration.

Effect of plant spacing on fruit maturity was significant only during 1980 and maturity was enhanced by 1.16 days in wider spacing (45 cm) as compared to closer spacing (30 cm).

Pruning improved earliness by about a weeks time as compared to unpruned control during both the years of experiment. In case of pruned plants, fruits were matured in 28.16 and 29.66 days from the day of flower opening as compared to 35.21 and 35.59 days in control (unpruned) during 1980 and 1981, respectively.

Earliest fruiting in Punjab Sunehari and Punjab Hybrid varieties of muskmelon may be due to their hermaphrodite flowers bearing habit at lower nodes as

TABLE 1

Effect of pruning and plant spacing on productivity of muskmelon varieties

Treatments	Days from flower opening to fruit maturity		Yield per plant (kg)		T.S.S. content (%)	
	1980	1981	1980	1981	1980	1981
Varieties						
Hara Madhu	34.51	34.56	1.22	1.95	11.70	14.53
Punjab Sunehari	28.96	—	1.47	—	10.51	—
Pusa Sarbati	—	34.51	—	3.15	—	10.12
Punjab Hybrid	30.17	28.73	0.47	1.00	8.83	9.08
Madhuras	33.11	32.71	1 17	1.87	9.94	10.78
Spacing (cm)						
30	32.47	32.29	0.89	1.78	9.94	10.60
45	31.11	32.96	1.27	2.20	10.66	11.65
Pruning						
Control	35.21	35.59	1.01	1.16	9.81	10.78
Pruning	28.16	29.66	1.46	2.53	10.76	11.49
C. D. at 5% for Varieties	1.96	2.09	1.07	0.21	0.47	0.88
Spacing	0.75	NS	0.07	0.22	0.47	0.49
Pruning	0.75	1.27	0.13	0.22	0.47	0.49

compared to other varieties. Pruning was found to induce earliness in all the muskmelon varieties by about a week over control which could be due to hermaphrodite flowers appearing about a week earlier in pruned plants (Mangal and Pandita, 1979; Singh and Mangal, 1981). Frazier (1939) suggested that greater exposure of fruits to the sun by pruning must have resulted in higher temperature which is believed to be the principal cause of early maturation. These results regarding pruning are in agreement with those of Mangal and Pandita (1979) in muskmelon. However, Singh and Mangal (1981) reported no beneficial effect of spacing on fruit maturity in case of muskmelon variety Hara Madhu.

Quality

Data in Table 1 reveal that T.S.S. content in fruits of different varieties of muskmelon varied. Significantly higher T.S.S. content (11.70%) was recorded in variety Hara Madhu followed by Punjab Sunehari and Madhuras. T.S.S. content was significantly lower in case of Punjab Hybrid during both the years of experiment. There was statistically no significant difference in T.S.S. content of Punjab Sunehari and Madhuras during 1980 and Pusa Sarbati and Madhuras during 1981.

Similarly wider spacing improved T.S.S. content significantly as compared to closer spacing. Pruning was also helpful in increasing T.S.S. content.

T.S.S. content of fruits was significantly improved in pruned plants as compared to unpruned plants.

Highest T.S.S. content in Hara Madhu and lowest in Punjab Hybrid may be because of their varietal characteristics. Increase in T.S.S. content under wider spacing may be due to the reason that plants and fruits have greatly exposed to light and temperature and ultimately resulted in more carbohydrates synthesis and higher T.S.S. content as compared to closer spacing. Improvement in T.S.S. content with pruning may be because of more availability of nutrients to the fruits and also due to their better exposure to sunlight. The results are in confirmity with the findings of Mangal and Pandita (1979) and Singh *et al.* (1982).

Yield

Average yield per plant among all the five varieties tried during both the years was significantly higher in case of Pusa Sarbati (3.15 kg/plant), followed by Hara Madhu and Madhuras during 1981. Yield per plant during 1980 was lower in all varieties as compared to the yield in 1981. Poorest yield was recorded in case of variety Punjab Sunehari as compared to other varieties tried during 1980 (Table 1).

Effect of spacing was significant and yield per plant significantly increased under wider spacing (45 cm) as compared to narrow (30 cm) plant spacing.

Data in Table 1 also reveal that pruning boosted the yield per plant by 0.26 and 1.59 kg during 1980 and 1981, respectively.

Yield per hectare was also affected by various treatments (Table 2). Highest fruit yield per hectare was recorded in case of Punjab Sunehari and Madhuras as compared to Hara Madhu and Punjab Hybrid. Punjab Hybrid produced lowest yield (79.98 and 132.09 q/ha) during both the years. Pusa Sarbati gave highest fruit yield followed by Hara Madhu and Madhuras. Hara Madhu and Madhuras were at par during 1981 but Madhuras significantly gave more fruit yield as compared to Hara Madhu in 1980.

Results regarding effect of spacing on yield per hectare were contradictory during both the years. Higher fruit yield was recorded in first year in wider spacing (45 cm) and in second year under narrow spacing (30 cm). Higher yield under wider spacing was due to the reason that plants get more area to absorb their food material as compared to closer spacing resulting in better vegetative growth, more hermaphrodite flowers, and higher number of fruits per plant (Mangal and Pandita, 1979; Singh *et al.*, 1982). However, higher fruit yield per hectare in closer spacing during 1980 may be because of more number of plants per unit area. Similar results have been reported by Mangal and Yadava (1979) in cucumber and Singh *et al.* (1982) in muskmelon.

Effect of pruning on fruit yield per hectare was found significant. Fruit yield was increased by about 30 and 55 q/ha during 1980 and 1981, respectively, under pruning treatment as compared to control. It is likely that pruning of muskmelon crop might have helped in diverting the flow of nutrients towards apical growing point, increasing

TABLE 2

Response of muskmelon varieties to pruning and spacing (yield q/ha)

Varieties	Spacing	Control		Pruning		Average for interaction (v × s)	
		1980	1981	1980	1981	1980	1981
Hara Madhu	30	179.02	142.19	189.95	238.00	184.49	190.41
	45	191.20	162.19	234.07	213.28	212.75	187 74
Average for interaction (v × p)		185.15	152.19	212.08	225.94	198.62+	169.07+
Sunehari	30	205.58	—	231.01	—	218.35	—
Pusa Sarbati	45	—	177.69	—	228.84	—	203.07
Average for interaction (v × p)		205.68	177.69	231.01	228.84	218.35+	203.07+
Punjab Hybrid	30	101.31	126.84	94.11	175 52	97.71	151.08
	45	63.05	101.75	61 32	124.41	62.25	113.08
Average for interaction (v × p)		82.25	114.20	77.71	149.96	79.98+	132.09+
Madhuras	30	204.35	176.40	222.08	239.50	213.28	207.95
	45	214.08	153.30	299.93	157.73	257.00	155.52
Average for interaction (v × p)		209.28	164.85	261.00	198.62	235.14+	181.74+
Average for pruning		172.62	154.00	200.75	211.49	—	—
Values for interaction (s × p)	30	172.72	159 85	184 35	241.93	178.49*	200.90*
	45	172.76	148.63	217.15	181.06	195.02*	164.85*

+Denotes average values for varieties.

*Denotes average values for spacing.

C. D. at 5% for		1980	1981
Varieties (v)	=	16.85	20 93
Spacing (s)	=	13.09	13.33
Pruning (p)	=	13.09	13.33
Interaction (v × s)	=	26.18	26 66
Interaction (v × p)	=	26.18	26.66
Interaction (s × p)	=	18.50	18.85
Interaction (s × p × v)	=	NS	NS

plant length with more number of leaves and ultimately assimilation of more food material like carbohydrates and proteins. Greater production of plant food under these treatments appears to have increased the number of fruits (Singh *et al.*, 1982) and ultimately higher fruit yield per plant. Another probable reason for high fruit yield per unit area under pruned plant may be due to greater exposure of plants to light, leading to higher photosynthetic activity and greater production of hermaphrodite flowers (Mangal and Pandita, 1979). Similar results have been reported by Sambos and Sabina (1974), Mangal and Yadava (1979) and Singh *et al.* (1982).

Two way interaction effect was also found significant. However, three way interaction of varieties × pruning × spacing was non-significant. Best treatment combinations of variety and pruning during both the years were Madhuras × pruning and Pusa Sarbati × pruning, respectively.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 4, pp. 560—566 (December 1983)

STABILITY AND ADAPTATION STUDIES FOR DAYS TO FLOWERING, MATURITY, 100-SEED WEIGHT AND HARVEST INDEX IN SOYBEAN

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(Received : January 25, 1982; Revised : January 13, 1983)

ABSTRACT

Studies on stability and adaptation of 55 soybean genotypes for days to flowering, days to maturity, 100-seed weight and harvest index, in three environments viz., low, medium and high were conducted during **kharif** 1977 and 1978. The study revealed significance of both the linear and non-linear components of g × e interactions for days to flower initiation and 100-seed weight, preponderance of non-linear component for days to maturity and of linear component for harvest index. PK 73-86, PK 73-128 and Bossier were found to possess high harvest index and were stable for some of the traits under study. These genotypes may be utilized in future breeding programme for such characters.

Genetic similarity of cultivars creates uncertainty regarding genetic vulnerability. The magnitude of both heritable and non-heritable variations is of merit in agronomically significant plant traits. Koppar (1974) attributed a large part of the genetic variation for seed yield to differences between linear slope of regression, though the non-linear component was also significant. Baihaki *et al.* (1976) reported highest contribution of low yielding soybean lines to total g × e interaction for yield and maturity, followed by medium and high yielding lines. In the present study the stability of the characters viz., days to flowering, days to maturity, 100-seed weight and harvest index in soybean was explored.

MATERIAL AND METHODS

Seeds of 55 soybean varieties after inoculation with the bacterial culture were sown in 4 m long rows each spaced at 45 cm apart with 4–5 cm spacing between plants. Experiments were repeated thrice in randomized block design, at Research Area of Haryana Agricultural University, Hissar. The treatments were provided with three different types of fertility environments artificially viz., low (N_{20} P_{40} K_{20} kg/ha), medium (N_{40} P_{80} K_{40} kg/ha) and high (N_{60} P_{120} K_{60} kg/ha). The study was conducted in **kharif** seasons of 1977 and 1978. For recording observations, five plants/row/replication were randomly selected for all the treatments

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in each of the 6 environments. Data were recorded on days to flower initiation, days to maturity, 100-seed weight, dry plant weight and seed yield to compute harvest index value. Stability analysis was undertaken as per model given by Ebberhart and Russell (1966).

RESULTS AND DISCUSSION

Analysis of variance conducted separately for each of the 6 environments revealed highly significant differences among genotypes for all the traits under study indicating thereby the presence of sufficient genetic variability and its suitability for stability and adaptation studies.

Mean performance of the genotypes under low, medium and high fertility environments (Table 1) depicted that the period from sowing to flower initiation increased significantly and linearly with increase in NPK fertility, i. e. from low to high fertility conditions. This increase in vegetative period of the genotypes may be partly due to fertilizer inputs added to soil before sowing and partly due to higher nitrogen fixed biologically through nodules on roots of the plants. A linear decrease in the reproductive period (from flower initiation to maturity) of genotypes under medium and high fertility compared to low fertility may be attributed to faster translocation of photosynthates to reproductive organs under medium and high fertility than under low fertility levels. However, slight differences in maturity period of the genotypes may be due to forced maturity brought about by variations in seasonal and adaphic effects. An indication to this effect is born by 100-seed weight which is highest under high fertility conditions (Table 1). It may be mentioned that highest average number of nodules/plant (2.90) recorded under medium maturity conditions compared to high (1.52) and low (1.45) fertility conditions might have contributed to hasten maturity through improved translocation of food reserves under medium fertility levels. Both elemental and biological nitrogen alongwith P and K inputs added to soil prior to sowing were found to have non-significant effects on traits viz., 100-seed weight and harvest index. Pronounced effects during **kharif** 1978 compared to **kharif** 1977 were noticed to favour genotypic performance for harvest index in all the environments of test. The favourable effects of fertility

TABLE 1

Mean performance of the soybean genotypes under low, medium and high fertility conditions

Characters	Fertility levels		
	Low	Medium	High
Days to flower initiation	43.22	49.04	53.19
Days to maturity	110.11	108.52	109.56
Period from flowering to maturity	66.89	59.48	56.37
100-seed weight (g)	9.66	9.63	10.07
Harvest index	0.56	0.55	0 55

TABLE 2

Regression analysis of certain quantitative traits in soybean

Sources	D. F.	Flower initiation (days)	Maturity (days)	100-seed weight (g)	Harvest index
Varieties	54	79.07**	36.81**	36.40**	0.40**
Environments	5	145.75**	1784.40**	5921.26**	0.74**
Var. x Environment	270	84.52**	32.79	25.20**	0.33**
Environment (Linear)	1	722.72	8899.49	104.11	0.33
Var. x Environment (Linear)	54	34.28	20.24	31.20**	0.28**
Pooled deviation	220	95.10**	35.41**	23.28**	0.01

**Significant at 1% level of significance.

levels on the photosensitive traits viz., days to flowering and days to maturity were also reported by Ramos and Castro (1975).

Joint regression analysis (Table 2) pointed out that mean square values for all the traits except days to maturity were highly significant indicating the significance and higher component of g × e interaction and probability of prediction for all such traits. The non-linear component compared to its linear component was found to be greater for the character days to maturity, due to which predictions across environments for this trait possibly could not be made.

Estimates of stability parameters viz., mean (xi) regression coefficient (bi) and squared deviations around regression (S^2di) for the character days to flowering (Table 3) ranged between 47.39 to 67.43 days, −0.08 to 5.63 and −29.41 to 1698.00, respectively. DS 73-16, the earliest variety to come into flowering, showed consistent performance ($S^2di=59.41$) but was non-responsive to the environments ($bi=0.05$). Another variety UPSM-244 that flowered in 47.7 days had $bi=1.92$ and $S^2di=39.72$. Similarly HMI started flowering after 48.06 days of sowing and possessed $bi=0.85$ and $S^2di=57.23$. Both these varieties exhibited stable performance but UPSM 244 possessed above average response and HM-1 showed below average response. PK 72-3 that was the last variety to come into flower (67.43 days), possessed above average response and was unstable. Varieties PK 73-142, PK 73-128, PK 74-276, PK 73-54, Cobb, Java 16, EC 113401, T-49 and EC 113397 that flowered in 49 to 54 days were found to possess average stability and general adaptability for this trait.

A perusal of the data in Table 3 revealed that range in days to maturity among genotypes was 105.13 to 124.41 days. Values of regression coefficients ranged from 0.46 to 1.62 with deviation from regression ranging from 31.12 to

TABLE 3

Estimates of stability parameters of elite soybean varieties over six environments

S. No.	Varieties	Flower initiation			Maturity			100-seed weight			Harvest index		
		xi	bi	S^2di	xi	bi	S^2di	xi	bi	S^2di	xi	bi	S^2di
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	PK 74-271	52.33	2.35*	—54.12	109.17	0.95*	—28.44	9.82	0.23	1.62	0.55	1.04	0.005
2.	PK 73-142	48.90	0.87	—58.14	108.72	1.15*	—24.03	10.03	—0.09	—0.21	0.59	1.77*	0.013
3.	PK 73-128	49.02	0.97	—58.79	108.96	0.92*	—26.43	10.37	1.48	—0.04	0.57	1.00	0.005
4.	Bossier	50.11	1 24*	—54.43	108.86	1 05	—29.99	10.99	0.13	2.37	0.62	1.00	0.004
5.	Kalitur	53 76	1.17	—50.74	110 17	0.96	29.02	6.53	1.01	—0.28	0.59	0.30*	0.003
6.	Alankar	49.75	0.66*	—62.14	109.67	1.13*	—31.12	10.34	0.77*	0.23	0.56	0.76*	0.001
7.	Clark 63	48.94	0.67*	—50.94	108.24	0.93*	—21.87	11.21	0.92	—0.07	0.52	1.17*	0.003
8.	PK 72-3	67.43	5.63*	169.83*	105.15	1.62*	—27.59	11.59	—1.15	6.47	0.51	1.41*	0.002
9.	IC 24374	52.50	2.31*	—47.54	108.67	1.01	—29.78	9.85	2.20	0.03	0.57	0.58*	0.006
10.	Wood Worth	49.98	0.51*	—62.74	106 65	0.97	—24.16	9.64	0.03	0.18	0.58	1.10*	0.018
11.	PK 74-276	49.17	0.91	—57.43	108.80	0.75*	—29.09	9.81	1.79	0.93	0.54	1.45*	0.048
12.	UPSM 116	50.07	1.06	—57.56	107.44	1.03	—30.20	10.39	—0.13	0.37	0.57	1.71*	0.002
13.	PK 73-54	49.96	1.08	—51.05	106.98	0.97	—28.77	11.00	0.59	0 10	0.60	0.69*	0.001
14.	Cobb	49.59	1.25*	—59.32	110.13	1.03	—28.90	12.11	3.32	0.98	0.51	0.21	0.016
15.	Ankur	50.83	0.74	—45.78	109.93	1.05	—28.13	9.54	0.91	0.33	0.54	1.86*	0.023
16.	Bragg	49.26	0.44*	—62.70	108.24	0.86*	—28 50	10.66	1.11	1 42	0.56	2.26*	0.001
17.	PK 74-275	49.15	—0.16*	55.80	108.90	1.15*	—30.81	9.54	1.15	—0.01	0.63	0.15	0.001
18.	PK 73-126	48.89	1.86*	—55.80	109.19	0.99	—29.53	10.29	1.02	—0.05	0.53	1.47*	0.001
19.	UPSM 244	47.74	1.92*	—39.72	108.24	0.96*	—29.93	9.98	0.81	—0.27	0.61	3.84*	0.001
20.	HMI	48.06	0.85	—57.23	108 28	1.42*	—30.20	11.16	0.58	0.24	0.65	3.45*	0.010
21.	EC 112828	51.54	0.93*	—58 82	108.75	1.43*	20 27	8.48	0.82*	—0.26	0.58	0.32*	0.055
22.	UPSM 462	50.46	3.04*	50.82	109.07	1.03	—29.77	10.26	0.61*	1.85*	0.67	2.21*	0.025

1	2	3	4	5	6	7	8	9	10	11	12	13	14
23.	UPSM 944	51.59	3.04*	—57.23	108.07	1.25*	—28.54	11.64	1.99*	16.69*	0.54	0.78*	0.003
24.	PK 73-86	52.04	1.17*	—50.20	109.74	1.21*	—30.90	10.30	0.16*	0.20	0.71	0.65*	0.002
25.	William	50.74	0.21*	—47.67	107.57	0.89*	—24.40	12.88	1.44*	5.34*	0.52	0.52*	0.001
26.	PK 74-258	51.76	2.99*	—52.69	108.89	1.16*	—28.95	10.10	1.63*	0.83*	0.62	2.19*	0.022
27.	EC 114524	58.22	—0.08	454 42*	124.41	0.93	1564.38*	7.65	—0.16*	0.57*	0.59	1.04	0.005
28.	EC 113401	51.24	0.97	—57.46	108.81	0.85	—26.72	9.62	1.40*	1.32*	0 57	2.65*	0.032
29.	Java 16	53.65	1.03	—45.07	108.65	1.15*	—29.82	8.54	2.03*	1.91*	0.59	2.73*	0.034
30.	EC 103349	52.59	1.14	—52.04	109.07	1.22*	—30.06	9.52	1.04	0.19	0.55	0.60*	0.002
31.	DS 73-16	47.39	0.01	—59.42	106.98	0.99	—30.05	9.57	2.40*	0.51*	0.54	4.50*	0.080
32.	T-49	50.96	1.05	—55.70	108 37	1.06	—23.14	8.60	2.59*	2.87*	0.57	—0.15	0.001
33.	EC 113397	53.89	0.77*	—43.23	110.93	0.92*	—29.41	7.01	0.69*	—0.19	0.63	0.32*	0.061
34.	EC 107009	49.63	1.07	—46.88	107.07	0.94*	—28.09	9.71	1.98*	0.08	0.52	1.08	0.005

* = Significant at 5% level of significance.

1564.38. PK 72-3 maturing in 105.13 days had bi=1.62 and $S^2di=-27.59$ which indicated above average response and stable performance of this genotype. On the other hand EC 114524 which matured in 124.41 days had bi=0.93 (below average response) and was highly unstable in performance ($S^2di=1564.38$). Average stability and general adaptability of lines IC 24374, Wood Worth, UPSM 116, PK 73-54, Cobb, Ankur, PK 73-126, UPSM 462, DS 73-16 and T-49 were recorded for this trait. Of these DS 73-16, T-49, PK 73-54 and Cobb were also found to possess average stability and general adaptability for days to flowering.

For the character 100-seed weight, two genotypes viz., Kalitur and EC 103349 exhibited average response (bi=1.01 and 1.04, respectively) and stable performance ($S^2di=0.28$ and 0.19, respectively) indicating thereby their average stability and general adaptability for this trait. Although all the lines showed consistent performance yet 24 lines possessed above average response and other 9 lines to high yielding environments and 9 lines to low yielding environments. UPSM 944 only exhibited above average response but was unstable in performance.

Harvest index of the genotypes viz., PK 73-86, UPSM 462, HMI, PK 74-275, EC 113397, PK 74-258, Bossier, UPSM 244 and EC 112828 was 60% and above. All genotypes expressed stability of performance over all the environments of test for this trait. Of these PK 72-86 with highest index showed below average response which indicated that harvest index value and performance do not have a direct relationship to stability. PK 74-271, Bossier, EC 114524 and EC 107009 exhibited average response.

Keeping in view the stability parameters for the traits days to flower initiation, days to maturity, 100-seed weight and harvest index of all the 55 genotypes, it was observed that PK 73-86 a genotype with high harvest index was specifically adapted to low yielding environments possessed above average stability. This genotype had above average stability and specific adaptability to high yielding environments for the character days to flowering and days to maturity. Soybean varieties PK 73-128 and Bossier were observed to have average stability and general adaptability for harvest index. The harvest index values in their favour were 0.57 and 0.62, respectively. Both these genotypes were in flower 50-51 days after sowing and matured in 109 days. Bossier with higher harvest index than PK 73-128, possessed slightly higher 100-seed weight. EC 114524 expressed average stability for harvest index but was unstable for the remaining three traits of this study.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 4, pp. 567—572 (December 1983)

RELATIONSHIP BETWEEN RAINFALL AT DIFFERENT STAGES OF CROP GROWTH WITH CROP MATURITY IN DRY AGRICULTURAL AREAS OF TEHSIL BAWANIKHERA

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(Received : November 25, 1981; Revised : June 4, 1982)

ABSTRACT

The relationship of rainfall at different stages of crop growth with the crop maturity of **bajra, jowar, guar,** mung and moth of **kharif** harvest and gram, mustard, taramira and barley of **rabi** harvest of dry cultivated areas of tehsil Bawanikhera has been studied. The close direct relationships were observed between : (i) the rainfall at sowing stage and the crop maturity of **jowar,** moth and barley, (ii) the rainfall at germination stage and the crop maturity of gram and barley, (iii) the rainfall at vegetative growth stage and the crop maturity of mung, (iv) the rainfall at flowering stage and the crop maturity of **jowar, guar,** gram, taramira and mustard, (v) the rainfall at grain formation stage and the crop maturity of **bajra, guar,** mung, **jowar,** mustard, gram, taramira and barley, and (vi) the rainfall at ripening stage and the crop maturity of mung.

Since, it will, perhaps, never be possible to irrigate the total cropland in India, the study of dryland agriculture deserves analysis. Rainfall has a significant impact on the extent of crop maturity in dryland agriculture. The present study was, therefore, undertaken to ascertain the relationship between rainfall at different stages of crop growth and the crop maturity during **kharif** and **rabi** harvests, separately, in dry agricultural areas of tehsil Bawanikhera, where 52.2% of the total cultivated land is rainfed in both **kharif** and **rabi** seasons.

The tehsil Bawanikhera of Bhiwani district is situated in the western part of Haryana State and is bounded by 28°51'N to 29°4'N latitude and 75°34'E to 76° 15'E longitude. It has a hot, semi-arid, sub-tropical, continental monsoonal type of climate. The soils comprise loamy sands and sandy loams. In places, there are patches of sandy soil. Sub-soil water is deepseated and mostly brackish.

MATERIAL AND METHODS

The study was conducted on the dry cultivated areas of tehsil Bawanikhera. The rainfall and the crop land-use data for five years, **kharif** 1971 through **rabi** 1976, were taken from the Kanugo of the tehsil (Tables 1 and 2).

A five years regime was adopted because of the fact that, generally, there is a probability of one bad and one good

TABLE 1

Rainfall (mm) at different stages of crop growth in **kharif** season of tehsil Bawanikhera

Years	Seasonal totals	Sowing	Germination	Vegetative growth	Flowering	Grain formation	Ripening
			Bajra				
	(1 July-30 Sep.)	(1-15 July)	(4-20 July)	(21 July-14 Aug.)	(15-30 Aug.)	(26 Aug.-10 Sep.)	(18-30 Sep.)
1971	220.0	95.0	75.0	59.0	48.0	66.0	0.0
1972	101.5	44.0	44.0	3.0	54.5	11.5	0.0
1973	234.5	37.6	16.7	88.1	6.1	10.2	0.0
1974	172.3	22.4	99.9	63.5	0.0	0.0	8.9
1975	232.1	38.3	81.5	52.7	35.0	37.0	8.0
			Jowar				
	(1 July-5 Oct.)	(1-15 July)	(5-21 July)	(22 July-19 Aug.)	(20 Aug.-5 Sep.)	(1-15 Sep.)	(25 Sep.-5 Oct.)
1971	220.0	95.0	15.0	59.0	48.0	18.0	0.0
1972	116.5	44.0	44.0	33.0	24.5	0.0	0.0
1973	262.4	37.6	42.1	88.1	10.2	100.0	27.9
1974	172.3	22.4	108.3	50.0	0.0	0.0	0.0
1975	241.1	38.3	94.2	40.0	35.0	42.0	4.0
			Guar				
	(10 July-15 Oct.)	(10-25 July)	(15-31 July)	(1-21 Aug.)	(22 Aug.-10 Sep.)	(6-28 Sep.)	(5-15 Oct.)
1971	125.0	7.0	22.0	37.0	66.0	18.0	0.0
1972	86.5	14.0	0.0	33.0	24.5	0.0	15.0
1973	239.5	42.1	27.4	62.7	10.2	96.6	0.0
1974	167.2	108.3	120.5	34.5	0.0	8.9	0.0
1975	220.3	86.3	73.6	40.0	67.0	50.0	0.0
			Mung				
	(1 July-15 Sep.)	(1-15 July)	(5-20 July)	(21 July-9 Aug.)	(10-22 Aug.)	(20-31 Aug)	(6-15 Sep)
1971	220.0	95.0	15.0	59.0	0.0	48.0	18.0
1972	101.5	44.0	44 0	1.0	32 0	24.5	0.0
1973	234.5	37.6	16.7	87.8	0.3	6.1	96.6
1974	163.0	22 4	94.8	48.3	15.2	0.0	0.0
1975	224.1	38.3	81.5	52.7	25.0	35.0	46 0
			Moth				
	(1 July-20 Sep.)	(1-15 July)	(5-20 July)	(21 July-14 Aug.)	(15-28 Aug.)	(25 Aug.-5 Sep.)	(10-20 Sep)
1971	220.0	95.0	15.0	59.0	48.0	48.0	0.0
1972	101.5	44 0	44.0	3.0	54.5	19.5	0.0
1973	234.5	37.6	16.7	88.1	3.8	10.2	96.6
1974	163.4	22.4	94.8	63.5	0.0	0.0	0.0
1975	232.1	38.3	81.5	52.7	35.0	10.0	18.0

Source : Rainfall data recorded at tehsil headquarter Bawanikhera.

TABLE 2

Rainfall (mm) at different stages of crop growth in rabi season of tehsil Bawanikhera

Year	Seasonal totals	Sowing	Germination	Vegetative growth	Flowering	Grain formation	Ripening
				Gram			
	(6 Oct.-25 March)	(6-20 Oct.)	(14-28 Oct.)	(29 Oct.-15 Jan.)	(16 Jan.-15 Feb.)	(10 Feb.-5 March)	(10-25 March)
1971-72	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1972-73	58.8	15.0	0.0	43.5	0.3	0.0	0.0
1973-74	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1974-75	11.1	0.0	0.0	5.8	3.0	1.3	1.0
1975-76	20.0	0.0	5.0	0.0	5.0	10.0	0.0
				Mustard			
	(1 Oct. 15 March)	(1-15 Oct.)	(6-22 Oct.)	(23 Oct. 7 Jan.)	(8 Jan.-10 Feb.)	(5-25 Feb.)	(6-15 March)
1971-72	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1972-73	58.8	15.0	15.0	43.5	0.3	0.0	0.0
1973-74	27.9	27.9	0.0	0.0	0.0	0.0	0.0
1974-75	11.1	0.0	0.0	5.8	3.0	1.3	1.0
1975-76	24.0	4.0	0.0	5.0	5.0	10.0	0.0
				Taramira			
	(24 Oct.-5 April)	(24 Oct.-15 Nov.)	(1-23 Nov.)	(24 Nov.-24 Jan.)	(25 Jan.-20 Feb.)	(15 Feb.-10 March)	(20 March-5 April)
1971-72	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1972-73	43.8	0.0	10.0	33.8	0.0	0.0	0.0
1973-74	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1974-75	11.1	0.0	0.0	5.8	4.3	2.3	0.0
1975-76	20.0	5.0	0.0	0.0	15.0	10.0	0.0
				Barley			
	(16 Oct.-15 March)	(16-25 Oct.)	(20-31 Oct.)	(1 Nov.-7 Jan.)	(8-22 Jan.)	(15 Jan.-10 Feb.)	(5-15 March)
1971-72	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1972-73	43.8	0.0	0.0	43.5	0.3	0.3	0.0
1973-74	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1974-75	11.1	0.0	0.0	5.8	0.0	3.0	1.0
1975-76	20.0	5.0	5.0	0.0	0.0	5.0	0.0

Source : Rainfall data recorded at tehsil headquarter Bawanikhera.

TABLE 3

Crop maturity index of dry cultivated areas of tehsil Bawanikhera

Years	Kharif crops					Rabi crops			
	Bajra	Jowar	Guar	Mung	Moth	Gram	Mustard	Taramira	Barley
1971-72	93.7	99.4	83.8	93.8	98.8	59.2	39.5	39.8	80.3
1972-73	20.8	58.4	15.8	46.3	17.4	31.6	24.7	9.8	18.4
1973-74	82.5	85.3	71.1	88.7	49.6	11.3	21.7	7.7	17.6
1974-75	7.8	3.0	12.9	41 1	46.0	22.2	8.6	43.6	30.3
1975-76	96.7	98.7	97.0	98.8	98.8	91.7	90.1	44.7	93.0

Crop maturity data recorded in the Lal Kitabs of the Kanugo of tehsil Bawanikhera.

rainfall year out of every five years. During the study period, 1972 seems to be a bad rainfall (164.0 mm) year and 1973 seems to be good rainfall (308.4 mm) year. The rest of the years, i.e., 1971, 1974 and 1975 received normal rainfall (269.2, 234.0 and 284.4 mm, respectively). Besides, socio-economic conditions change after five years is evident from 'Five-Year-Plans'.

Duggal's (1978) CMI was applied for processing crop land-use data. Simple correlation coefficients between rainfall and crop maturity were calculated from K. Pearson's Product Moment Coefficient. The data was processed as under and the results are given in Table 3.

$$\text{Crop Maturity Index (CMI)} = \frac{\text{Actual matured area in a sequence of years}}{\text{Total sown area in that sequence of year}} \times 100$$

$$\text{Correlation coefficient} = \frac{\text{Covariance } (xy)}{\text{Standard deviation of } x \times y} = \frac{1/n\Sigma(x-\bar{x}) \times (y-\bar{y})}{\sqrt{\frac{\Sigma(x-\bar{x})^2}{n}} \times \sqrt{\frac{\Sigma(y-\bar{y})^2}{n}}}$$

where x = value of rainfall, y = value of crop maturity, $\bar{x}$, $\bar{y}$ = mean values, and n = number of years of observations.

RESULTS AND DISCUSSION

Kharif Season

A close direct relationship was exhibited between the seasonal rainfall and the crop maturity of **bajra, jowar,** mung and moth (Table 4). This reveals that rain favours considerably the maturity of these crops. But the relationship of seasonal rainfall with the crop maturity of **guar** was weak when compared with the crop maturity of **bajra, jowar,** mung and moth. This indicates that **guar** is a more drought resistant **kharif** crop in dry agricultural areas (Batra *et al.*, 1976).

The incidence and proper distribution of rainfall in different periods of crop growth are more important than the seasonal totals. Consequently, the correlation coefficients between rainfall at different stages of crop growth and the

TABLE 4

Correlation coefficients between rainfall at different stages of crop growth and crop maturity of dry cultivated areas during **kharif** season of tehsil Bawanikhera

Crops	Seasonal totals of rainfall	Rainfall at sowing	Rainfall at germination	Rainfall at vegetative growth	Rainfall at flowering	Rainfall at grain formation	Rainfall at ripening
Bajra	0.82	0.24	-0.20	0.45	0.21	0.73	0.22
Jowar	0.59	0.60	−0.58	0.22	0.78	0.51	0.29
Guar	0.53	0.13	−0.31	0.44	0.76	0.58	-0.57
Mung	0 87	0 48	−0 42	0.64	0.47	0.57	0.66
Moth	0.79	0.53	-0.03	0.41	0.16	0.43	-0.09

crop maturity of **bajra, jowar, guar,** mung and moth were analysed (Table 4) and the close direct relationships were observed between the following variables : (a) Rainfall at sowing stage and the crop maturity of **jowar** and moth; (b) rainfall at vegetative growth stage and the crop maturity of mung; (c) rainfall at flowering stage and the crop maturity of **jowar** and **guar;** (d) rainfall at grain formation stage and the crop maturity of **bajra, guar,** mung and **jowar;** (e) rainfall at ripening stage and the crop maturity of mung.

The rainfall at germination stage showed inverse relationship with the crop maturity of **bajra, jowar, guar,** mung and moth. This may be attributed to the problem of soil crusting after a light shower or due to seed burning in the soil in the event of heavy shower.

Rabi Season

The **rabi** rain yielded chance relationships with the crop maturity of gram, mustard, taramira and barley (Table 5). This explains that the maturity of these crops does not favour/disfavour rain. It may be perhaps, due to availability of conserved soil moisture which protects the maturity of **rabi** crops. However, when compared with other crops, the crop maturity of taramira was less associated with the **rabi** rain. This indicates that taramira is more drought resistant crop of this season in dry agricultural areas (Daya Ram, 1977).

The rainfall at different stages of crop growth is more important than the seasonal totals, hence the crop maturity of gram, mustard, taramira and barley was correlated with the rainfall at different stages of crop growth. The close direct relationships were observed between the following variables : (a) Rainfall at sowing stage and the crop maturity of barley; (b) rainfall at germination stage and the crop maturity of gram and barley; (c) rainfall at flowering stage and the crop maturity of gram, taramira and mustard; (d) rainfall at grain formation stage and the crop maturity of mustard, gram, taramira and barley.

The rainfall at vegetative and ripening stages showed inverse relationships with the crop maturity of gram, mustard, taramira and barley. Thus, the rainfall

TABLE 5

Correlation coefficients between rainfall at different stages of crop growth and crop maturity of dry cultivated areas during **rabi** season of tehsil Bawanikhera

Crops	Seasonal totals of rainfall	Rainfall at sowing	Rainfall at germination	Rainfall at vegetative growth	Rainfall at flowering	Rainfall at grain formation	Rainfall at ripening
Gram	0.02	−0.20	0.84	-0 24	0.60	0.81	−0.36
Mustard	−0.06	−0.22	−0.22	−0.22	0.58	0.89	0.50
Taramira	−0.27	0.47	- 0.58	- 0.52	0.60	0.58	0 00
Barley	−0.22	0.70	0.70	- 0.51	0.04	0.51	- 0 27

at these stages is not required for the maturity of these crops.

These relationships emphasize the need of rainfall at critical stages of crop growth for the maturity of respective crops. It can be concluded that the dependence of crop maturity on rainfall is more acceptable in the **kharif** season than in the **rabi** season. While sowing crops in the **kharif** and the **rabi** seasons, **guar** and taramira, respectively, should be preferred because of their low rainfall requirements. At least protective irrigation should be provided to respective crops at critical stages of crop growth, so that crops do not fail after sowing. Water availability to the crops at grain formation stage seems to be most critical for taking good harvest of the crops.

ACKNOWLEDGEMENTS

Thanks are due to Dr. Mahendra Singh, Prof. and Head, Department of Soils, for providing facilities and to Dr. M. C. Oswal, Soil Physicist, Dryland Agriculture Research Project, for going through the manuscript.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 4, pp. 573—578 (December 1983)

EFFECT OF SPACING, NITROGEN AND PHOSPHORUS LEVELS ON YIELD OF CAULIFLOWER, VARIETY HISSAR-1

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(Received : November 5, 1981; Revised : May 1, 1982)

ABSTRACT

An experiment to assess the effect of three plant spacings (60 × 40, 60 × 60 and 60 × 80 cm), four levels of nitrogen (0, 50, 100 and 150 kg/ha) and three levels of phosphorus (0, 60 and 120 kg/ha) on the curd yield of cauliflower was conducted. Spacing (60 × 40 cm) recorded highest curd yield. Effect of nitrogen was very pronounced and highest yield was recorded with 150 kg N/ha. The response of phosphorus application was statistically significant during second year and was not significant during first year but on the basis of pooled means, application of 120 kg P_2O_5 produced highest yield. The most important interactions were 60 × 40 cm spacing, 150 kg N/ha and 60 kg P_2O_5/ha during first year and 120 kg P_2O_5/ha during second year. Average profit of two years over control was maximum (Rs. 6011.25) in 60 × 40 cm spacing, 150 kg N/ha and 60 kg P_2O_5/ha.

Cauliflower is one of the most important vegetable crops of India because of its good taste and multipurpose uses. There are five groups in cauliflower, i.e., very early, early, mid, mid-late and late. There are different fertilizer requirements of all the groups. The Hissar-1 is a mid-late variety, needs proper and sufficient manure for handsome yield. Dhesi *et al.* (1964) reported that 224 kg N/ha gave the highest yield in cauliflower variety Snowball-16. Saimbhi *et al.* (1969) reported that a combination of 112 kg N and 56 kg P_2O_5 per hectare was optimum for cauliflower production. Rajput and Singh (1975) obtained highest yield of cauliflower variety Snowball-16 with 120 kg N/ha. Thus, there are different reports for different regions in different years. Keeping this in view the experiment was carried out with variety Hissar-1.

MATERIAL AND METHODS

The experiment was conducted at the Agricultural University, Hissar during the years 1979-80 and 1980-81. The soil was sandy loam in texture. The experimental field was having 95 and 80 kg N/ha; 35 and 28 kg P_2O_5/ha; 855 and 838 kg K_2O/ha; and 0.43 and 0.39 per cent organic matter, during 1979-80 and 1980-81, respectively. The trial included three spacings (S_1 — 60 × 40, S_2 — 60 × 60 and S_3 — 60 × 80 cm), four levels of nitrogen (N_0, N_{50}, N_{100} and N_{150} kg/ha and three levels of phosphorus (P_0, P_{60} and P_{120} kg/ha). Potash was applied @ 60 kg/ha in all the treatments. There were 36 treatment combinations in all. The lay out consisted of a split plot design with three replications. In both the years, spacing treatments were in the main plots and N × P treatments in sub-plots.

Entire P and K and half the dose of N were applied before planting of the seedlings, while the remaining N was side dressed a month later. Thirtyfive days and 38 days old seedlings of cauliflower were transplanted on 6th October and 13th October, during first and second year, respectively. Gaps were filled by planting more seedlings in the usual manner. Economics of different treatments over control was also calculated. Since all the other operations, except the application of fertilizers were common under all the treatments only the cost of fertilizer was taken into consideration. The minor expenditure incurred on seedlings for different treatments and top dressing of fertilizer has also not been taken into account. The economics was calculated on the basis of average yield recorded under different treatments.

RESULTS AND DISCUSSION

Effect of Spacing

It was noticed that spacing S_1 (60×40 cm) consistently produced the highest curd yield in both the years (292.00 and 227.59 q/ha, respectively). Spacings S_1 and S_2 were at par and yielded significantly higher than S_3 during both the years (Table 1). This may be due to more number of plants in S_1 than S_2 and S_3. Closer spacing of 60×40 cm resulted in higher yield of marketable heads in variety Snowball-16 (Arora *et al.*, 1970). The curd leaf ratio was not affected significantly by any of the spacing treatments.

Effect of Nitrogen Levels

The effect of nitrogen on the crop was very pronounced. There was consider-

TABLE 1

Effect of spacing, nitrogen and phosphorus levels on curd yield and curd leaf ratio

Treatments	Curd yield (q/ha)			Curd and leaf ratio	
	1979-80	1980-81	Mean	1979-80	1980-81
Spacing					
S_1(60×40 cm)	292.00	227.59	259.80	2.14	1.61
S_2(60×60 cm)	261.10	178.19	219.60	2.30	1.81
S_3(60×80 cm)	246.21	167.70	206.96	2 65	2.09
C. D. at 5%	12 47	11.40	—	NS	NS
Nitrogen levels (kg/ha)					
N_0	181.78	139.43	160.61	1.96	1.47
N_{50}	247.61	187.72	217.67	2.24	1.73
N_{100}	304.05	212.21	258.13	2.52	1 97
N_{150}	332.30	228.26	280.28	2.74	2.18
C. D. at 5%	9.43	13.86	—	NS	NS
Phosphorus levels (kg/ha)					
P_0	264.14	184.45	224.30	2.41	2.37
P_{60}	267.54	189.95	228 75	2.31	2 31
P_{120}	265.53	199.03	232.28	2.37	1.87
C. D. at 5%	NS	12.00	—	NS	NS

able increase in the curd yield with the corresponding increase in nitrogen applied to the crop. Statistically all the doses were at par with each other. Highest curd yields (332.30 and 228.26 q/ha) were obtained in 150 kg N/ha and lowest yields (181.78 and 139.43 q/ha) were recorded in control during both the years, respectively (Table 1). Increase in curd yield with the increase in nitrogen level has been reported by Saimbhi *et al.* (1969) and Rajput and Singh (1975). The beneficial effect of nitrogen may be due to the fact that it increases the production of green leaves which helps in the synthesis of carbohydrate, protein, etc. for building up of new tissues. Eventually there is an increase in the growth and yield of curd. There was non-significant effect of nitrogen on curd and leaf ratio.

Effect of Phosphorus

The effect of phosphorus was not found statistically significant during first year but it was significant during second year (Table 1). An increase in the level of phosphorus application increased the curd yield in second year. The application of 120 kg P_2O_5/ha showed significant superiority over control but 60 and 120 kg P_2O_5/ha did not differ significantly with each other. The data of mean yield indicated that phosphorus was beneficial for curd yield of cauliflower. These findings are in close conformity with those of Sharma and Singh (1963). However, Dhesi *et al.* (1964) did not get any beneficial effects of added phosphorus in the soil.

Interaction Effect

The interactions of spacing, nitrogen and phosphorus were significant at 5% level in respect of curd yield in two years.

The higher curd yield was obtained in S_1 with 150 kg nitrogen and all phosphorus levels than S_2 and S_3 spacings with same combinations (Table 2). The highest curd yield (382.41 q/ha) was under 60×40 cm (S_1) spacing, 150 kg N/ha and 60 kg P_2O_5/ha during first year and 60×40 cm (S_1) spacing, 150 kg N/ha and 120 kg P_2O_5/ha during second year (275.39 q/ha) and this was significantly more than most of the other yields. This is in conformity with the results obtained by Arora *et al.* (1970). The marked effect of S_1 spacing with 150 kg N in different combinations of P_2O_5 may be due to the fact that under S_1 spacing there were more number of plants per hectare supplemented with proper nutrients resulting in higher curd yield. Among the S_2 spacing, the combination of N_{150} and P_{120} recorded highest yield (320.87 q/ha) in first year and N_{150} and P_0 (240.51 q/ha) during second year and are more than the highest yields of S_3 combinations. In general, the curd yield during 1979-80 was better with all the treatments than those of 1980-81 because of scarcity of water in the latter year at the time of curd formation and development.

Economics of the Treatments

It is evident from Table 2 that there was no need of applying phosphorus without nitrogen in cauliflower. In S_1 spacing as the dose of nitrogen increased from 50 kg to 100 kg/ha with different combinations of P_2O_5, the average profit over control increased almost double and increased upto 150 kg N/ha but the rate

TABLE 2

Profit and loss over control due to spacing and fertilization in cauliflower variety Hissar-1

Treatments	Cost of fertilizer		Total	Yield of curd (q/ha)		Income from the yield of cauliflower per ha @ Rs. 50/q		Average income per ha	Average profit over control
	CAN @ Rs. 100/q	Single super-phosphate @ Rs. 90/q		1979-80	1980-81	1979-80	1980-81		
$S_1N_0P_0$	—	—	—	190.20	160.52	9510.00	8026.00	8768.00	Nil
$S_1N_0P_{60}$	—	337.50	337.50	186.90	165.97	9345.00	8298.50	8821.75	−283.75
$S_1N_0P_{120}$	—	675.00	675.00	180.67	152.35	9033.50	7617.50	8325.50	−1117.50
$S_1N_{50}P_0$	320.00	—	320.00	262.99	227.59	13149.50	11379.50	12264.50	3176.50
$S_1N_{50}P_{60}$	320.00	337.50	657.50	262.99	224.99	13149.50	11249.50	12199.50	2774.00
$S_1N_{50}P_{120}$	320.00	675.00	995.00	260.65	230.29	13032.50	11514.50	12273.50	2510.50
$S_1N_{100}P_0$	640.00	—	640.00	341.92	250.97	17096.00	12548.50	14822.25	5414.25
$S_1N_{100}P_{60}$	640.00	337.50	977.50	355.67	250.76	16783.50	12538.00	14660.75	4915.25
$S_1N_{100}P_{120}$	640.00	675.00	1315.00	356.52	265.90	17826.00	13295.00	15560.50	5477.50
$S_1N_{150}P_0$	960 00	—	960.00	362.48	265.74	18124.00	13287.00	15705.50	5977.50
$S_1N_{150}P_{60}$	960.00	337.50	1297.50	382 41	260.66	19120.50	13033.00	16076.75	6011.25
$S_1N_{150}P_{120}$	960.00	675.00	1635.00	380.58	275.39	19029.00	13669.50	16349.25	5946.25
$S_2N_0P_0$	—	—	—	179.85	119.79	8992 50	5989.50	7491.00	Nil
$S_2N_0P_{60}$	—	337.50	337.50	188.65	155.89	9432.50	7794.50	8613.50	785.00
$S_2N_0P_{120}$	—	675.00	675.00	188.81	1401.7	9440.50	7008.50	8224.50	59.50
$S_2N_{50}P_0$	320.00	—	320.00	236.48	176.60	11824.00	8830.00	10327.00	2516.00
$S_2N_{50}P_{60}$	320.00	337.50	657.50	247.94	170.92	12397.00	8546.00	10471.50	2323.00
$S_2N_{50}P_{120}$	320.00	675.00	995.00	252.41	190.18	12620.50	9509.00	11064.75	2578.75
$S_2N_{100}P_0$	640.00	—	640.00	299.88	201.47	14994.00	10073.50	12533.75	4402.75
$S_2N_{100}P_{60}$	640.00	337.50	977.50	294.65	188.35	14732.50	9417.50	12075.00	3606.50
$S_2N_{100}P_{120}$	640.00	675.00	1315.00	302.45	218.12	15122.50	10906.00	13014.25	4208.25

$S_2N_{150}P_0$	960.00	—	960.00	308.58	240.51	15429.00	12025.50	13727.25	5276.25
$S_2N_{150}P_{60}$	960.00	337.50	1297.50	312.50	200.05	15629.50	10002.50	12816.00	4027.50
$S_2N_{150}P_{120}$	960.00	675.50	1635.00	320.87	230.77	16043.50	11538.50	13791.00	4665.00
$S_3N_0P_0$	—	—	—	185.68	115.05	9284.00	5752.50	7518.25	Nil
$S_3N_0P_{60}$	—	337.50	337.50	165.28	113.88	8264.00	5694.00	6979.00	−876.75
$S_3N_0P_{120}$	—	675.00	675.00	166.98	130.65	8349.00	6532.50	7440.75	−752.50
$S_3N_{50}P_0$	320.00	—	320.00	233.30	124.99	11665.00	8249.50	8957.25	1119.00
$S_3N_{50}P_{60}$	320.00	337.50	657.50	237.99	146.37	11899.50	7318.50	9609 00	1433.25
$S_3N_{50}P_{120}$	320.00	675.00	995.00	233.72	170.56	11686.00	8528.00	10107.00	1593.75
$S_3N_{100}P_0$	640.00	—	640.00	262.48	158.08	13124.00	7904.00	10514.00	2355.75
$S_3N_{100}P_{60}$	640.00	337.50	977.50	285.59	191.38	14279.50	9569.00	11924.25	3428.50
$S_3N_{100}P_{120}$	640.00	675 00	1315.00	256.32	184.97	12816.00	9248.50	11032.25	2199.00
$S_3N_{150}P_0$	960.00	—	960.00	307.02	172.08	15351.00	8604.00	11977.50	3499.25
$S_3N_{150}P_{60}$	960.00	337.50	1297.50	305.82	210.68	15291.00	10534.00	12912.50	4096.75
$S_3N_{150}P_{120}$	960.00	675.00	1635.00	310.35	198 47	15517.50	9937.00	12727.25	3574.00

C. D. at 5% for curd yield; spacings × nitrogen × phosphorus levels 1979-80 28.29
1980-81 41.59

Costs of CAN and single superphosphate were same in both the years.

of increase was less as compared to 100 kg N. Under S_2 spacing, the highest average profit (Rs. 5276.25) over control was recorded in 150 kg N and PO. S_3 spacing was not so economical as S_1 and S_2. Among all the combinations, S_1 (60×40 cm) spacing in combination with 150 kg N/ha and 60 kg P_2O_5/ha recorded maximum average profit (Rs. 6011.25) over control closely followed by $S_1 \times N_{150} \times P_{120}$. Thus, it can be concluded that S_1 spacing in combination with 150 kg N and 60 kg P_2O_5 may help in increasing the remunerative profit over control

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Haryana agric. Univ. J. Res., Vol. XIII, No. 4, pp. 579—586 (December 1983)

GROUNDWATER BALANCE—A CASE STUDY IN AN IRRIGATED AREA

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(Received : December 31, 1981; Revised : May 17, 1982)

ABSTRACT

A groundwater balance study was conducted at the University Farm, Hissar, covering an area of 1300 ha during October 1979 to September 1980. Various components of the water balance equation, viz. sub-surface inflow, outflow, recharge from rainfall, loss of water through capillary rise, evapotranspiration, groundwater pumpage and seepage from irrigation system were estimated. It is concluded that natural sub-surface drainage is quite inadequate at the Farm.

The drainage problems of an irrigated area are closely related with its transmitting properties. Generally, in arid and semi-arid regions where the natural subsurface drainage is not well developed, introduction of canal irrigation results in the rise of water table. When the groundwater level rises close to the ground surface, salinization may occur. In such areas, before taking up any remedial measure for stabilizing the water table, it is utmost essential to estimate the contribution of different sources. This requires the undertaking of detailed water balance study of the area.

METHODOLOGY

The water table data were recorded by installing 75 observation wells at a grid interval of 600 × 600 m at the Farm and surrounding areas. These water levels were used to draw water table fluctuation map (Oct. 1979 to Sep. 1980) to determine the net change in storage during the period. The daily release data for Farm Minor and Sarsana Minor which supply irrigation water to the Farm were recorded from canal department. The sub-surface inflow and outflow were estimated by using flow net technique. The evapotranspiration of different crops was estimated by using Blaney Criddle technique (Israelsen and Hansen, 1962). The loss of water through capillary rise was determined using Rijtema model. The recharge of rainfall was taken as 20% of total rainfall during the entire period. The data on pumpage were procured from Director Farm and Public Health Department of the University.

GROUNDWATER BALANCE MODEL

General hydrologic equation (Domenico, 1972) from continuity consideration is

$$I(t) - I(o) = \triangle s \quad \ldots (1)$$

where

$I(t)$ = inflow during a given period of time;

I (o) = outflow during a given period of time;

$\triangle s$ = change of water in storage during the time interval '$\triangle t$'.

For the Farm following are the various components :

Inflow components :

(i) Sub-surface flow

(ii) Percolation from precipitation

(iii) Percolation from irrigation

Outflow components :

(i) Sub-surface outflow

(ii) Evapo-transpiration

(iii) Capillary rise

(iv) Groundwater pumpage

The capillary rise from shallow water table depth shall meet the part requirement of the crops. Therefore, knowing the record of total water available during a particular period and corresponding evapo-transpiration, the total recharge from irrigation system is determined provided capillary amount is shifted to input side. It avoids the estimation of percolation losses from individual sources, viz. canal, water courses and field. In the present study, same approach was used to determine the water balance of the Farm. It was assumed that changes in the soil moisture of soil profile were negligible. The average transmissivity of the Farm estimated through pumping tests ranged from 40 to 50 m^2/day.

Sub-surface inflow and outflow. The average water table contour map (Oct. 1979 to Sep. 1980) of the Farm was used to estimate the inflow and outflow from the area by drawing flow net along the Farm's boundaries. The flow net (Fig. 1) was constructed by drawing flow lines perpendicular to the equipotential lines in such a manner that squares were formed. The flow rate through any channel or path of flow between two adjacent flow lines was obtained using the following formula (Anonymous, 1974).

$$Q = n . \triangle h . KD \quad ...(2)$$

Where n = number of squares;

$\triangle h$ = drop in head between equipotential lines;

K = hydraulic conductivity of aquifer 'm/day';

D = full saturated thickness of aquifer 'm'.

Capillary rise. The average water table depth ranged from 1.5 to 6 m over the entire year. Such shallow water table results in appreciable loss of water through capillary rise. Rijtema model (Rijtema, 1970) was used to estimate the flow velocity (mm/day) of water in soil. The average daily flow velocity was estimated for each node and isocapillary rise map (Fig. 2) was drawn. The area under different capillary rise ranges was determined.

Rainfall recharge. Most of the empirical formulae developed to estimate recharge from rainfall are for the areas where no canal irrigation is practised. According to these formulae an average annual rainfall less than 400 mm shall not contribute to the recharge of ground-

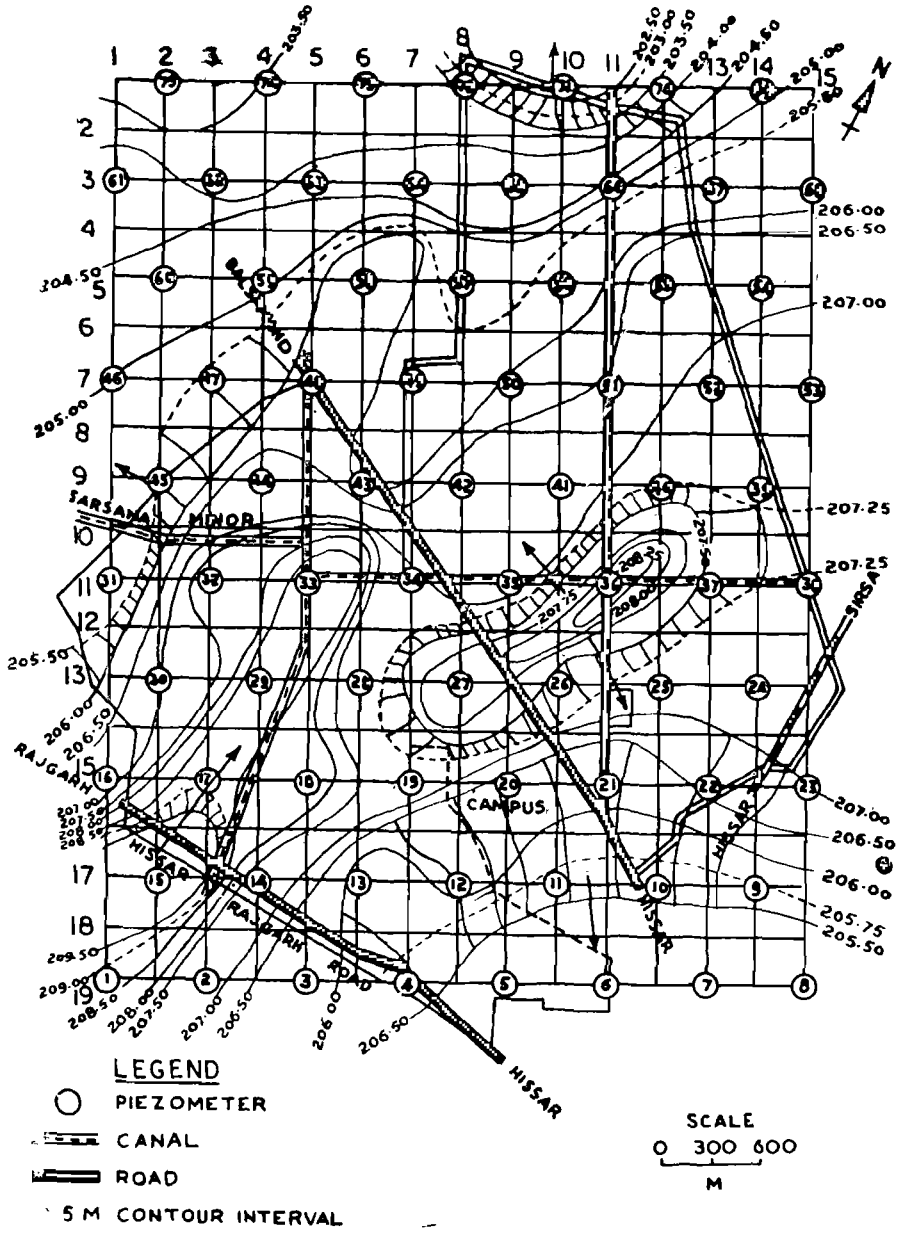


Fig. 1. Average water table contour map and flow net (Oct. 1979—Sep. 1980).

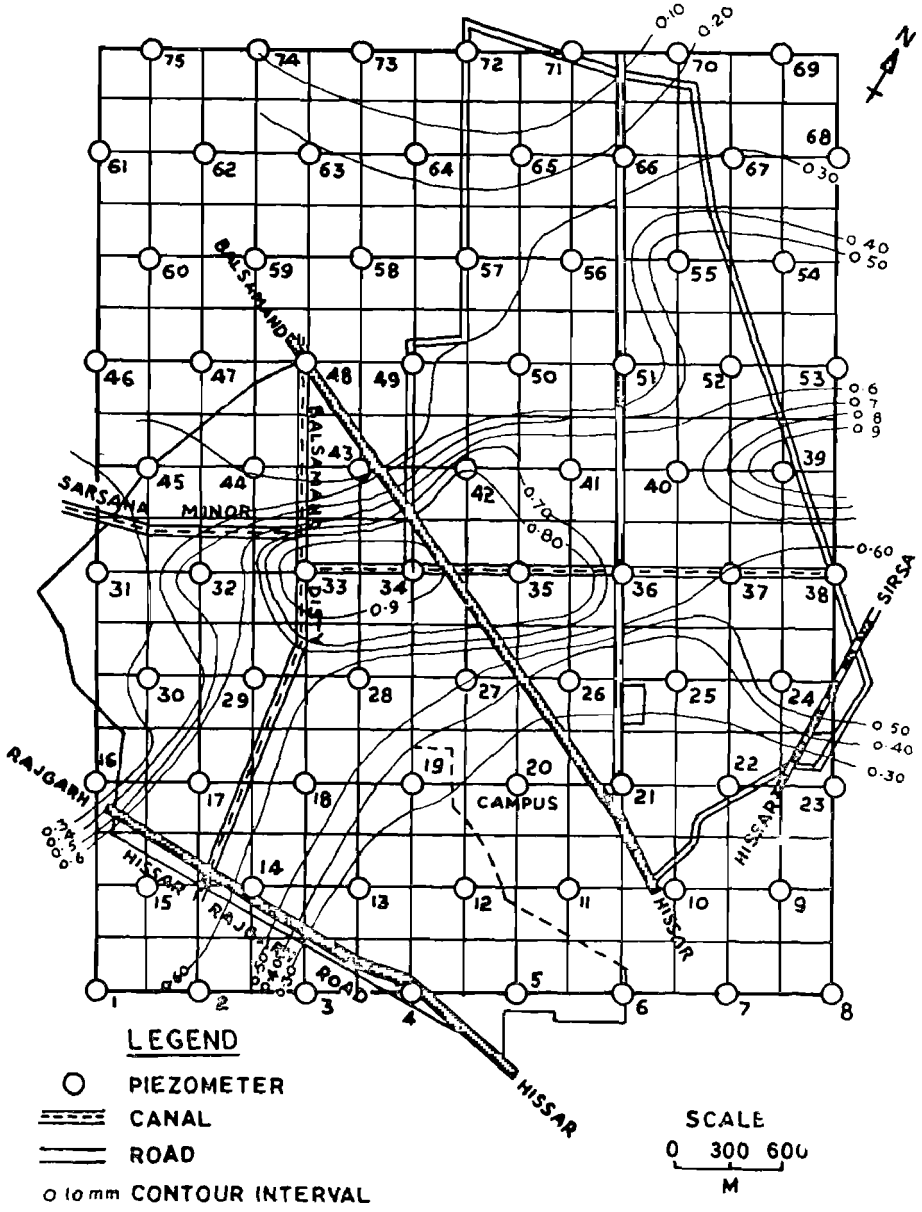


Fig. 2. Isocapillary rise map of HAU Farm Hissar (Oct. 1979—Sep. 1980).

water. In the present case 20% of the total rainfall of the period was assumed to contribute towards deep percolation as per the Haryana Groundwater Boards's norms.

Tubewell pumpage. There were fifteen working tubewells in the Farm. The discharge of these tubewells ranged from 13,500 to 36,000 l/h. The running hours data were collected from the Director Farm and Public Health Department of the University.

Water available. The Farm got water from two minors of Balsmand Distributory. The Farm minor supplied water to old Farm area and Chawani block and the Sarsana minor to Gangwa block. At full supply level the Farm's share at the Farm minor and Sarsana minor was 0.48 cumec and 0.12 cumec, respectively. The daily data of running schedule of the Farm minor and Sarsana minor collected from irrigation department were used to determine the water availability during every month. The tubewells under the control of Director Farm were exclusively used for irrigation. The Public Health tubewells were used in conjuction with canal water to irrigate lawns in the campus area. Since there was no separate record available as to how long a particular tubewell was run for irrigation or to supply water, it was assumed that 50% of the water was used for irrigation and rest 50% for drinking purposes.

Evapo-transpiration. To determine the total evapo-transpiration during the period it is essential to know the area under different crops at the Farm. These data were procured from the Director Farm and different departments and are given in Table 5. The evapo-transpiration for different crops was estimated using Balney Criddle technique and compared with experimental data (Singh *et al.*, 1978, 1979). The experimental values for wheat, gram, oil seeds and barley were 36, 18, 24 and 20 cm, respectively, while the estimated values were 42,20,27 and 23 cm, respectively. Thus, there was variation of only 10 to 15 per cent between the estimated and experimental values of evapo-transpiration.

RESULTS AND DISCUSSION

By using Fig. 1 sub-surface inflow to the Farm and outflow from the Farm were estimated as follows :

$$\text{Inflow} = 12 \times 0.5 \times 52$$
$$= 312\ m^3/day = 1138.8\ ha\text{-}cm/year$$

$$\text{Outflow} = (7 \times 0.25 \times 40 + 13 \times 0.50 \times 43 + 13 \times 0.50 \times 36)$$
$$= 583.5\ m^3/day = 2129.7\ ha\text{-}cm/year$$

Capillary Rise

The area under different capillary rise was determined from Fig. 2 and is reported in Table 1. In 43% of the area, the flow velocity from water table was more than 0.4 mm per day. The total loss through capillary rise during the entire period (Oct. 1979 to Sep. 1980) was 18,522 ha-cm.

Rainfall Recharge

The total rainfall received during Oct. 1979 to Sep. 1980 was 318 mm. The total recharge from rainfall amounts to 7548 ha-cm during this period.

TABLE 1

Area under different capillary rise ranges at the Farm* (Oct. 1979-Sep. 1980)

Description	Capillary rise range (mm)									
	0-0.1	0.1-0.2	0.2-0.3	0.3-0.4	0.4-0.5	0.5-0.6	0.6-0.7	0.7-0 8	0.8-0.9	0.9-10.0
% area	2.33	3.10	31.78	19.77	6.20	14.73	11.63	2.71	5.42	2.33
Area in hectare	27.66	36.89	377.23	234.67	73.59	174.85	138.05	32.17	64.34	27.66

*The area under buildings and roads is excluded for capillary rise.

TABLE 2

Tubewells running hours under Director Farms (1979-80)

Month	Tubewell Nos.						
	2	4	5	7	9	10	12
Oct. 79	—	17	6	—	71	39	98
Nov. 79	—	26	38	127	87	13	49
Dec. 79	48	5	8	—	140	52	—
Jan. 80	26	21	24	—	39	41	15
Feb. 80	59	17	34	26	28	9	—
March 80	15	7	16	18	24	6	19
April 80	—	15	10	79	64	61	—
May 80	—	—	—	141	86	—	—
June 80	—	—	9	194	—	21	—
July 80	—	—	—	—	—	—	—
Aug. 80	—	6	21	64	76	80	—
Sep. 80	—	10	15	191	187	115	33

TABLE 3

Tubewells running hours under Public Health (1979-80)

Month	Tubewell Nos.							
	2	5	7	8	9	10	11	12
Oct. 79	124	277	171	171	391	135	27	42
Nov. 79	54	370	62	62	338	59	16	18
Dec. 79	187	326	28	28	358	159	30	—
Jan. 80	163	—	—	241	262	154	69	—
Feb. 80	140	—	—	148	182	132	57	—
March 80	201	—	66	118	120	119	52	—
April 80	215	—	45	222	262	199	99	—
May 80	416	—	—	398	352	214	80	—
June 80	367	—	—	394	351	304	90	—
July 80	87	71	—	95	109	172	188	—
Aug. 80	14	42	—	24	110	25	28	—
Sep. 80	7	123	—	4	217	106	14	39

TABLE 4

Total water available from Farm Minor, Sarsana Minor and tubewells during 1979-80

Month	Amount of water available (ha-cm)
Oct. 79	7542
Nov. 79	7469
Dec. 79	3699
Jan. 80	7299
Feb. 80	3965
March 80	6789
April 80	8613
May 80	8151
June 80	8442
July 80	10924
Aug. 80	13333
Sep. 80	10086

TABLE 5

Existing cropping pattern at the Farm (1979-80) and evapo-transpiration of different crops

Season	Crop	Area (ha)	Evapo-transpiration (cm)
Rabi	Wheat	350	42
	Gram	120	20
	Oilseeds	55	27
	Fodder	190	70
	Barley	60	23
	Fallow	152	10
Kharif	Cotton	270	71
	Bajra	70	30
	Guar	105	32
	Fodder	225	90
	Pulses	85	25
	Fallow	172	20
	Others	60	178
(Fruits, vegetables, etc. for entire year)			

TABLE 6

Different water balance components of the Farm (Oct. 1979-Sep. 1980)

Description of component	Amount (ha-cm)
Total water available	+ 96,322
Recharge from rainfall	+ 7,548
Sub-surface inflow	+ 1,139
Capillary rise	+ 18,522
Actual evapo-transpiration from	
(a) Farm area	— 92,884
(b) Lawns	— 21,900
Sub-surface outflow	— 2,130
Pumpage	— 4,700
Change in groundwater storage	+ 1,921

Tubewell Pumpage and Water Available

The running hours for different tubewells and months are shown in Tables 2 and 3. The total pumpage during the period worked out to be 4700 ha-cm. The water availability during different months from all sources is given in Table 4. The total water availability during the period amounts to 96,322 ha-cm.

Evapo-transpiration

The total evapo-transpiration from the Farm and lawn was 92,884 ha-cm and 21,900 ha-cm, respectively. At present approximately 20% of the total water available is getting lost through capillary rise. The sub-surface inflow and outflow components were quite low in comparison to other components. The pumpage was also low because of poor underground water quality.

CONCLUSION

Different water balance components are summarised in Table 6. The sub surface flow component is quite inadequate in comparison to other components. Major recharge is occurring through irrigation water. Appreciable quantity of water is getting lost through capillary rise. In case water table is depressed through pumpage then after sometime the decline in water table shall not commensurate with pumpage.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 4, pp. 587—592 (December 1983)

STUDY OF THE EFFECT OF PRECEDING CROPS AND PHOSPHATIC MANURING ON NITROGEN REQUIREMENT OF SUCCEEDING MUSTARD CROP (*BRASSICA JUNCEA*)

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(Received : January 8, 1982; Revised : September 16, 1982)

ABSTRACT

Nitrogen requirement of raya *(Brassica juncea)* in different crop sequences including legumes and non-legumes with and without phosphatic manuring was studied. The preceding crops of **jowar**, cowpea, **guar** and **bajra** gave 267.2, 220.9, 219 9 and 237 5 q/ha green fodder while yield of moong (grain) was 7.4 q/ha. The yield of raya succeeding fallow, cowpea, **guar**, moong (grain), **bajra** and **jowar** was 13.04, 13.46, 12 63, 14.91, 10 16 and 9.51 q/ha, respectively, indicating higher yields after legumes. The per cent increase worked out to be 37.0, 41.5, 32.3, 56.8 and 6.8, respectively over jowar-raya sequence. The responses to nitrogen were highest after **jowar** and **bajra**. There was saving of 30 kg N when raya was grown in sequence with legumes. Application of phosphate increased the yields of recipient crops of legumes and also of the succeeding raya crop. The increase in yield of raya was due to increase in grain weight and number of branches per plant. Moong-raya rotation gave highest return followed by cowpea-raya and **guar**-raya.

Rape *(Brassica campestris* L.*)* and mustard *(B. juncea* (L.) Czern. & Coss.*)* are the most important oil seed crops of northern India. In India, area under these crops is 31.45 lakh hectares while the production is 40.4 lakh tonnes. In Haryana, the area and production of rape and mustard is 106 thousand hectares and 67 thousand tonnes, respectively. Out of this area, nearly 75% is under raya *(B. juncea)*. Although the average yield of raya in Haryana during the last 5 years has increased from 3.1 q/ha to 7.6 q/ha, it is still very low. The crop is mostly grown under rainfed conditions and follows **kharif** fallow. Under irrigated conditions it is possible to grow raya crop after early maturing **kharif** crops or after early summer crops e.g., moong and fodders. When the crop is grown after exhaustive crops like **jowar** and **bajra** which are the common **kharif** crops in Haryana, the deficiency of nitrogen may be acute. For the adoption of multiple cropping and maintenance of soil fertility, leguminous crops are the probabilities in the sequence. The beneficial effects of phosphate applied to legumes on succeeding crops are known (Parr and Bose, 1944; Negi and Singh, 1955; Sen and Bains, 1955; Pahwan *et al.*, 1975). The yields of

succeeding crops after **kharif** legume were found to be considerably higher than after non-legumes (Singh *et al.*, 1966). The requirement of nitrogen has also been reported to vary in relation to preceding crops (Negi and Singh, 1955). However, no information is available on yield variation in raya crop in relation to manuring and residual effect of preceding crops under irrigated conditions. The studies were, therefore, undertaken on raya under different cropping sequences.

MATERIAL AND METHODS

The investigation was carried out at the Haryana Agricultural University Farm, Hissar, during the years 1977-78 and 1978-79 which included all combinations of fallow (C_0), five preceding crops viz., cowpea (*Vigna unguiculata* (L.) Walp) (C_1), **guar** (*Cyamopsis tetragonoloba* (Linn.) (C_2), moong bean (*Vigna radiata* L. Wilczek) (C_3) as legumes and **bajra** *(Pennisetum typhoides)* (C_4) and **jowar** *(Sorghum vulgare)* (C_5) as non-legumes, and two levels of phosphorus, i.e., control (P_0) and 40 kg P_2O_5/ha (P_1) allocated in main plots, and four levels of nitrogen viz., control (N_0), 30 (N_1), 60 (N_2) and 90 (N_3) kg N/ha applied to raya crop in sub-plots. The soil was sandy loam while available N, P_2O_5 and K_2O were 160, 11 and 410 kg/ha, respectively, and pH was 8.3. The preceding crops were sown in May and harvested in the first week of September. Raya was sown in first week of October and harvested in March. Nitrogen was applied to raya crop in two splits, half at sowing and half after first irrigation. Five plants were taken at random for recording branches per plant and were harvested separately for yield component studies. The test-weight was determined by taking a random sample of 1000 seeds from the produce of each treatment. The harvest from each plot was threshed, cleaned and weighed.

RESULTS AND DISCUSSION

Effect of Phosphate on Preceding Crops

The yield of preceding crops under different treatments is given in Table 1. Perusal of the data indicates that

TABLE 1

Effect of phosphate on preceding crops

Preceding crops	Yield (q/ha)						Increase/ decrease
	1977-78		1978-79		Mean		
	P_0	P_1	P_0	P_1	P_0	P_1	P_1—P_0
Cowpea (C_1) (fodder)	235.1	253.3	225.4	235.8	230.3	244.6	14.3
Guar (C_2) (fodder)	233.0	246.8	192.3	206.8	212.7	226.8	14.1
Moong (C_3) (grain)	4.5	5.2	7.2	8.5	5.9	6.9	1.0
Bajra (C_4) (fodder)	158.5	164.6	277.5	282.9	218.0	223.8	5.8
Jowar (C_5) (fodder)	197.4	198.9	335.6	337.0	266.5	267.9	1.4

TABLE 2

Effect of preceding crops on yield of raya (q/ha)

Preceding crops	Yield			Increase over jowar	Per cent increase
	1977-78	1978-79	Mean		
Fallow	11.54	14.55	13.04	3.53	37.1
Cowpea	12.45	14.47	13.46	3.95	41.5
Guar	11.11	14.15	12.63	3.12	32.8
Moong	13.84	15.97	14.91	5.40	56.8
Bajra	9.57	10.74	10.16	0.65	6.8
Jowar	8.62	10.40	9.51		
S. Em.±	0.319	0.282			
C. D. at 5%	0.993	0.878			

TABLE 3

Effect of nitrogen in different sequences on yield of raya (q/ha)

Preceding crops	Doses of nitrogen	Yield			Increase over control
		1977-78	1978-79	Mean	
Fallow	0	8.60	10.92	9.76	—
	30	10.40	13.15	11.82	2.06
	60	12.50	16.75	14.62	4.96
	90	14.66	17.39	16.02	7.26
Cowpea (fodder)	0	8.45	10.09	9.27	—
	30	12.48	13.40	12.94	3.67
	60	13.87	16.29	15.06	5.81
	90	15.02	18.11	16.57	7.30
Guar (fodder)	0	7.33	10.60	8.97	—
	30	10.56	13.68	12.12	3.15
	60	12.13	15.36	13.75	4.78
	90	14.43	16.94	15.69	6.72
Moong (grain)	0	10.21	10.15	10.18	—
	30	13.74	15.34	14 54	4.36
	60	15.23	18.36	16.80	6.62
	90	16.20	20.02	18.11	7.93
Bajra (fodder)	0	5.00	5.27	5.15	—
	30	7.78	9.80	8.79	3.65
	60	10.99	12.75	11.87	6.73
	90	14.53	15.14	14.84	9.70
Jowar (fodder)	0	4.94	6.13	5.54	—
	30	5.51	8.97	7.24	1.70
	60	10.00	11.71	10.86	5.32
	90	14.03	14.79	14.41	8.87
S. Em.±		0.53	0.84		
C. D. at 5%		1.65	2.61		

maximum fodder yield was obtained from **jowar** followed by cowpea, **bajra** and **guar**. Due to the application of phosphorus the increase in the yield of leguminous crops was more as compared to non-leguminous crops in both the years.

Effect of Preceding Crops on Raya

The yield of raya succeeding various crops is given in Table 2. Significantly higher yield of raya was obtained after legumes viz., moong, cowpea and **guar** as compared to **bajra** and **jowar** as evident from the percentage increase over **jowar** i.e. 56.8, 41.5, 32.8, 32.7 and 6.8, respectively. Legume-raya rotation was found to be more productive as compared to fallow-raya. These findings are in conformity with those of Singh *et al.* (1966, 1967).

Effect of Nitrogen on Yield of Raya in Different Sequences

The data in Table 3 reveal that the response of raya to nitrogen was higher with non-leguminous crops compared to legumes particularly at the higher levels of nitrogen. This indicates greater depletion of nitrogen by the non-leguminous crops viz., **bajra** and **jowar**. The increase in yield of raya succeeding legumes was of the same magnitude as obtained with 30 kg N/ha. The graded doses of nitrogen upto 90 kg/ha were found to be economical. There was no significant increase in raya yield over 60 kg N/ha succeeding legumes, however significant increase was obtained after non-legumes under all levels of nitrogen.

TABLE 4

Effect of residual phosphate on yield of raya (q/ha)

Preceding crops	Doses of P_2O_5	Yield			Increase over control
		1977-78	1978-79	Mean	
Fallow	0	11.36	13.34	12.35	—
	40	11.72	14.89	13.31	0.96
Cowpea (fodder)	0	11.26	13.79	12.53	—
	40	13.63	15.16	14.40	1.87
Guar (fodder)	0	10.94	13.54	12.24	—
	40	11.29	14.75	13.02	0.78
Moong (grain)	0	15.37	15.27	14.32	—
	40	14.32	16.66	15.49	1.17
Bajra (fodder)	0	9.56	10.28	9.92	—
	40	9.59	11.20	10.39	0.47
Jowar (fodder)	0	8.68	9.94	9.31	—
	40	8.56	10.86	9.71	0.40
S. Em.±		0.19	0.16		
C. D. at 5%		0.59	0.50		

TABLE 5

Economics of phosphate applied to preceding crops and residual effect on raya

Preceding crops	Increase in yield of preceding crops (q/ha)	Income (Rs /ha)	Increase in yield of raya (q/ha)	Income (Rs./ha)	Total income (Rs /ha)	Additional net income (Rs./ha)
Fallow	—	—	0.96	384	384	124
Cowpea	14 3	143	1.87	748	891	631
Guar	14.1	141	0.78	312	453	193
Moong	1.0	350	1.17	468	818	558
Bajra	5.8	58	0.47	188	246	—14
Jowar	1 4	14	0.40	100	174	—96

Pure fodders @ Rs. 10/q; moong grain @ Rs. 350/q and raya @ Rs. 400/q; cost of P_2O_5 @ Rs. 6.50/kg.

TABLE 6

Effect of preceding crops, residual phosphate and nitrogen levels on yield components of raya

Treatments	1000-seed weight			Seed yield/plant			Branches/plant		
	1977-78	1978-79	Mean	1977-78	1978-79	Mean	1977-78	1978-79	Mean
Preceding crops									
Fallow	2.71	2.92	2.81	15.90	17.40	16.55	16.80	18.88	17.79
Cowpea	2 79	2.91	2.85	16.84	17.50	17.17	17.90	18.38	18.14
Guar	2.72	2.84	2.78	15.90	16.60	16.25	15.50	18 60	17.05
Moong	2.98	3.12	3.05	18.10	19.50	18.80	20.21	21.65	20.93
Bajra	2.25	2.32	2.29	12.20	13.20	12.70	15.50	15.97	15.74
Jowar	2.18	2.20	2.19	11.80	13.00	12.40	15.20	16.60	15.90
S. Em.±	0.075	0.061	—	0.521	0.728	—	0.628	0.534	—
C. D. at 5%	0.233	0.189	—	1.62	2.26	—	1.95	1.68	—
Levels of phosphate									
P_0	2.46	2.50	2.48	14.10	15.20	14.60	16.40	17.60	17.0
P_1	2.76	2.90	2.83	15.98	16.80	16.35	17.80	18.54	18.17
S. Em.±	0.082	0.048	—	0.56	0.51	—	0.62	0.524	—
C. D. at 5%	0.25	0.15	—	1.74	1.58	—	N.S.	N.S.	—
Levels of nitrogen									
N_0	2.20	2.30	2.25	8.20	8.90	8.55	13.00	14.34	13.67
N_1	2.41	2.50	2.45	15.19	16.50	15.85	16.52	17.80	17.16
N_2	2.68	2.75	2.71	17.40	18.50	17.95	18.34	18.92	18.63
N_3	3.15	3.25	3.20	19.45	20.10	19.78	20.54	21.30	20.92
S. Em.±	0.050	0.032	—	0.211	0.178	—	0.295	0.325	—
C. D. at 5%	0.13	0.088	—	0.603	0.510	—	0.847	0.953	—

Residual Effect of Phosphate Applied to Preceding Crops on Raya

The residual effect of 40 kg P_2O_5/ha applied to preceding leguminous crops was more pronounced (Table 4). The percentage increase in raya yields after fallow, cowpea, guar, moong, bajra and jowar was 7.9, 15.4, 6.2, 8.2, 5.0 and 4.3, respectively. Mahajan and Khanna (1968) also reported that continuous application of phosphorus to the preceding crops at the rate of 40 kg/ha resulted in highest increase in grain yield of succeeding crop.

The application of phosphate to preceding crops was found to be more remunerative in cowpea-raya followed by moong (seed)-raya and guar-raya while there was no gain out of its application to non-leguminous crops viz., bajra and jowar (Table 5).

Effect of Preceding Crops, Residual Phosphate and Nitrogen on Yield Component of Raya

The data in Table 6 reveal that test weight, yield per plant and branches per plant were higher after leguminous crops, phosphatic and nitrogenous manuring. The increase in yield per hectare, therefore, was attributed to increase in grain weight and higher number of branches per plant.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 4, pp. 593—595 (December 1983)

EVALUATION OF VARIOUS PACKINGS OF **BER** FRUIT IN RELATION TO DECAY LOSS CAUSED BY VARIOUS MICROBES

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(Received : February 20, 1982; Revised : December 29, 1982)

ABSTRACT

Four types of packages and two cushioning materials were evaluated for their effect on microbial decay during storage of Umran and Kaithli cultivars of **ber** fruits at room temperature. Packings made of gunny bags and wooden boxes were better in reducing spoilage than those of bamboo basket and card board. *Paper cuttings were the best cushioning material for the* reduction of decay losses due to *Ulocladium chartarum, Phoma hissarensis* and *Botryodiplodia theobromae.*

Ber *(Zizyphus mauritiana* Lamk.) is one of the commonly grown fruits in the arid and the semi-arid regions of India. In Haryana, **ber** occupies nearly 10-15% of total fruit cultivated area. The shelf-life of **ber** fruits is very short due to decay losses caused by several microbes (Vyas and Panwar, 1976; Gupta and Madan, 1977; Kainsa *et al.*, 1978). Considering the commercial importance and heavy losses, it was thought essential to find out the suitable packings for prolonging the storage life of **ber** fruits at room temperature.

MATERIAL AND METHODS

The present investigation was undertaken at the Post-harvest Technology Laboratory of the Department of Horticulture. Mature **ber** fruits of two cultivars viz., Umran and Kaithli were harvested just when they showed the sign of changing colour from dark green to yellowish green, and were packed in vented (about 1%0) cartons made of wooden boxes (40 × 30 × 20 cm), card board (30 × 25 × 15 cm), bamboo basket and gunny bags (each 10 kg capacity) by using paper cuttings or grass hay (450 g/pack) as cushioning material in all the different types of cartons except gunny bags packings. The fruits were packed or arranged horizontly in all the packings. Cushioning material was about 3 inch thick at the bottom and 2 inch thick above the fruits in each pack. After packing, the baskets were stored at room temperature 25±5°C. Each packet contained 3.5 kg of healthy fruits and for each observation four replications were kept.

Microbial decay was determined by weighing the number of fruits showing symptoms of decay (Srivastava and Tandon, 1968). Isolations from the decaying fruits were done by standard methods (Riker and Riker, 1936). The

TABLE 1

Decay loss (%) in various packings during storage

Packs	Cushioning material	After 4 days of storage		After 8 days of storage	
		Umran	Kaithli	Umran	Kaithli
Wooden box	Paper cutting	0.00	3.55	5.63	10.11
	Grass hay	0.00	3 66	6.24	15.63
Bamboo basket	Paper cutting	0.00	3.89	3.48	13.05
	Grass hay	0.00	6.88	7.41	27.90
Card board	Paper cutting	0.00	6.12	4.90	18.20
	Grass hay	0.00	20.97	5.85	48.01
Gunny bag		0.00	6.47	5.63	14 39
C. D. at 5%		—	3.17	2.22	4 36

TABLE 2

Fungi associated with decay of **ber** fruits in different packs during storage

Fungi	Frequency of occurrence of fungi in						
	Wooden box		Bamboo basket		Card board		Gunny bag
	Paper cutting	Grass hay	Paper cutting	Grass hay	Paper cutting	Grass hay	
Alternaria solani	0	1	0	1	0	1	0
Botryodiplodia theobromae	1	1	1	2	1	3	1
Fusarium roseum	0	0	0	1	0	1	0
Penicillium crysogenum	1	0	1	1	1	0	1
Phoma hissarensis	1	2	2	3	2	3	2
Ulocladium chartarum	2	3	2	3	2	2	2
Unidentified (Black mycelium)	0	1	1	0	0	1	0

0=nil, 1=rare, 2=common, 3=very common.

pathogenicity of the isolation organisms was studied on the healthy **ber** fruits of cv. Kaithli.

RESULTS AND DISCUSSION

The packings made of gunny bag and wooden box were better in reducing the spoilage than those of bamboo basket and card board (Table 1). Paper cuttings as cushioning material were superior in reducing decay loss over grass hay. These differences in decay in the packs may be attributed to the presence of fungal propagules on the surface of the packs and packing material (Singh and Gupta, 1979). The extent of loss due to decay increased with an increase in the storage period in all the packings and in both the cultivars. The least decay was in Umran, the fruit of which showed no decay upto 4 days of storage in all the packings. The decay was the highest (48.01%) in Kaithli fruits when stored for 8 days in card board packing with grass hay as cushioning material. This may be attributed to the low aeration in the packing.

Ulocladium chartarum, Phoma hissarensis and *Botryodiplodia theobromae* were isolated more frequently in all the packings (Table 2). Kainsa *et al.* (1978) isolated *U. chartarum* and *P. hissarensis* from the surface of the healthy **ber** fruits and Vyas and Panwar (1976) considered *Phoma* sp. and *B. theobromae* as primary cause of decay of **ber** fruits in storage. In addition to the above mentioned organisms *Alternaria solani, Fusarium roseum, Penicillium crysogenum* and one unidentified organism (no spore formation on PDA) were also isolated. It was found that these two groups of fungi jointly cause a major decay of **ber** fruits. However, *A. solani* and *F. roseum* were isolated only from the packs which has grass hay as cushioning material. This may be attributed to the presence of fungal propagules in the grass hay. All the isolates were found pathogenic on **ber** fruits.

ACKNOWLEDGEMENTS

The authors are thankful to the Director, C. M. I., Kew Surey, England for the identification of the isolates.

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XIII, No. 4, pp. 596—598 (December 1983)

GENETIC VARIABILITY STUDIES IN CUMIN (*CUMINUM CYMINUM* L.)

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(Received : November 6, 1981; Revised : March 31, 1982)

To bring about an effective improvement in a crop, understanding of magnitude and extent of genetic variability of desirable traits is important because selection of genotype on the phenotypic performance basis depends on the degree of heritability and genetic advance which are important components of genetic variability. Cumin is an important spices of Northern India and very little information is available on these aspects. The present experiment was carried out to investigate the nature and magnitude of genetic variability for six quantitative characters in cumin.

Fifty diverse genotypes of cumin were grown in a randomized block design with three replications in November, 1979, at the Vegetable Research Farm in a single row trial. The spacing between rows and plants was kept at 40 and 10 cm, respectively. Observations were recorded on 10 randomly selected plants of each genotype for six characters, viz. days to germination, bolting, plant height, number of seeds per umbel, number of umbellets per umbel and yield per plant. Statistical analysis for computation of coefficient of genotypic and phenotypic variation was worked out according to the method suggested by Burton and DeVane (1953) and heritability and genetic advance were calculated by the method of Hanson *et al.* (1956).

There were significant differences among genotypes suggesting wide range of variation. General mean, range, phenotypic and genotypic variances and coefficients of variation, heritability (in broad sense) and genetic advance as per cent of mean have been shown in Table 1. Maximum range was recorded for yield per plant.

The estimate of coefficients of variation revealed that yield per plant, days to germination, number of seeds per umbel and plant height had a high degree of genotypic coefficient of variation in order. High phenotypic coefficient of variation was observed for yield per plant, seeds per umbel and plant height. Similar findings in cumin were also reported by Mathur *et al.* (1971) for yield per plant. Though this estimate indicate the presence of a high degree of genetic variation but the amount of heritable portion of variance can only be determined by heritability and genetic advance.

Yield per plant exhibited highest heritability followed by days to germination

TABLE 1

Variability parameters for different characters in Cumin

Characters	General mean	C. D. at 5%	Range	Range difference as per cent of mean	Variance due to			Coefficients of		Heritability (%) in broad sense	Genetic advance as per cent of mean
					Treatment	Genotypic	Phenotypic	Genotypic (%)	Phenotypic (%)		
Yield/plant (g)	5.57	0.53	3.10-9.08	107.37	5.2106	1.6996	1.8813	23.41	24.17	93.83	46.71
No. of seeds/umbel	38.05	5.86	33.72-44.90	29.38	22.6505	3.0833	16.4838	4.61	10.67	18.71	4.11
No. of umbellets/umbel	5.76	0.51	5.33-6.28	16.50	0.1564	0.0186	0.3453	2.37	5.99	15.60	1.93
Height of plant (cm)	46.85	4.10	38.33-50.47	25.92	19.1135	4.1849	10.7436	4.37	7.00	38.95	5.61
Days to bolting	65.22	0.73	62.99-66.99	6.13	0.6463	0.4358	0 6463	1.01	1.23	67.43	1.71
Days to germination	14.13	1.36	12.67-15.67	21.23	0.6327	0.4440	0.6327	4.72	5.63	70.18	8.06

and bolting, whereas moderate heritability was found for plant height. Mathur *et al.* (1971) also investigated high heritability for yield per plant though this estimate indicates the effectiveness of selection on phenotypic performance basis. However, estimate of heritability alongwith genetic advance are more useful for selection.

Johnson *et al.* (1955) suggested that heritabi lity estimate alongwith genetic advance are usually more fruitful and should be considered together for making an effective selection. Yield per plant exhibited highest range, coefficients of variation, heritability and genetic advance, probably due to additive gene effects (Panse, 1957). Hence, this character should be given due importance for selection.

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XIII, No. 4, pp. 599—601 (December 1983)

ASSESSMENT OF SOME GRAPE CULTIVARS FOR BUD, FLOWER AND BERRY DROP

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(Received : January 12, 1982; Revised : July 21, 1982)

The problem of bud, flower and berry drop, was first reported in serious proportions in grape growing areas around Jodhpur (Rajasthan) by an expert committee of ICAR. It has also been reported in other grape growing areas of North India (Bindra, 1977; Chundawat and Jindal, 1978; Dabas *et al.*, 1980). Chundawat and Jindal (1978) determined the extent and kind of drop in a number of promising cultivars and discussed the possible causes for the same. Some other grape cultivars which find a suitable place under North Indian conditions like Himrod, Pusa Seedless, Banquiabyad, Champion, etc. are yet to be assessed. In present study, eight grape cultivars including the above ones, were assessed for the extent of bud, flower and berry drop.

Four uniform vines of each cultivar were selected and four panicles were tagged on each vine to record different observations. For calculating berry set (extent of bud and flower drop), total buds/panicle and berries set/bunch were counted. The data on subsequent berry drop were recorded by counting the number of berries per bunch at harvest. The berries per bunch were counted just before harvest and then the samples were taken to the laboratory in paper bags. The berries dropped during harvest and handling were counted and on that basis per cent post-harvest berry drop was calculated.

The data in Table 1 revealed that berry set was comparatively poor in Himrod, Red Prince and Kishmish, mainly due to heavy drop of unopened buds and flowers while in other cultivars such as Mandeleine Angevine, Champion, Banquiabyad, Seedless and Pusa Seedless berry set was fairly high. The subsequent berry drop was recorded very high in Pusa Seedless, Seedless and Kishmish cultivars. The minimum berry drop (15.91%) was found in Banquiabyad. In Champion and Mandeleine Angevine, the berry drop was around 25% which was possibly within the safe limits as all the buds if developed into berries may produce a very compact bunch. In these two cultivars, the berry set was also comparatively more. Unfertilized and physiologically weak berries tend to abscise just after set (Chundawat and Jindal, 1978). However, in Himrod and Red

*Present address : S-2 (Grape breeder), I.A.R.I., New Delhi-110 012.

TABLE 1

Berry set and berry drop in different cultivars of grapes

Cultivars	Per cent berry set	Per cent berry drop	Per cent post-harvest drop
Himrod	22.34	26.79	—
Banquiabyad	74.76	15.91	1.12
Champion	75.00	23.83	—
Red Prince	27.22	24.94	0.76
Seedless	53.39	46.03	—
Pusa Seedless	53.65	47.41	—
Mandeleine Angevine	94.52	26.74	—
Kishmish	45.66	34.34	—
C. D. at 5%	33.31	20.17	—

Prince, the situation was quite serious as the berry set was low and there was subsequent high berry drop, which resulted into loose bunches and thereby reduced yield. The berry drop during handling was observed in Banquiabyad and Red Prince only and that too negligible. The differential extent of the problem in different cultivars may also be accentuated by excessive nitrogen application (Chundawat *et al.*, 1977), auxin and carbohydrate imbalance (Chatterjee and Leopold, 1963; Chundawat *et al.*, 1979; Dabas *et al.*, 1980) and the extent may vary in different training systems (Jindal *et al.*, 1980). Auxin application prior to abscission (Dabas, 1979) and girdling (Chundawat *et al.*, 1979) have been reported to reduce the extent of bud, flower and berry drop.

Post-harvest berry drop during transportation and storage is another important factor, which needs to be worked out for different cultivars so that the remedial measures can be found and suggested.

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RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XIII, No. 4, pp. 602—603 (December 1983)

STUDIES ON WEED PLANTS AS HOST RANGE OF URDBEAN LEAF CRINKLE VIRUS

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(Received : March 1, 1982; Revised : July 21, 1982)

Urdbean leaf crinkle virus (ULCV) causing leaf crinkle disease on urdbean *(Vigna mungo* (L.) Hepper) is known to spread through seeds and insects (Nene, 1972; Dhingra, 1975; Kadian, 1980; Kadian and Varma, 1981). The virus is also known to be sap transmissible (Kolte and Nene, 1975). Information on susceptible hosts is confined only to cultivated plants (Kolte and Nene, 1975). In order to find out the weed plants susceptible to leaf crinkle the present study was undertaken.

For studying host range and host reactions to ULCV, 23 weed plant species belonging to 13 families were maintained in the screen-house under insect proof conditions. Apparently healthy seedlings of a few weed plants which were not raised from seeds in screen-house, were obtained from the fields particularly from areas where pulse crops had been grown during the **kharif** season, and planted in pots inside the screen-house. Ten plants of each species were mechanically inoculated as per procedure described by Kolte and Nene (1975) and 5 plants of the same species were kept as uninoculated (control). Transmission of the virus was confirmed by back inoculation on test plants of urdbean cv. Krishna.

The results showed that *Convolvulus arvensis* L., *Datura stramonium* L., *D. metal* L., *D. metaloides* L. and *D. incrimis* L. were susceptible to the virus. The symptoms/reactions expressed by them are given in Table 1. The plant species which were not infected are : *Achyranthes* spp., *Amaranthus* spp., *Boerhavia diffusa* L., *Cannabis sativa* L., *Celosia argentea* L., *Chenopodium amaranticolor* L., *C. quinoa* L., *Cyperus rotundus* L., *Digera arvensis* Forsk., *Euphorbia hirta* L., *E. microphylla* Heyne, *Justicea quingqueangularis* Koen., *Nicotiana plumbaginifolia* Viv., *Phyllanthus niruri* L., *Polygala chinensis* L., *Portulaca oleracea* L., *Trianthema monogyna* L. and *Xanthium strumarium* L.

A perusal of results indicates that out of 23 weed plant species under test, 5 were infected. Infection was systemic in *C. arvensis*, whereas it was localized in *Datura* species (Table 1). It was also observed that the disease incidence was more in those fields where *C. arvensis* was prevalent as compared to the fields free from this weed.

ACKNOWLEDGEMENTS

Author is grateful to Dr. J. P. Varma, Associate Professor, Department of Plant

TABLE 1

Symptoms of urdbean leaf crinkle virus on susceptible weed plants

Plant species	Symptoms
C. arvensis	After 2-3 weeks of sap inoculation, the infected plants showed reduction in size of leaves exhibiting crinkling and mosaic mottling. Inflorescence became bushy, internodes increased in length but reduced in thickness.
D. stramonium	Necrotic lesions developed on inoculated leaves about 20 days after inoculation. No systemic symptoms were noticed.
D. metal	-do-
D. metaloides	-do-
D. incrimis	-do-

Pathology and thankful to Dr. Jai Parkash and Dr. S. P. Singh, Weed Scientists of Haryana Agricultural University, Hissar for valuable suggestions and identification of the weed species.

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Haryana agric. Univ. J. Res., Vol XIII, No. 4, pp. 604—609 (December 1983)

EFFECT OF PRESSURE COOKING ON THE *IN VITRO* DIGESTIBILITY AND FLATULENCE FACTORS IN HIGH YIELDING VARIETIES OF BENGAL GRAM, GREEN GRAM AND LENTILS

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(Received : May 20, 1982; Revised : April 29, 1983)

ABSTRACT

Effect of pressure cooking on the *in vitro* digestibility and flatulence factors viz., sucrose, raffinose and stachyose in two high yielding varieties each of bengal gram, G-130 and C-214; green gram, MH-1 and H-70-16 and lentils, T-36 and L-9-12, was investigated. Green gram had the highest amount of protein and bengal gram the lowest. Cooking did not alter the protein content, but increased the digestibility of protein by 10-11% and there was not much change in the flatulence factors of pulses. For total flatulence factors, green gram H-70-16 ranked the lowest and lentils T-36 the highest.

Pulses occupy a prominent place in the low cost Indian dietary due to their high protein content. These are relatively rich in carbohydrates, vitamins such as thiamine and riboflavin, minerals especially iron and have low level of oil. Though these have high protein content, yet their consumption is limited due to the presence of flatulence factors. Bacterial fermentation of food residues after digestion and assimilation in the intestines is the major source of gas production and distress. Alpha galactosides, raffinose and stachyose are the principal sources of gastro-intestinal gases in man. These carbohydrates are not digested due to lack of alpha galactosidase activity in mammalian intestinal mucosa (Steggerda, 1968).

In recent years, several disease resistant and high yielding varieties of pulses have been evolved. Besides the high yielding potential and nutritional composition, their digestibility and flatulence factors are other important criteria for the acceptability of pulses in daily diet. Cooking of pulses is said to destroy antinutritional factors and thus improve their digestibility. The present investigation deals with the *in vitro* digestibility and flatulence factors of raw and pressure cooked pulses of two high yielding varieties each of bengal gram, green gram and lentils evolved by Haryana Agricultural University, Hissar.

MATERIAL AND METHODS

Two high yielding varieties each of bengal gram *(Cicer arietinum)* G-130 and C-214, green gram *(Phaseolus aureus)* MH-1 and H-70-16 and lentils *(Lens esculenta)* T-36 and L-9-12 were obtained

from the Department of Plant Breeding, Haryana Agricultural University, Hissar. The method of pressure cooking the whole pulses was standardized. This cooking method was selected as it is becoming popular among the masses for its fuel and time saving property. Fifty gram sample of each variety was washed once with tap water and drained. Required quantity of tap water was put in the pressure cooker along with pulses and the pulses were cooked for the required time (Table 1). The cooked pulses were homogenised and dried at 60°C for 4-5 h, and were finely ground and stored in air tight containers for analysis.

The proximate composition was determined with the method described by AOAC (1975). The crude protein was calculated by using the conversion factor of N×6.25. The *in vitro* digestibility was determined by the method of Akerson and Stahman (1964). The sample was incubated with pepsin solution for 24 h followed by incubation with pancreatin solution for 24 h. The undigested protein was determined by Micro Kjeldahl method (AOAC, 1975). The digestible protein was determined by subtracting the residual protein from the total protein of the sample. Per cent digestibility coefficient was calculated as :

$$\frac{\text{Digested protein}}{\text{Total protein}} \times 100$$

Flatulence factors were determined by quantitative determination of sucrose, raffinose and stachyose by using partition paper chromatography with the solvents viz., ethyl acetate, acetic acid, formic acid and water in proportion of 9 : 1.5 : 5 : 2 (V/V) by the method of Bailey and Pridham (1962). The oligosaccharides were extracted and clarified by the AOAC (1970) method. Sugar in the elute extract was determined by the phenol sulphuric acid method of Dubois *et al.* (1956) and the orange colour developed was read at 520 nm in Spectronic 20.

TABLE 1

Water and time required for cooking pulses

Pulses	Amount of pulse (g)	Water added (ml)	Cooking time (min)	Weight of cooked product (g)
Bengal gram				
G-130	50	300	25	210
C-214	50	300	25	215
Green gram				
MH-1	50	250	15	225
H-70-16	50	250	15	225
Lentils				
T-36	50	250	15	235
L-9-12	50	250	15	225

RESULTS AND DISCUSSION

Data on the protein content of raw and cooked pulses reveal that green gram H-70-16 had the highest amount of protein followed by the two varieties of lentils. Bengal gram had the lowest amounts of protein (Table 2). The crude protein content of raw bengal gram is similar to the findings of Lal *et al.* (1963), but it is more than 3% higher than the report of Gopalan *et al.* (1978). Bhatty *et al.* (1976) have reported higher values for protein in lentils, whereas Verma *et al.* (1977) in their study on seven new high yielding varieties of lentils reported a crude protein content of 20.2 to 22.9 per cent. Gupta and Wagle (1978) reported a crude protein content of 22.3 to 27.9% for three varieties of green gram. The differences in the protein content of pulses may be due to differences in variety, type and amount of fertilizer used and the environment. According to Tandon *et al.* (1957) environment is a dominating factor affecting the protein content which is also likely to differ from year to year.

Among the pulses investigated, green gram had the highest *in vitro* digestibility followed by bengal gram (Table 2). Lentils had the lowest digestibility of protein. Pressure cooking of bengal gram increased the *in vitro* digestibility from 78.33% in raw G-130 and 76.4% in C-214 to 87.30 and 84.78 per cent, respectively. Similarly, the cooked samples of green gram and lentils had about 10-11% higher digestibility values than the raw samples. Thus, pressure cooking of pulses increases their digestibility. Jaffe (1950) and Subba Rao and Subramanyan (1950) also reported an increase in the digestibility of pulses due to cooking. This increase in digestibility may be due to destruction of phyto-haemagglutinins and trypsin inhibitors during heat processing. Orr and Watt (1968) reported that heat processing inactivated the antinutritional substances and improved the nutritive value of pulse proteins. Kakade *et al.* (1969) further showed that both selective removal of the trypsin inhibitors and denaturation of protein by heat increased digestibility of the proteins. However,

TABLE 2

Protein content and *in vitro* digestibility of raw and cooked pulses

Pulses	Protein (g/100 g)		Protein digestibility (%)		
	Raw	Cooked	Raw	Cooked	Increase
Bengal gram					
G-130	22.75	22.60	78.33	87.30	8.97
C-214	20.87	20.72	76.14	84.78	8.64
Green gram					
MH-1	24.75	24.53	79.90	90.10	10.20
H-70-16	26.12	25.99	80.33	90.15	9.82
Lentils					
T-36	24 87	24.73	61 89	73.03	11.14
L-9-12	24.81	24.66	64.98	74.66	9.68

Jaffe *et al.* (1972) reported that the presence of trypsin or chymotrypsin inhibitors does not fully explain the lower digestibility of pulses. They observed that a variety of beans which did not contain trypsin or chymotrypsin inhibitors still had only 71% digestibility.

The data on the flatulence factors of pulses are presented in Table 3. Green gram H-70-16 had the lowest amounts of sucrose and stachyose, and bengal gram G-130 contained the lowest amount of raffinose. For total flatulence factors green gram H-70-16 was the lowest (4.59%) and lentils T-36 contained the highest amounts of flatulence factors (6.77%) followed by bengal gram G-130 (6.72%), lentils L-9-12 (6 63%) and green gram MH-1 (6.29%). It is also apparent from Table 3 that there is wide variation in the amounts of flatulence factors within the same variety. Similar findings have been reported by Deosthale (1980). Pressure cooking of pulses did not bring about much change in the flatulence factors. Unlike trypsin inhibitor and other antinutritional factors oligosaccharides are heat stable. Similar results have been reported by Rao and Belavady (1978) for sucrose and raffinose content of raw bengal gram and sucrose content of raw green gram. They have also reported that there are significant variations in the flatulence factors in the varieties of the same pulse. Tanaka *et al.* (1975) reported much lower values i.e. 0.93, 0.44 and 1.96 per cent of sucrose, raffinose and stachyose, respectively, for the flatulence factors in green gram. Gupta (1977) reported the sucrose, raffinose and stachyose content of three varieties of moong to vary from 0.56–1.06, 0.73–1.03 and 1.10–1.17 per cent, respectively. Cooked green gram had the highest digestibility followed by bengal gram and lentils. Pulses with high digestibility values had low values for flatulence factors. Green gram has the highest amount of protein, digestibility and lowest amount of flatulence factors and, thus, ranks number one from the

TABLE 3

Flatulence factors of raw and cooked pulses
(% dry matter basis)

Pulses	Raw				Cooked			
	Sucrose	Raffi-nose	Stac-hyose	Total	Sucrose	Raffi-nose	Stac-hyose	Total
Bengal gram								
G-130	1.59	1.90	3.23	6 72	1.56	1.90	3.21	6.67
C-214	1.29	0.80	2.92	5.01	1.28	0.80	2.90	4.98
Green gram								
MH-1	1.47	1.04	3.78	6.29	1.45	1.03	3.76	6.24
H-70-16	1.02	1.15	2.42	4.59	1.15	1.13	2.41	4.69
Lentils								
T-36	1.22	2.42	3.13	6.77	1.20	2.40	3.10	6.70
L-9-12	1.51	2.04	3.08	6.63	1.48	2.00	3.04	6.52

point of view of suitability for human consumption. Although the protein content of lentils is higher than that of bengal gram, its digestibility is the lowest and the total flatulence factors are higher than that of bengal gram.

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Haryana agric. Univ. J. Res., Vol. XIII, No. 4, pp. 610—616 (December 1983)

A STUDY ON ECONOMICS OF LIVESTOCK AND POULTRY REARING IN RURAL HARYANA

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(Received : May 22, 1982; Revised : April 6, 1983)

ABSTRACT

Studies were conducted to work out the cost of rearing she buffalo, cows (Hariana and cross-bred), bullocks and poultry birds, their pattern of rearing on different sizes of farms and also their contribution to the farm business income of the farmers. Cost of rearing she buffalo was found to be highest followed by cross-bred cow, bullocks and Hariana cow. Although the average cost of rearing these animals decreased with the increase in size of holdings, yet cost of rearing poultry enterprise was of reverse order. Agriculture and animal husbandry contributed the major portion of the total farm business income in all the categories of farms. However, capital has a vital role to play in the development of these enterprises in the State.

In India, the average size of holding of the farmers and their income are among the lowest in the world. [1]Disguised employment of labour is one of the important factors for low income of the rural people. Thus, combining livestock and poultry enterprises with Indian agriculture is of paramount importance specially due to the fact that farmers are risk averter. Since the quantity and quality of proteins in the total food production in the country are very low, the increase in the production of milk and poultry products carries added importance for agricultural development through increasing income and employment. Haryana agriculture is mainly characterised as crop cum bovine agriculture. Poultry, sheep and goat rearing are also gaining some importance. Although there are several studies (Johl *et al.*, 1965; Dhawan and Johl, 1967, 1969; Singh, 1968; Rao and Singh, 1974; Kahlon *et al.*, 1975; Verma and Pant, 1978; Pandey and Bhogal, 1980; Raut *et al.*, 1980; Sirohi *et al.*, 1980) at India level with regard to economics of mixed farming, yet practically a little is known about it in the State which is facing continuous dynasim in the resource adjustments and product-mix-decisions. Thus, the study of the economics of rearing livestock enterprise will help to the policy makers as well as to the dairy farmers in a long way for sound decision making.

METHODOLOGY

Multi-stage random sampling technique was used to select the ultimate unit of the sample. Hissar district of Haryana State was selected purposively and of the total blocks in the district, two blocks were randomly selected and then 5% of the total number of villages

from each selected block were selected randomly. Amongst all the farmers who have dairy enterprise in these selected villages, 5% (65) were randomly selected. Besides this, 20 farmers (about 7%) who maintained poultry birds were also selected. Data with regard to input-output details and incomes were collected from these selected dairy farmers for the year 1978-79.

The various cost concepts used in this study are :

1. **Fixed costs.** These are the costs that do not vary with output (i.e., not a function of output). These are the expenses that must be paid even if nothing is produced and do not increase under bumper yields and high production. The fixed costs on the sample farms include :

(i) Interest on fixed capital,

(ii) Depreciation on cattle-shed, equipments and assets,

(iii) Cost of family labour.

2. **Variable costs.** These are farming expenses which are a function of output in the production period. These do not occur if nothing is produced. Their amount depends on the scale of production. Variable costs on the sample farm include :

(i) Cost of feed and fodder,

(ii) Veterinary expenses including miscellaneous expenses,

(iii) Interest on working capital.

3. **Net cost.** The net cost under this study is the total cost minus returns from the dung. However, returns from milk have been excluded here.

4. **Average cost.** This is in fact, the total cost divided by output. In this study, the total cost divided by the number of observations (sample farmers in each category) has been used.

RESULTS AND DISCUSSION

1. Distribution of Young Stocks

Distribution of calves maintained by different dairy farmers according to different age groups has been shown in Table 1. The data reveal that large number of calves maintained by these farmers were above one year.

TABLE 1

Age group-wise distribution of young stocks

S. No.	Age group	She buffalo	Cow		Bullock (Hariana)
			Hariana	Cross-bred	
1.	Below 1 month	6	6	5	3
2.	1-6 months	7	6	7	4
3.	6-12 months	8	5	7	2
4.	1-2 years	22	5	3	4
5.	Above 2 years	71	27	3	63
	Total	114	49	25	76

TABLE 2

Components of the cost of rearing young stocks

S. No.	Items	She buffalo		Cow				Bullock (Hariana)	
				Hariana		Cross-bred			
		Quantity (q)	Amount (Rs.)	Quantity (q)	Amount (Rs.)	Quantity (q)	Amount (Rs.)	Quantity (q)	Amount (Rs.)
1.	Green fodder	51.9	633.36	40.3	389.17	60.2	806.40	40.9	417.73
2.	Dry fodder	50.0	1510.13	39.1	1231.26	41.1	1277.50	30.2	1016.66
3.	Milk	1.4	376.50	1.1	183.00	1.50	236.25	1.4	243.75
4.	Concentrates	10.4	751.20	8.5	411.04	9.8	739.63	10.8	758.75
5.	Family labour in days	74	734.43	56	556.83	84	835.25	76	762.33
6.	Veterinary expenses	—	17.00	—	16.10	—	32.15	—	50.53
7.	Miscellaneous expenditure (Bull service, gur, salt, oil, etc.)	—	50.33	—	49.15	—	89.50	—	75.15
	Sub-Total	—	4072.95	—	2836.55	—	4016.68	—	3324.90
8.	Interest on working capital @ 10%		407.29		283.65		401.67		332.49
9.	Interest on fixed capital @ 10%		203.60		202.60		205.20		201.15
10.	Depreciation on cattle-shed @ 10%		100 00		100.00		100.00		100.00
11.	Depreciation on equipment and assets @ 10%		3.60		3.50		3 70		3.20
	Total cost		4787.44		3426.30		4727.25		3961.74
	Return from dung		350.00		320.00		325.10		310.15
	Ner cost		4437.44		3106.30		4402.15		3651.59

2. Cost of Rearing Young Stocks

Table 2 shows the components of the cost of rearing of a young stock of different categories of animals. The cost of rearing a she buffalo is highest followed by cross-bred cow, bullocks and Hariana cow. Of the total cost, fodder, concentrates and labour form the major portion.

The category-wise costs of rearing a young livestock and poultry bird are given in Table 3 which show that the cost of rearing she buffalo was highest on small farms and lowest on large farms*. The cost of rearing a Hariana cow and bullock was also decreased with the increase in size of holding. This trend was perhaps because of the existence of economics on large farms. Cross-bred cow was reared only by medium and large farmers. Amongst these two categories of farmers, large farmers had lowest cost of rearing. The cost of rearing poultry enterprise was highest on large farms and lowest on small farms. It is because of the fact that there is wastage of feed and higher veterinary expenses are incurred on large farms. Besides, the poultry birds on small farms are allowed to take their feed outside the poultry shed which ultimately reduces the cost of poultry rearing.

3. Components of Poultry Bird Rearing on Different Sizes of Farms

The breakup of the cost of rearing the poultry enterprise on different categories of farms shows that the cost of rearing poultry enterprise increased with the increase in size of holding (Table 4). Of the different components of the cost, maize forms the major portion followed by groundnut cake, veterinary charges, wheat bran, fish meal, mineral mixture, povimix/vita blend labour and electricity charges.

4. Pattern of Young Stocks and Poultry Rearing

The pattern of adult livestock and poultry rearing is given in Table 5. On an average three buffaloes and bullocks were maintained by the dairy farmers. These farmers had also maintained on an average two Hariana cows, one cross-bred cow and 70 poultry birds. This shows that the number of livestock and poultry birds reared increased with the increase in size of holding. Besides, the farmers adaptations specially for poultry enterprise are probably due to extension efforts, availability of required infrastructures, etc.

5. Contribution of Livestock and Poultry Enterprise in Total Farm Business Income

It is evident from the data in Table 6 that agriculture and animal husbandry form the major portion of the farm business income in all the categories of farms. Poultry enterprise had almost negligible contribution to the total farm business income in all the categories of farms.

The above analysis indicates that fodder, concentrates and labour form the

*In present study the different categories of farmers were as under :

Below 3 ha	: Small farmers
Between 3 to 7.5 ha	: Medium farmers
Above 7.5 ha	: Large farmers

TABLE 3

Cost of rearing (Rs.) young stocks and poultry birds on different sizes of farms

S. No.	Farm size	Average cost			Bullock (Hariana)	Poultry
		She buffalo	Cow			
			Hariana	Cross-bred		
1.	Small	4637.50	3200.10	—	3839.25	11.88
2.	Medium	4440.39	3104.40	4456.48	3759.05	12.23
3.	Large	4234.45	3014.40	4347.82	3356.47	13.06
	Average	4437.44	3106.30	4402.15	3651.59	12.39

TABLE 4

Breakup of the cost of rearing (Rs) a poultry bird on different sizes of farms

S. No.	Particulars	Average cost			
		Small	Medium	Large	Average
1.	Maize	7.05	7.20	7.77	7.34
2.	Wheat bran	0 62	0.63	0.63	0.62
3.	Groundnut cake	1.02	1.02	1.03	1.02
4.	Fish meal	0.12	0.12	0.13	0.12
5.	Mineral mixture	0.10	0.15	0.17	0.64
6.	Povimix/Vita blend	0.15	0.17	0.19	0.17
7.	Veterinary charges	0.55	0.60	0.75	0.63
8.	Labour charges	1.00	0.95	0.95	0.97
9.	Electricity charges	0.10	0 11	0.12	0.11
	Sub-total	10.71	10.95	11.74	11.12
10.	Interest on working capital @ 10%	0.54	0.55	0.59	0.56
11.	Interest on fixed capital @ 10%	1.50	1.56	1.56	1.54
12.	Depreciation on poultry shed and equipment @ 5%	0.75	0.78	0.78	0.77
	Total cost	13 50	13.84	14.67	13.99
	Return from poultry manure	1.62	1.61	1.61	1.61
	Net cost	11.88	12.23	13.06	12.39

TABLE 5

Pattern of livestock and poultry rearing on different sizes of farms

S. No.	Farm size	Average number				
		She buffalo	Cow		Bullock	Poultry
			Hariana	Cross-bred	(Hariana)	
1.	Small	1	1	—	2	35
2	Medium	3	2	1	3	65
3.	Large	4	3	1	4	105
	Average	3	2	1	3	70

TABLE 6

Annual contribution from livestock and poultry enterprise in the total farm business income (Rs.)

S. No.	Farm size	Net returns from agriculture/ ha	Net returns from products/ livestock	Net returns/ poultry bird	Total
1.	Small	2091.15 (53.25)	1806.03 (45.99)	30.00 (0.76)	3927.18 (100.00)
2.	Medium	1802.35 (50.50)	1735.63 (48.63)	30.85 (0.87)	3568.83 (100.00)
3.	Large	1706.96 (52.50)	1561.56 (46.55)	31.75 (0.95)	3354.27 (100.00)
	Average	1884.82 (52.12)	1701.07 (47.03)	30.87 (0.85)	3616.76 (100.00)

Figures in parentheses are the percentages to the total farm business income.

major portion of the total cost of rearing the young livestock. The cost of rearing the she buffalo was highest followed by cross-bred cow, bullocks and Hariana cow. Only medium and large farmers maintained cross-bred cow. The cost of rearing she buffalo, cross-bred cow, Hariana cow and bullocks decreased with the increase in size of holding but the case was reverse for poultry. Of the total components of the cost of rearing poultry birds, maize formed the major portion followed by groundnut cake, wheat bran, veterinary expenses and labour charges. Agriculture and animal husbandry contribute the major portion of the total farm business income in all the categories of farms. However, growth of farm business income is conditioned by capital availability.This implies that institutional credit agencies of the region have an important role to play in financing dairy farmers specially for livestock rearing.

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VOL. XIII, 1983

COMPILED BY
S. P. Goyal

HARYANA AGRICULTURAL UNIVERSITY
JOURNAL
OF
RESEARCH

PUBLISHED QUARTERLY BY
THE DIRECTORATE OF PUBLICATIONS
HARYANA AGRICULTURAL UNIVERSITY
HISSAR
INDIA

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