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GENETIC ANALYSIS OF COMPONENTS OF YIELD IN WHEAT

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(Accepted : December 2, 1993)

ABSTRACT

The study revealed the significance of additive gene effects (d) for yield per plant. Dominance effects (h) were significant for yield per plant, number of grains per spike and 1000-grain weight. Considering individual digenic epistatic effects, additive $\times$ additive (i) effect appeared to be significant for yield per plant in cross HD 2329 $\times$ Kalyan sona. It was also significant for number of grains per spike and 1000-grain weight in cross HD 2009 $\times$ Sonalika. Additive $\times$ dominance (j) type of gene effects were found significant for yield per plant, number of grains per spike, and 1000-grain weight in cross HD 2329 $\times$ Kalyan sona; for number of grains per spike, and 1000-grain weight in cross HD 2009 $\times$ Sonalika. Dominance $\times$ dominance (l) type of epistatic effects were observed significant for yield per plant, number of grains per spike, and 1000-grain weight in cross HD 2329 $\times$ Kalyan sona, for number of grains per spike and 1000-grain weight in cross HD 2009 $\times$ Sonalika.

Further advancement in wheat yield may be possible through the understanding of gene effects of important yield contributing characters and through the adoption of appropriate breeding method. Though much work on the gene effects in wheat has been done, yet there remains much to be done to study the important quantitative aspects in a wheat population. The present investigation was carried out to obtain the information on the inheritance of yield and its components and to determine the nature and magnitude of gene effects of the characters under consideration.

MATERIAL AND METHODS

The material was developed from two crosses involving four high yielding

varieties of bread wheat, viz HD 2329, Kalyan sona, HD 2009 and Sonalika. HD 2329 possesses more number of tillers and number of grains per spike than Kalyan sona. Similarly, HD 2009 has more number of grains per spike and more number of tillers but Sonalika possesses high 1000-grain weight. The four varieties were involved in two crosses, viz. HD 2329 $\times$ Kalyan sona, and HD 2009 $\times$ Sonalika and were utilized for producing different generations. The varieties and their F_1 's were crossed and selfed to produce F_1 , F_2 and back cross generations. The samples of BC_1 and BC_2 were selfed. The result of these crosses produced nine generations, viz. P_1 , P_2 , F_1 , F_2 , F_3 , BC_1 , BC_2 , BC_1s and BC_2s . The final experiment was conducted in randomized block design with

three replications during the *rabi* season of 1990-91. The plot size was a single row of one metre length with plant to plant and row to row distance of 10 cm and 30 cm, respectively. The number of plants sampled per replication were 10 for P_1 , P_2 , F_1 , BC_1 and BC_2 , 40 for F_2 , and 50 for F_3 , BC_3 and BC_4 s. The observations were recorded on grain yield per plant (g), spike number, number of grains per spike, and 1000-grain weight (g). For genetical analysis for the estimation of generation means, the non-epistatic model of Cavalli (1952) and epistatic model of Hayman (1958) were made use of.

RESULTS AND DISCUSSION

The joint scaling test (Cavalli, 1952) is more powerful in detecting epistasis

since it uses information from all the generations. This test was applied to test the adequacy of the simple additive-dominance model, which was found to be inadequate for yield per plant, number of grains per spike and 1000-grain weight in cross HD 2329 $\times$ Kalyan sona (Table 1). It was inadequate for number of grains per spike and 1000-grain weight in cross HD 2009 $\times$ Sonalika (Table 2). Therefore, analysis was extended to the digenic epistatic model. The six parameter model, however, failed for yield per plant in cross HD 2329 $\times$ Kalyan sona, and for number of grains per spike in cross HD 2009 $\times$ Sonalika, which indicated the existence of higher order interactions or linkages in the material under study. In six parameter model, the additive gene effects were found to be significant for grain yield per plant and spike number in cross

TABLE 1

Estimates of genetic parameters in respect of some quantitative characters of cross HD 2329 $\times$ Kalyan sona in wheat

Parameter	Yield/plant	Spike number	Number of grains/ spike	1000-grain weight
3-parameter model				
m	20.41	9.94	49.84	42.62
(d)	0.28	0.29	2.55**	0.87
(h)	-2.08	-1.96	1.48	6.66**
Chi-square	23.22	9.79(NS)	37.33	19.66
6-parameter model				
m	26.63	12.03	48.64	44.63
(d)	8.23**	4.00	2.04	0.38
(h)	-28.08**	-10.69	2.23	9.58
(i)	-26.10**	-8.12	3.96	7.32
(j)	16.30**	6.74	4.62*	-6.10*
(l)	16.40**	-0.62	12.02**	-29.44**
Chi-square	13.93	3.15(NS)	5.10(NS)	1.25(NS)
Interaction	Duplicate	Complimentary	Complimentary	Duplicate

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

GENETIC ANALYSIS OF YIELD COMPONENTS IN WHEAT

TABLE 2

Estimates of genetic parameters in respect of some quantitative characters of cross HD 2009 × Sonalika in wheat

Parameter	Yield/plant	Spike number	Number of grains/ spike	1000-grain weight
3-parameter model				
m	19.09	8.53	44.54	15.81
(d)	1.41*	0.11	2.14	5.17**
(h)	-2.51	-1.40	-0.45	3.03
Chi-square	5.70 (NS)	8.43 (NS)	17.08	19.97
6-parameter model				
m	16.76	7.43	49.67	48.41
(d)	0.24	1.90	0.27	0.55
(h)	5.56	3.06	-35.76**	-7.72*
(i)	9.00**	3.96	-35.70**	-9.22*
(j)	2.83	3.06	-12.97**	15.18**
(l)	-13.47**	-8.64**	40.75**	25.28**
Chi-square	3.96 (NS)	1.98 (NS)	8.05	4.54 (NS)
Interaction	Duplicate	Duplicate	Duplicate	Duplicate

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

HD 2329 × Kalyan sona. Similar results were also reported by Kulshreshtha *et al.* (1991) and Redhu and Chowdhury (1991). The dominance component was significant for grain yield per plant and 1000-grain weight in cross HD 2329 × Kalyan sona, and for number of grains per spike and 1000-grain weight in cross HD 2009 × Sonalika. The dominance type of gene action was also reported for yield per plant and 1000-grain weight by Redhu and Chowdhury (1991) and Singh *et al.* (1991) and for number of grains per spike by Singh *et al.* (1991). The additive and dominance gene effects were significant for grain yield per plant in cross HD 2329 × Kalyan sona. Pre-dominance of both additive and dominance gene effects has also been reported by Singh *et al.* (1987). The

additive × additive gene effects were significant for yield per plant in cross HD 2329 × Kalyan sona. The additive × additive gene effects were also significant for yield per plant, number of grains per spike and 1000-grain weight in cross HD 2009 × Sonalika. The additive × dominance gene effects were significant for grain yield per plant in cross HD 2329 × Kalyan sona and for number of grains per spike and 1000-grain weight in cross HD 2009 × Sonalika. Similar results have been reported by Dhindsa *et al.* (1991) and Singh *et al.* (1991). Thus, the information collected on the relative magnitude of additive and non-additive gene effects can be used for maximum efficiency in wheat improvement programmes.

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EFFECT OF POTASSIUM NITRATE ON SEED GERMINATION
OF *ERAGROSTIS* SPECIES

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(Accepted : December 30, 1993)

The nature of germination regulating mechanisms in seeds lends itself to an interpretation in terms of survival value of a species (Sen, 1977, 1982). The fundamental aspect of seed is to germinate and produce offspring but seeds of many species exhibit some kind of inhibition to immediate germination even when the environmental conditions are congenial. Such seeds are said to be dormant. The regulation of dormancy as well as enhancing the germination have practical importance. Several inorganic and organic chemical substances have been used for breaking dormancy and stimulating seed germination. Among various chemical substances, nitrate plays an important role in the germination behaviour of many grass species (Bawa, 1992). In the present investigation, an attempt was made to assess the effect of potassium nitrate on seed germination of fresh and one year old seeds of *Eragrostis* spp.

Seeds of *E. ciliaris*, *E. tremula* and *E. poaeoides* were collected from the New Campus of the Jodhpur University in 1991 and 1992. The seeds were stored in polythene containers under laboratory conditions. Germination studies were

carried out in sterilized petridishes lined with a single layer of filter paper and moistened with distilled water. The experiments were performed in triplicate with each petridish containing 10 seeds in continuous light (1000 lux) at $28^{\circ} \pm 2^{\circ}\text{C}$. The seeds were given the soaking pre-treatment in 50, 100, 250, 500 and 1000 ppm of potassium nitrate for 24 h. Observations were taken at the end of seven days.

The data in Table 1 reveal that seeds of all *Eragrostis* spp. exhibited dormancy as no germination was obtained under control except for 26.7% in one year old seeds of *E. tremula*. All the concentrations of potassium nitrate enhanced germination percentage in fresh as well as one year old seeds. In fresh seeds, the maximum germination was observed in *E. tremula* (53.3%) after 500 ppm treatment, while in *E. ciliaris* (26.7%) after 1000 ppm treatment of potassium nitrate. One year old seeds of these species showed increased germination percentage. The maximum germination occurred in *E. tremula* (96.7%) after 50 ppm treatment and in *E. ciliaris* (36.7%) after 1000 ppm, but no germination was observed in *E. poaeoides*.

TABLE 1

Effect of different concentrations of potassium nitrate on germination percentage of seeds of *Eragrostis* spp. (observations taken after seven days)

Conc. (ppm)	<i>E. ciliaris</i>		<i>E. poaeoides</i>		<i>E. tremula</i>	
	Fresh	1 yr old	Fresh	1 yr old	Fresh	1 yr old
0	—	—	—	—	—	26.7 ± 5.8
50	6.7 ± 11.6	23.3 ± 15.3	—	—	26.7 ± 23.1	96.7 ± 5.8
100	—	13.3 ± 5.8	—	—	23.3 ± 6.8	83.3 ± 15.3
250	6.7 ± 5.8	23.3 ± 5.8	—	—	30.0 ± 20.0	83.3 ± 5.8
500	6.7 ± 5.8	33.3 ± 28.9	—	—	53.3 ± 15.3	86.7 ± 20.1
1000	16.7 ± 5.8	36.7 ± 5.8	—	—	26.7 ± 20.1	86.7 ± 11.6

— = No germination.

The present study indicates that nitrate plays an important role in enhancing the germination. Storage of seeds under laboratory conditions affects the germination mechanism. The aging of seeds improving the germination percentage in *Alysicarpus vaginalis* and *Phaseolus trilobus* has been reported (Bansal, 1978). In the present study the storage of seeds in the laboratory appeared to reduce the dormancy of seeds as increased germination percentage was observed. One year old seeds at all concentrations of potassi-

um nitrate exhibited far better germination as compared to fresh seeds, which may be due to some kind of dormancy in fresh seeds. Promotion of germination by potassium nitrate has been reported in *Lepidium virginicum*, *Eragrostis curvula*, *Polypogon monspeliensis*, various species of *Agrostis* and *Sorghum halepense* by Mayer and Mayber (1982). In the present study potassium nitrate is also effective on one year old seeds of both *E. ciliaris* and *E. tremula* and on fresh seeds of *E. tremula*.

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WEED FLORA IN GRAM AND RAYA CROPS IN HARYANA STATE

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(Accepted : September 4, 1993)

ABSTRACT

A survey of weed flora of major chickpea and raya producing districts of Haryana state was conducted. Twenty-four species of weeds were recorded in gram and 29 in raya crop. *Chenopodium album*, *Asphodelus tenuifolius*, *Euphorbia dracunculoides* and *Trigonella polycerata* were the dominant weeds of gram and raya crops. *Anagallis arvensis*, *Melilotus indica*, *Phalaris minor*, *Fumaria parviflora*, *Avena ludoviciana*, *Launaea nudicaulis*, *Convolvulus arvensis* and *Chenopodium murale* were other main weeds of raya crop. The relative intensity of *Asphodelus* was found to be more than *Chenopodium* in both the crops. Spectrum of weed flora was more in Hisar and Sirsa districts and minimum in Faridabad and Bhiwani in both the crops. Sierozem soils inhabited more number of weeds as compared to desert soils.

Losses caused by weeds in pulse and oilseed crops are enormous. The occurrence of weed flora is influenced by a number of factors including crop history, soil seed bank, soil cultivation, selection of crops, application of fertilizers, irrigation and agronomic practices. The distribution is also influenced by soil type (Streibig *et al.*, 1984; Andreasen *et al.*, 1991), weed control measures (Haas and Streibig, 1982) and environmental factors (Schafer and Chilcote, 1969). A knowledge of major weeds and their distribution may help in the selection of a crop/variety and measures for their efficient timely control. In the past there has been no systematic study of weeds infesting gram and raya crops of Haryana state. The present study was, therefore, an attempt to survey the weed flora of gram and raya crops of the State.

MATERIAL AND METHODS

The survey was conducted during February-April, 1990 in the south-western parts of Haryana state where gram (*Cicer arietinum*) and raya (*Brassica* sp.) are the predominant crops. Visual observations were recorded for the intensity on 0-10 scale (where 10=100) and occurrence of weeds at every 10 km intervals. The fields were selected in the interior from roadside to have a uniform and true representation of the area. Average of more than two fields was recorded from one spot. The survey was conducted avoiding highways and inhabited areas. The relative intensity and per cent occurrence of weeds were calculated as follows :

$$\text{Relative intensity} = \frac{\text{Sum of average intensity of species in a zone}}{\text{Total number of observations recorded in the zone}}$$

$$\text{Per cent occurrence} = \frac{\text{Number of occurrences of a species in a zone}}{\text{Total number of observations recorded in the zone}} \times 100$$

The per cent occurrence data were statistically analysed by using 'Z test' on proportions, as under :

$$Z = \frac{P_1 - P_2}{\sqrt{pq \left(\frac{1}{n_1} + \frac{1}{n_2} \right)}}$$

Where, P_1 is proportional value (per cent occurrence/100) to be compared,

P_2 is the proportional value being compared,

$$p = \frac{x_1 + x_2}{n_1 + n_2}$$

where, x_1 and x_2 are the observed spots in a zone,

n_1 and n_2 are total number of spots in that zone,

and $q = 1 - p$

The final data so obtained were classified on the basis of district and soil types as given by Singh *et al.* (1985). The soils of south-western parts constitute mainly of sierozem (300—500 mm average annual precipitation, where problems of salinity and alkalinity and calcareous 'kankar' layer at a depth of 75 to 125 cm are common) and desert soils (300 mm average annual precipitation and wind erosion a serious problem).

RESULTS AND DISCUSSION

Weeds of Gram Crop

In gram crop, 24 species belonging to 15 families were observed with predominance of Leguminosae (33%), Compositae (27%), Caryophyllaceae

(13%) and Gramineae. *Chenopodium album*, *Asphodelus tenuifolius* and *Euphorbia dracunculoides* were equally distributed in all the four districts (Table 1). *Trigonella polycerata* and *Launaea nudicaulis* occurred significantly more in Sirsa than Bhiwani district. The occurrence of perennial weeds was more in areas of Bhiwani district, whereas Hisar inhabited maximum number of weed species followed by Sirsa and Bhiwani having the minimum. The relative intensity of *Chenopodium album* and *Asphodelus tenuifolius* was more in Bhiwani, whereas *Euphorbia dracunculoides* was more intense in Rohtak followed by Bhiwani district. Similarly, the intensity of *Melilotus indica*, *Silene conoidea* and *Anagallis arvensis* was more in Rohtak and of

WEED FLORA IN GRAM AND RAYA CROPS

TABLE 1

Relative intensity and per cent occurrence of weeds in gram crop in four districts of Haryana state

Species	Relative intensity (0-10 scale)				Per cent occurrence			
	Sirsa	Hisar	Bhiwani	Rohtak	Sirsa	Hisar	bhiwani	Rohtak
<i>Chenopodium album</i> L.	1.33	1.77	1.80	0.75	100 ^a	94 ^a	100 ^a	75 ^a
<i>Asphodelus tenuifolius</i> Cav.	1.25	2.19	2.35	2.00	100 ^a	94 ^a	92 ^a	100 ^a
<i>Euphorbia dracunculoides</i> Lamk.	0.42	1.02	1.37	1.63	50 ^a	67 ^a	46 ^a	75 ^a
<i>Fumaria parviflora</i> Lamk.	0.17	0.17	—	—	33 ^a	17 ^a	—	—
<i>Convolvulus arvensis</i> L.	0.42	0.33	—	0.20	50 ^a	33 ^a	—	25 ^a
<i>Trigonella polycerata</i> L.	0.70	0.72	0.45	0.25	67 ^a	44 ^{ab}	15 ^b	25 ^{ab}
<i>Carthamus oxycantha</i> Beib.	0.50	0.10	—	—	67 ^a	6 ^b	—	—
<i>Leunaea nudicaulis</i> Hook f.	0.17	0.25	0.02	—	50 ^a	33 ^{ab}	8 ^b	—
<i>Spergula arvensis</i> L.	0.10	0.10	—	0.38	17 ^a	11 ^a	—	25 ^a
<i>Sisymbrium irio</i> L.	0.17	0.25	0.11	—	33 ^a	28 ^a	15 ^a	—
<i>Melilotus indica</i> All Fl Ped	0.10	0.10	—	0.88	17 ^{ab}	6 ^b	—	50 ^a
<i>Silene conoidea</i> L.	0.10	—	—	0.88	17 ^a	—	—	25 ^a
<i>Phalaris minor</i> Retz.	0.10	0.10	—	0.12	17 ^a	6 ^a	—	25 ^a
<i>Lophochloa phleoides</i> (Vill) Richhb	0.10	0.10	—	—	17 ^a	6 ^a	—	—
<i>Anagallis arvensis</i> L.	—	0.11	—	0.75	—	11 ^a	—	50 ^a
<i>Desmostachya bipinnata</i> (L.) Stapf.	—	0.10	0.46	0.04	—	6 ^a	31 ^a	25 ^a
<i>Vicia sativa</i> L.	—	0.11	—	0.11	—	11 ^a	—	25 ^a
<i>Aerva javanica</i> Burm (f) Juss ex Sch!	—	0.11	0.11	—	—	22 ^a	15 ^a	—
<i>Zizyphus rotundifolia</i> Lamk.	—	0.10	0.11	—	—	17 ^a	23 ^a	—
<i>Athagi camalorum</i> Fisch.	—	—	0.15	—	—	—	15	—
<i>Artemisia scoparia</i> Wadst & Ketab	—	—	0.15	—	—	—	15	—
<i>Argemone mexicana</i> L.	—	—	0.11	—	—	—	15	—
<i>Sonchus arvensis</i> L.	0.01	—	—	—	17	—	—	—
<i>Lathyrus aphaca</i> L.	—	—	—	0.25	—	—	—	25

Values having the same superscripts in rows are not significantly different at 5% level of significance.

TABLE 2

Per cent occurrence of weeds in raya crop in different districts of Haryana state

Species	Hisar	Sirsa	Rohtak	Bhiwani	Gurgaon	Faridabad
<i>Chenopodium album</i>	88 ^a	100 ^a	100 ^a	75 ^a	100 ^a	33 ^b
<i>Asphodelus tenuifolius</i>	81 ^a	100 ^a	88 ^a	100 ^a	67 ^{ab}	17 ^b
<i>Euphorbia dracunculoides</i>	50 ^{ab}	17 ^b	38 ^{ab}	75 ^a	17 ^b	—
<i>Trigonella polycerata</i>	60 ^{ab}	50 ^{ab}	13 ^b	75 ^a	17 ^b	—
<i>Anagallis arvensis</i>	25 ^a	17 ^a	25 ^a	—	—	33 ^a
<i>Sisymbrium lris</i>	38 ^a	17 ^a	—	25 ^a	—	—
<i>Spergula arvensis</i>	13 ^a	—	—	—	17 ^b	—
<i>Melilotus indica</i>	25 ^a	17 ^a	63 ^a	—	33 ^a	—
<i>Fumaria parviflora</i>	31 ^a	17 ^a	13 ^a	—	17 ^a	—
<i>Phalaris minor</i>	44 ^a	17 ^a	25 ^a	—	—	67 ^a
<i>Avena ludoviciana</i> Dur	6 ^b	17 ^{ab}	23 ^{ab}	—	—	67 ^a
<i>Convolvulus arvensis</i>	25 ^a	33 ^a	25 ^a	—	—	—
<i>Rumex maritimus</i> L.	13 ^a	—	—	—	—	—
<i>Vicia sativa</i>	19 ^a	17 ^a	—	—	—	—
<i>Lathyrus aphaca</i>	6 ^a	—	—	—	—	—
<i>Chenopodium murale</i> L.	6 ^a	—	—	25 ^a	17 ^a	—
<i>Polypogon monspeliensis</i> Desf	13 ^a	—	—	—	—	—
<i>Launaea nudicaulis</i>	6 ^a	33 ^a	—	25 ^a	17 ^a	—
<i>Argemone mexicana</i>	13 ^a	—	—	—	17 ^a	—
<i>Cirsium arvense</i> (L.) Scop	—	—	13 ^a	—	—	—
<i>Carthamus oxycantha</i>	5 ^a	17 ^a	—	—	—	—
<i>Sapponaria vaccaria</i> L.	6 ^a	—	—	—	—	—
<i>Silene conoidea</i>	13 ^a	17 ^a	—	—	—	—
<i>Lophochloa phleoides</i>	—	17 ^a	—	—	—	—
<i>Zizyphus rotundifolia</i>	—	—	13 ^a	—	—	—
<i>Alhagi camelorum</i>	—	—	—	—	17 ^a	33 ^a
<i>Polygonum plebifem</i> R Br	—	—	—	—	17 ^a	—
<i>Pluchea lanceolata</i> Oliv	—	—	—	—	—	67 ^a
<i>Coronopus didymus</i> (L.) Sm	6 ^a	—	—	—	—	—

Values having the same superscripts in rows are not significantly different at 5% level of significance.

WEED FLORA IN GRAM AND RAYA CROPS

TABLE 3

Relative intensity (on 0-10 scale) of weeds in raya crop in different districts of Haryana state

Species	Hisar	Sirsa	Rohtak	Bhiwani	Gurgaon	Faridabad
<i>Chenopodium album</i>	1.81	2.00	1.75	1.13	1.51	0.33
<i>Asphodelus tenuifolius</i>	2.08	1.80	1.81	1.13	3.50	0.17
<i>Euphorbia dracunculoides</i>	0.62	0.10	0.94	2.75	0.60	—
<i>Trigonella polycerata</i>	0.88	0.42	0.18	1.40	0.41	—
<i>Anagallis arvensis</i>	0.38	0.10	0.75	—	—	0.17
<i>Sisymbrium lrio</i>	0.63	0.10	—	0.05	—	—
<i>Spergula arvensis</i>	0.17	—	—	—	0.06	—
<i>Mellilotus indica</i>	0.46	0.10	1.12	—	0.83	—
<i>Fumaria parviflora</i>	0.34	0.25	0.06	—	0.10	—
<i>Phalaris minor</i>	1.25	0.17	0.35	—	—	1.17
<i>Avena ludoviciana</i>	0.10	0.25	0.18	—	—	2.17
<i>Convolvulus arvensis</i>	0.38	0.17	0.25	—	—	—
<i>Rumex maritimus</i>	0.29	—	—	—	—	—
<i>Vicia sativa</i>	0.15	0.10	—	—	—	—
<i>Lathyrus aphaca</i>	0.04	—	—	—	—	—
<i>Chenopodium murale</i>	0.04	—	—	0.03	0.17	—
<i>Polypogon monspeliensis</i>	0.17	—	—	—	—	—
<i>Launaea nudicaulis</i>	0.10	0.12	—	0.20	0.10	—
<i>Argemone mexicana</i>	0.17	—	—	—	0.10	—
<i>Cirsium arvense</i>	—	—	0.03	—	—	—
<i>Carthamus oxycantha</i>	0.02	0.10	—	—	—	—
<i>Saponaria vaccaria</i>	0.04	—	—	—	—	—
<i>Silene conoidea</i>	0.06	0.10	—	—	—	—
<i>Lophochloa phleoides</i>	—	0.10	—	—	—	—
<i>Zizyphus rotundifolia</i>	—	—	0.06	—	—	—
<i>Alhagi camelorum</i>	—	—	—	—	0.33	0.33
<i>Polygonum plebijem</i>	—	—	—	—	0.25	—
<i>Pluchea lanceolata</i>	—	—	—	—	—	1.33
<i>Coronopus didymus</i>	0.03	—	—	—	—	—

Desmostachya bipinnata in Bhiwani. The variation in the relative intensity and per cent occurrence may be due to variation in soil types, amount of precipitation received, cropping pattern and agronomic practices followed.

Weeds of Raya Crop

Raya crop was infested with 29 species belonging to 14 families. Leguminosae, Gramineae, Compositae and Caryophyllaceae constituted more than

50% of the total weed spectrum. *Chenopodium album*, *Asphodelus tenuifolius*, *Euphorbia dracunculoides*, *Trigonella polycerata*, *Melilotus indica*, *Anagallis arvensis*, *Fumaria parviflora* and *Sisymbrium irio* were the main weeds of raya crop (Tables 2 and 3). Grassy weeds like *Phalaris minor* and *Avena ludoviciana* were also found in a big way except in areas of Bhiwani and Gurgaon districts. *Launaea nudicaulis*, *Convolvulus arvensis* and *Chenopodium murale* also had wide occurrence. Per cent occurrence of *Chenopodium album* and *Asphodelus tenuifolius* was less in Faridabad district. Minimum number of weed species was recorded in areas of Faridabad and Bhiwani and maximum in Hisar and Sirsa districts. *Euphorbia dracunculoides* and *Trigonella polycerata* were significantly more in Bhiwani district (Table 2). The relative intensity of all weeds except *Avena ludoviciana* and *Pluchea lanceolata* was minimum in Faridabad district (Table 3). Highest intensity of *Asphodelus tenuifolius* was found in Gurgaon follo-

wed by Hisar district.

Effect of Soil Types

The per cent occurrence of major weeds of gram and raya was statistically at par under both sierozem and desert soils (Table 4). *Zizyphus rotundifolia* and *Aerva javanica* only had significantly more occurrence in desert soils than sierozem soils in gram crop. Relative intensity of *Chenopodium album* and *Trigonella polycerata* was more in desert soils in gram crop, whereas *Asphodelus tenuifolius* and *Euphorbia dracunculoides* were more in sierozem soils. High rainfall in sierozem soils might have favoured their dominance. Tripathi (1965, 1968) observed that moisture played a significant role in determining the growth of *Asphodelus tenuifolius* and *Euphorbia dracunculoides*. Similar trend was observed in raya crop but with marginal variations. One irrigation which is common in raya crop might have mitigated the effect of soil types (moisture).

TABLE 4

Relative intensity and per cent occurrence of weeds in gram and raya crops in sierozem and desert soils of Haryana state

Species	Relative Intensity				Per cent occurrence			
	Gram		Raya		Gram		Raya	
	Sierozem	Desert	Sierozem	Desert	Sierozem	Desert	Sierozem	Desert
1	2	3	4	5	6	7	8	9
<i>Chenopodium album</i>	1.14	1.75	1.84	1.92	94 ^a	100 ^a	88 ^a	92 ^a
<i>Asphodelus tenuifolius</i>	2.50	1.75	1.70	1.81	100 ^a	92 ^a	80 ^a	92 ^a
<i>Euphorbia dracunculoides</i>	1.15	0.83	0.78	0.77	58 ^a	50 ^a	36 ^a	54 ^a
<i>Trigonella polycerata</i>	0.45	0.92	0.05	0.77	32 ^a	50 ^a	36 ^a	54 ^a

contd.

WEED FLORA IN GRAM AND RAYA CROPS

1	2	3	4	5	6	7	8	9
<i>Anagallis arvensis</i>	0.13	0.04	0.50	0.04	10 ^a	8 ^a	36 ^a	8 ^a
<i>Convolvulus arvensis</i>	0.27	0.25	0.24	0.31	29 ^a	33 ^a	28 ^a	38 ^a
<i>Spergula arvensis</i>	0.10	—	0.26	—	10	—	20	—
<i>Sisymbrium irio</i>	0.19	0.08	0.19	0.23	26 ^a	8 ^a	24 ^a	15 ^a
<i>Fumaria parviflora</i>	0.11	0.08	0.16	0.30	13 ^a	17 ^a	20 ^a	31 ^a
<i>Melilotus indica</i>	0.16	—	0.40	0.10	10	—	28 ^a	15 ^a
<i>Phalaris minor</i>	0.01	0.02	0.78	—	6 ^a	7 ^a	48	—
<i>Avena ludoviciana</i>	—	—	0.10	—	—	—	8	—
<i>Rumex maritimus</i>	—	—	0.14	—	—	—	8	—
<i>Lathyrus aphaca</i>	0.05	—	0.02	—	3	—	4	—
<i>Vicia sativa</i>	0.07	—	0.10	0.04	13	—	16 ^a	8 ^a
<i>Chenopodium murale</i>	—	—	0.02	—	—	—	8	—
<i>Launaea nudicaulis</i>	0.17	0.12	0.07	0.11	29 ^a	17 ^a	8 ^a	23 ^a
<i>Argemone mexicana</i>	0.02	0.08	0.02	0.11	3 ^a	8 ^a	4 ^b	8 ^a
<i>Cirsium arvense</i>	0.01	—	—	—	3	—	—	—
<i>Carthamus oxycantha</i>	0.08	0.12	0.02	0.05	13 ^a	17 ^a	4 ^a	15 ^a
<i>Silene conoidea</i>	0.13	—	0.03	0.08	3	—	8 ^a	15 ^a
<i>Saponaria vaccaria</i>	—	—	0.02	—	—	—	4	—
<i>Zizyphus rotundifolia</i>	0.03	0.22	—	—	3 ^b	33 ^a	—	—
<i>Alhagi comelorum</i>	0.03	0.17	0.04	0.15	3 ^a	17 ^a	4 ^a	8 ^a
<i>Pluchea lanceolata</i>	—	—	0.16	—	—	—	8	—
<i>Aerva javanica</i>	0.04	0.23	—	—	6 ^b	33 ^a	—	—
<i>Desmostachya bipinnata</i>	0.18	0.08	—	—	10 ^a	8 ^a	—	—
<i>Lophochloa phleoides</i>	0.01	0.04	0.02	—	1 ^a	8 ^a	4	—
<i>Sonchus arvensis</i>	—	0.04	—	—	—	8	—	—
<i>Coronopus didymus</i>	—	—	0.02	—	—	—	4	—
<i>Polypogon monspeliensis</i>	—	—	0.06	—	—	—	4	—
<i>Artemisia scoparia</i>	—	0.12	—	—	—	8	—	—

Values having the same superscripts in rows of gram and raya crops are non-significantly different at 5% level of significance.

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USE OF VARIOUS SUBSTANCES IN SPAWN PREPARATIONS OF *PLEUROTUS SAJOR-CAJU* (Fr.) SINGER

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ABSTRACT

Wheat grains supplemented with organic substances showed better mycelial running of *Pleurotus sajor-caju* in spawn containers. The other inorganic carbon and nitrogen substances also proved better in spawn preparations. The organic substances not only enhanced the mycelial running but also improved the quality of mushroom spawn by providing fluffy, luxuriant and non-primordial growth in spawn.

Cultivation of *Pleurotus* spp. is increasing all over the world as they have high biological efficiency, easiest method of production and better shelf-life. Yield of these mushrooms is mainly correlated with the quality of spawn. These fungi start producing primordia (fruit bodies) itself in the spawn containers prior to use for their cultivation if the spawn is not used hurriedly. In view of these problems, the present studies were undertaken to identify the supplements which may delay the primordial formation and provide better growth during spawn preparation.

MATERIAL AND METHODS

To prepare spawn of *Pleurotus sajor-caju* the wheat grains were boiled for 30 min taking 1.5 times more water than the weight of grains. The grains were boiled to get them moist and then allowed to soak for another 15 min without further heating. The excess water

was drained off and the grains were allowed to cool. The cooled grains were mixed with 2% calcium carbonate and 6% calcium sulphate (Gypsum) on wet grain weight basis.

To study the effect of various carbon, nitrogen and organic substances on the growth of *P. sajor-caju* during spawn preparations, these were mixed in the boiled grains before filling and sterilizations of bottles. The carbon sources, viz. cellulose, dextrose, fructose, galactose, maltose, mannitol, pectin, starch, sucrose, xylose, and organic substances (groundnut cake, mustard cake, and wheat bran) were mixed @ 0.1, 0.2 and 0.3 per cent of boiled grains. The nitrogen sources, viz. ammonium chloride ammonium nitrate, ammonium sulphate, calcium nitrate, potassium nitrate and urea were mixed @ 0.05, 0.1 and 0.2 per cent of boiled grains. The grains were filled into half litre empty glucose bottles @ 400 g per bottle. The

bottles were plugged with non-absorbent cotton and sterilized at 20 lb per square inch pressure for two hours. The sterilized bottles were allowed to cool and then inoculated with mother spawn prepared by inoculating with pure stock culture of *P. sajor-caju*.

RESULTS AND DISCUSSION

The organic substances, *viz.* groundnut cake, mustard cake and wheat bran enhanced the mycelium running and early spawn preparation of *P. sajor-caju* in comparison to control. Mustard cake (0.3%) and groundnut cake (0.3%) showed best mycelial running in spawn bottles (Table 1). Mustard cake (0.2%), groundnut cake (0.2%) and wheat bran (0.3%) when mixed with spawn substrates also proved better without showing any significant difference with each other.

Spawn substrate supplemented with dextrose and mannitol (0.3%) showed higher vertical growth of *P. sajor-caju* (108 mm) followed by 0.3% galactose (106 mm), 0.1 and 0.2 per cent fructose (104 mm) and 0.1% cellulose and 0.2% mannitol (102 mm). Sucrose 0.1 and 0.3 per cent supported 100 mm and 101 mm vertical growth of the fungus, respectively (Table 2). The results obtained with cellulose (0.1%), dextrose (0.3%), fructose (0.1 and 0.2 per cent), galactose (0.3%), maltose (0.2 and 0.3 per cent), mannitol (0.2 and 0.3 per cent), sucrose (0.1 and 0.3 per cent) and xylose (0.1%) showed significantly better results of commercial spawn production with non-significant difference with each other.

Data in Table 3 reveal that all the tried nitrogen sources increased the vertical growth of *P. sajor-caju* during spawn preparation. Nevertheless, lower

TABLE 1
Effect of organic substrates on vertical growth of *Pleurotus sajor-caju* in spawn bottles

Treatment	Rate of application (%)	Growth (mm) after inoculation		
		4th day	8th day	12th day
Control	—	23	50	65
Groundnut cake	0.1	35	65	83
	0.2	55	80	99
	0.3	58	82	102
Mustard cake	0.1	40	48	85
	0.2	62	55	90
	0.3	68	82	105
Wheat bran	0.1	50	72	90
	0.2	56	78	91
	0.3	40	64	96
C. D. (0.05)		5.17	7.18	10.08
Average of three replications.				

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TABLE 2

Effect of carbon sources on vertical growth of *Pleurotus sajor-caju* in spawn bottles

Treatment	Rate of application (%)	Growth (mm) after inoculation		
		4th day	8th day	12th day
Control	—	28	50	65
Cellulose	0.1	65	88	102
	0.2	54	68	90
	0.3	50	62	83
Dextrose	0.1	48	70	92
	0.2	55	70	96
	0.3	60	87	108
Fructose	0.1	52	85	104
	0.2	58	80	104
	0.3	46	62	86
Galactose	0.1	44	64	87
	0.2	45	67	89
	0.3	65	73	106
Maltose	0.1	38	57	90
	0.2	50	75	97
	0.3	55	80	98
Mannitol	0.1	52	72	95
	0.2	60	80	102
	0.3	68	88	108
Pectin	0.1	48	67	76
	0.2	70	85	90
	0.3	40	50	78
Starch	0.1	33	60	84
	0.2	40	65	87
	0.3	45	65	95
Sucrose	0.1	75	92	100
	0.2	40	72	95
	0.3	70	95	101
Xylose	0.1	52	72	98
	0.2	50	65	90
	0.3	40	64	80
C. D. (0.05)		6.97	8.89	11.21

Average of three replications.

dose of nitrogen sources showed better results than higher dose. Calcium nitrate (0.05%) measured 110 mm mycelium running followed by sodium nitrate (0.1%), ammonium chloride (0.05%), potassium nitrate (0.1%) and calcium

nitrate (0.1%) which supported 107 mm, 106 mm, 106 mm, and 105 mm growth, respectively.

During spawn preparations although the organic substances, carbon and

TABLE 3

Effect of nitrogen sources on vertical growth of *Pleurotus sajor-caju* in spawn bottles

Treatment	Rate of application (%)	Growth (mm) after inoculation		
		4th day	8th day	12th day
Control	—	28	50	65
Ammonium chloride	0.05	65	90	106
	0.1	48	63	90
	0.2	20	41	75
Ammonium nitrate	0.05	45	64	78
	0.1	50	66	91
	0.2	55	72	100
Ammonium sulphate	0.05	50	70	98
	0.1	65	94	100
	0.2	38	52	78
Calcium nitrate	0.05	74	84	110
	0.1	65	76	105
	0.2	50	72	90
Potassium nitrate	0.05	20	67	97
	0.1	75	93	106
	0.2	56	76	99
Sodium nitrate	0.05	65	87	96
	0.1	74	95	107
	0.2	62	76	92
Urea	0.05	48	70	95
	0.1	48	55	84
	0.2	40	50	72
C. D. (0.05)		9.37	8.67	12.39
Average of three replications.				

nitrogen sources enhanced the mycelium running, yet mustard cake, dextrose, mannitol, galactose and calcium nitrate showed better results than other treatments and control. Among all the treatments the organic substances not only enhanced the mycelial running but also improved the quality of mushroom spawn by providing fluffy, luxuriant and non-primordial growth in spawn containers.

The organic substances showed their superiority over carbon and nitrogen

sources by supporting the growth of *P. sajor-caju* in spawn containers. The observations revealed that the organic substances may carry some additional growth promoting elements which might have influenced better growth of the fungus. Spawn preparation on cereal grains has already been reported by various workers (Jandaik and Kapoor, 1976; Sivaprakasam and Kandaswamy, 1981). Coffee pulp (Go, 1959) and a mixture of rice straw and hard wood saw dust (Jong and Peng, 1975) have been

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reported as a substrate for spawn production. Alicbusan (1977) reported fermented and washed mixture of dried ipil-ipil leaves and saw dust supplemented with rice bran as a substrate for spawn production of *Pleurotus*. Present studies also revealed that the supplements enhanced the mycelial growth during

spawn preparations as compared to control but the organic substances produced better quality spawn as they delayed the primordial formation itself in the spawn containers. On its contrary the nitrogen and carbon sources induced early mycelial running and primordial formation in the spawn containers.

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SPECIES OF ROOT-LESION NEMATODE (*PRATYLENCHUS*) IN HARYANA : DISTRIBUTION AND IDENTIFICATION KEY

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ABSTRACT

Surveys of different districts of Haryana for root-lesion nematodes, *Pratylenchus* species revealed the presence of 12 species of this genus. *Pratylenchus thornei* and *P. zeae* were the most common species found in the samples collected from all districts of the State. *P. mulchandi*, *P. brachyurus* and one undescribed species of *Pratylenchus* were recorded for the first time from Haryana. *P. gibbicaudatus*, a new record from India, is compared with its original population described from Japan. An identification key and compendium to *Pratylenchus* species in Haryana are given.

Several species of root-lesion nematodes, viz. *Pratylenchus bhattii* Siddiqi *et al.*, 1991, *P. coffeae* (Zimmermann, 1898) Filipjev & Sch. Stek., 1941, *P. cruciferus* Bajaj & Bhatti, 1984, *P. ekrami* Bajaj & Bhatti, 1984, *P. microstylus* Bajaj & Bhatti, 1984, *P. neglectus* (Rensch, 1924) Filipjev & Sch. Stek., 1941, *P. thornei* Sher & Allen, 1953, and *P. zeae* Graham, 1951 have already been reported from Haryana (Bajaj and Bhatti, 1984; Siddiqi *et al.*, 1991). The information on the distribution of *Pratylenchus* species in Haryana on the basis of surveys conducted during 1987-90 and preceding years has been presented in this paper.

MATERIAL AND METHODS

Soil and root samples, collected by standard methods from around the roots of different plants (cultivated and wild)

of Haryana state were processed in the laboratory. Soil samples were processed by Cobb's sieving and decanting method coupled with modified Baermann funnel technique and roots by blender Baermann funnel technique (Hooper, 1970). Nematodes were killed and fixed in hot 4% formalin and processed to anhydrous glycerine by slow method. Absolute frequency was determined by Norton's (1978) formula.

RESULTS AND DISCUSSION

In all, 12 species of lesion nematodes associated with various plants in different districts of Haryana were recorded (Table 1). Most frequent were *P. thornei* and *P. zeae* which were present in all the districts from where samples were collected. *P. mulchandi* Nandkumar & Khera, 1970 was the other very common species detected in Hisar and Jind districts

DISTRIBUTION OF ROOT LESION NEMATODES IN HARYANA

TABLE 1

Pratylenchus species associated with different hosts in Haryana

Species	Host	District
<i>Pratylenchus bhattii</i>	<i>Saccharum officinarum</i>	Rohtak
	<i>S. spontaneum</i>	Sonepat
<i>P. brachyurus</i>	Unidentified grasses	Ambala
<i>P. coffeae</i>	<i>Citrus</i> spp.	Hisar, Sirsa
	Unidentified grasses	Ambala
<i>P. cruciferus</i>	<i>Triticum aestivum</i>	Sonepat
	<i>Brassica</i> spp.	Rohtak
	<i>Cicer arietinum</i>	Bhiwani
<i>P. ekremi</i>	<i>Jasminum sambac</i>	Hisar
<i>P. gibbicaudatus</i>	<i>Vetiveria zizanioides</i>	Hisar
<i>P. microstylus</i>	<i>Sorghum halepense</i>	Hisar
<i>P. mulchandi</i>	<i>C. arietinum</i> , <i>T. aestivum</i> ,	Jind
	<i>Crotalaria</i> sp., <i>Pennisetum</i>	
	<i>typhoides</i> , <i>S. officinarum</i> ,	
	<i>Sasamum indicum</i> , <i>Eucalyptus</i> sp.	
	and grasses	
	<i>Solanum melongena</i> and	Hisar
	<i>Lycopersicon esculentum</i>	
<i>P. neglectus</i>	<i>Psidium guajava</i>	Kurukshetra
<i>Pratylenchus</i> sp.	<i>Zea mays</i>	Ambala
<i>P. thornei</i>	<i>T. aestivum</i> , <i>Z. mays</i> , <i>Sorghum</i>	Ambala, Bhiwani, Jind, Hisar,
	<i>vulgare</i> , <i>Cajanus cajan</i> , <i>Citrus</i>	Karnal, Kurukshetra, Mohindergarh,
	spp., <i>Brassica</i> spp. and	Rohtak
	<i>C. arietinum</i>	
<i>P. zeae</i>	<i>T. aestivum</i> , <i>Z. mays</i> , <i>S. vulgare</i> ,	Ambala, Bhiwani, Jind, Hisar,
	<i>S. officinarum</i> , <i>C. cajan</i> ,	Karnal, Kurukshetra,
	<i>C. arietinum</i> , <i>Brassica</i> spp. and	Mohindergarh, Rohtak
	<i>Citrus</i> spp.	

from a variety of plants. *P. coffeae*, a major pest of citrus and coffee throughout world (Fortuner, 1976) was recorded frequently from Hisar and Sirsa districts parasitizing citrus. It was also found in one sample of grasses in nursery of Kalesar forests (Ambala).

P. brachyurus (Godfrey, 1929) Filipjev & Sch. Stek., 1941, *P. mulchandi* and one undescribed species of *Pratylenchus* are being reported for the first time from Haryana. *P. gibbicaudatus* Miagawa, 1982, an hitherto unreported species from India, was recorded parasitizing roots of

TABLE

Compendium of *Pratylenchus*

Species	L(mm)	a	c	V	Head annuli	Spermatheca
<i>Pratylenchus bhattii</i>	0.35-0.60	25-31	15-21	69-76	3	Full of sperm
<i>P. brachyurus</i>	0.39-0.75	15-29	13-28	82-89	2	Inconspicuous
<i>P. colicae</i>	0.37-0.70	18-38	14-26	76-84	2	Large variable full of sperm
<i>P. cruciferus</i>	0.65-0.79	26-40	19-28	76-81	3	Indistinct
<i>P. ekrami</i>	0.40-0.63	20-39	17-30	79-83	3	Elongate oval full of sperm
<i>P. gibbicaudatus</i>	0.38-0.53	16-39	13-23	69-82	2	Absent/empty
<i>P. microstylus</i>	0.39-0.46	19-26	16-22	75-77	3	Absent
<i>P. mulchandii</i>	0.44-0.58	22-28	17-27	75-78	3	Absent
<i>P. neglectus</i>	0.31-0.58	17-32	14-27	76-88	2	Empty
<i>Pratylenchus</i> species	0.50-0.66	26-34	14-19	70-77	3	Empty
<i>P. thornei</i>	0.41-0.77	25-36	18-25	73-80	3	Absent
<i>P. zeae</i>	0.36-0.58	25-30	13-21	68-76	3	Absent

PUS=Post uterine sac, VBD=Vulval body diameter.

vetiver (*Vetiveria zizanoides*) in Hisar. Its population is comparable with the original population (from Japan) and measurements are as follows :

43 females : L=0.38-0.51(0.44±0.03) mm, a=24-39(30.5±2.2), b=3.9-6.0 (4.89±0.44), b'=3.1-4.8(3.5±0.33), c = 15-23(18.2±1.7), stylet = 13-15 (13.5±0.7) µm, V=73-82(77.8±1.9), c' = 1.9-2.8(2.31 ± 0.27), tail 19-29 (24.4 ± 2.0) µm, tail annuli = 20-41 (24.5±4.8).

This Indian population differs from Japanese population (Minagawa, 1982) in having posteriorly located vulva, few ovarian cells in post uterine sac and a shorter tail (V=69.5-77.4(72.8±1.8), post uterine sac with many ovarian cells; tail = 25.3-36.6 (31.2 ± 2.9) µm in Japanese population).

Key to *Pratylenchus* species from Haryana

1. Head with two annuli.....2
- Head with three annuli.....5

DISTRIBUTION OF ROOT LESION NEMATODES IN HARYANA

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species of Haryana

Stylet length (μ m)	PUS	Males	Tail
12-14	< One VBD with rudimentary ovarian cells	Present	Sub-cylindrical to conoid with rounded smooth tip
17-22	One VBD	Very rare	Broadly conoid, smooth/broadly rounded/truncate or spatulate at tip
14-18	1-1½ VBD	Abundant	Conoid, tip indented/smooth or crenate
15-16	0.7-1.4 VBD	Absent	Sub-cylindrical to cylindrical, tip truncated/round and smooth
11-13	2-3 VBD long with 2-3 differentiated cells	Present	Elongate conoid to sub-cylindrical, tip variable usually crenate
13-16	1.5 VBD	Absent	Cylindrical truncated with crenate terminus
11-12	<one VBD	Absent	Hemispherical bluntly pointed, tip smooth
16-20	1½ VBD	Absent	Obliquely conical, truncated, narrowly or broadly rounded with smooth tip
15-19	Small, undifferentiated	Present	Sub-hemispherical bluntly pointed and smooth
16-19	1.4-2.3 VBD	Absent	Cylindrical with crenate terminus
15-19	1½ VBD	Rare	Sub-cylindrical with bluntly round/truncated smooth tip
15-17	One VBD	Absent	Conoid, tip pointed smooth/annulated

2. Spermatheca full of sperm, males common..... *P. coffeae*

Spermatheca empty, males rare or absent..... 3

3. Tail terminus crenate *P. gibbicaudatus*

Tail terminus smooth..... 4

4. Stylet knobs notched anteriorly, lateral field with oblique lines *P. neglectus*

Stylet knobs rounded, lateral field without oblique lines *P. brachyurus*

5. Spermatheca full of sperm, males common 6

Spermatheca devoid of sperm, males rare or absent 7

6. V=79-83; tail with 26-40 annuli
... *P. ekrami*

V=69-76; tail with 16-18 annuli
P. bhattii

7. Tail tip crenate *Pratylenchus* species
Tail tip smooth 8
8. Mean body length more than 700 μm , central zone of lateral field with oblique lines *P. cruciferus*
Mean body length less than 600 μm , central zone of lateral field without oblique lines 9
9. Tail subcylindrical, terminus broadly rounded to truncate 10
Tail conoid, tapering towards terminus 11
10. Lip region high, continuous with rest of body *P. thornei*
Lip region not conspicuously high, slightly offset from rest of body
... *P. mulchandi*
11. $V=75-77$; stylet=11-12 μm *P. microstylus*
 $V=68-76$; stylet=15-17 μm ... *P. zaeae*.

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INFLUENCE OF TRALKOXYDIM APPLIED ALONE OR AS TANK MIXTURE ON THE CONTROL OF GRASSY WEEDS IN WHEAT

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ABSTRACT

Field studies were conducted at Hisar and Karnal during 1988-89 and 1989-90 to determine the efficacy of tralkoxydim applied alone or tank-mixed with 2,4-D, fluroxypyr and isoproturon on the control of wild oat and wild canary grass in wheat. Tralkoxydim at 0.30 or 0.35 kg/ha effectively controlled the wild oat. Tank mixing of tralkoxydim and 2,4-D did not improve the control of wild oat or wild canary grass. Combination of tralkoxydim and isoproturon improved the control of wild canary grass. Plots treated with tralkoxydim at 0.35 kg/ha provided significantly higher grain yield than isoproturon treated plots. Tralkoxydim at 0.35 kg/ha plus fluroxypyr at 0.20 kg/ha treated plots yielded 5117 and 5808 kg/ha as compared to 6068 and 6248 kg/ha in weed free plots during 1988-89 and 1989-90, respectively. In the field dominated by wild canary grass, isoproturon at 1.0 kg/ha registered significantly higher grain yield than tralkoxydim.

Wild canary grass (*Phalaris minor* Retz.) is one of the most serious weeds of wheat in rice-wheat sequences. The problem of wild oat is wide-spread in north western India in most cropping sequences including cotton-wheat and pearl millet-wheat. Common lambs-quarter (*Chenopodium album* L.) is mostly found as a dominating weed in pearl millet-wheat rotation. The shift in the weed flora in favour of wild oat and some broad leaf weeds including *Medicago sativa* and *Rumex meritimus* has been recorded in the latest survey of weeds in wheat (Anonymous, 1990). Isoproturon has been frequently used for the control of annual grasses (Bhagwati *et al.*, 1990). Tank mixtures with other herbicides have been recommended for complex weed flora (Malik *et al.*, 1989). 2,4-D used alone or as tank mixture

caused large scale development of ear deformities and reduced the grain yield of some wheat cultivars (Sharma *et al.*, 1987). Fluroxypyr has proved as an effective substitute of 2,4-D (Panwar *et al.*, 1989), and mixture of isoproturon and fluroxypyr has been found successful. Isoproturon applied post-emergence is not effective against wild oat once it crosses four leaf stage (Gupta *et al.*, 1990). Tralkoxydim has been found selectively controlling wild oat and wild canary grass in wheat (Sutton *et al.*, 1987) but broad leaf weeds are not controlled by this herbicide (Malik *et al.*, 1990). Most varieties have been found to tolerate this herbicide at 0.35 kg/ha (Balyan *et al.*, 1991). Tank mixture of tralkoxydim plus 2,4-D or fluroxypyr or isoproturon may help in providing broad spectrum weed control.

MATERIAL AND METHODS

Experiment 1

Field experiments were conducted at the Haryana Agricultural University Research Farm, Hisar, during 1988-89 and 1989-90. The soil was sandy loam with 0.4% organic matter and a pH of 8.1. It was low in available nitrogen (162 kg/ha), medium in available phosphorus (14 kg/ha) and rich in available potash (510 kg/ha). The field was heavily infested with the natural population of wild oat during the preceding few years. Common lambsquarter was also present but in relatively less density. Nitrogen, phosphorus and zinc were applied at 120, 60 and 25 kg/ha, respectively. Fields were irrigated as and when required as per package of practices recommended in Haryana state. Treatments consisted of tralkoxydim at 0.25, 0.30 and 0.35 kg/ha, 2,4-D at 0.50 kg/ha, fluroxypyr at 0.20 and 0.30 kg/ha, tralkoxydim+2,4-D at 0.25+0.25, 0.30+0.25 and 0.35+0.25 kg/ha, tralkoxydim+fluroxypyr at 0.25+0.20, 0.30+0.20 and 0.35+0.20 kg/ha. Weedy and weed free control treatments were included for comparison. Isoproturon at 1.0 kg/ha (existing recommendations for grassy weeds) was also included as a standard check. Treatments were arranged in randomized complete block design with three replications. Wheat variety WH-283 was seeded on 13 November, 1988 and 1 December, 1989. Herbicides were sprayed 35 days after sowing using knapsack sprayer with a spray volume of 650 l/ha. Weed counts (number/m²) and their dry weight (g/m²) were recorded at 60-90 DAS with the help of 0.5 m×0.5 m random quadrat.

Experiment 2

Field studies were conducted at Regional Research Station, Uchani, Karnal, during 1989-90 and 1990-91. The soil was clay loam with a pH of 8.9 and organic matter content of 0.3%. The field was heavily infested with a natural population of wild canary grass. Nitrogen, phosphorus and zinc were applied at 150, 60 and 25 kg/ha, respectively. Five irrigations were applied during the whole season. Treatments consisted of tralkoxydim at 0.25, 0.30 and 0.35 kg/ha, isoproturon at 0.75 and 1.0 kg/ha, tralkoxydim+isoproturon at 0.25+0.50, and 0.25+0.75 kg/ha, tralkoxydim+2,4-D at 0.25+0.20 kg/ha and tralkoxydim+fluroxypyr at 0.25+0.20 kg/ha applied post-emergence; and pendimethalin at 1.0 and 1.5 kg/ha applied pre-emergence. All treatments except isoproturon at 1.0 kg/ha were given 20 days after sowing. Isoproturon at 1.0 kg/ha was applied 35 days after sowing. Weedy and weed free control treatments were also included for comparison. The treatments were replicated three times in a randomized complete block design. Wheat variety HD-2329 was seeded on 22 November, 1989 and 27 November, 1990 in 20 cm rows. Assessments of weed counts and their dry weight were made 120 days after sowing at two sites in each plot, using 0.5 m×0.5 m random quadrat.

RESULTS AND DISCUSSION

Effect on Weeds

In the untreated check, 119 and 54 wild oat plants/m² were found in 1988-89 and 1989-90, respectively. The lower wild oat density in second year may be

CONTROL OF GRASSY WEEDS IN WHEAT

TABLE 1

Influence of tralkoxydim alone and in combination with other herbicides on wild oat (*Avena ludoviciana*) population and total number of weeds at 60 DAS

Treatment	Rate (kg/ha)	Wild oat population (plants/m ²)		Total weed population (plants/m ²)	
		1988-89	1989-90	1988-89	1989-90
Tralkoxydim	0.25	7.41	5.03	9.10	7.89
Tralkoxydim	0.30	5.61	3.68	6.25	7.22
Tralkoxydim	0.35	3.74	2.64	5.83	6.34
Isoproturon	1.00	7.76	3.29	7.76	3.37
2, 4-D	0.50	10.43	6.34	11.38	6.34
Tralkoxydim+2,4-D	0.25+0.25	9.76	6.79	9.76	6.79
Tralkoxydim+2,4-D	0.30+0.25	6.75	6.46	6.75	6.69
Tralkoxydim+2,4-D	0.35+0.25	4.33	5.13	5.48	5.13
Fluroxypyr	0.20	9.62	7.09	9.69	7.09
Fluroxypyr	0.30	9.49	7.18	9.49	7.18
Tralkoxydim+Fluroxypyr	0.25+0.20	6.72	4.93	7.75	6.32
Tralkoxydim+Fluroxypyr	0.30+0.20	4.92	3.77	6.04	4.60
Tralkoxydim+Fluroxypyr	0.35+0.20	3.66	3.41	5.43	3.96
Weedy check		10.72	7.37	12.42	9.67
Weed free		1.00	1.00	1.00	1.00
C, D, at 5%		2.84	2.39	2.17	2.17

DAS—Days after sowing.

Transferred values of weeds have been presented.

attributed to delayed sowing of the crop. Moreover, large proportion of wild oat seed reservoir had already emerged before wheat sowing. In second experiment, the field was dominated by a natural population of wild canary grass. Tralkoxydim at 0.35 kg/ha was more effective than isoproturon against wild oat (Table 1) but not against wild canary grass (Table 4). Wild oat density decreased with the corresponding increase in the dose of tralkoxydim. In 1988-89, tralkoxydim at 0.35 kg/ha, tralkoxydim at 0.35 kg/ha+fluroxypyr at 0.20 kg/ha, tralkoxydim at 0.35 kg/ha+2,4-D at 0.25 kg/ha, tralkoxydim at 0.30 kg/ha+

fluroxypyr at 0.20 kg/ha, and tralkoxydim at 0.30 kg/ha were most effective in controlling wild oat in that order (Table 1). In 1989-90, in addition to above treatments, isoproturon also provided good control of wild oat. Similar results on tralkoxydim were reported earlier (Gupta *et al.*, 1990). The increased efficacy of isoproturon against wild oats in the second year was because at spraying wild oat did not cross four leaf stage. Earlier studies by Gupta *et al.* (1990) have also shown good control of wild oat by isoproturon sprayed before wild oat attained four leaf stage.

Tralkoxydim at 0.25 kg/ha+isoproturon at 0.75 kg/ha applied 20 DAS (3-leaf stage of wild canary grass), isoproturon at 1.0 kg/ha applied 35 DAS (6-leaf stage of wild canary grass), and tralkoxydim at 0.25 kg/ha+isoproturon at 0.50 kg/ha were effective in reducing wild canary grass population. Tralkoxydim was not as effective as isoproturon applied 3- or 6-leaf stage of wild canary grass. Similar effect of tralkoxydim and isoproturon, each applied alone, was reported earlier (Panwar *et al.*, 1989).

The combination of tralkoxydim and 2,4-D at 0.25+0.25 kg/ha did not improve the control of total weeds over tralkoxydim at 0.25 kg/ha alone. The

dry weight of total weeds at 60 DAS following treatment of tralkoxydim at 0.25 kg/ha was 60.0 and 4.1 g/m² as compared to 50.5 and 9.5 g/m² following treatment of tralkoxydim at 0.25 kg/ha+2,4-D at 0.25 kg/ha in 1988-89 and 1989-90, respectively. The corresponding values at 90 days after sowing were 121.6 and 57.2 compared to 120.1 and 29.7 g/m² (Table 2). The corresponding wild oat densities with the addition of 2,4-D to tralkoxydim were more than the plots where tralkoxydim was applied alone (Table 1). The lack of enhanced overall control with the addition of 2,4-D in both experiments (Tables 1, 2 and 4) might be attributed to the reduced acti-

TABLE 2

Influence of tralkoxydim alone and in combination with other herbicides on total dry weight of weeds at 60 and 90 DAS

Treatment	Rate (kg/ha)	Dry weight of total weeds (g/m ²)			
		60 DAS		90 DAS	
		1988-89	1989-90	1988-89	1989-90
Tralkoxydim	0.25	60.0	4.1	121.6	52.7
Tralkoxydim	0.30	32.2	3.9	69.7	22.3
Tralkoxydim	0.35	15.7	3.7	56.1	10.7
Isoproturon	1.00	38.1	3.8	87.3	13.7
2, 4-D	0.50	169.7	16.7	183.7	61.4
Tralkoxydim+2,4-D	0.25+0.25	50.5	9.6	120.1	29.7
Tralkoxydim+2,4-D	0.30+0.25	41.5	6.9	100.4	26.8
Tralkoxydim+2,4-D	0.35+0.25	14.7	4.4	41.5	13.7
Fluroxypyr	0.20	199.9	15.2	227.6	63.4
Fluroxypyr	0.30	185.9	18.3	191.0	77.8
Tralkoxydim+Fluroxypyr	0.25+0.20	31.1	4.3	109.0	18.1
Tralkoxydim+Fluroxypyr	0.30+0.20	27.5	1.9	49.1	13.9
Tralkoxydim+Fluroxypyr	0.35+0.20	22.5	1.9	49.7	5.8
Weedy check		213.9	21.1	309.4	133.9
Weed free		0.0	0.0	0.0	0.0
C. D. at 5%		52.9	8.3	71.7	40.4

TABLE 3
Influence of tralkoxydim alone and in combination with other herbicides on plant height, effective tillers and grain yield of wheat at harvest

Treatment	Rate (kg/ha)	Plant height (cm)		Effective tillers (metre row length)		Grain yield (kg/ha)	
		1988-89	1989-90	1988-89	1989-90	1988-89	1989-90
Tralkoxydim	0.25	108	86	90	95	4169	4153
Tralkoxydim	0.30	107	84	98	99	4181	4387
Tralkoxydim	0.35	107	82	102	102	4983	5234
Isoproturon	1.00	107	82	97	100	4008	4110
2,4-D	0.50	106	85	88	89	1258	2430
Tralkoxydim + 2,4-D	0.25 + 0.25	107	83	95	96	1369	2779
Tralkoxydim + 2,4-D	0.30 + 0.25	105	85	100	101	3207	3582
Tralkoxydim + 2,4-D	0.35 + 0.25	103	83	102	105	3527	3637
Fluroxypyr	0.20	109	88	85	88	1492	3165
Fluroxypyr	0.30	109	89	89	91	1690	3304
Tralkoxydim + Fluroxypyr	0.25 + 0.20	107	88	95	102	4058	4220
Tralkoxydim + Fluroxypyr	0.30 + 0.20	108	86	99	105	5168	5637
Tralkoxydim + Fluroxypyr	0.35 + 0.20	108	85	104	109	5117	6808
Weedy check		109	85	85	87	1135	2166
Weed free		109	87	107	111	6068	6248
C. D. at 5%		NS	NS	10	11	842	754

TABLE 4
Influence of tralkoxydim alone and in combination with other herbicides on density and dry weight of *Phalaris minor* at 120 DAS and grain yield of wheat

Treatment	Rate (kg/ha)	Time of application	Weed population (plants/m ²)		Dry weight of weeds (g/m ²)		Grain yield (kg/ha)	
			1989-90	1990-91	1989-90	1990-91	1989-90	1990-91
Tralkoxydim	0.25	20	11.29	10.50	145.6	65.7	3067	3775
Tralkoxydim	0.30	20	10.39	10.11	139.1	60.5	3490	3950
Tralkoxydim	0.35	20	7.75	7.21	103.1	53.5	3063	4167
Isoproturon	0.75	20	5.30	4.23	5.5	11.7	3935	4558
Isoproturon	1.00	35	6.06	3.90	8.3	6.3	4038	4567
Tralkoxydim + Isoproturon	0.25 + 0.50	20	6.37	4.19	24.4	7.2	3940	4767
Tralkoxydim + Isoproturon	0.25 + 0.75	20	3.75	1.75	8.2	2.2	3600	4383
Tralkoxydim + 2,4-D	0.25 + 0.50	20	9.46	9.19	149.9	47.2	3004	3883
Tralkoxydim + Fluroxypyr	0.25 + 0.20	20	10.33	10.02	170.6	53.1	3049	3833
Pendimethalin	1.00	Pre-emergence	7.64	6.58	74.5	22.1	3706	4325
Pendimethalin	1.50	Pre-emergence	6.85	5.45	42.9	13.5	3894	4908
Weedy check			16.50	16.50	345.7	192.2	2732	3192
Weed free			1.00	1.00	0.0	0.0	4008	4916
L. S. D.			2.7	2.1	52.6	52.6	686	344

Transferred values of weeds have been presented.

vity of tralkoxydim on these grassy weeds. The population and dry weight of wild oat and wild canary grass in the plots treated with the combination of tralkoxydim and fluroxypyr remained similar to that of tralkoxydim applied alone at corresponding doses (Tables 1, 2 and 4).

Effect on Crops

Average yield of wheat was higher at Hisar than at Karnal (Tables 3 and 4). At Hisar wheat was grown after green manuring, whereas at Karnal it was grown after paddy. The average yield reductions were more due to wild oats competition (Table 3) than due to wild canary grass competition (Table 4). The lower yields in the wild oats dominated untreated check (Table 3) suggest that wild oat offers much severe competition than wild canary grass. Wheat yields in wild oats dominated field were greater than the untreated check in all herbicide treatments except 2,4-D or fluroxypyr or tralkoxydim at 0.25 kg/ha+2,4-D at 0.25 kg/ha. The greater yields under tralkoxydim or tralkoxydim+fluroxypyr treatments were due to less competition (Table 3) of wild oats resul-

ting in increased tillers and plant height. Excellent control of wild oats by tralkoxydim has also been reported earlier (Sutton *et al.*, 1987).

Lower yields in the plots treated with tralkoxydim+2,4-D may be because of 46 to 47 per cent malformed spikes caused by 2,4-D (data not included in Table). Yield reductions following 2,4-D treatments were of the same magnitude as in weedy check. Higher wild oats density and developmental deformities of wheat spikes caused reduction in yield in the 2,4-D treated plots. In 1988-89, fluroxypyr treated plots registered similar yields to that obtained in the unweeded control. In 1989-90, the yield reduction was lower than 1988-89. Lower yield in first year might be because of higher wild oat density than the second year. In the field dominated by wild canary grass, isoproturon treated plots registered greater yields as compared to tralkoxydim treated plots. Lower crop yields in the plots where combination of tralkoxydim and 2,4-D or fluroxypyr were applied could be attributed to the greater population and dry weight of wild canary grass in these plots.

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INTER-RELATIONSHIP OF HARVEST INDEX AND OTHER TRAITS IN WHEAT

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ABSTRACT

Forty-five genotypes comprising nine parents and their 36 hybrids of spring wheat were studied for phenotypic and genotypic correlations under normal and stress environments. In general, genotypic correlations were higher than the corresponding phenotypic correlations. Grain yield was significantly positively associated with tiller number, biological yield and grains/ear but harvest index was negatively correlated with biological yield in both the environments. Harvest index had significant positive correlation with grain yield in normal environment and no correlation in stress environment. Path analysis indicated that biological yield and harvest index were the most important yield components. The usefulness of harvest index and biological yield as the components of an ideotype has been discussed in light of the results obtained.

Grain yield in wheat is the product of tiller number, number of grains/ear and 1000-grain weight. Improvement in any of these characters would cause more yield per unit area. Jatasra and Paroda (1978) discussed yield component compensation in crop plants and concluded that it occurs frequently. If this is the case, increasing one yield component will not necessarily increase yield. Therefore, a knowledge of genetic association among yield components and harvest index may be useful in planning a successful breeding programme in order to achieve further improvement in grain yield.

MATERIAL AND METHODS

In the present study nine spring wheat varieties, viz. WL 711, NP 846, WG 377,

HD 1981, UP 262, HD 1925, HD 2122, Raj 821 and Sonalika were crossed in all possible combinations, excluding reciprocals. The field trials with 36 F₁'s and 9 parents were conducted in a randomized block design with three replications under two different environments, i. e. normal (high fertility irrigated conditions) and stress (low fertility rainfed conditions). The seeds were sown in a three metre long row at 30 and 15 cm row to row and plant to plant distance, respectively. Data were recorded on 10 randomly selected plants on days to heading, plant height, tiller number, biological yield, number of grains/ear, 1000-grain weight, grain yield/plant and harvest index. Phenotypic and genotypic correlations were calculated using formulae suggested by Miller *et al.* (1958) and path analysis was performed according to Dewey and Lu (1959).

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RESULTS AND DISCUSSION

The analysis of variance revealed significant mean squares for all the characters under both the environments. Although, in general, correlations at genotypic and phenotypic levels exhibited similar trend, yet the former were of greater magnitude than the latter in both normal (Table 1) and stress (Table 2) environments. Further, in most of the cases correlations were more pronounced under stress environment than under normal environment. Under normal environment, harvest index was significantly positively correlated with grain yield and negatively correlated with days to heading, plant height and biological yield (Table 1).

Grain yield showed significant positive association with tiller number, biological yield and number of grains/ear but negative significant correlation with days to heading. Singh and Stoskopf (1971), Chaudhary *et al.* (1977), Thakral *et al.* (1979) and Sharma *et al.* (1991) also observed positive correlation of harvest index with grain yield and negative correlation with biological yield. In stress environment, harvest index was not correlated with grain yield but it showed negative correlations with days to heading, plant height and biological yield (Table 2). Similar findings have earlier been reported by Sharma and Smith (1986). Thus, an improvement in grain yield can be brought about with an increase in harvest index.

TABLE 1

Genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficients between yield and its components in normal environment in wheat

Character	Days to heading	Plant height (cm)	Tiller number	Biological yield (g)	Number of grains/ear	1000-grain weight (g)	Grain yield/plant (g)	Harvest index
Days to heading		0.58	-0.22	0.33	0.32	-0.44	-0.33	-0.74
Plant height	0.53**		0.29	0.43	0.13	-0.19	0.04	-0.38
Tiller number	-0.21	0.23		0.57	-0.25	0.02	0.58	0.10
Biological yield	0.25	0.37*	0.56**		0.34	-0.14	0.63	-0.27
Number of grains/ear	0.24	0.15	-0.15	0.30*		-0.43	0.44	0.20
1000-grain weight	-0.39**	-0.15	0.03	-0.06	-0.34*		0.08	0.27
Grain yield/plant	-0.32*	0.05	0.54**	0.61**	0.42**	0.13		0.56
Harvest index	-0.61**	-0.30*	0.04	-0.32*	0.18	0.23	0.55**	

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

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TABLE 2

Genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficients between yield and its components in stress environment in wheat

Character	Days to heading	Plant height (cm)	Tiller number	Biological yield (g)	Number of grains/ear	1000-grain weight (g)	Grain yield/plant (g)	Harvest index
Days to heading		0.84	0.20	0.45	0.41	-0.37	0.22	-0.64
Plant height	0.81**		0.27	0.46	0.35	-0.35	0.27	-0.55
Tiller number	0.12	0.23		0.74	0.19	-0.38	0.57	-0.55
Biological yield	0.40**	0.43**	0.63**		0.67	-0.29	0.82	-0.33
Number of grains/ear	0.40**	0.36*	0.18	0.61**		-0.55	0.69	-0.08
1000-grain weight	-0.35*	-0.32*	-0.17	-0.22	-0.48**		-0.10	0.61
Grain yield/plant	0.21	0.28	0.51**	0.87**	0.63**	-0.06		0.07
Harvest index	-0.37*	-0.31*	-0.27	-0.31*	0.01	0.34*	0.20	

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

Path coefficient analysis plays an important role in determining the contribution of various traits to the grain yield. Biological yield and harvest index indicated the highest positive direct effect on grain yield in normal (Table 3) as well as in stress environment (Table 4), while plant height, tiller number, number of grains/ear and 1000-grain weight had low direct effect on grain yield. The indirect effect of plant height on yield through biological yield was relatively high and positive, via harvest index it was high and negative, and via number of grains/ear it was low and negative. The high correlation of tiller number with grain yield was observed as a result of its indirect contribution through biological yield. Most of the causal components exhibited high correlations with grain yield

because of their indirect contribution through biological yield.

The path analysis was also performed after excluding harvest index. In normal environment, amongst the causal components, number of grains/ear followed by tiller number, biological yield and 1000-grain weight were observed to have the positive direct effect on grain yield (Table 5). Under stress environment, biological yield followed by number of grains/ear and 1000-grain weight were having positive direct effect on grain yield (Table 6). Residual effect was of low magnitude in both the environments, suggesting that most of the components contributing to yield have been included in the analysis.

TABLE 3

Path coefficient analysis of factors influencing grain yield in normal environment

Character	Effect via							
	Days to heading	Plant height (cm)	Tiller number	Biological yield (g)	Number of grains/ear	1000-grain weight (g)	Harvest index	Correlation with grain yield
Days to heading	-0.05	-0.02	-0.02	0.25	0.03	-0.01	-0.51	-0.33
Plant height	-0.03	-0.03	0.03	0.33	0.01	0.00	-0.27	0.04
Tiller number	0.01	-0.01	0.10	0.44	-0.02	0.00	0.07	0.58
Biological yield	-0.02	-0.01	0.06	0.77	0.03	0.00	-0.19	0.63
Number of grains/ear	-0.02	-0.01	-0.02	0.26	0.10	-0.01	0.14	0.44
1000-grain weight	0.02	0.01	0.00	-0.11	-0.04	0.01	0.19	0.08
Harvest index	0.03	0.01	0.01	-0.21	0.02	0.00	0.69	0.56

Residual effect = 0.005

TABLE 4

Path coefficient analysis of factors influencing grain yield in stress environment

Character	Effect via							
	Days to heading	Plant height (cm)	Tiller number	Biological yield (g)	Number of grains/ear	1000-grain weight (g)	Harvest index	Correlation with grain yield
Days to heading	0.15	-0.05	-0.08	0.81	-0.31	0.22	-0.52	0.22
Plant height	0.12	-0.06	-0.11	0.81	-0.26	0.21	-0.45	0.27
Tiller number	0.03	-0.02	-0.41	1.32	-0.14	0.23	-0.44	0.67
Biological yield	0.07	-0.03	-0.30	1.77	-0.50	0.18	-0.27	0.92
Number of grains/ear	0.06	-0.02	-0.08	1.19	-0.75	0.34	-0.06	0.69
1000-grain weight	-0.05	0.02	0.15	-0.51	0.41	-0.61	0.49	-0.10
Harvest index	-0.10	0.03	0.22	-0.58	0.06	-0.37	0.81	0.07

Residual effect = -0.018

The results discussed above indicated that biological yield followed by harvest index had substantial direct contribution towards yield under both the environments. In both the environments, when harvest index was not considered as

causal component, biological yield was one of the main contributors to the grain yield. Thus, biological yield and harvest index are the main characters to be taken into account while making selection of superior genotypes.

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TABLE 5

Path coefficient analysis of yield components excluding harvest index in normal environment

Character	Effect via						
	Days to heading	Plant height (cm)	Tiller number	Biological yield (g)	Number of grains/ear	1000-grain weight (g)	Correlation with grain yield
Days to heading	-0.42	-0.02	-0.11	0.10	0.22	-0.09	-0.33
Plant height	-0.25	-0.04	0.14	0.13	0.09	-0.04	0.04
Tiller number	0.09	-0.01	0.50	0.17	-0.17	0.01	0.58
Biological yield	-0.14	-0.02	0.28	0.30	0.24	-0.03	0.63
Number of grains/ear	-0.14	-0.01	-0.12	0.10	0.70	-0.09	0.44
1000-grain weight	0.19	0.01	0.01	-0.04	-0.30	0.22	0.08

Residual effect=0.065

TABLE 6

Path coefficient analysis of yield components excluding harvest index in stress environment

Character	Effect via						
	Days to heading	Plant height (cm)	Tiller number	Biological yield (g)	Number of grains/ear	1000-grain weight (g)	Correlation with grain yield
Days to heading	-0.26	0.08	0.03	0.30	0.20	-0.13	0.22
Plant height	-0.22	0.10	0.04	0.30	0.17	-0.13	0.27
Tiller number	-0.05	0.03	0.15	0.49	0.09	-0.14	0.57
Biological yield	-0.12	0.05	0.11	0.65	0.33	-0.10	0.92
Number of grains/ear	-0.11	0.04	0.03	0.44	0.49	-0.20	0.69
1000-grain weight	0.10	-0.03	-0.08	-0.19	-0.27	0.36	-0.10

Residual effect=0.045

Harvest index is a function of economic and biological yields. In stress environment, biological yield is the limiting factor which is reflected in high harvest index paradoxically. On the other hand harvest index and/or grain yield is

the limiting factor in normal environment. Therefore, it would be desirable to make crosses between the parents having complementary characters of high harvest index and high biological yield. The F₂ or subsequent generations should be

grown in stress environment to make selection for high biological yield and the selected individuals should be tested in normal environment for high harvest index. This would complete one cycle

of selection. The three or four cycles of selection in sequence should be followed to exploit limiting factors in stress as well as in normal environments.

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EFFECT OF ANILOFOS ON RNASE AND DNASE ACTIVITY IN SEEDS/SEEDLINGS OF RICE AND *ECHINOCHLOA CRUSGALLI* L.

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ABSTRACT

The effect of 0, 5, 10, 20 and 40 ppm of anilofos, given as pre-sowing soaking and continuous treatment, on the activities of RNase and DNase in rice and *Echinochloa crusgalli* was studied to understand the basis of selectivity of the herbicide towards the weed. Samples were taken for enzymes analysis at 8, 12, 24, 48 and 72 h after treatment. Increasing concentration of anilofos progressively reduced the activity of RNase in rice. However, in *E. crusgalli*, the activity of RNase increased upto 24 h but decreased thereafter with anilofos. Anilofos increased the DNase activity upto 48 h but reduced it thereafter both in rice and *E. crusgalli*. More reduction in the activities of RNase and DNase in *E. crusgalli* than in rice, might be the cause of death of *E. crusgalli* seedlings.

Herbicides have been used for weed control in several crops, especially in cereals and plantation crops. The use of these chemicals has increased production and their use, being economical, is increasing day by day. Anilofos (S-[2-[(4-chlorophenyl) (1-methyl-ethyl) amino] 2-oxoethyl] O, O-dimethyl phosphorodithioate) is used to control weeds in the rice fields. It is applied to the soil primarily to inhibit germination and growth of *E. crusgalli*, one of the main competent weeds (Prakash *et al.*, 1989). However, no work has been done so far to study how germination or seedling growth is inhibited by the herbicide. Present investigations were, therefore, conducted to make a beginning in this direction by studying the effect of anilo-

fos on the activities of RNase and DNase of rice and *E. crusgalli* seeds during germination.

MATERIAL AND METHODS

Seeds of rice (*Oryza sativa* L.) cv. Jaya, and *Echinochloa crusgalli* L. were soaked in distilled water or anilofos solution for 12 h. Solutions of 5, 10, 20 and 40 ppm of anilofos were used for pre-sowing soaking (PSS) treatment as well as for continuous treatment. After soaking, 20 seeds of rice and 200 seeds of *E. crusgalli* were placed on filter paper in each 9 cm petridish separately. Five ml of distilled water for PSS treatment and 5 ml of anilofos solution for continuous treatment were added to each petridish. The petri-

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dishes were placed in BOD incubator at $30^{\circ}\pm 1^{\circ}\text{C}$ for germination of seeds. Samples were taken for enzymes analysis after 6, 12, 24, 48 and 72 h of sowing. Seeds/seedlings sample was extracted in tris HCl buffer (pH 7.4) and crude extract was used for assay of RNase and DNase activities according to Wilson (1968). Statistical analysis of the data was carried out using factorial CRD.

RESULTS AND DISCUSSION

RNase activity (expressed as one unit = μg RNA hydrolysed/g fresh weight/h) increased upto 72 h with the passage of time both in PSS and continuous treatments irrespective of anilofos concentration used in rice (Table 1). Application of anilofos reduced the activity of RNase, the effect increased with increase in concentration irrespective of the time of sampling. The activity of RNase increa-

sed with passage of time upto 24 h but decreased thereafter upto 72 h in *E. crus-galli* (Table 2). Very high RNase activity of 24 h in *E. crusgalli* was associated with rapid growth of its seedlings (unpublished data). Further, RNase activity was higher in *E. crusgalli* than in rice. Application of anilofos reduced the activity of RNase under both PSS and continuous treatments. Inhibition of RNase activity due to herbicide application was more in *E. crusgalli* than in rice. Reduced RNA hydrolysis during germination might be responsible for reduced seedling growth (Audus, 1976).

DNase activity (expressed as one unit = μg DNA hydrolysed/g fresh weight/h) increased upto 48 h but decreased at 72 h (Table 3). Anilofos application reduced the activity of DNase, the magnitude of reduction increased with increase in concentration of the herbicide. However,

TABLE 1

Effect of anilofos on RNase activity (μg RNA hydrolysed/g seeds or seedlings fresh weight/h) in rice during germination

Con- centra- tion (ppm)	Pre-sowing soaking						Continuous					
	Time of sampling (h)											
	6	12	24	48	72	Mean	6	12	24	48	72	Mean
0	81	234	278	537	813	388	210	319	378	692	985	516
5	74	206	264	519	728	358	178	239	334	530	829	422
10	68	187	253	446	445	279	62	193	309	466	707	347
20	66	136	223	422	473	262	44	149	286	415	418	268
40	63	117	212	410	451	248	39	120	239	525	603	305
Mean	68	176	246	466	682	307	107	204	309	526	714	372

C. D. at 5% level

Period = 14

Concentration = 13

PSS vs. Conc. = 19.

EFFECT OF ANILOFOS ON RNASE AND DNASE ACTIVITY IN RICE

TABLE 2

Effect of anilofos on RNase activity (μg RNA hydrolysed/g seeds or seedlings fresh weight/h) in *Echinochloa crusgalli* during germination

Con- centra- tion (ppm)	Pre-sowing soaking						Continuous					
	Time of sampling (h)											
	6	12	24	48	72	Mean	6	12	24	48	72	Mean
0	757	890	1714	885	586	966	767	892	1791	728	615	968
5	742	832	1644	760	576	980	745	840	1748	702	592	925
10	660	690	1563	720	563	837	680	720	1708	672	537	863
20	620	640	1499	680	505	788	632	662	1590	626	502	802
40	592	620	1462	622	489	755	606	622	1507	592	492	763
Mean	672	732	1576	733	543	851	686	755	1668	664	547	862

C. D. at 5% level

Period=16

Concentration=15

PSS vs. Conc.=18.

TABLE 3

Effect of anilofos on DNase activity (μg DNA hydrolysed/g seeds or seedlings fresh weight/h) in rice during germination

Con- centra- tion (ppm)	Pre-sowing soaking						Continuous					
	Time of sampling (h)											
	6	12	24	48	72	Mean	6	12	24	48	72	Mean
0	230	296	518	762	474	454	172	533	944	1158	622	686
5	207	244	491	658	166	353	158	434	933	1092	613	646
10	185	237	427	651	160	312	126	354	892	1932	533	587
20	178	206	349	520	112	273	107	330	884	978	519	564
40	160	174	317	420	95	233	94	256	795	882	484	502
Mean	192	231	420	580	201	325	131	381	889	1028	554	596

C. D. at 5% level

Period=29

Concentration=30

PSS vs. Conc.=62.

TABLE 4

Effect of anilofos on DNase activity (μ g DNA hydrolysed/g seeds or seedlings fresh weight/h) in *Echinochloa crusgalli* during germination

Con- centra- tion (ppm)	Pre-sowing soaking						Continuous					
	Time of sampling (h)											
	6	12	24	48	72	Mean	6	12	24	48	72	Mean
0	173	285	556	842	663	503	169	574	1067	1510	778	819
5	139	274	516	713	623	453	97	407	948	1620	669	745
10	111	247	494	665	551	413	45	322	889	1735	415	681
20	110	286	463	537	418	362	36	435	860	1845	883	811
40	146	322	610	507	308	379	22	483	945	1946	856	850
Mean	135	282	528	653	513	422	73	444	941	1731	717	781

C. D. at 5% level

Period=39

Concentration=38

PSS vs. Conc.=25.

continuous treatment was more toxic as compared to PSS treatment. The activity of DNase in *E. crusgalli* increased upto 48 h under both the conditions but decreased thereafter. Anilofos decreased the activity of DNase only upto 10 ppm but not at higher level in continuous treatment, but was reduced at all concentrations in PSS treatment. Reduced

DNase activity with the application of herbicide in rice and *E. crusgalli* might be responsible for inhibition of seedling growth in both the cases. Sheoran and Garg (1978) found reduced DNase activities to be associated with reduced growth of seedlings under salt stress conditions.

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USE OF POTASSIUM IODIDE—A DESICCANT AS TECHNIQUE FOR SCREENING DROUGHT TOLERANT GENOTYPES IN WHEAT

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ABSTRACT

A study was conducted to understand the mobilization of assimilates in wheat genotypes by spraying potassium iodide, a desiccant, under irrigated conditions. The mobilization of assimilates from source to sink was estimated by the changes in the source and sink dry matter in the treatments along with the test weight and grains per spike. The potassium iodide (0.3%) spray on stem (KIS) was comparable with the natural drought created by withholding of irrigation at flag leaf (boot) stage. The spray on whole shoot caused sharp reduction in test weight, grains per spike, and sink : source ratio due to fast desiccation of sink tissues as well as source, hence, resulting in very little mobilization. The effect of desiccation was more severe on test weight than grains per spike and was similar to natural drought conditions. Among the genotypes, AP 425 translocated least assimilates from source to sink resulting in very low test weight and grain yield, therefore, it can be classified as susceptible to drought. Contrarily, cvs. WH 337, WH 533, HD 2380 and HUW 318 translocated more assimilates to grain which resulted in higher grain yield and, therefore, can be considered as tolerant to drought.

Rainfall in Indian sub-continent is scanty during winter months. Therefore, winter season cereals invariably suffer from moisture stress at anthesis (Behl *et al.*, 1992) when sown on conserved soil moisture. Under such conditions, kernel growth becomes increasingly dependent on mobilization of plant assimilates (stored prior to anthesis) due to limited current (transient) photosynthesis (Austin *et al.*, 1980; Blum *et al.*, 1983 a; Asana *et al.*, 1987). The use of natural dry environment for screening drought tolerant genetic material is also time consuming. Therefore, Blum *et al.* (1983 a) suggested the use of magnesium chlorate as chemical desiccant (14 days

after anthesis) in irrigated wheat to induce earlier mobilization of assimilates. In subsequent studies, Turner *et al.* (1989) recommended the use of 0.3 to 0.4 per cent potassium iodide than magnesium chlorate. But the controversy to spray plant parts or whole crop canopy remained unsettled. Even it was not certain that these desiccants resemble natural post-anthesis water stress (Blum *et al.*, 1983 a; Turner *et al.*, 1989). This study was, therefore, aimed firstly to compare the effects of desiccant applied on plant parts (leaving ears) and on whole plant, and secondly to compare the effect of desiccants with natural drought.

MATERIAL AND METHODS

Experiments on 10 and 13 wheat genotypes, with four replications, were conducted during 1990-91 and 1991-92, respectively, under field and drought plot conditions, at CCS Haryana Agricultural University, Hissar. The crop was sown on 21 November and 2 December during 1990 and 1991, respectively, after pre-sowing irrigation. The field soil was sandy loam in texture and medium in fertility which retained about 23 cm available water per metre depth between 0.3 and 15 bar tensions. Contrarily, the drought plots were concrete structure of $30 \times 6 \times 1$ m in size filled with dunal sand and poor in fertility, retaining about 15 cm available water between 0.1 and 15 bar tensions. The fertilizers were applied as per recommendations. The irrigated control (wet) was given irrigations as per recommendations. The spray of KI was done on different dates due to variation in phenology of various genotypes. The natural dry environment was created by withholding irrigation at flag leaf (boot) stage. The potassium iodide (0.3%) was sprayed on stem (KIS) as well as on whole plant (KIW) in irrigated control, when about 1/3 of the grain cavity in the middle of spike was filled. During 1990-91, moisture stress could not be created by withholding irrigation in the field at flag leaf stage due to shallow water table. Hence, the experiment was repeated in 1991-92 at concrete drought plots to draw valid conclusion. The crop was harvested at maturity. The grain size (100-grain weight), grains per spike, grain yield and biomass were recorded from 100 representative tillers per treatment.

RESULTS AND DISCUSSION

Spray of potassium iodide (0.3%) resulted in complete death of treated tissues within a week. The death of different tissues with this desiccant was, however, low as compared to magnesium chlorate (0.4%) which killed all tissues (awns, glumes, leaf lamina, parts of leaf peduncle and leaf sheaths) within two days of its spray as reported by Blum *et al.* (1983 b).

The effects of desiccant spray on the grain size and grains per spike, for the two seasons, are given in Tables 1 and 2. As expected the effect of quick senescence due to potassium iodide was more pronounced on grain size than on grains per spike. The smallest grain size was recorded in cv. AP 425 during both the years of study. During 1990-91 the highest test weight was observed in cv. P 5451 followed by cvs. WH 147 and PBW 175, whereas during 1991-92 it was highest in cv. PBW 175. The maximum reduction in test weight was in cv. C 306 followed by cv. AP 425 and minimum in cv. WH 147M during 1990-91. However, during 1991-92 maximum injury was recorded in WH 533 followed by HI 1011 and WH 551, whereas it was lowest in WH 337 and HUW 318. The highest reduction in C 306 might be due to less translocation of assimilates as the crop was highly lodged. Cultivar AP 425 seems to be the most drought susceptible genotype and cvs. WH 337, HUW 318 and WH 147 M drought tolerant due to better seed development under stress. Significantly less grains per spike under wet environment in cvs. C 306 and P 20313 were

DROUGHT TOLERANT GENOTYPES IN WHEAT

TABLE 1

Effect of potassium iodide sprayed as desiccant on test weight and grains per spike of wheat genotypes (1990-91)

Genotype	Test weight (g)				Grains per spike			
	Wet	KIS	KIW	Mean	Wet	KIS	KIW	Mean
AP 425	36.7	22.2	11.0	23.3	31.2	27.1	29.5	29.3
C 306	47.3	24.0	18.5	29.3	20.0	33.0	25.7	26.3
P 5451	54.5	39.0	24.0	39.2	32.5	28.4	20.6	27.2
P 20100	36.5	25.0	24.0	28.5	42.8	26.7	29.7	33.1
P 20313	43.4	28.5	14.0	28.8	27.4	37.1	23.1	29.2
P 20347	38.2	28.8	19.6	28.2	34.1	25.2	22.6	27.3
PBW 176	50.8	31.0	25.0	35.6	24.7	27.3	25.1	25.7
WH 147	50.0	37.0	24.5	37.1	32.5	25.4	18.5	25.5
WH 147 M	32.1	27.5	19.6	26.4	35.3	32.1	30.1	32.6
WH 533	35.4	30.0	12.8	26.1	42.2	38.5	30.8	37.2
Mean	42.5	29.1	19.1		32.3	30.1	25.6	
L. S. D. (P=0.05)	G =1.7				G =1.5			
	T =0.9				T =0.8			
	G×T=3.0				G×T=2.6			

TABLE 2

Effect of potassium iodide sprayed as desiccant on test weight and grains per spike of wheat genotypes (1991-92)

Genotype	Test weight (g)					Grains per spike				
	Wet	Dry	KIS	KIW	Mean	Wet	Dry	KIS	KIW	Mean
AP 425	26.9	22.7	17.9	13.9	20.2	35.4	32.8	36.0	27.6	33.0
C 306	36.4	35.1	30.0	18.6	30.0	32.4	33.7	32.4	27.2	31.4
HD 2329	40.0	29.4	39.1	28.1	34.2	35.2	31.2	26.4	29.0	33.0
HD 2380	41.2	34.2	36.3	23.0	31.2	42.1	27.2	20.6	26.8	29.1
HI 1011	38.6	26.0	27.5	24.4	29.1	45.5	34.1	35.6	27.6	35.7
HUW 318	35.3	31.3	35.0	21.0	30.7	50.8	39.3	38.0	30.2	39.5
IWP 72	33.7	20.8	28.0	20.0	25.6	43.0	30.4	41.9	34.0	37.3
PBW 176	42.1	32.0	38.2	25.0	34.4	27.2	27.0	26.2	29.0	27.4
WH 147	39.2	26.5	34.0	23.0	30.7	41.4	39.1	40.1	28.4	29.7
WH 337	32.8	24.6	33.0	24.3	28.6	37.4	37.5	32.2	35.8	35.7
WH 533	32.8	24.5	25.8	15.7	24.7	47.4	37.2	35.0	16.8	34.0
WH 551	39.2	17.9	35.5	26.2	29.8	48.4	31.7	31.2	19.4	32.7
WH 572	31.8	27.0	27.7	14.8	25.3	54.8	36.5	41.8	37.4	42.6
Mean	35.5	27.1	31.4	21.4		41.6	33.7	35.2	28.4	
L. S. D. (P=0.05)	G =1.3					G =1.6				
	T =0.7					T =0.9				
	G×T=2.6					G×T=3.1				

TABLE 3

Effect of potassium iodide sprayed as desiccant on source (leaf+stem+spike-seed) and sink (seed) weights per shoot of wheat genotypes (1990-91)

Genotype	Source (g)				Sink (g)			
	Wet	KIS	KIW	Mean	Wet	KIS	KIW	Mean
AP 425	2.93	3.13	2.88	2.98	1.37	1.31	1.19	1.29
C 306	3.68	3.06	2.91	3.19	1.73	1.24	1.09	1.35
P 5451	3.37	2.96	2.84	3.05	2.03	1.61	1.36	1.66
P 20100	3.26	1.92	1.74	2.31	1.87	1.68	1.28	1.62
P 20313	3.67	2.80	2.31	2.90	1.53	1.32	1.04	1.29
P 20347	2.46	2.09	2.13	2.21	1.72	1.21	0.99	1.30
PBW 175	3.08	1.70	1.81	2.19	1.99	1.56	1.36	1.64
WH 147	3.08	1.93	1.90	2.28	1.89	1.37	1.25	1.50
WH 147 M	3.24	2.89	2.75	2.95	1.56	1.66	1.25	1.49
WH 533	3.42	3.42	3.08	3.31	1.77	1.85	0.99	1.53
Mean	3.22	2.59	2.20	2.75	1.75	1.46	1.18	1.46
L. S. D. (P=0.05)	G =0.11				G =0.09			
	T =0.08				T =0.05			
	G × T=0.20				G × T=0.15			

TABLE 4

Effect of potassium iodide sprayed as desiccant on source (leaf+stem+spike-seed) and sink(seed) weights per shoot of wheat genotypes (1991-92)

Genotype	Source (g)					Sink (g)				
	Wet	Dry	KIS	KIW	Mean	Wet	Dry	KIS	KIW	Mean
AP 425	2.88	1.73	1.90	2.38	2.19	1.16	0.87	0.56	0.24	0.70
C 306	2.14	2.09	2.18	2.87	2.32	1.35	0.82	1.05	0.61	0.96
HD 2329	1.77	1.49	1.56	1.98	1.69	1.37	1.07	0.76	0.42	0.90
HD 2380	2.09	1.97	2.02	2.16	2.05	1.62	1.34	1.17	0.73	1.21
HI 1011	1.82	2.12	2.22	2.04	2.04	1.18	0.89	0.95	0.69	0.92
HUW 318	2.01	2.40	2.26	2.92	2.40	1.54	1.12	1.22	0.44	1.08
IWP 72	2.01	1.84	2.25	2.75	2.21	1.46	0.97	1.17	0.57	1.04
PBW 175	1.84	1.42	1.83	1.73	1.82	1.14	0.78	1.07	0.77	0.93
WH 147	2.08	1.63	1.67	2.24	1.91	1.39	1.07	1.09	0.53	1.02
WH 337	2.61	1.91	2.12	2.35	2.24	1.25	1.10	1.38	0.82	1.13
WH 533	2.30	1.87	2.08	2.58	2.20	1.72	1.24	1.19	0.57	1.18
WH 551	3.07	1.71	2.42	2.89	2.53	1.31	0.93	0.86	0.36	0.86
WH 572	2.33	1.64	2.06	2.46	2.11	1.12	0.72	1.07	0.88	0.95
Mean	2.22	1.83	2.04	2.41		1.36	0.99	1.04	0.59	
L. S. D. (P=0.05)	G=0.12				G =0.07					
	T=0.07				T =0.04					
	G × T=0.24				G × T=0.15					

due to lodging in crop. The lesser grains per spike in cvs. WH 147, PBW 175 and C 306 were due to their higher test weight. The minimum differences in grains per spike under KIS and KIW in genotypes WH 337 and PBW 175 during both the years show better translocation and higher drought tolerance. Contrarily in cv. P 20100, the sharp decline in grains per spike under KIS and KIW treatments shows very little translocation of assimilates to developing grains.

The grain yield was reduced by 16.6 and 32.6 per cent under KIS and KIW treatments over control during 1990-91. But the quantum of reduction during 1991-92 was higher in grains as well as in other vegetative plant parts due to overall poor plant growth. It may be due to dunal sand which causes early moisture stress (low water holding capacity). The reduction in grain yield during 1991-92 was 27.2, 23.5 and 56.6 per cent under dry, KIS and KIW treatments, respectively. Among the genotypes highest grain yield was recorded in cv. HD 2380 along with highest sink : source ratio at harvest which was closely followed by cvs. WH 533 and WH 337. Contrarily, the lowest seed yield with lowest sink :

source ratio was recorded in cv. AP 425 followed by cv. WH 551.

The dry matter accumulation in vegetative plant parts during 1990-91 reduced by 19.6 and 24.2 per cent under KIS and KIW, respectively, over irrigated control (Table 3), whereas there was no mobilization of assimilates during 1991-92 in KIW treatment (Table 4). This may be due to the blockage/death of sink as the senescence in spike also started along with other vegetative plant parts. That is why, the translocation of pre-anthesis assimilates was not observed. This fact can also be ascertained by 39.5% reduction in grain size, 31.7% reduction in grains per spike, and 56.6% reduction in grain yield under treatment KIW. The mobilization of assimilates was 8.1% in KIS and 17.6% under dry treatment. The less mobilization of assimilates in KIS could be due to fast senescence of the vegetative plant parts in comparison to the dry treatment. The sink : source ratio was highest in wet (0.61) and was lowest in KIW (0.25). The ratio was almost same under KIS (0.51) and dry (0.54) environment during 1991-92 which further supports that KIS treatment can easily be compared with natural dry environment.

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EVALUATION OF SOME EXOTIC DATE-PALM CULTIVARS FOR BUNCH AND FRUIT CHARACTERISTICS AT 'KHALAL' STAGE GROWN UNDER NORTH INDIAN CONDITIONS

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ABSTRACT

Six date-palm (*Phoenix dactylifera* L.) cultivars, grown under north Indian conditions, were evaluated for their bunch and physico-chemical fruit characters at 'Khalal' stage. Shamran recorded the highest average number of bunches (13.7) per palm, whereas Zaidi had the lowest (7.0). The average bunch weight was maximum in Zaglool (12.27 kg) and minimum in Shamran (4.42 kg). Three cultivars, viz. Hillawi, Khadrawy and Zaidi were found to be short stranded, whereas Zaglool, Medjool and Shamran were long stranded. The number of strands per bunch and number of berries per strand were highest in Zaglool and lowest in Hillawi. The fruits of all the cultivars were yellow in colour except that of Zaglool which were red. The fruits of Hillawi were comparatively sweet in taste and the rest were lesser sweet. Cultivars Medjool and Shamran were astringent at 'doka' stage. The average weight of fruit was maximum in Medjool (19.57 g) followed by Zaglool and Hillawi, whereas it was minimum in Zaidi (6.47 g). The cultivar Hillawi produced the fruits of best quality with highest T. S. S. (29.1%), maximum reducing sugars (76.13%) and lowest acidity (0.12%). The cultivars Hillawi and Khadrawy having negligible amount of sucrose were confirmed as soft type dates and the other four cultivars containing higher proportion of sucrose were categorised as semi-dry type dates.

Date-palm (*Phoenix dactylifera* L.) is yet not cultivated commercially in any part of India. The wild grooves of seedlings are, however, found growing in the coastal belt of western India since long ago which is an indication towards the possibility of successful date cultivation in the country. Therefore, during 1954-62 some good varieties from U. S. A., Iraq and other Middle-East countries were introduced in India for the first time

to explore the possibility of their commercial cultivation in the selected parts of north-western India. The performance of these plantations has been satisfactory and now on the basis of various climatic parameters and availability of water resources, the potential date growing regions of India have been identified (Pareek, 1984). At present there are 34 known cultivars of date-palm in India of which eight are available at Hisar in north

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India which is one of the selected centres for date-palm research. Unlike the Middle-East countries, the fruits do not attain full ripening at this centre and are generally harvested at 'Khalal' stage to avoid spoilage due to ensuing rain and high humidity. In present study, an attempt has been made to describe date cultivars available at the Hisar centre for bunch and fruit characters.

MATERIAL AND METHODS

Five representative palms of about 10 years age of the six cultivars grown at Experimental Orchard of the University were selected for collection of data on various bunch and fruit characters. The data were recorded on number of bunches per plant, weight of bunch, length of bunch, number of strands per bunch, average length of strands and number of berries per strand.

For recording observations with respect to various physico-chemical fruit characters, ten samples of 25 fruits each

of all the six cultivars were taken. The fruits were harvested in the month of August when the minimum and maximum mean temperatures were 22.8°C and 38.8°C, respectively. The total soluble solids (T. S. S.) were determined with the help of hand refractometer. The fruit samples were analysed for moisture, sugar and acidity using procedures given in AOAC (1975). The astringency and sweetness were evaluated by organoleptic tests.

RESULTS AND DISCUSSION

Bunch Characteristics

The data on various bunch characters have been given in Table 1. The number of bunches per palm in cultivars under observation ranged from 7 to 14, the maximum being borne by Shamran and minimum by Zaidi. Pareek and Muthana (1978) have also reported the highest number of bunches per palm in Shamran. The bunch weight was maximum in Zaglool closely followed by Medjool and minimum in Shamran. The cultivars

TABLE 1
Bunch characters of six date-palm cultivars grown under north Indian conditions

S. Variety No.	Bunches per plant	Weight of bunch (kg)	Length of bunch (cm)	Strands per bunch	Average length of strand (cm)	Berries per strand
1. Khadrawy	7.7	5.42	76.33	40.0	27.2	23.2
2. Hillawi	11.3	4.64	68.67	38.7	28.3	22.0
3. Medjool	9.0	11.13	130.07	46.3	35.6	31.7
4. Zaglool	10.0	12.27	97.67	63.0	38.4	32.1
5. Zaidi	7.0	8.55	78.87	55.7	26.5	26.4
6. Shamran	13.7	4.42	106.10	49.7	40.3	27.3
C. D. at 5%	2.7	1.33	9.12	3.6	2.9	3.6
C. D. at 1%	3.8	1.86	12.78	5.1	4.1	5.1

EVALUATION OF EXOTIC DATE-PALM CULTIVARS

TABLE 2
Physical fruit characters of six date-palm cultivars grown under north Indian conditions

S. No.	Variety	Colour of fruit	Shape of fruit	Shape of apex	Base	Taste	Rag	Wt. of fruit (g)	Length of fruit (cm)	Breadth of fruit (cm)	Wt. of seed (g)	Length of seed (cm)	Breadth of seed (cm)
1.	Khadrawy	Yellow	Oblong-ovate	Round	Oblique slightly prominent	Sweet	Average	9.93	3.55	2.25	0.73	2.06	0.77
2.	Hillawi	Yellow	Oblong	Round	Flat slightly prominent	Very sweet	Little	14.27	4.47	2.38	0.96	2.49	0.79
3.	Medjool	Yellow	Oval	Tapering	Flat slightly prominent	Astringent	Little	19.57	4.78	2.77	1.25	2.60	0.99
4.	Zaglool	Red	Oblong-oblique	Tapering	Slightly prominent	Sweet	Much	16.47	4.87	2.39	1.24	2.32	0.90
5.	Zaidi	Yellow	Ovate	Tapering	Slightly prominent	Sweet	Little	6.47	3.26	2.04	0.59	1.65	0.78
6.	Shamran	Pinkish yellow	Oblong	Tapering	Prominent	Astringent	Average	10.00	4.05	2.11	0.63	2.18	0.67
C. D. at 5%								2.38	0.51	0.09	0.21	0.28	0.07
C. D. at 1%								3.34	0.71	0.13	0.29	0.39	0.10

Medjool, Zaglool and Shamran were categorised as long stranded with longer bunches and larger number of strands per bunch, whereas the other three cultivars were found to be short stranded carrying smaller bunches and lesser number of strands per bunch. The number of berries per strand was highest in Zaglool and lowest in Hillawi. The highest average number of fruits per strand in Hillawi and lowest in Medjool, recorded by Chohan *et al.* (1972) under almost similar climatic conditions, seems to be contrary to the present observations.

Physical Characteristics of Fruits

The data in Table 2 show that fruits of all the cultivars were yellow in colour at 'Khalal' stage, except that of Zaglool having red fruits, a pinkish blush was observed on the fruits of Shamran; which distinguishes these cultivars from others with respect to colour. Eighteen Saudi Arabian date cultivars were classified by Hussain *et al.* (1976) on the basis of colour at Khalal stage and it was observed the most reliable character in identification.

The shape of the fruit was another important characteristic on the basis of which all the six cultivars could easily be differentiated. The fruits of Zaglool were oblong oblique in shape, whereas that of Khadrawy were oblong ovate. The fruits of Medjool were oval and that of Zaidi were ovate. The other two cultivars, *i.e.* Shamran and Hillawi had oblong fruits but the fruits of Shamran were distinct by the presence of a curve in the middle on one side of the fruit. The shape of the fruit apex was round in Hillawi and

Khadrawy, whereas in others it was tapering. The base was slightly prominent in all the cultivars except Shamran where it was prominent.

The organoleptic rating indicated that fruits of Hillawi were very sweet in taste at Khalal stage, whereas that of Khadrawy, Zaglool and Zaidi were sweet. The fruits of Medjool and Shamran were rated as astringent. The weight of the fruit ranged from 6.47 g in Zaidi to 19.57 g in Medjool. The highest length of the fruit (4.87 cm) was obtained in Zaglool closely followed by Medjool (4.78 cm), and it was found to be lowest (3.26 cm) in Zaidi. The breadth of the fruit was maximum (2.77 cm) in Medjool and minimum in Zaidi (2.04 cm). The seed weight was almost equal in Medjool (1.25 g) and Zaglool (1.24 g) but it was lowest in Zaidi (0.59 g). The seed length was maximum (2.60 cm) in Medjool followed by Hillawi (2.49 cm) and Zaglool (2.32 cm), whereas it was minimum in Zaidi (1.65 cm). The breadth of the seed was recorded maximum (0.99 cm) in Medjool and minimum (0.67 cm) in Shamran (Table 2).

Most of the characteristics of cultivars described in the present study are in conformity with the earlier work done in India by Chohan *et al.* (1972), Kalra and Jawanda (1972, 1976), Pareek and Muthana (1978) and the studies performed in Iraq and United States (Nixon, 1950). The slight variations in the physical fruit characteristics of the date cultivars could be due to influence of various cultural practices like pollen source, thinning of fruits, etc. and environmental factors. It is expected that this study

EVALUATION OF EXOTIC DATE-PALM CULTIVARS

TABLE 3

Chemical fruit characters of six date-palm cultivars grown under north Indian conditions

S. No.	Variety	TSS (%)	Acidity (%)	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)	Moisture (%)
1.	Khadrawy	22.1	0.163	77.67	74.00	3.67	66.60
2.	Hillawi	29.1	0.120	79.00	76.13	2.87	73.07
3.	Medjool	19.7	0.127	76.17	66.07	10.10	77.70
4.	Zaglool	21.3	0.187	69.17	62.00	7.17	70.59
5.	Zaidi	22.7	0.160	72.03	56.33	15.70	70.59
6.	Shamran	25.0	0.127	79.00	68.73	10.27	73.15
C. D. at 5%		3.0	0.035	4.35	4.30	3.94	5.86
C. D. at 1%		4.1	0.049	6.10	6.03	5.53	—

will supplement the work already in progress on evaluation and identification of date cultivars and will also give an idea about the performance of important commercial cultivars under Indian conditions.

Chemical Characteristics of Fruits

The total soluble solids (TSS) in six cultivars varied from 19.7% in Medjool to 29.1% in Hillawi (Table 3). The TSS values were slightly less than those obtained by Kalra and Jawanda (1972) in the same cultivars. The TSS values of Khadrawy and Zaidi reported by Mohamed *et al.* (1983) were more, whereas in Hillawi TSS values were less than those reported in the present study. The acidity was highest in Zaglool (0.18%) and lowest in Hillawi (0.12%). The date fruits have been reported to be slightly acidic, and high acidity is often correlated with

poor quality (Rygg, 1948). The moisture content of the fruits varied from 66.60% in the Khadrawy to 77.70% in Medjool. The lower moisture content in Khadrawy is an indication towards the fact that it is least susceptible to damage by rain and high humidity as reported by Nixon (1966). The total sugar content was recorded to be highest (79.00) in Hillawi and Shamran but lowest (69.17%) in Zaglool. It is evident from the data that reducing sugars were the dominant form of sugar in all the cultivars. Only two cultivars, *viz.* Khadrawy and Hillawi were found to contain less amount of sucrose at Khalal stage and can be regarded as belonging to the group of soft cultivars. The other cultivars having higher proportions of sucrose can be categorised as semi-dry dates. These results corroborate the findings of Cook and Furr (1953).

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CHANGING FACTOR SHARES AND PRODUCTIVITY IN HARYANA AGRICULTURE

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ABSTRACT

Based on index number approach to productivity measurement, the present study measured growth rates of outputs and inputs for each of the 12 districts in Haryana state during period I (Green revolution period 1970-71 to 1979-80) and period II (Post-green revolution period 1980-81 to 1989-90). The analysis of data reveals that unless an appropriate technology exists, it would be futile to expect the rapid output growth merely due to the modern inputs like fertilizers, machines, insecticides/pesticides, weedicides, etc. Thus, the technology generating and disseminating activities like agricultural research and extension have most critical role to play. The study also suggests that according to present trends, the areas which receive relatively higher rainfall are likely to record further advances in output growth but dryland areas have much potential to be exploited. Hence, evolving viable dryland technologies and timely disseminating the same to farmers require the attention of research administrators, extension workers and planners.

Haryana agriculture which is characterised as "crop-cum-bovine 'agriculture'" has made rapid progress, particularly after the mid-sixties which also coincides with the creation of new State in November 1966, in the wake of new technology. This fact has been reflected by the increased agricultural production in the State from 26 lakh tonnes during 1966-67 to about 91 lakh tonnes in 1991-92 due to the increased use of modern inputs and also increased investment in agricultural research and extension. Of late, the progress in the production of food grains and other crops has slowed down, the production is increasing only marginally

and even some signs of stagnation are also visible. Furthermore, some districts are progressing rapidly and others are lagging behind. Accordingly, it is essential to measure and analyse the output and productivity changes in Haryana agriculture during the last two decades or so. Since the State is characterized by considerable heterogeneity in agro-climate, resource endowments and economic performance, we have started from the district level. Indeed, in this paper two related aspects, viz. (i) the pattern of output, input and productivity growth in all the districts of the State during the last two decades, and (ii) whether these

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movements were related to the differences in natural resource endowments, have been examined.

DATA AND METHODOLOGY

The study was based on the secondary data and used "Index number approach" to productivity measurement. Indeed, the study used "total factor productivity" concept which implies an index of output per unit of all aggregate factor inputs. Apart from being a more satisfactory measure of productivity, this has the added advantage of providing a measure of technology advance.

Solow's geometric index of a total factor productivity duly adopted under Indian conditions (Evenson and Jha, 1973; Patil and Jha, 1978; Pandey *et al.*, 1985) has been used. Conceptually, geometric aggregation implies an aggregate production function of the Cobb-Douglas form:

$$Y = P X_1^{b_1} X_2^{b_2} \dots X_n^{b_n}$$

where, P is the geometric index of production; $b_1, b_2, \dots, b_n$ are elasticities of production for $X_1, X_2, \dots, X_n$ factors, respectively, and Y is an output index. By taking time derivatives on both the sides, we get the following growth equation:

$$\frac{\dot{Y}}{Y} = \frac{\dot{P}}{P} + b_1 \frac{\dot{X}_1}{X_1} + b_2 \frac{\dot{X}_2}{X_2} + \dots + b_n \frac{\dot{X}_n}{X_n}$$

or

$$\frac{\dot{P}}{P} = \frac{\dot{Y}}{Y} - \sum_{i=1}^n \left[b_i \frac{\dot{X}_i}{X_i} \right]$$

The above relation states that the rate of change in total factor productivity is

the difference between the rate of change in output and a weighted sum of the rates of change in factor inputs. Under perfectly competitive equilibrium assumptions, the factor shares equal the respective production elasticities and the growth equation becomes:

$$\frac{\dot{P}}{P} = \frac{\dot{Y}}{Y} - \sum_{i=1}^n \left[s_i \frac{\dot{X}_i}{X_i} \right]$$

where, s_i are the respective shares. The Divisia index of productivity change is appropriate only for the short periods of time and, therefore, the factor shares (s_i) should be calculated for relatively shorter time periods. A chain linked index of weighted growth rates of inputs (and outputs) with frequently changing weights is, therefore, desirable.

The analysis involved measurement of growth rates of outputs and inputs for each of the 12 districts of Haryana state during period I (Green revolution period: 1970-71 to 1979-80) and period II (Post-green revolution period: 1980-81 to 1989-90).

The "output index" constructed by us is the sum of quantity indices of 14 crops weighted by their respective value shares. These crops included rice, wheat, bajra, jowar, maize, barley, green-gram, black gram, gram, lentil, rapeseed and mustard, sugarcane (gur), cotton (desi) and cotton (american). In fact the district-wise figures for these crops were obtained from the Statistical Abstracts of Haryana issued by the Economic and Statistical Organization, Planning Department, Government of Haryana. Indeed, the output index series for each crop was constructed by average

quantity of three years 1970-71 to 1972-73, as a base. However, the output value shares for each crop were calculated at five points of time (1971, 1976, 1981, 1986 and 1990), using the current quantities and prices, and for intervening years, by the linear interpolation. The aggregate output index was finally obtained as :

$$O = C_1Y_1 + C_2Y_2 + \dots + C_{14}Y_{14}$$

where, Y is the quantity index and C is the value share.

The aggregate input is similarly defined as the sum of quantity indices of 16 inputs weighted by their respective factor shares. The 16 inputs considered were : unirrigated land, irrigated land, human power, animal power, canal irrigation, wooden ploughs, iron ploughs, bullock carts, sugarcane crushers both bullock and power operated, oil pumps, electric pumps, tractors, and nitrogenous, phosphatic and potassic fertilizers. The data regarding these inputs were taken from published sources such as Statistical Abstracts of Haryana, Indian Agriculture in Brief brought out by the Directorate of Economics and Statistics, Ministry of Agriculture, New Delhi and FAS (1981), and were adjusted accordingly. Thus, the aggregate input index is obtained as :

$$I = S_1X_1 + S_2X_2 + \dots + S_{16}X_{16}$$

where, X is the quantity index and S is its respective factor share. The quantity index had average of the triennium ending 1973 as a base. Factor shares (si) were also estimated at five points of time (1971, 1976, 1981, 1986 and 1990), and linear interpolation was done for the intervening years.

The series of five yearly moving averages of output indices were constructed to check the irregular fluctuations and the same were used for calculation of growth rates. In this study the disaggregation of total input (I) growth rate into the growth rates of traditional and modern inputs has also been done.

The study also examines the relationship between the agricultural performance (as shown by output and productivity growth) and natural resource endowments. To do so, the State has been divided into two agro-climatic regions, *i.e.* Eastern (irrigated) and Western (unirrigated).

RESULTS AND DISCUSSION

1. Changing Factor and Value Shares in Haryana Agriculture

The estimated factor shares in Haryana agriculture during five points of time have been shown in Table 1. It is clear from the data that till 1976 the traditional inputs accounted for about 72% of the total inputs; of which shares of land, canal irrigation and animal power were about 31, 19 and 18 per cent, respectively. Amongst modern inputs which accounted for about 28% of the total inputs during the same period, the tractors and pumpsets were the major share owners (about 14 and 10 per cent, respectively). In 1990, the share of traditional inputs went down to about 36% wherein the land, animal power and implements were the major factor share owners (about 13, 11 and 6 per cent, respectively). However, the increase in shares of modern inputs

TABLE 1
Estimated factor shares in Haryana agriculture

S. No.	Particulars	Year				
		1971	1976	1981	1986	1990
1.	Traditional inputs	0.8416	0.7180	0.5391	0.4191	0.3663
	Land	0.3765	0.3121	0.2583	0.1778	0.1290
	Canal irrigation	0.2611	0.1908	0.0992	0.0649	0.0507
	Animal power	0.1658	0.1760	0.1378	0.1222	0.1126
	Human power	0.0009	0.0012	0.0015	0.0016	0.0022
	Implements	0.0373	0.0381	0.0424	0.0527	0.0618
2.	Modern inputs	0.1584	0.2820	0.4609	0.5809	0.6437
	Pumpsets	0.0473	0.0977	0.1448	0.1580	0.1541
	Tractors	0.0703	0.1438	0.2518	0.3464	0.4163
	Fertilizers	0.0408	0.0406	0.0643	0.0765	0.0733

(about 64%) was mainly because of tractors, pumpsets and fertilizers during the same period. The data with regard to HYV seeds, weedicides and insecticides/pesticides were not available. Indeed, it is believed that the share of modern inputs by considering these inputs too, would be about 75% in 1990. Thus, the share of modern inputs during green and post-green revolution periods recorded considerable increase. Accordingly, it has ultimately increased the dependence of Haryana agriculture on agro-industrial products.

Data in Table 2 show the estimated value shares in Haryana agriculture. The cereals occupied the highest value shares in output in all the periods (it ranged between 50 and 65 per cent during 1971 and 1990). Moreover, the commercial crops retained the second position in all the periods except 1976 (wherein the pulses occupied second position while coarse grains the third). The shares of

both coarse grains and pulses in total output value, however, drastically declined during the last two decades (it declined from 14 to 4 per cent and 13 to 6 per cent, respectively). Moreover, the share of rapeseed and mustard which was about 4% in 1971 went up as much as 13% in 1990. Thus, the impact of technological change has resulted into the increasing value shares of cereals in the total output which is mainly at the cost of coarse grains and pulses.

2. Total Factor Productivity Changes in Haryana Agriculture

The output, input and total factor productivity growth rates for green revolution (1970-71 to 1979-80) and post-green revolution (1980-81 to 1989-90) periods have been presented in Table 3. All the districts including State recorded positive output and input growth rates during both the periods. In green revolution period, the State has observed out-

CHANGING FACTOR SHARES AND PRODUCTIVITY IN HARYANA AGRICULTURE

TABLE 2

Estimated value shares in Haryana agriculture

S. No.	Particulars	Year				
		1971	1976	1981	1986	1990
1.	Cereals	0.5008	0.6058	0.5827	0.6531	0.6129
	Rice	0.0580	0.0930	0.1315	0.1397	0.1279
	Wheat	0.4428	0.5128	0.4512	0.5134	0.4850
2.	Coarse grains	0.1415	0.1501	0.0819	0.0446	0.0406
	Bajra	0.1019	0.0906	0.0495	0.0247	0.0285
	Jowar	0.0070	0.0052	0.0050	0.0022	0.0018
	Maize	0.0160	0.0255	0.0085	0.0050	0.0039
	Barley	0.0166	0.0289	0.0189	0.0127	0.0064
3.	Pulses	0.1295	0.1721	0.0934	0.1017	0.0569
	Green gram	0.0025	0.0033	0.0006	0.0006	0.0006
	Lentil (Masur)	0.0028	0.0037	0.0026	0.0025	0.0014
	Black gram	0.0010	0.0014	0.0015	0.0007	0.0002
	Gram	0.1232	0.1642	0.0887	0.0979	0.0647
4.	Rapeseed and mustard	0.0375	0.0023	0.0751	0.0767	0.1323
5.	Commercial crops	0.1907	0.0898	0.1669	0.1250	0.1573
	Sugarcane (Gur)	0.1288	0.0151	0.1281	0.0903	0.1150
	Cotton (American)	0.0263	0.0163	0.0261	0.0287	0.0385
	Cotton (Desi)	0.0356	0.0384	0.0127	0.0060	0.0038

put and input growth rates at 1.71 and 2.96 per cent per annum, respectively. During the same period the traditional input growth was though 0.50% per annum yet modern input growth occurred at the annual rate of 2.46 per cent. In post-green revolution period, the output and input growth rates were at 2.28 and 2.22 per cent per annum, respectively. However, the traditional input growth rate was though 0.91% per annum yet modern input growth rate was 1.31% per annum. In general, the output growth rates were higher in western region as compared to eastern region in both the periods thereby revealing the diverse nature of agriculture in that region.

Of the six districts in each of eastern and western regions, four districts in each region had output growth rate above that of State's average during period I. Likewise, all the districts in western region though had output growth above that of State's average during period II yet only three districts in eastern region observed greater output growth. In case of input growth, three and four districts in each of eastern and western regions though had growth rate above that of State's average during period I yet five and three districts in period II recorded input growth rate above the State's average.

TABLE 3

Estimated total factor productivity in Haryana agriculture

S. No.	District	Output growth	Input growth	Traditional inputs growth	Modern inputs growth	Total factor productivity
1. Period I (1970-71 to 1979-80)						
A. Eastern region						
	Ambala	2.03	2.89	0.75	2.14	-0.86
	Karnal	1.93	3.46	0.60	2.86	-1.53
	Kurukshetra	2.21	3.30	0.48	2.82	-1.09
	Sonepat	0.99	2.91	0.94	1.97	-1.92
	Rohtak	0.21	3.61	-0.10	3.71	-3.40
	Jind	2.81	2.87	1.42	1.45	-0.06
B. Western region						
	Hisar	2.81	3.24	1.00	2.24	-0.43
	Sirsa	3.12	4.46	1.21	3.24	-1.33
	Bhiwani	1.86	5.77	0.95	4.82	-3.91
	Mahendragarh	3.30	8.88	0.27	8.59	-5.58
	Gurgaon	1.34	1.24	-1.08	2.32	0.10
	Faridabad	—	—	—	—	—
	State	1.71	2.96	0.50	2.46	-1.25
2. Period II (1980-81 to 1989-90)						
A. Eastern region						
	Ambala	2.69	2.97	1.32	1.65	-0.28
	Karnal	2.18	2.27	1.09	1.18	-0.09
	Kurukshetra	1.83	2.39	0.87	1.52	-0.66
	Sonepat	0.81	3.74	2.73	0.99	-2.83
	Rohtak	3.99	4.14	0.49	3.65	-0.15
	Jind	2.57	1.23	0.28	0.95	1.34
B. Western region						
	Hisar	3.09	3.85	1.27	2.58	-0.78
	Sirsa	2.99	2.54	1.11	1.43	0.45
	Bhiwani	4.34	1.58	-0.05	1.63	2.78
	Mahendragarh	5.71	2.42	0.65	1.77	3.29
	Gurgaon	2.84	2.04	-0.67	2.71	0.80
	Faridabad	2.44	2.13	-0.19	2.42	0.31
	State	2.28	2.22	0.91	1.31	0.08

The residual total factor productivity that was negative for the State in period I became positive in period II. Indeed, input growth occurred much faster in comparison to the output growth during period I. Of course, the extremely high input growth (above 4% per annum) that occurred in Sirsa, Bhiwani and Mahendragarh districts during period I could disappear in period II with exception to that of Rohtak district. The sustained input growth during period II, however, resulted into the greater output growth which ultimately resulted in positive total factor productivity in the State. Total factor productivity growth rates of eastern region were negative in almost all the districts and in both the periods (with exception to that of Jind district in period II). In western region although four districts had negative total factor productivity growth rates during period I yet only Hisar district recorded negative growth rate in period II. The fact that western region comprised mostly dryland areas and high productivity growth suggests, contrary to popular belief, that a substantial "technological slack" existed even during the eighties and this was exploited. However, this slack was related to the modern inputs, including extension efforts and dryland research technology. Likewise, the extremely high output growth rates for Rohtak and Jind districts in period II also suggests the "technological slack" that existed in eighties and the same was exploited.

3. Inter-period Comparison

The data in Table 3 indicate that substantial changes took place in the performance of different districts between these

two decades. The changes in absolute growth rates of output between the two periods have been summarised in Table 4. Of the 12 districts, 8 recorded gain in output growth while remaining 4 observed a loss. The districts recording gain in output growth revealed the fact that the "unexploited technologies" of 1970's were further exploited by these districts in 1980's. The districts recording loss in output growth were mostly organised in 1970's as compared to 1980's. Indeed, there existed slackness in 1980's. However, Jind district could not relatively perform well in 1980's.

TABLE 4

Distribution of districts recording relative gain or decline in output growth between two periods

Category	Districts
Gain in output growth rate	Ambala, Karnal, Rohtak, Hisar, Faridabad, Bhiwani, Mahendragarh, Gurgaon]
Decline in output growth rate	Kurukshetra, Sonapat, Jind, Sirsa

TABLE 5

Distribution of districts recording relative gain or decline in residual productivity growth between two periods

Category	Districts
Gain* in productivity growth	Ambala, Karnal, Kurukshetra, Jind, Rohtak, Sirsa, Bhiwani, Mahendragarh, Gurgaon, Faridabad
Decline in productivity growth	Sonapat, Hisar

*Reduction in the rate of decline in productivity has also been considered as gain.

The districts which recorded an increase or decrease in growth rates of residual factor productivity have been listed in Table 5. Of the 12 districts, as much as 10 gained in productivity. Indeed, the districts which recorded low or negative productivity growth in 1970's generally gained in 1980's. Moreover, the productivity growth of Hisar and Sonapat districts further deteriorated in 1980's as compared to 1970's. Of course, rapid decline in factor producti-

vity of Hisar district seems to be due to the more use of traditional inputs despite fairly rapid growth in modern inputs. Moreover, the decline in factor productivity of Sonapat district seems to be due to the decline in modern inputs growth. All this suggests that it is erroneous to presume that growth in modern inputs, *per se*, would lead to growth in output. Modern inputs play their role only if a suitable (transferable) technology is available.

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RESEARCH NOTE

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EFFECT OF ALTERNARIA POD BLIGHT ON THE YIELD AND QUALITY CONTRIBUTING CHARACTERS OF BROWN SARSON

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Alternaria blight caused by *Alternaria brassicae* is an endemic disease in south-western belt of Haryana causing considerable losses in yield in rapeseed and mustard. Though this disease has been considered to take a heavy toll of this group of crops, not much work has been done to determine yield losses caused by the disease under Indian conditions. The present paper envisages the effect of this disease on the yield and quality contributing characters of brown sarson (*Brassica campestris* var. brown sarson).

Dry pods infected with *Alternaria brassicae* were collected under following grades :

Grade	Description
0	No symptoms on pods
1	Scattered spots covering 1-10 per cent pod area
2	Spots covering 11-25 per cent pod area
3	Spots covering 26-50 per cent pod area
4	Spots covering 51-70 per cent pod area
5	Numerous spots covering > 70 per cent pod area

Seeds were extracted from the graded pods separately to record the 1000-seed weight. The sterilized seeds were plated on moist sterile blotters and incubated at $30^{\circ}\pm 2^{\circ}\text{C}$. Lids were removed after 4 and 8 days for recording germination percentage, root/shoot length, short/long percentage and fungus incidence. The oil percentage was also recorded.

As could be seen from the data in Table 1, the germination was cent per cent in the first four grades after four days, however, it reduced in last two grades, i.e. 97% in 4th and 95.3% in 5th grade.

Seeds from infected pods (>70%) developed *Alternaria* in only one per cent seeds after 4 days of incubation, whereas in other grades there was no fungus infection. However, after 8 days of incubation, percentage increased corresponding to the increase in various grades. The fungus percentage was 4.0 and 12.7 in the 1st and 5th grade, respectively, after 8 days.

The 1000-seed weight was 4.32 g in 1st grade and 3.13 in 5th grade. The weight as well as root/shoot length decreased with the increase in disease in-

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TABLE 1

Effect of *Alternaria* pod blight on various growth and yield characteristics of brown sarson

Grade	Germination after 4 days (%)	Root/shoot length (cm)		Short/long (%)		Incidence (fungus) (%)		1000-seed weight (g)	Oil (%)
		4 days	8 days	4 days	8 days	4 days	8 days		
0	100	9.3/4.5	15.5/6.8	12.0/88.0	6.3/93.7	—	—	4.32	40
1	100	9.2/4.4	15.3/6.8	14.0/86.0	6.7/93.3	—	4.0	4.25	39
2	100	8.9/4.4	14.6/6.5	16.7/83.3	9.3/90.7	—	6.3	4.07	38
3	100	8.6/3.7	14.6/6.3	18.0/82.0	12.7/87.3	—	7.3	3.50	36
4	97.0	8.4/3.6	14.3/6.1	23.3/76.7	12.7/87.3	—	9.3	3.20	32
5	95.3	8.2/3.5	9.9/4.2	27.3/72.7	12.7/87.3	1.0	12.7	3.13	29

tensity. The length was more in 1st grade and less in last grade. The percent germination of seeds where lengths of plumule and radicle were small was 11.0 and 5.3 and long 89.0 and 94.7 in the 1st grade and 27.3, 12.7, and 56.7, 80.0 after 4 and 8 days, respectively in the last grade. The oil percentage also decreased with the increase in disease severity.

Reduction in 1000-seed weight and seed yield due to *Alternaria* blight in rapeseed and mustard has been reported (Kolte *et al.*, 1987). The loss in yield due to shrivelling of seeds in rapeseed has been reported to be about 15.66% under Punjab conditions (Randhawa and Aulakh, 1981). McDonald (1959) reported high percentage of shrunken seeds and reduced yield of rapeseed under artificially inoculated conditions in Canada.

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RESEARCH NOTE

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EFFECT OF MULCHING, HOEING AND PENDIMETHALIN ON WEED GROWTH IN COTTON

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Pendimethalin has been found successful for control of annual weeds in cotton (Balyan *et al.*, 1983). Most farmers practise one or two hoeings for better aeration, soil moisture conservation and root growth (Jain *et al.*, 1982). Field studies were conducted at CCS Haryana Agricultural University, Hisar during kharif 1990 to compare the effect of pendimethalin with and without hoeing with hoeing alone and with polyethylene mulching. The sandy loam soil of the field, low in nitrogen (170 kg/ha), medium in phosphorus (124 kg/ha) and high in potash (410 kg/ha) was harrowed two times and cultivated twice before sowing of cotton (*Gossypium hirsutum* L.) variety H-777 on 26 May, 1990. The 14 treatments were one hoeing at 40 DAS, two hoeings at 40 and 75 DAS, pendimethalin applied pre-emergence at 1.5 kg/ha, pendimethalin applied pre-emergence at 1.5 kg/ha followed by one hoeing at 40 DAS, one hoeing at 40 DAS followed by pendimethalin @ 1.0 and 1.5 kg/ha, black and transparent polyethylene (white) immediately after sowing, 40 DAS or one hoeing at 40 DAS followed by black and transparent polyethylene mulch, weedy and weed free check. The crop was grown as per package of practices of the area.

Pendimethalin was applied by Knapsack sprayer using 650 litres water/ha. Weed count (number/m²) and dry weight of weeds (g/m²) were recorded at two spots in each plot by using 0.50 m × 0.50 m quadrat at 60 and 90 DAS.

Field was heavily infested with carpet weed (*Trianthema portulacastrum* L.). Therefore, one hoeing was not sufficient to reduce the weed population and their dry weight significantly at 60 and 90 DAS (Table 1). Black or transparent polyethylene mulch or pendimethalin applied post-emergence at 1.5 kg/ha after giving one hoeing at 40 DAS provided similar weed control. The seed cotton yield in plots where black and transparent polyethylene were used was similar to that of two hoeings as well as to pendimethalin supplemented with one hoeing. It appeared that black and transparent polyethylene and two hoeings effectively controlled weeds and conserved moisture to significantly improve the seed cotton yield over the weedy check and one hoeing (Table 1). In all plots where black polyethylene was used malformation of leaves was observed which recovered immediately after rainfall. This malformation, however, did not reduce the seed cotton yield. Similar

TABLE 1

Influence of mulching, hoeing and pendimethalin on the weed population, total dry weight of weeds and seed cotton yield

S. No.	Treatment	Rate (kg/ha)	Time of application	Total number of weeds/m ²		Total dry weight (g/m ²)		Seed cotton yield (q/ha)
				60 DAS	90 DAS	60 DAS	90 DAS	
1.	Hoeing 40 DAS			16.00 (256)	6.60 (43)	42.0	133.7	14.38
2.	Hoeing 40 and 75 DAS			14.88 (221)	5.39 (29)	22.9	52.9	18.25
3.	Pendimethalin	1.5	Pre-emergence	7.55 (59)	5.79 (33)	39.7	60.1	17.05
4.	Pendimethalin followed by hoeing 40 DAS	1.5	Pre-emergence	7.58 (57)	4.79 (25)	16.3	46.2	19.83
5.	Hoeing 40 DAS followed by pendimethalin	1.0	Post-emergence	6.33 (39)	5.14 (26)	4.9	64.0	18.03
6.	Hoeing 40 DAS followed by pendimethalin	1.5	Post-emergence	6.00 (35)	4.43 (19)	3.5	40.8	19.97
7.	Black polyethylene sheet just after sowing			5.97 (35)	4.79 (22)	41.3	47.1	19.55
8.	Black polyethylene sheet 40 days after sowing			5.91 (34)	5.72 (32)	41.0	50.3	18.79
9.	Black polyethylene sheet 40 days after hoeing			6.28 (39)	4.57 (20)	13.4	40.3	20.81
10.	Transparent polyethylene sheet just after sowing			6.08 (36)	5.09 (27)	42.4	59.4	19.34
11.	Transparent polyethylene sheet 40 days after sowing			6.01 (35)	5.85 (33)	43.5	53.7	18.35
12.	Transparent polyethylene sheet 40 days after hoeing			6.47 (40)	4.77 (22)	14.2	45.4	20.48
13.	Weedy check			12.74 (161)	6.84 (48)	144.7	162.5	10.24
14.	Weed free check			1.00 (0)	1.00 (0)	0.0	0.0	22.49
	C. D. at 5%			1.13	1.05	12.8	22.1	3.60

Data presented are transferred values.

Values in the parentheses are actual.

DAS - Days after sowing.

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yields in two hand weeded plots and in plots where polyethylene mulch was used also indicate that improved aeration may not be as important as improved soil moisture conservation or weed control practices. Therefore, the requirement of one hoeing before or after spraying pendimethalin may assist through improved soil moisture conservation and the removal of weed population.

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DRINKING WATER AVAILABILITY AND EXTENT OF ITS POLLUTION IN HISAR DISTRICT

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ABSTRACT

The availability of water, its quality and reasons for pollution were studied in two villages of Haryana. Water from public well and tap was easily available and used by majority of the respondents. The respondents were satisfied with drinking water obtained from public well. Defecation by people or animals near water source was main cause of pollution of potable water. Clinical tests indicated that water samples from all the sources were non-potable as per standards of Indian Council of Medical Research.

The problem of drinking water is acute as about 80% people inhabiting the rural regions of developing world have no access to safe water. The importance of safe water as a factor in preventing diseases has been increasingly recognised but action to rectify the situation needs to be accelerated. Gaur and Sood (1989) reported that daily need of a person is of 35-40 gallons (150-200 litres) of water, but its availability is much less in rural areas where it is as low as 5-10 litres per head per day.

Although Indian villages today look brighter than these did decades ago, but still lack proper sanitation and have inadequate water supply. To understand the intensity of the problem of the rural water sanitation, it is necessary to study the available water supply of rural households and quality of drinking water which is affecting their health.

METHODOLOGY

The study was conducted in Ladwa and Khempur villages of Blocks I and II, respectively, in Hisar district. A sample of 75 households from each village was selected randomly, constituting a total of 150 households. To study the availability and quality of water, a pretested interview schedule was used to collect the data. The quality of water was also tested clinically for each source.

RESULTS AND DISCUSSION

The distribution of rural respondents according to source of water available and their perception regarding the quality of water has been presented in Table 1. Maximum number of respondents was using tap water (94.0%) followed by pond (69.3%) and uncovered public well (50.0%). Other sources,

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TABLE 1
Distribution of respondents according to sources of water available and its quality as perceived by them

S. No.	Source of water available	Frequency using water source	Quality regarding taste			Quality regarding washing			Overall acceptability	
			Sweet	Normal	Sour	Soft	Normal	Hard	Yes	No
1.	Tap	141 (94.0)	106 (70.0)	35 (23.3)	—	141 (94.0)	—	—	91 (60.3)	50 (33.7)
2.	Hand-pump	57 (38.0)	16 (10.7)	36 (24.0)	5 (3.3)	16 (10.7)	37 (24.7)	4 (2.7)	26 (17.3)	31 (20.7)
3.	Private well (uncovered)	20 (13.3)	20 (13.3)	—	—	18 (12.6)	1 (0.7)	—	15 (10.0)	5 (3.3)
4.	Tubewell	18 (12.0)	4 (12.7)	3 (2.0)	11 (7.3)	4 (2.7)	7 (4.6)	7 (4.6)	4 (2.7)	14 (9.3)
5.	Public well (uncovered)	75 (50.0)	73 (48.0)	2 (1.4)	—	29 (19.3)	46 (30.7)	—	75 (50.0)	—
6.	Pond	104 (69.3)	—	—	104 (69.3)	62 (41.3)	34 (22.7)	8 (5.3)	—	104 (69.3)
7.	Diggi	23 (15.3)	20 (13.3)	3 (2.0)	—	—	20 (13.3)	3 (2.0)	20 (13.3)	3 (2.0)
8.	Canal	50 (33.3)	12 (8.0)	36 (24.0)	2 (1.3)	50 (33.3)	—	—	32 (21.3)	18 (12.0)

Values in parentheses are percentages.

viz. hand-pump, private well, diggi and canal were either not available or at a far away distance and, therefore, were less commonly used by the respondents.

The data regarding taste of water indicate that majority of the respondents reported tap water as sweet (70.7%) followed by uncovered public well (48.0%). Pond water was reported to be sour by 69.3% of the respondents. The data regarding washing quality of water revealed that tap water was considered soft by majority of the respondents (94.0%) followed by pond (41.3%) and canal water (33.3%). A little less than one third of the respondents reported uncovered public well water as normal (30.7%). Regarding overall acceptability, it was found that tap was most acceptable source of water (60.3%) followed by public well (50.0%). Pond water was not found acceptable by 69.3% of

the respondents though they were using it for washing purpose as the quantity of tap water available was not sufficient. Prasad (1982) also reported that municipal tap was most acceptable source of water (54.4%) followed by wells (39.3%).

Data in Table 2 depict correlation of independent variables with quality of water as perceived by the respondents. Regarding taste of water, caste was found positively and significantly correlated with pond and diggi water, occupation with pond water, education with diggi water, land holding with pond, outside contact with well, pond and diggi water and highest education in the family with tubewell and well water. Caste, education and highest education in the family had negative significant correlation with hand-pump water, probably because the source was either not available or it

TABLE
Association of socio-personal and economic variables with

S. No.	Variable	Quality regarding taste					
		Tap	Hand-pump	Tubewell	Well	Pond	Diggi
1.	Age	-0.0777	0.0050	0.0231	-0.1811*	0.0226	-0.1070
2.	Caste	-0.1256	-0.2920*	0.1394	0.0148	0.2166*	0.2000*
3.	Occupation	0.4590	0.1086	0.0285	-0.1229	0.1582*	-0.0359
4.	Education	0.0250	-0.1608*	-0.0519	0.0489	0.1512	0.2120*
5.	Land holding	-0.1021	-0.0105	-0.0986	-0.0612	0.2626*	0.1286
6.	Annual income	0.0097	-0.0484	-0.0197	-0.0521	0.1586	0.0449
7.	Outside contact	0.1124	-0.1448	0.0174	0.0174	0.2617*	0.3300*
8.	Highest education in family	-0.0382	-0.2667*	0.3157*	0.1663*	0.1050	0.0598

— Significant at 5% level of significance with 148 df.

*Tabulated value—158 at 5% level of significance with 148 df.

was far away and respondents did not develop the taste for this water.

Regarding quality of water for washing of clothes, caste, education, outside contact and highest education in the family had negative and significant correlation with hand-pump water. It may be because hand-pump water was not commonly used. For tubewell, only highest education in the family had positive and significant correlation. Education and outside contact had positive and significant correlation with pond and diggi water.

Data in Table 3 reveal that defecation by people or animals near the water sources was the main cause of pollution (98.6%) followed by animal drinking from the same source (87.4%). Other important reasons given by the respondents were uncovered source of water

(81.2%), due to rainy season (58.7%) and improper drainage (56.7%). World Health Organization estimated that as much as 80% of all the diseases in the world are associated with water.

When water from all the sources was clinically tested, coliform counts were found to be the maximum, *i. e.* 1800/100 ml in all the water sources except the tap water where it was 1600/100 ml (Table 4). The faecal coliform were maximum in diggi water (120/100 ml) followed by tubewell (95/100 ml). It was minimum in tap water (15/100 ml). The viable counts at 30°C were uncountable in water from all the sources. The report was compared with that of Indian Council of Medical Research and water from all the sources was found to be non-potable as coliforms and faecal coliforms were more than recommended. It was also reported by Malik *et al.* (1983) that

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quality of water perceived by the respondents

Quality regarding washing					
Tap	Hand-pump	Tubewell	Well	Pond	Diggi
-0.0771	-0.0014	0.0188	-0.0949	-0.0690	-0.1465
-0.1716*	-0.2490*	-0.0401	-0.0842	-0.0056	-0.1256
-0.0963*	0.1344	0.0928	-0.0777	0.0380	-0.0724*
0.0696	-0.1778*	-0.1113	-0.0499	0.2676*	0.1933*
0.2062*	0.0181	0.0604	-0.0332	-0.0489	0.0490
-0.0735	-0.0643	0.0411	-0.0544	0.0185	-0.0330
0.1598*	0.2273*	-0.1138	0.0001	0.0447*	0.2521*
0.0188	-0.2416*	0.2690*	0.0910	0.2213*	0.0701

TABLE 3

Distribution of respondents according to reasons for pollution of water as perceived by them

		(N=150)	
S. No.	Reasons for pollution	Yes	No
1.	Rainy season	88 (58.7)	62 (41.7)
2.	Improper drainage	85 (56.7)	65 (43.3)
3.	Animal drinking from same source	131 (87.4)	19 (12.6)
4.	Defecation by people or animals near water source	148 (98.8)	2 (1.4)
5.	Uncovered source of water	122 (81.2)	28 (18.8)

Values in parentheses are percentages.

TABLE 4

Clinical test of water from different sources

S. No.	Source of water	Coliform per 100 ml	Faecal coliform/ 100 ml	Viable count/ml at 30°	Remarks
1.	Tap	1600	15	Uncountable	Non-potable
2.	Tubewell	1800	95	"	"
3.	Hand-pump	1800	40	"	"
4.	Well	1800	45	"	"
5.	Diggi	1800	120	"	"

only 16% of the inhabited villages were provided with safe drinking water supply, whereas 84% villages were in danger of water borne diseases.

It may be, thus, concluded that in majority of the cases the water quality was not upto the required standard. A sound value-based educational programme may

work as an important tool for imparting functional information to the people. Popularization of technical information related to quality of water and impact of poor quality water may be made in such a way that the results of the two are apparent to the people which in turn can mobilise the better participation in such a programme.

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I, Prof. N. R. Godara, hereby declare that the particulars given above are true to the best of my knowledge and belief.

Sd/-
Prof. N. R. Godara

A STUDY ON FOETAL FLUIDS IN PARTURIENT BUFFALOES

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The foetal fluids perform several important functions during pregnancy and at the time of parturition. Although the gestational changes in the biochemical constituents of foetal fluids have been studied in cattle (Reeves *et al.*, 1972; Baetz *et al.*, 1976) and buffaloes (Soliman, 1975), no report is available on the physical and biochemical characteristics of foetal fluids at the time of parturition.

The present study was conducted on the allantoic and amniotic fluids collected from 10 pluriparous Murrah buffaloes as soon as the allantoic and amniotic sacs made their appearance at the vulvar lips. The study on physical characteristics consisted of recording the pH and the specific gravity. The hydrogen ion concentration was determined with the help of digital pH meter. The specific gravity was calculated by the formula :

$$\text{Specific gravity} = \frac{\text{Mass}}{\text{Volume}},$$

after weighing a 10 ml aliquot of foetal fluid. Biochemical studies comprised determining the concentrations of sodium (flame photometer), potassium (flame photometer), chloride (Schales and Schales, 1941), total proteins (Lowry *et*

al., 1951), magnesium (Garner, 1946), calcium (Trinder, 1960), inorganic phosphorus (Tausky and Shorr, 1952), creatinine (Folin and Wu, 1919) and urea nitrogen (Richter and Lapointe, 1962).

The physical properties and biochemical composition of allantoic and amniotic fluids from buffaloes at term have been presented in Table 1. The mean pH of the allantoic fluid was found to be less than the pH of amniotic fluid. The specific gravity of the amniotic fluid was also more than that of the allantoic fluid.

The allantoic fluid from different buffaloes varied greatly in its sodium content (1.0 to 15.2 mEq/l). In comparison to the allantoic fluid, the amniotic fluid contained significantly higher sodium content (92.0 to 109.0 mEq/l). The chloride concentration was also much higher in the amniotic than in the allantoic fluid. The chloride content in the allantoic fluid ranged from 20.8 to 33.3 mEq/l, whereas the corresponding values in the amniotic fluid were 88.3 to 95.8 mEq/l). The higher level of sodium and chloride in the amniotic fluid than allantoic one suggests the hypothesis that the former is a transudate of serum. Very low levels of chloride in the allantoic fluid are probably

TABLE 1
Physical and biochemical characteristics of foetal fluids at parturition

Nature of fluid	pH	Specific gravity	Sodium (mEq/l)	Chloride (mEq/l)	Potassium (mEq/l)	Calcium (mEq/l)	Magnesium (mg %)	Phosphorus (mg %)	Total protein (mg %)	Creatinine (mg %)	Urea nitrogen (mg %)
Allantoic fluid	6.83 ±0.03	0.81 ±0.01	7.64 ±1.95	28.31 ±1.49	18.90 ±2.68	38.04 ±4.79	22.39 ±0.90	4.32 ±0.78	622.60 ±32.02	139.89 ±7.18	295.52 ±27.44
Amniotic fluid	7.06 ±0.04	0.91 ±0.01	101.14 ±2.46	88.07 ±1.68	6.49 ±0.72	5.62 ±0.83	3.27 ±0.49	10.68 ±1.42	86.52 ±2.06	17.24 ±4.07	61.24 ±8.98

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because of its origin from foetal urine. Contrary to sodium and chloride concentration, the levels of potassium in amniotic fluid were much lower than those in the allantoic fluid.

The allantoic fluid was richer in calcium as compared to the amniotic fluid. Calcium appears to be utilised by the foetus for growth and osseous development resulting in low calcium concentrations in the amniotic fluid. Compared with the calcium concentrations, phosphorus concentrations in the foetal fluids exhibited a reverse trend. The mean phosphorus concentration in the allantoic fluid was nearly half the mean concentration in the amniotic fluid. The preferential escape of urine into the amniotic fluid of bovine foetuses near term, coupled with increased urinary excretion of phosphate in late pregnancy might be responsible for increased phosphorus concentration in the amniotic fluid.

The magnesium levels in the allantoic fluid, which ranged between 17.84 and 26.31 mg %, were higher than those in the amniotic fluid (2.07 to 5.28 mg %). The

protein content in the amniotic fluid was much less than that in the allantoic fluid. The protein concentration in the allantoic and amniotic fluids ranged from 491 to 830 mg % and 80.4 to 95.0 mg %, respectively. It seems that the liquor amnii contributes to foetal nutrition and may well provide a source of gamma globulins to the foetus.

Creatinine and urea nitrogen concentrations were recorded to be lower in the amniotic than the allantoic fluid. High concentrations of creatinine and urea in the allantoic fluid of buffaloes indicate that foetal urine keeps on accumulating in the allantoic sac till the end of gestation. Intestinal absorption of urea from the swallowed amniotic fluid might contribute towards keeping the urea concentration in the amniotic fluid at a lower level than in the allantoic fluid.

The observations recorded in the present study are in accordance with those reported earlier by Reeves *et al.* (1972), Baetz *et al.* (1976) and Frerking (1979) in cattle and by Sollman (1975) in buffaloes in late gestation.

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GENETIC ARCHITECTURE OF SOME PHYSIOLOGICAL CHARACTERS IN WHEAT

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ABSTRACT

Analysis of variance revealed that mean squares due to generations were significant for all the characters in both the crosses, *i. e.* HD 2329 × Kalyan sona and HD 2009 × Sonalika. The results indicated the significance of additive gene effects (*d*) for shoot weight, root/shoot ratio, and uppermost internode length in both the crosses. However, dominant gene effects (*h*) were significant in case of uppermost internode length in both the crosses. Additive × additive (*i*) type of gene effects were significant for root weight, shoot weight, uppermost internode length in cross HD 2329 × Kalyan sona but these were significant only for shoot weight, flag leaf area and uppermost internode length in cross HD 2009 × Sonalika. Additive × dominance (*j*) type of gene effects were found significant for all the characters except uppermost internode length in cross HD 2009 × Sonalika.

Knowledge about genetic architecture of some physiological characters is very useful in formulation and effective execution of most efficient procedures to be adopted in any breeding programme. Therefore, present study is specifically an attempt to identify the plant with best biological efficiency in different segregating and non-segregating generations with respect to nature and magnitude of gene effects of some important physiological characters in wheat.

MATERIAL AND METHODS

Four genetically diverse homozygous varieties, *viz.* HD 2329, Kalyan sona, HD 2009 and Sonalika were involved in two crosses, *i. e.* HD 2329 × Kalyan sona and HD 2009 × Sonalika. The varieties

and their F_1 's were crossed and selfed to produce F_1 , F_2 and backcross generations. A sample of F_2 , BC_1 and BC_2 was selfed. The result of these crosses produced nine generations, *i. e.* P_1 , P_2 , F_1 , F_2 , F_3 , BC_1 , BC_2 , BC_1S and BC_2S . The final experiment was conducted in the net house in randomised block design with three replications during 1991-92. The number of plants sampled per replication was 10 for P_1 , P_2 , F_1 , BC_1 , BC_2 ; 40 for F_2 ; and 50 for F_3 , BC_1S and BC_2S . Five seeds of each cultivar and different generations were planted in plastic pots having 15 inches depth and 12 inches diameter filled with 3 parts soil and 1 part sand. Seeds were planted in each pot at a depth of about one inch in a circular pattern. Removal and cleaning of roots were facilitated by flooding the pots several hours prior to

the process of washing soil from the roots. Observations were recorded at physiological maturity stage. Dry weights (g) of root and shoot were determined after drying the plant material in oven at 60°C for 24 h after taking the data on flag leaf area (sq cm) and uppermost internode length (cm). The genetic analysis for the estimation of generation means was undertaken by using the non-epistatic model of Cavalli (1952) and epistatic model of Hayman (1958).

RESULTS AND DISCUSSION

The mean squares due to replications, generations and error indicated significant differences for all the characters under investigation in both the crosses and, thus, indicated the presence of sufficient variation among generations (Tables 1 and 2). Joint scaling test (Cavalli, 1952) was found to be inadequate for root weight and flag leaf area in both the crosses (Tables 3 and 4). Therefore, the analysis was extended to the digenic epistatic model of Hayman (1958). The 6-parameter model, however, also failed for flag leaf area in both the crosses

which indicated the presence of higher order interactions and/or linkages in the material under investigation. Similar results were also reported by Kumar *et al.* (1993) for this character.

In 3-parameter model, the additive effects (d) for shoot weight, root/shoot ratio and uppermost internode length were significant in both the crosses. However, non-additive gene effects were also found significant in the case of uppermost internode length in both the crosses. Gamble (1962) suggested that when inheritance of quantitative traits becomes complex, the contribution of dominance effect (h) to their inheritance becomes more. Their importance was indicated not only by their significance and relative magnitude but also by their signs. The presence of significant and positive dominance effects suggested an enhancing effect in the case of uppermost internode length (4.35 in cross HD 2329×Kalyan sona; 12.88 in cross HD 2009×Sonalika).

In 6-parameter model, the additive effects (d) were found significant in cross

TABLE 1
Analysis of variance for some physiological characters in cross
HD 2329×Kalyan sona in wheat

Source of variation	Degree of freedom	Mean squares				
		Root weight	Shoot weight	Root/shoot ratio	Flag leaf area	Uppermost internode length
Replications	2	0.42	1.82	0.01	2.79	8.15
Generations	8	11.45**	9.57**	0.13**	25.75**	101.12**
Error	16	0.19	1.49	0.02	1.18	1.68

**Significant at 1 per cent.

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TABLE 2

Analysis of variance for some physiological characters in cross
HD 2009 × Sonalika in wheat

Source of variation	Degree of freedom	Mean squares				
		Root weight	Shoot weight	Root/shoot ratio	Flag leaf area	Uppermost internode length
Replications	2	0.29	1.50	0.01	6.19	7.30
Generations	8	21.63**	102.09**	0.12**	25.08**	76.32**
Error	16	0.20	1.60	0.01	1.35	0.58

**Significant at 1 per cent.

TABLE 3

Gene effects of some physiological characters in cross
HD 2329 × Kalyan sona in wheat

Parameter	Root weight	Shoot weight	Root/shoot ratio	Flag leaf area	Uppermost internode length
3-parameter model					
m	4.72	21.61	0.22	19.50	24.31
(d)	4.30*	2.48*	0.27*	2.91**	7.08**
(h)	1.36	1.98	0.15	-1.84	4.35**
Chi-square	2.30	1.83 (NS)	0.08 (NS)	12.67	4.66 (NS)
6-parameter model					
m	5.25	23.50	0.21	18.17	23.40
(d)	6.84**	2.43*	0.20*	1.60*	4.30*
(h)	3.88	1.90	1.70	3.73**	1.28*
(l)	4.80*	4.60*	-1.60*	1.06	2.70*
(j)	1.82**	1.67	1.25	1.30*	0.36
(l)	-5.04	1.35	6.11**	15.98**	2.78
Chi-square	0.19 (NS)	1.50 (NS)	0.16 (NS)	10.23	0.63 (NS)
Interactions	—	—	—	Duplicate	—

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

TABLE 4

Gene effects of some physiological characters in cross HD 2009 × Sonalika in wheat

Parameter	Root weight	Shoot weight	Root/shoot ratio	Flag leaf area	Uppermost internode length
3-parameter model					
m	4.17	18.22	0.23	13.93	18.02
(d)	6.26*	4.64*	0.16	7.06*	19.90**
(h)	3.26	1.96	0.09	-12.86*	12.88**
Chi-square	1.97	6.26 (NS)	0.25 (NS)	8.82	4.17 (NS)
6-parameter model					
m	4.10	16.78	0.25	13.83	17.70
(d)	21.25*	2.83*	0.96*	11.00**	10.15*
(h)	21.97**	1.73*	1.97	21.97**	21.97**
(i)	2.88	7.21**	0.88	6.68*	20.11**
(j)	-15.97**	10.96**	5.90*	-15.90**	-5.90
(l)	11.92**	39.91**	0.42	11.42**	-6.42
Chi-square	0.62 (NS)	3.38 (NS)	0.41 (NS)	14.50	4.01 (NS)
Interactions	Complementary	Complementary	—	Complementary	—

*, **Significant at 5 and 1 percent, respectively.

HD 2329 × Kalyan sona for root weight (6.84), shoot weight (2.43), root/shoot ratio (0.20), flag leaf area (1.60) and uppermost internode length (4.30), whereas dominance component (h) was also significant for uppermost internode length (1.28). Similar trend was also observed in cross HD 2009 × Sonalika. Redhu and Chowdhury (1991) also reported that dominance component was important for flag leaf area. Additive × additive (i) type of gene effects were significant for root weight (4.80), shoot weight (4.60), root/shoot ratio (-1.50) and uppermost internode length (2.70) in cross HD 2329 × Kalyan sona but these were significant only for shoot weight (7.21), flag leaf area (6.68) and uppermost internode length (20.11) in cross HD 2009 × Sona-

lika. Additive × dominance (j) type of gene effects were found significant for all the traits under investigation except uppermost internode length and root weight in cross HD 2009 × Sonalika but these were significant only for root weight (1.82) and flag leaf area (1.30) in cross HD 2329 × Kalyan sona. The dominance × dominance (l) type of gene effects were significant for root weight and flag leaf area in both the crosses and root/shoot ratio in cross HD 2329 × Kalyan sona, shoot weight in cross HD 2009 × Sonalika. The interactions appeared to be of duplicate type for flag leaf area in case of HD 2329 × Kalyan sona. Complementary type of interactions were observed for root weight, shoot weight and flag leaf area in cross HD 2009 × Sonalika. In the present

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investigation, additive as well as additive $\times$ additive gene effects figured important in determining the inheritance for most of the characters. Further additive and non-additive gene effects were also important for uppermost internode length in both the crosses. In order to exploit additive as well as non-additive gene effects simultaneously breeding methods like reciprocal recurrent selection and biparental mating approach should be followed for maximum efficiency in wheat.

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COMPARATIVE PERFORMANCE OF NODULATION IN *PHASEOLUS VULGARIS* L. (RAJMASH) UNDER CHILLUM JAR AND POT-CULTURE CONDITIONS

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ABSTRACT

Comparative studies of *Phaseolus vulgaris* L. under controlled growth and natural soil conditions showed that the symbiotic parameters had lower values under natural soil condition as compared to those of sterilized conditions. However, out of 13 strains of *Rhizobium leguminosarum* bv *phaseoli* tested, the strains 106, 107, 102 and TAL 1378 were found quite effective under both types of conditions.

Traditionally, *Phaseolus vulgaris* is grown as rainy season crop in the hilly tracts of Jammu and Kashmir, Himachal Pradesh, U. P., and parts of Maharashtra occupying about 85,000 hectares of land in India. It is also known as French-bean, 'Kidney bean' or common bean. There is conflicting evidence as to the value of symbiosis in this crop. Some regard this crop as poor in nodulation as compared to other legumes (Hardy *et al.*, 1968; Graham, 1981). Due to this reason *Rhizobium leguminosarum* bv. *phaseoli* inoculants are not widely used.

Rajmash crop is newly introduced crop in Northern plains of India. Pot house experiments have shown that *P. vulgaris* responds well to inoculation (Burton *et al.*, 1954; Awonaike *et al.*, 1980). So to understand the physiology of nodulation in rajmash, the study was undertaken under greenhouse conditions.

MATERIAL AND METHODS

Nodulation experiments were undertaken in 'chillum jar' and pot culture under natural day light. The crop was grown in normal crop season (in the month of September). Seeds of rajmash cultivar VL-63 were surface sterilized and inoculated with 13 strains of *Rhizobium leguminosarum* bv *phaseoli*. These were sown in sterilized modified Leonard jar (chillum) assemblies (Dahiya and Khurana, 1981). For pot experiment, rajmash crop was grown in pots containing 5 kg of dry sandy loam soil. Each treatment was replicated thrice. Nitrogen free slogger's solution was also added to the plants at 10 days interval. The plants were harvested 40 days after sowing and acetylene reduction activity, fresh weight of nodules, and shoot dry weight per plant were observed.

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RESULTS AND DISCUSSION

Evaluation of rhizobial strains under natural soil conditions for their adaptability and competitive establishment is very essential for selection of strains to be recommended for mass production. All the 13 strains of *Rhizobium leguminosarum* bv *phaseoli* tested for nodulation against *Phaseolus vulgaris* cv. VL-63 responded both under 'chillum jar' and pot culture conditions but varied in their ability to nodulate the test cultivar. Weight of fresh nodules ranged from the minimum of 0.18 g with strain TAL-1865 to a maximum of 1.12 g per plant

with strain 106 under 'chillum jar' conditions (Table 1). Shoot dry weight per plant ranged from 0.42 to 1.23 g per plant. Response to inoculation in terms of total ARA was also significant. Total ARA for different strains ranged from 1.88 to 11.31 μ moles C_2H_4 /h/plant. Shoot weight ratio indicated that although all the strains had positive effect on the symbiosis but the response to strains 102, 104, 106, 107, RM-3 and TAL-1376 was remarkable.

This experiment was also performed in unsterilized soil under pot culture conditions to compare the performance

TABLE 1

Nodulation studies in *Phaseolus vulgaris* cv. VL-63 with efficient strains of *R. leguminosarum* bv *phaseoli* under chillum jar conditions

<i>Rhizobium</i> strain	Nodule fresh wt. (g/plant)	Shoot dry wt. (g/plant)	Total ARA (μ moles/h/plant)	Shoot wt. ratio*
102	0.96	0.91	10.26	4.44
104	0.76	0.53	2.41	3.33
105	0.47	0.84	4.45	1.88
106	1.12	1.10	11.31	4.07
107	1.07	1.23	9.42	4.81
B-66	0.54	0.84	5.91	2.22
RM-3	0.50	0.79	4.71	2.96
UASB-51	0.20	0.47	2.04	1.74
HURR-1	0.34	0.42	4.78	1.48
CIAT-1127	0.50	0.61	3.29	2.18
TAL-1376	0.73	0.75	8.41	2.75
TAL-943	0.60	0.64	4.52	2.00
TAL-1865	0.18	0.45	1.88	1.66
Uninoculated control	—	0.27	0.00	—
C. D. at 5%	0.24	0.21	1.36	

— = no nodulation.

*Shoot weight ratio = $\frac{\text{Shoot dry wt. (g) of inoculated plant}}{\text{Shoot dry wt. (g) of uninoculated plant}}$

TABLE 2

Nodulation studies in *Phaseolus vulgaris* cv. VL-63 with efficient strains of *R. leguminosarum* bv *phaseoli* under pot culture conditions

<i>Rhizobium</i> strain	Nodule fresh wt. (g/plant)	Shoot dry wt. (g/plant)	Total ARA (μ moles C_2H_4 /h/ plant)	Shoot wt. ratio
102	0.55	0.61	3.29	2.54
104	0.35	0.58	2.09	2.41
105	0.27	0.48	3.41	1.91
106	0.72	0.69	5.91	2.87
107	0.83	0.67	4.71	2.79
B-66	0.32	0.39	2.11	1.62
RM-3	0.21	0.42	2.54	1.71
UASB-51	0.34	0.49	2.71	2.04
HURR-1	0.21	0.37	3.21	1.54
CIAT-1127	0.54	0.47	4.32	1.95
TAL-1376	0.46	0.61	2.94	2.54
TAL-943	0.62	0.54	3.74	2.25
TAL-1865	0.12	0.31	2.59	1.29
Uninoculated control	0.03	0.24	—	—
C. D. at 5%	0.26	0.19	1.01	

— = Not detectable.

of effective strains with cultivar VL-63 (Table 2). All symbiotic parameters had lower values as compared to those under sterilized conditions. But the strains which were quite effective under chillum jar conditions, performed in the same fashion under pot culture conditions. Nodule fresh weight under pot culture conditions ranged from 0.12 to 0.83 g, while shoot weight ratio showed that nodulation affected shoot weight in all the strains tested. Total ARA for the most effective strain 106 was found 5.91μ moles C_2H_4 /h/plant, which is lesser than the value obtained under chillum jar conditions.

These variations in the results can be attributed due to the competitive ability

of the individual rhizobial strain with native microflora and its establishment in soil. This is in confirmation of the results of Halliday (1984) and Dudeja and Khurana (1988). They reported that superiority of an isolate adjudged under chillum jar conditions may not always correspond to ranking of effectiveness under natural soil conditions. Graham (1981) suggested that poor response to bean inoculation might be due to competition for nodulation sites between strains and those indigenous to the soil. While, Martinez *et al.* (1988) reported that the genome of *R. phaseoli* is complex, containing a large amount of reiterated DNA sequences and, thus, it has more probability of genetic variability in capacity to fix nitrogen.

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EFFECT OF NITROGEN AND ZINC ON PRODUCTION OF CAULIFLOWER VARIETY SNOWBALL-16

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ABSTRACT

An experiment comprising four levels of nitrogen (0, 60, 120 and 180 kg/ha) and four levels of zinc (0.0, 2.1, 4.2 and 6.3 kg/ha) was conducted. Nitrogen application increased the leaf size index, curd size index, curd weight and marketable yield significantly upto 120 kg/ha. However, number of leaves per plant and days to 50% curd maturity remained unaffected and leaf curd ratio declined with increase in the levels of nitrogen. Zinc application increased the leaf size index, curd size index and marketable yield significantly upto 4.2 kg Zn/ha and leaf curd ratio upto 2.1 kg Zn/ha but it had no effect on number of leaves per plant and days to 50% curd maturity. Interaction effect of these nutrients was found significant on leaf size index, curd weight and marketable yield. Response of one nutrient was increased by the higher levels of other nutrient thereby indicating the necessity of application of these nutrients in this crop. Maximum yield was obtained at 120 kg N and 4.2 kg Zn per hectare. Response curve indicates 138.88 kg N and 4.19 kg Zn per hectare as optimum dose for this crop.

Cauliflower (*Brassica oleracea* var. botrytis) cv. Snowball-16 is the most important of the late grown group of cauliflowers being grown throughout India. This variety is a heavy feeder of nitrogen (Welch *et al.*, 1985) but in zinc deficient conditions plants fail to absorb nitrogen although sufficiently available in the soil. Under zinc deficiency condition there is accumulation of a substance, an alkaloid possibly a glucosinolate derivative along with the perforation plates in the xylem vessels of roots which impede water transport from roots to aerial parts (Sharma *et al.*, 1984). Therefore, it was considered important to work out the nitrogen and zinc requirement of Snowball-16 for Haryana state where the soils are generally deficient in nitrogen and zinc.

MATERIAL AND METHODS

The field experiment was conducted during the winter of 1989-90 at Vegetable Research Farm of CCS Haryana Agricultural University, Hisar, in the soil having pH 8.2, electrical conductivity (dS/m) 0.50, organic carbon 0.34%, available P_2O_5 17 kg/ha, available K_2O 359 kg/ha, diethylene triamine penta acetic acid (DTPA) extractable Zn 0.60 ppm. The treatments involved four levels of nitrogen (0, 60, 120 and 180 kg/ha) and four levels of zinc (0.0, 2.1, 4.2 and 6.3 kg/ha). The experiment having 16 treatment combinations was conducted in randomised block design with three replications. Seedlings were transplanted on 9 November, 1989 at a spacing of 45 cm × 45 cm. Full dose of recommended P_2O_5 and Zn

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and one-third dose of nitrogen were placed in the soil before transplanting the crop. The remaining two-third nitrogen was top dressed in two splits after 30 and 45 days of transplanting. Other cultural operations were adopted as per recommendations given in the package of practices. Observations on leaf and curd size indices, leaf curd ratio, number of leaves and days to 50% curd maturity were recorded.

RESULTS AND DISCUSSION

Nitrogen application increased the leaf size index, curd size index, curd weight and marketable yield significantly upto 120 kg N/ha (Table 1). However, number of leaves per plant remained unaffected. Similar effects of nitrogen have been reported by Pimpini (1965), Sharma and

Chaudhary (1985), and Scaife and Wurr (1990). On the other hand leaf curd ratio declined with the increase in the levels of nitrogen. This relationship clearly indicates that nitrogen application was more beneficial in the development of curd than the leaves. These findings are in agreement with the results of Pimpini *et al.* (1971) and Balyan and Dhankhar (1988). The increase in marketable yield by application of 120 kg N/ha was 72.07% over control. The equation of quadratic nature, $Y=120.86+1.25 X-.0045 X^2$, was worked out which fits in well with the observed values, R^2 being .995. The optimum dose of nitrogen came out to be 138.88 kg/ha (Fig. 1).

Zinc application increased the leaf size index, curd weight and marketable yield significantly upto 4.2 kg/ha, whereas

TABLE 1

Effect of nitrogen and zinc on leaf size index, curd size index, leaf curd ratio, leaves/plant, days to 50% curd maturity, curd weight and marketable yield

Treatment	Leaf size Index (cm ²)	Curd size index (cm ²)	Leaf curd ratio	Leaves/ plant	Days to 50% curd maturity	Curd weight (g)	Marketable yield (g/ha)
Nitrogen (kg/ha)							
0	598.32	123.95	1.27	30.53	90.41	359.03	121.86
60	669.90	145.17	1.29	31.12	89.83	424.57	176.70
120	736.45	160.35	1.14	32.10	89.33	511.61	209.86
180	733.15	164.87	1.18	31.42	89.41	499.97	199.68
C. D. at 5%	30.82	10.61	0.08	NS	NS	15.11	5.95
Zinc (kg/ha)							
0.0	594.27	126.95	1.13	30.27	90.25	385.87	139.60
2.1	682.02	149.45	1.25	31.02	89.83	460.95	185.47
4.2	736.70	166.77	1.25	32.10	89.00	482.96	198.57
6.3	727.32	161.17	1.25	31.70	89.91	465.40	184.46
C. D. at 5%	30.82	10.61	0.08	NS	NS	15.11	5.95

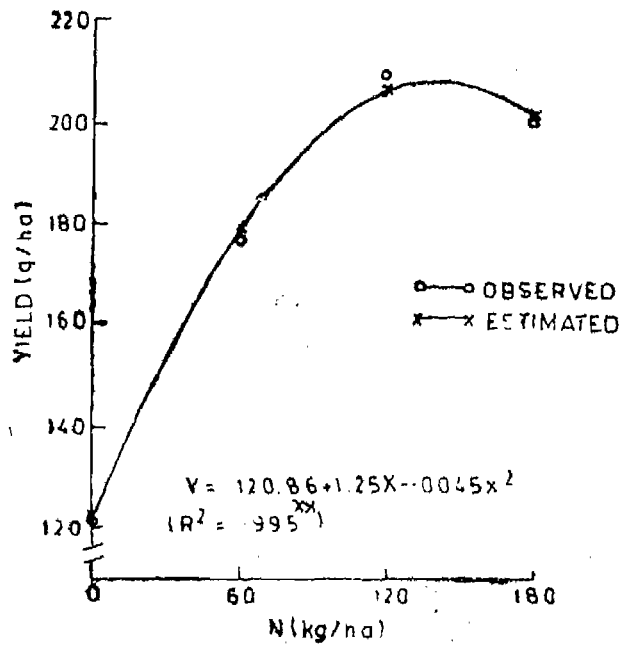


Fig. 1. Response of cauliflower to nitrogen.

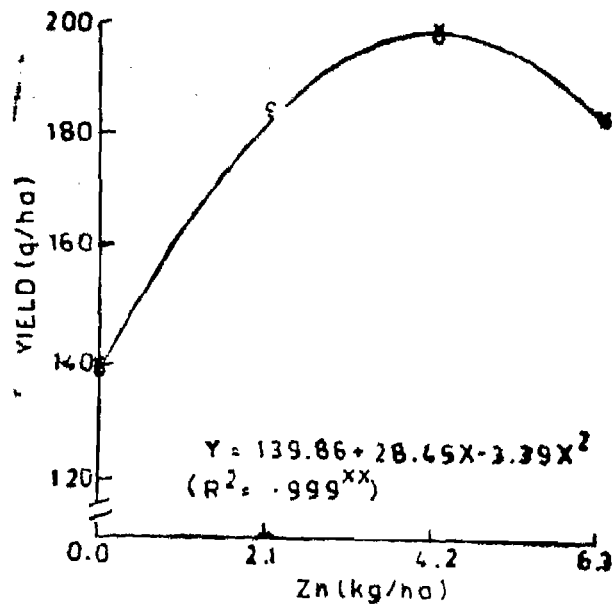


Fig. 2. Response of cauliflower to zinc.

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increase in leaf curd ratio was upto 2.1 kg/ha (Table 1). However, number of leaves per plant and days to 50% curd maturity remained unaffected. These results are in agreement with lyenger *et al.* (1979) and Balyan and Dhankhar (1988). Response curve of zinc was quadratic in nature (Fig. 2). The optimum dose of zinc was found to be 4.19 kg/ha.

The interaction effects of nitrogen and zinc on the leaf size index, curd size index and marketable yield indicate that nutrients had synergistic effects upto 120 kg N and 4.2 kg Zn per hectare. Toxic effect of 6.3 kg Zn/ha was observed at lower levels of nitrogen and it decreased

with the increase in nitrogen dose (Table 2). Since increasing availability of soil nitrogen increased the photosynthetic activities, zinc being a constituent of the carbonic anhydrase enzyme, is utilised in the photosynthesis and, therefore, resulted in more utilization and less toxicity at higher level of nitrogen application. Corroborative results have been obtained by Pimpini *et al.* (1971), Pandey *et al.* (1974) and lyenger *et al.* (1979).

Cauliflower yield had highly positive correlation with the leaf size index, curd size index and number of leaves per plant. Similar results have been obtained by Singh (1984).

TABLE 2
Effect of N×Zn on leaf size index, curd weight and marketable yield

Zinc (kg/ha)	Nitrogen (kg/ha)			
	0	60	120	180
Leaf size index (cm²)				
0.0	524.60	592.60	626.80	623.30
2.1	598.60	665.30	732.60	731.60
4.2	639.30	714.80	800.30	792.60
6.3	630.80	707.10	786.30	785.10
C. D. at 5%	61.64			
Curd weight (g)				
0.0	240.34	368.47	487.36	447.32
2.1	384.76	434.02	515.50	509.54
4.2	419.95	468.83	521.43	521.85
6.3	391.07	426.99	522.17	521.39
C. D. at 5%	30.22			
Marketable yield (q/ha)				
0.0	91.72	146.16	160.27	159.26
2.1	116.92	195.55	224.78	204.62
4.2	140.11	202.60	227.80	223.77
6.3	139.10	162.28	226.80	210.67
C. D. at 5%	11.93			

TABLE 3

Correlation coefficient between yield and yield attributing characters

Character	Yield	Number of leaves	Leaf curd ratio	Leaf size index	Curd size index
Yield	—	—	—	—	—
Number of leaves	0.824**	—	—	—	—
Leaf curd ratio	0.019	-.024	—	—	—
Leaf size index	0.833**	.910**	.029	—	—
Curd size index	0.903**	.840**	-.008	.942**	—
'r' at 5%	0.497				

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COMPARATIVE PERFORMANCE OF GUAYULE AT DIFFERENT STAGES OF GROWTH

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ABSTRACT

Among the eight genotypes of Guayule compared, the highest rubber content was in HG-9 followed by Arizona-101 at all stages of development after one year. Other genotypes such as HG-10, G-4 and USDA were found to possess significantly higher rubber content. The mean values of agrobottanical characters of two years old genotypes and rubber and resin contents at different stages of development have been reported.

As a result of the renewed interest in natural rubber and chemical specialties, Guayule (*Parthenium argentatum* Gray) is receiving considerable attention. The quality of Guayule rubber is comparable to that of the rubber tree *Hevea brasiliensis* (NAS, 1977). It holds advantage over hevea since the latter is cultivated only in tropical zone and requires fertile land. Guayule is the crop of arid zone and can be grown on marginal lands and, thus, can provide income to desert dwellers. In order to improve the Guayule crop for rubber and resin yields, research has been carried out through selection within the introduced material.

The rubber is contained within cells throughout the plant but varies in amount in different parts of the plant and the time of extraction (De Leo, 1940). Generally, the percentage of rubber increases in the hot season and is mainly deposited in the tissues of bark (Curtis, 1947). Different methods

have been developed for the extraction of rubber and resin (David and Caldwell, 1933; Traub, 1946; Willits *et al.*, 1946; Bhatia and Masohan, 1983). One method developed by Garrot *et al.* (1981) makes use of liquid nitrogen which eliminates the time consuming steps of drying and deterioration of quality of rubber. Another method consists in grinding the plant material, pulping it in the presence of alkali and extraction of rubber from the pulp with a suitable solvent. But the method used in the present study is more practical and economical.

MATERIAL AND METHODS

The varietal trial consisting of eight genotypes, viz. HG-8, HG-9, HG-10, G-3, General, USDA, Arizona-101 and G-4 were planted in the field (dry land area) of CCS Haryana Agricultural University, Hisar, in the month of February, 1990. The transplanting was done at a distance of 75 cm × 45 cm.

To prevent the plants from root rot, these were treated with Bavistin. First data on morphological traits were recorded after seven months of transplantation; second and third data at three months interval; and fourth data were taken after 10 months of interval. Data were recorded on six characters, viz. plant canopy girth, stem girth, plant height, basal branches per plant, rubber and resin content. The rubber and resin contents analysis was undertaken after 1½, 2 and 2½ years of transplantation.

The freshly harvested shrub was dipped in hot water (below 80°C) for 15 min., to coagulate the rubber in the latex cells and thus prevent deterioration. The parboiled shrubs were defoliated, chopped into small pieces, air dried for 12 h, and disintegrated in a Wiley Mill with a 2 mm screen. Dry weights were determined by drying at 80°C for 48 h. Replicated fresh weights (10, 20 and 30 g) were each stirred for

10 min in 100 ml of acetone (AR, BDH). The mixture was vacuum filtered through Whatman filter paper No. 1 and cake rinsed with 50 ml of acetone. The filtrate was dried to a constant weight and the residue was referred to as resin. The filter cake was air dried and heated with 100 ml of hexane (AR, BDH) for 15 min at 70°C. This process was repeated twice to ensure complete extraction of rubber and the combined extracts were filtered. The filtrate containing rubber along with some impurities like triglycerides and terpenes was stirred for 2 h with 15% NaOH solution at 50°C. The triglycerides, thus, converted into sodium salts of fatty acids were removed with water layer. The organic layer containing rubber along with some impurities like terpenes and waxes, was concentrated, passed through a small column of silica gel and eluted with hexane to remove the terpenes and waxes. The elute was dried to a constant weight to determine the per cent rubber.

TABLE 1

Agro-botanical characters of two years old Guayule genotypes

Genotype	Plant girth (cm)	Stem girth (cm)	Plant height (cm)	Basal branches/plant
HG-8	260.7	16.7	87.2	17.3
HG-9	216.0	13.4	48.2	17.0
HG-10	213.2	12.8	49.8	10.9
G-3	206.0	9.3	48.0	6.7
General	198.2	10.2	45.7	8.0
USDA	195.7	11.3	48.3	10.3
Arizona-101	210.2	11.8	47.3	9.1
G-4	203.7	10.8	54.1	9.3
Mean	211.5±16.1	12.0±2.2	53.6±12.9	11.1±3.7

PERFORMANCE OF GUAYULE GENOTYPES

TABLE 2

Per cent rubber and resin contents in different genotypes of Guayule at various stages of growth

Genotype	1½ years		2 years		2½ years	
	Rubber	Resin	Rubber	Resin	Rubber	Resin
HG-8	6.13	4.47	6.45	4.82	6.52	4.98
HG-9	7.32	5.61	7.84	5.33	7.92	5.45
HG-10	6.28	5.52	6.82	6.11	6.91	6.17
G-3	5.12	6.54	6.19	6.41	6.32	6.53
General	5.03	4.82	5.71	4.66	5.87	4.74
USDA	5.95	4.52	6.34	4.21	6.63	4.82
Arizona-101	7.04	5.32	7.54	5.08	7.67	5.33
G-4	5.32	6.21	6.42	5.46	6.79	5.61
Mean	6.02±1.62	5.50±0.80	6.66±0.66	5.26±0.69	6.83±0.63	5.45±0.60

RESULTS AND DISCUSSION

A large range of variation was observed in all the six characters in different Guayule genotypes. It is evident from Table 1 that genotype HG-8 had maximum branches (17.3) followed by HG-9 (17.0). G-3 exhibited least number of tillers per plant. HG-8 was the tallest (87.2 cm) followed by G-4 (54.1 cm). Genotypes General and Arizona-101 were the shortest. HG-8 also had maximum stem girth (16.7 cm) followed by HG-9 (13.4 cm) and HG-10 (12.8 cm); least stem girth was exhibited by G-3 (9.3 cm). Plant girth also followed similar trend. USDA genotype recorded

minimum plant girth (195.7 cm). These differences in vegetative characters are indicative of substantial genotypic differences in the experimental material.

The rubber and resin contents of all the genotypes differed significantly at different stages of growth (Table 2). Higher values were recorded for rubber content in 2½ years old stage, whereas the trend was not consistent for resin content. The rubber content was highest in HG-9 (7.92%) followed by Arizona-101 (7.67%) and least in General (5.87%), while the resin content was highest in G-3 (6.53%) in the 2½ years old shrub and least in HG-8 (4.98%).

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EFFECT OF SOIL AMENDMENTS WITH AND WITHOUT WATER STRESS CONDITIONS ON TRANSPLANTED RICE

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ABSTRACT

In a long-term field experiment, rice husk, gypsum, FYM and dhaincha (*Sesbania aculeata*) were applied at the rate of 5 t/ha after final puddling before transplanting rice. Water stress to the crop was given by withholding the irrigation for about 12 days during maximum tillering stage (50 days after transplanting). Water stress increased the percolation rate (45.5%) and reduced the rice yield (9.19 q/ha) over no water stress condition. All soil amendments decreased the percolation rate and increased the rice yield in both—with and without water stress conditions, more so in water stress condition. The maximum effect was observed in dhaincha followed by FYM, gypsum and rice husk. Rice yield and percolation rate showed a negative correlation ($r = -0.93$). Yield of succeeding wheat crop was also significantly increased in FYM and dhaincha treatments.

Rice is a major kharif (rainy season) crop of Haryana which covers about 0.6 million hectares area mainly in north-eastern region of the State. Rice being semi-aquatic plant, requires a water regime near soil saturation for optimum yield. In this region it is, however, not always possible to maintain such a water regime due to erratic rainfall, canal closures, tubewell failures, etc., and crop is thus subjected to water stress for a varying period on a considerable area. Water stress conditions are more prevalent in the years of low rainfall or early withdrawal of monsoon. Water stress results in drying of soil leading to the formation of cracks particularly in the fine textured soil which enhances water percolation rate, besides withering of plants. Once the soil cracks are developed, maintenance of an optimum water regime

becomes very difficult inspite of increased irrigations and finally results in lower yields. Calcium and organic matter promote soil aggregation and decrease formation of soil cracks. Therefore, use of rice husk, gypsum, farm yard manure (FYM) and dhaincha (*Sesbania aculeata*) may be useful to sustain the rice yield under water stress conditions. The present study was, therefore, undertaken to assess their effects on water percolation and rice yield and residual effect on succeeding wheat crop.

MATERIAL AND METHODS

The experiment was started in kharif 1988 at CCS Haryana Agricultural University Regional Research Station, Uchani, Karnal and continued upto rabi 1991-92 in the same layout. Soil of the field was

clay loam in texture and had pH (1 : 2) 8.85, EC 0.30 ds/m, organic carbon 0.36%, available P 15 kg/ha and available K 257 kg/ha. Five treatments of soil amendments, viz. control (no amendment), rice husk, gypsum, farm yard manure (FYM) and green dhaincha (chopped) with and without water stress conditions were replicated four times in split-plot design keeping amendments in main-plots and water stress in sub-plots. About 50 days old dhaincha was added from outside. Amendments were applied @ 5 t/ha on dry weight basis after final puddling in ponded water before transplanting rice. Water stress was given by withholding the irrigation for about 12 days during maximum tillering stage of crop (50 days after transplanting, DAT). Irrigations were resumed thereafter and water percolation rate was measured using cylinder-infiltrometer. Depth of irrigation was 6 cm. Submergence was maintained upto tillering (55 DAT), then irrigation at four days interval upto 50% flowering (80 DAT) and thereafter weekly irrigations were given to keep the soil

only saturated. Transplanted rice 'Jaya' was taken during kharif (rainy season) which was fertilized with 120 kg N, 60 kg P_2O_5 , 60 kg K_2O and 25 kg zinc sulphate/ha. After the harvest of rice, wheat 'HD 2285' was grown during rabi (winter season) which received fertilizers at 120 kg N, 60 kg P_2O_5 and 30 kg K_2O /ha. There were no sub-plots in wheat crop, so data of only main-plots were recorded. This sequence was continued for four years wherein the soil amendments and water stress treatments were applied to rice crop every year.

RESULTS AND DISCUSSION

The data in Table 1 show that rice yield in water stress condition was less than under no water stress irrespective of treatments in all the years, but the difference was significant only in control. Soil amendments increased rice yield over control in both with and without water stress conditions in all the years more so in water stress condition and the increase was maximum in dhaincha followed by

TABLE 1
Effect of soil amendments on unhusked rice yield (q/ha)

Treatment	1988 stress		1989 stress		1990 stress		1991 stress		Mean	
	+	-	+	-	+	-	+	-	+	-
Control	50.4	61.0	55.7	64.8	56.9	64.4	60.6	70.2	55.9	65.1
Rice husk	57.2	64.9	62.0	69.2	62.8	68.8	65.8	72.5	61.9	68.8
Gypsum	59.7	66.3	66.1	70.8	63.4	70.0	69.6	75.1	64.7	70.5
F. Y. M.	66.5	68.5	70.5	72.1	67.8	71.3	73.9	79.1	69.7	72.7
Dhaincha	68.8	70.2	72.4	73.6	70.6	72.9	77.1	81.1	72.2	74.5
Mean	60.5	66.2	65.3	70.1	64.3	69.5	69.4	75.6	64.9	70.3
C. D. at 5%										
Main plots	6.8		6.0		6.1		5.5			
Sub-plots	2.1		3.3		3.5		3.1			
Interaction	8.2		7.4		7.5		6.9			

EFFECT OF WATER STRESS ON TRANSPLANTED RICE

FYM, gypsum and rice husk (Table 1). Thus, in water stress condition, gypsum, FYM and dhaincha and in no water stress condition dhaincha only brought about significant increase in rice yield over their respective control. On an average, the increase in yield over control with water stress was 6.0, 8.8, 13.8 and 16.3 q/ha in rice husk, gypsum, FYM and dhaincha, respectively, while without water stress, the corresponding increase was 3.7, 5.4, 7.6 and 9.4 q/ha over control. Evidently the increase in yield over control by these amendments was more in water stress condition. The loss in yield due to water stress was minimised in rice husk and gypsum treatments and instead of any decrease, there was a net increase of 4.6 and 7.1 q/ha in FYM and dhaincha, respectively when compared with control without stress (Table 1).

Data in Table 2 show that water stress treatment enhanced the percolation rate as compared to no water stress irrespective of treatments in all the years. However, soil amendments decreased it over control in both with and without water stress conditions more so under water stress condition. In control, water stress increased the percolation rate from 8.58 to 12.48 mm/day, an increase of 45.5 per cent. Among various treatments, the percolation rate was in decreasing order of control, gypsum, rice husk, FYM and dhaincha irrespective of water stress treatments (Table 2).

Data in Table 3 show that soil amendments applied to rice also gave residual effect on succeeding wheat crop except rice husk but the effect was significant in FYM and dhaincha treatments only being maximum in latter.

TABLE 2

Effect of soil amendments on average percolation rate (mm/day)

Treatment	Percolation rate	Increase/ Decrease
With water stress		
Control	12.48	+3.90
Rice husk	11.73	+3.15
Gypsum	10.78	+2.20
F. Y. M.	8.78	+0.20
Dhaincha	7.63	-0.95
Mean	10.28	
Without water stress		
Control	8.58	0.00
Rice husk	7.38	-1.20
Gypsum	7.90	-0.68
F. Y. M.	6.35	-2.23
Dhaincha	5.70	-2.88
Mean	7.18	

Data in Tables 1 and 2 indicate that water stress increased percolation and decreased rice yield as compared to no water stress treatment. Soil amendments decreased percolation and increased rice yield, irrespective of water stress treatment more so under water stress condition. This may be due to drying of soil and formation of soil cracks besides withering of plants under water stress condition. On resumption of irrigation, soil cracks did not disappear completely as reflected by increased percolation rate. This hampered the maintenance of an optimum water regime which finally resulted in lower yield than no water stress condition. Soil amendments alleviated the formation of soil cracks during water stress and thus resulted in lesser

TABLE 3
Residual effect of soil amendments on wheat yield (q/ha)

Treatment	1988-89	1989-90	1990-91	1991-92	Mean
Grain					
Control	45.2	38.3	33.6	42.1	39.8
Rice husk	44.7	38.4	33.2	43.0	39.8
Gypsum	46.4	40.1	35.4	45.6	41.9
F. Y. M.	47.4	41.7	36.8	49.2	43.8
Dhaincha	48.9	43.3	37.8	50.7	45.2
C. D. at 5%	NS	2.6	2.8	4.3	
Straw					
Control	65.4	58.4	53.3	51.3	57.1
Rice husk	65.3	58.0	52.8	53.6	57.4
Gypsum	67.8	60.1	55.3	54.4	59.4
F. Y. M.	71.6	64.0	57.8	59.3	63.2
Dhaincha	72.4	65.8	58.2	61.8	64.5
C. D. at 5%	6.6	4.1	4.1	6.9	

increase in percolation rate and accordingly lesser decrease in rice yield. The percolation rate and rice yield were found negatively correlated ($r = -0.93$) and so were their increase or decrease ($r = -0.95$) as shown in Fig. 1. Therefore, increase or decrease in rice yield was mainly attributed to the soil water regime as affected by water percolation rate in different treatments.

Soil of the experimental field was clay loam in texture with alkaline pH (8.85) and had a tendency to form cracks on drying. Addition of gypsum and organic matter reduced the formation of soil cracks. Rice husk could not be effectively mixed into the surface soil as it floated on the water and also found undecomposed during wheat season, may be attributed to its least effectiveness. Gypsum improved soil physical conditions

and favoured a better soil-water regime. FYM and dhaincha brought in more improvement in soil physical conditions being maximum in latter and kept the soil wet by conserving more moisture, so gave better soil-water regimes than gypsum and also added about 30 kg (only 12 kg in rice) and 25 kg N per hectare, respectively, into the soil. The decomposition of dhaincha during rice crop helped steady release of plant nutrient (Khind *et al.*, 1985) resulting into maximum increase in rice yield.

The improvement in soil physical conditions especially soil aggregation brought in by gypsum, FYM and dhaincha persisted after rice also, therefore, succeeding wheat crop yielded more than control under these treatments. The increase in wheat yield may be attributed mainly to the improved soil physical

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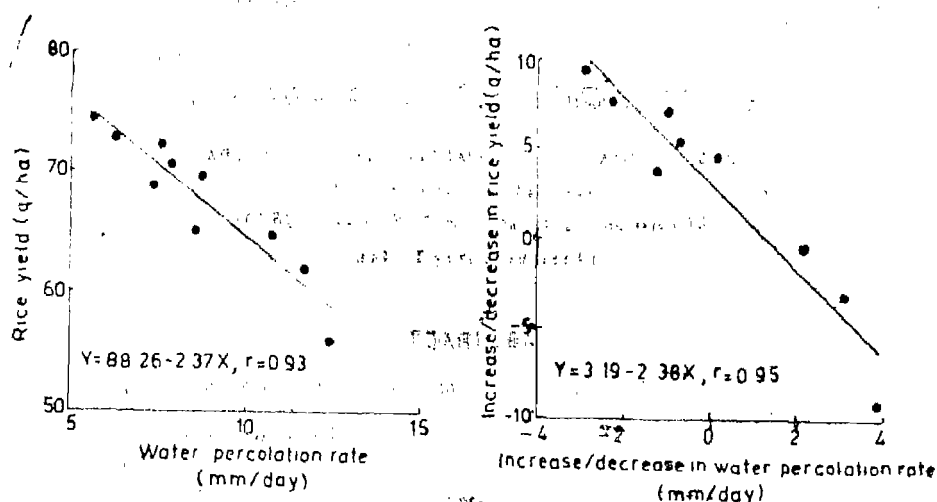


Fig. 1. Relationship between water percolation rate and rice yield.

conditions rather than addition of small amounts of nutrients from FYM or dhaincha to the second crop because full recommended doses of N, P and K were already added to wheat. Beneficial effect of FYM and dhaincha on rice and residual

effect on wheat have also been reported by Meelu and Rekhi (1981) while Tiwari *et al.* (1980) and Bhardwaj *et al.* (1981) reported the similar effect of dhaincha on rice and wheat crops.

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USE OF GROWTH REGULATORS IN RELATION TO NITROGEN FOR ENHANCING QUALITY INDICES OF BITTER GOURD (*MOMORDICA CHARANTIA* L.)

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ABSTRACT

Nitrogen @ 75 kg/ha maximally improved the rind flesh thickness, dry weight, and fruit shape index, and reduced the weight loss 2 and 4 days after storage (DAS), while N @ 50 kg/ha produced the maximum weight of flesh, vitamin C and T. S. S. contents in bitter gourd. Thickness or weight of rind and fruit rind : flesh ratio were recorded maximum with MH 50 mg/l, while maximum thickness or weight of flesh, dry matter, vitamin C and T. S. S. contents were observed with cycocel 250 mg/l. GA₃ 25 mg/l resulted in maximum seeds in fruits, while MH 25 mg/l and ethep 100 mg/l caused maximum weight loss of fruits 2 and 4 DAS, respectively. Interaction of N 75 kg/ha+MH 50 mg/l improved the thickness of rind or flesh and weight of rind, whereas N at 25 kg/ha+MH 50 mg/l was effective in increasing fruit rind : flesh ratio. N 50 kg/ha+cycocel 250 mg/l produced maximum flesh weight, dry matter, vitamin C and T. S. S. contents. N 50 kg/ha+ethep 100 mg/l or GA₃ 25 mg/l improved the shape index and seed content of fruits, respectively.

Bitter gourd (*Momordica charantia* L.) is an important cucurbitaceous crop grown in India. Its fruit quality is amenable to application of nitrogenous fertilizers and plant growth substances. Several workers have reported improvement in the fruit yield (Samdyan *et al.*, 1992) and quality of cucurbits through agronomic practices and the use of plant growth substances (Siyag and Arora, 1988; Arora *et al.*, 1993, 1994). Since the information on these factors either alone or in combination is not available in bitter gourd, the present study was, therefore, undertaken.

MATERIAL AND METHODS

The study on bitter gourd cv. Pusa Domausmi was conducted at Vegetable

Research Farm and Laboratory, CCS Haryana Agricultural University, Hisar, during summer seasons of 1989 and 1990. Soil of experimental field was sandy loam in texture, having pH 8.18, electrical conductivity 0.67 mmhos/cm, organic carbon 0.38%, available P 15.3 kg/ha and K 335 kg/ha. The combinations of three levels of nitrogen (25, 50 and 75 kg/ha) as main plot treatments and two concentrations each of cycocel (100 and 250 mg/l), ethep (50 and 100 mg/l), gibberellic acid (10 and 25 mg/l) and maleic hydrazide (25 and 50 mg/l) including untreated control, thus making a total of nine treatments as sub-plot treatments, were arranged in split-plot design in three replications. Each plot measuring 3 m × 2.7 m accommodated 12

plants in two beds spaced 45 cm apart. The half dose of N (as per treatment) and full dose of P and K were applied at sowing and remaining half dose of N was top dressed in two splits at 25 and 50 days after sowing in both the years. Crop was sown on 15 and 20 March in 1989 and 1990, respectively. Single bed buffers were provided in between two treatments. Aqueous solution of plant growth substances was sprayed twice, i. e. at 2- and 4-true leaf stages of the plants. Tween-20 @ 0.05% was added to solution for its uniform distribution on leaves. The observations on quality parameters were recorded on 10 randomly selected immature marketable fruits from each treatment at second picking. Ascorbic acid and T. S. S. were estimated from the extracted juice (AOAC, 1975). Observations averaged over two years were statistically analysed following the standard procedure.

RESULTS AND DISCUSSION

Rind Weight, Thickness and Ratio with Flesh

Significant differences in rind thickness, its weight and ratio with flesh were recorded due to N (except weight and ratio with flesh), plant growth substances (PGS) and their interaction (Table 1). Maximum rind thickness was recorded with 75 kg N/ha and the least with 25 kg N/ha. MH 50 mg/ha resulted in maximum rind thickness, its weight and ratio with flesh, while these were least with GA₃. The combination of 75 kg N/ha + MH 50 ppm produced maximum thickness and weight of rind/fruit, whereas its ratio with flesh was obtained maximum with 25 kg N/ha + MH 50 mg/l. The least values of

rind thickness and weight with 25 kg N/ha + GA₃ 25 ppm and rind to flesh ratio with 25 kg N/ha + GA₃ 10 mg/l were observed.

Thickness, Weight of Flesh and Dry Matter Content of Fruits

Maximum flesh thickness and dry matter content (DMC) of fruits were observed with 75 kg N/ha and flesh weight with 50 kg N/ha, while least with 25 kg N/ha (Table 1). Among PGS, cycocel 250 mg/l gave maximum weight of flesh thickness and DMC of fruits. A combination of 75 kg N/ha + MH 50 mg/l gave maximum flesh thickness, whereas its weight and DMC of fruits were recorded maximum with 50 kg N/ha + cycocel 250 mg/l. The least values for these characters were obtained with 25 kg N/ha. These results contradicted the findings of Siyag and Arora (1988) who obtained maximum DMC of fruits with 25 kg N/ha + 40 kg P/ha in summer crop of sponge gourd.

Seed Content of Fruits

Reduced seed content of fruits is a desirable character. Significant differences in number of seeds/fruit were recorded due to PGS and the interaction effect of N × PGS (Table 2). GA₃ at 25 mg/l produced maximum while ethrel 50 mg/l gave the least seed content which confirmed the findings of Arora and Partap (1988) in pumpkin. A treatment combination of 50 kg N/ha + GA₃ 25 mg/l resulted in maximum seed content, while 50 kg N/ha with cycocel 250 mg/l had the least.

TABLE 1

Effect of nitrogen (N) and plant growth substances (PGS) on the thickness and weight of rind and flesh, rind and flesh ratio and dry matter content in bitter gourd cv. Pusa Domausmi

Plant growth substance (mg/l)	Nitrogen levels (kg/ha)				Average	Nitrogen levels (kg/ha)				Average
	25	50	75			25	50	75		
Thickness of rind (cm)						Weight of rind per fruit (g)				
Control (untreated)	0.52	0.55	0.57	0.55		35.8	38.9	38.2	37.6	
CCC 100	0.48	0.49	0.52	0.49		37.1	38.8	38.3	38.1	
250	0.52	0.55	0.55	0.54		37.8	40.8	39.8	39.5	
Ethrel 50	0.44	0.53	0.55	0.51		35.8	37.0	37.8	36.9	
100	0.43	0.49	0.52	0.48		36.7	37.4	39.3	38.4	
GA ₃ 10	0.47	0.51	0.53	0.50		31.7	31.7	32.3	31.9	
25	0.41	0.48	0.48	0.46		30.6	31.5	31.7	31.3	
MH 25	0.51	0.57	0.59	0.56		41.9	42.9	43.7	42.8	
50	0.59	0.59	0.61	0.60		43.1	44.1	44.7	44.0	
Average	0.48	0.53	0.55			36.7	38.2	38.4		
C. D. at 5%	N=0.06 PGS=0.09 N×PGS=0.13					N=NS PGS=2.1 N×PGS=3.6				
Thickness of fruit flesh (cm)						Weight of flesh (g)				
Control (untreated)	1.94	2.06	2.18	2.06		10.1	11.1	11.2	10.8	
CCC 100	2.42	2.85	2.81	2.69		13.2	15.2	14.4	14.3	
250	2.59	3.16	3.21	2.99		14.7	16.5	14.5	15.3	
Ethrel 50	2.21	2.63	2.57	2.47		10.8	11.8	12.1	11.6	
100	2.38	2.82	2.84	2.68		12.1	14.6	12.7	13.1	
GA ₃ 10	1.97	2.30	2.36	2.21		13.6	12.6	12.4	12.9	
25	1.97	2.25	2.30	2.17		12.1	12.3	12.1	12.2	
MH 25	2.42	2.93	2.94	2.76		12.7	12.4	12.8	12.6	
50	2.59	2.98	3.33	2.97		10.9	11.4	11.6	11.3	
Average	2.27	2.67	2.72			12.2	13.1	12.6		
C. D. at 5%	N=0.36 PGS=0.74 N×PGS=1.06					N=NS PGS=2.1 N×PGS=3.2				
Fruit rind and flesh ratio						Dry matter content (%)				
Control (untreated)	3.7	3.6	3.8	3.7		9.9	11.1	12.4	11.1	
CCC 100	2.8	2.6	2.7	2.7		12.7	15.7	15.1	14.5	
250	2.6	2.4	2.8	2.6		14.4	18.5	17.2	16.7	
Ethrel 50	3.3	3.1	3.2	3.2		11.6	13.6	13.2	12.8	
100	3.0	2.6	3.3	3.0		13.4	14.5	15.2	14.4	
GA ₃ 10	2.3	2.5	2.6	2.5		11.4	12.1	14.2	12.6	
25	2.5	2.6	2.8	2.6		12.8	12.7	16.3	13.9	
MH 25	3.4	3.5	3.3	3.3		13.0	13.8	14.2	13.7	
50	4.3	3.4	3.9	3.9		14.9	16.5	15.7	15.7	
Average	3.1	3.0	3.1			12.7	14.3	14.8	13.9	
C. D. at 5%	N=NS PGS=1.2 N×PGS=1.8					N=0.5 PGS=0.9 N×PGS=1.6				

GROWTH REGULATORS FOR QUALITY INDICES OF BITTER GOURD

TABLE 2

Effect of nitrogen (N) and plant growth substances (PGS) on the seeds/fruit, ascorbic acid and total soluble solid contents, fruit shape index and weight loss in bitter gourd cv. Pusa Domauemi

Plant growth substance (mg/l)	Nitrogen levels (kg/ha)			Average	Nitrogen levels (kg/ha)			Average
	25	50	75		25	50	75	
Number of seeds/fruit					Ascorbic acid (mg/100 g edible portion)			
Control (untreated)	22.7	23.1	25.0	23.6	38.3	42.9	42.8	41.3
CCC 100	22.2	20.4	20.4	21.0	39.8	43.1	41.1	41.3
250	21.1	18.3	21.6	19.7	43.6	48.3	41.9	44.6
Ethrel 50	18.2	17.4	18.4	17.3	40.0	40.0	39.8	40.0
100	19.7	20.2	18.0	19.3	43.1	45.2	44.5	44.3
GA ₃ 10	23.2	20.8	18.6	20.9	36.8	37.9	37.6	37.4
25	24.7	25.4	21.7	23.9	39.2	40.9	40.3	40.1
MH 25	23.6	25.1	20.8	23.2	39.0	40.1	40.0	39.7
50	22.4	23.0	21.1	22.2	39.4	40.0	39.5	39.6
Average	22.0	21.3	20.4		39.9	43.7	40.9	
C. D. at 5%	N=NS PGS=2.8 N×PGS=4.8				N=2.4 PGS=3.6 N×PGS=4.3			
Total soluble solids (%)					Fruit shape index			
Control (untreated)	4.0	4.1	3.7	3.9	0.13	0.11	0.10	0.11
CCC 100	4.5	4.8	4.7	4.7	0.11	0.09	0.08	0.09
250	4.8	6.5	4.9	5.1	0.11	0.09	0.10	0.10
Ethrel 50	3.8	4.3	4.6	4.2	0.15	0.09	0.11	0.12
100	3.8	4.7	4.8	4.4	0.11	0.07	0.10	0.09
GA ₃ 10	4.1	4.9	4.4	4.5	0.16	0.14	0.12	0.14
25	4.6	4.9	4.7	4.7	0.12	0.12	0.11	0.12
MH 25	3.8	4.3	4.3	4.1	0.10	0.09	0.10	0.10
50	3.8	3.6	4.1	3.8	0.09	0.09	0.10	0.09
Average	4.1	4.6	4.5		0.12	0.10	0.10	
C. D. at 5%	N=0.2 PGS=0.3 N×PGS=0.4				N=0.01 PGS=0.02 N×PGS=0.03			
Weight loss (%) after two days of storage					Weight loss (%) after four days of storage			
Control (untreated)	21.1	23.1	23.1	22.4	38.5	37.7	40.6	38.3
CCC 100	17.3	17.7	18.9	18.0	21.5	31.7	34.7	29.3
250	15.9	17.1	18.6	17.2	31.7	32.2	34.4	32.8
Ethrel 50	20.4	22.5	23.6	22.2	37.3	38.3	38.9	38.2
100	20.4	22.0	24.2	22.2	39.0	40.0	41.8	40.3
GA ₃ 10	16.2	18.0	19.3	17.8	31.1	31.2	34.3	32.2
25	16.1	17.3	19.1	17.5	30.1	31.2	35.2	32.2
MH 25	21.7	23.0	24.3	23.0	36.9	36.1	38.8	37.3
50	20.8	21.8	23.5	22.0	36.2	38.0	38.6	37.6
Average	18.9	20.3	21.6		34.6	35.2	37.5	
C. D. at 5%	N=1.6 PGS=2.0 N×PGS=3.2				N=2.2 PGS=1.8 N×PGS=3.2			

Ascorbic Acid and T. S. S. Contents

Vitamin C and T. S. S. contents of fruits are desirable which were maximum with 50 kg N/ha and least with 25 kg N/ha (Table 2). Cycocel 250 mg/l resulted in maximum vitamin C and T. S. S. contents while lowest were noted with GA₃ 10 mg/l and MH 50 mg/l, respectively. The interaction effect indicated that 50 kg N/ha+cycocel 250 mg/l gave maximum vitamin C and T. S. S. contents while least were with 25 kg N/ha+GA₃ 10 mg/l and 75 kg N/ha (unsprayed control), respectively. However, Arora *et al.* (1994) reported maximum vitamin C and T. S. S. contents of ridge gourd fruits with 50 kg N/ha+ethephon 100 mg/l.

Fruit Shape Index

Lesser the index value, better is the fruit shape. Fruit shape was improved with 50 and 75 kg N/ha. Cycocel 100 mg/l, ethrel 100 mg/l and MH 50 mg/l

also improved the fruit shape, while GA₃ 10 mg/l distorted the fruit shape considerably. The interaction effects showed that 50 kg N/ha+ethrel 100 mg/l improved, while 25 kg N/ha+GA₃ 10 mg/l distorted the fruit shape.

Post-harvest Weight Loss

Data in Table 2 indicate that 75 kg N/ha resulted in maximum while 25 kg N/ha the least loss of fruit weight after 2 and 4 days of storage, respectively. Cycocel 250 mg/l reduced the fruit weight loss significantly, while it was maximum with ethrel 100 mg/l. The treatment combination of 75 kg N/ha+MH 25 mg/l and 75 kg N/ha+ethrel 100 mg/l caused greater weight loss, while minimum was recorded with 25 kg N/ha+cycocel. Maximum weight loss with higher levels of nitrogen was due to increased fruit succulency at harvest stage (Nilsson, 1980).

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SCREENING OF VARIOUS SUBSTRATES FOR MUSHROOM SPAWN PREPARATION

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ABSTRACT

Studies were conducted to evaluate different agro-wastes for their utility under mushroom production technology. Out of different substrates studied, gram husk, sugarcane baggase and wheat straw gave encouraging results during spawn preparations and these could replace the cereal grains which contribute towards the cost of spawn. Among other combinations, sugarcane baggase with paddy husk, paddy straw and saw dust proved better and produced 14.80, 11.86 and 12.93 kg mushroom yield per 100 kg compost, respectively.

Mushroom production is a promising and economically viable enterprise capable of recycling agricultural wastes and generating new employment opportunities for the unemployed. Besides, mushroom cultivation which does not need much land, can augment income of the rural masses. The organic wastes used as nutrients for the cultivation of mushrooms are in abundance. In addition, use of agro-wastes for mushroom cultivation, will also help in reducing the environmental pollution vis-a-vis health hazards. Not much work has been done on the utilization of agricultural and industrial byproducts for the production of *Agaricus* spawn. Keeping this in view, the studies were conducted to find out whether some agricultural and industrial waste products could be utilized for spawn production.

MATERIAL AND METHODS

The spawn for the white button mushroom cultivation was prepared using various agro-wastes, viz. paddy husk, paddy straw, wheat straw, saw dust, cotton waste, gram husk, poultry manure, sugarcane baggase, and grains of wheat and bajra. The waste substrates were soaked in water (1.5 times of ingredient) for 12 h. Excess water was drained out. The wetted/boiled substrates were mixed with calcium carbonate (6% w/w) separately. The mixtures were filled in polypropylene bags (8"×12"). For each treatment there were three replications. Each bag was filled with 1 kg substrate. The bags were ringed, plugged with non-absorbent cotton and sterilized at 20 lb pressure per square inch for 2 h. The sterilized bags were inoculated with master spawn of *Agaricus bisporus* by

transferring 10 g/container. Inoculated bags were incubated at $25^{\circ}\pm 2^{\circ}\text{C}$ and periodical observations were made to record the fungal growth and development on different substrates during spawn preparation. Spawning, with different spawn preparations, was done by thorough mixing with compost. The mushroom yield of each treatment was noted and calculated per 100 kg of compost.

RESULTS AND DISCUSSION

The data on growth and development of mycelium of *A. bisporus* on different substrates revealed that boiled wheat grains supported the maximum growth of *A. bisporus*. Growth of fungal mycelium on bajra grains was quite slow in the starting but it picked up later on at a faster rate. Amongst the other substrates gram husk, sugarcane baggase, wheat straw, poultry manure, cotton waste and saw dust, supported better mycelial growth as compared to paddy husk and paddy straw. Cotton waste and saw dust were at par with each other. Mycelial growth was the poorest on paddy husk. As evident from the data in Table 1, gram husk and sugarcane baggase stimulated early and fast growth of the fungus which covered the substrates in one week after inoculation. Out of different combinations of substrates, wheat straw+gram husk, followed by sugarcane baggase and paddy husk supported the maximum growth of *A. bisporus*.

The suitability of the various substrates for spawn production was

further confirmed by conducting the cropping experiments. Evaluation of different spawn sources revealed that some of the straws/byproducts were superior to the cereal grains in supporting mushroom yield. Spawn produced on gram husk, sugarcane baggase and sugarcane baggase+paddy husk gave significantly higher mushroom yield of 15.20, 14.86 and 14.80 kg per 100 kg of compost, respectively (Table 2). Spawn prepared with sugarcane baggase+saw dust, poultry manure, wheat grain and paddy straw plus sugarcane baggase also gave encouraging results of mushroom as they produced 12.93, 12.80, 12.73 and 11.86 kg mushroom/100 kg of compost, respectively. The other treatments, viz. wheat straw, bajra grain, wheat straw+gram husk and cotton waste had intermediate rating.

Bisht and Harsh (1984) reported that boiled wheat grains supplemented with tea leaves proved to be the best for preparing spawn of *A. bisporus*. Among agro-wastes, gram husk, sugarcane baggase and wheat straw were much superior to paddy husk and paddy straw with respect to mycelial running. When gram husk was mixed with inferior substrate like wheat straw the fertility of mixture was improved which gave comparable results to those obtained when gram husk alone was used. Similar was the case when sugarcane baggase mixed with paddy husk was used, resulting in significant improvement in the fertility of mixture compared to when either was used alone. Conversely, although sugarcane baggase and wheat straw when used alone gave good mycelial growth, their combination

SUBSTRATES FOR MUSHROOM SPAWN PREPARATION

TABLE 1
Growth of *A. bisporus* in different spawn substrates

Substrate	Mycelial growth at 6 days interval							
	6	12	18	24	30	36	42	48
Wheat grain	++	++	+++	++++	++++	++++	++++	++++
Bajra grain	+	+	+	++	++++	++++	++++	++++
Gram husk	++	+++	+++	+++	+++	+++	++++	++++
Sugarcane baggase	++	++	++	++	++	+++	+++	++++
Paddy husk	+	+	+	+	+	+	+	++
Saw dust	+	+	++	++	++	++	+++	++++
Cotton waste	+	+	++	++	++	++	+++	++++
Poultry manure	+	+	++	++	+++	+++	++++	++++
Paddy straw	+	+	++	++	++	++	+++	+++
Wheat straw	+	++	++	+++	+++	+++	+++	+++
Gram husk+	+	+	+	+	++	++	++	++
Saw dust								
Gram husk+	+	+	+	+	+	++	++	++
Paddy husk								
Gram husk+	+	++	+++	+++	+++	++++	++++	++++
Wheat straw								
Sugarcane baggase+	+++	+++	+++	+++	+++	+++	+++	+++
Paddy husk								
Sugarcane baggase+	+	++	++	++	++	++	++	+++
Paddy straw								
Sugarcane baggase+	++	++	++	++	++	++	++	++
Wheat straw								
Sugarcane baggase+	+	+	+	++	++	++	++	+++
Saw dust								
Cotton waste+	+	+	++	++	++	++	+++	+++
Saw dust								

Scale :

- + — Slow mycelial growth
- ++ — Medium mycelial growth
- +++ — Good mycelial growth
- ++++ — Very good mycelial growth.

seemed to be incompatible. Perusal of literature revealed that little work has been done on use of different combinations of agro-wastes for spawn production. However, in some combinations of agro-wastes with the cereals the mycelium manifested early better

growth, while other combinations delayed the completion of mycelial growth (Kumar and Chandra, 1988; Suman *et al.*, 1988). Thus, replacement of the cereal grains by different agro-wastes and their combination will substantially reduce the cost of spawn production.

TABLE 2
Effect of different spawn sources on mushroom yield

Spawn source	Weight of fresh mushroom per 100 kg of compost* (kg)
Wheat grain	12.73
Bajra grain	10.80
Sugarcane baggase	14.86
Saw dust	8.13
Poultry manure	12.80
Gram husk	15.20
Wheat straw	10.93
Paddy husk	8.28
Cotton waste	9.25
Sugarcane baggase+Saw dust	12.93
Sugarcane baggase+Paddy straw	11.86
Sugarcane baggase+Paddy husk	14.80
Gram husk+Saw dust	9.20
Gram husk+Wheat straw	10.74
C. D. at 5 %	1.09

*Average of three replications.

Studies on effect of different spawn sources on mushroom yield revealed that agro-wastes could very well replace cereal grains for spawn production. Some of the agro-wastes like gram husk, sugarcane baggase, and sugarcane baggase+paddy husk were even significantly better than the wheat and bajra grains. Taking into account the economics of spawn production on different substrates, some of the treatments proved much cheaper as well as effective as compared to that having wheat or bajra as

substrates. The present study on use of agro-wastes for spawn production is first of its kind and no information is available; although some information is available on mixture of grains with agro-wastes (Kumar and Chandra, 1988; Suman *et al.*, 1988). As evident from preceding discussion on mycelial growth with respect to spawn source and yield of mushroom, substitution of agro-wastes for cereals will considerably reduce the cost of spawn production because of their cheapness and easy availability.

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PHYSICAL AND CHEMICAL PARAMETERS AS AFFECTED BY POST-HARVEST TREATMENT OF DIFFERENT CHEMICALS ON THE SHELF-LIFE OF GOLA BER (*ZIZYPHUS MAURITIANA* LAMK.) FRUITS

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ABSTRACT

The studies were conducted with different chemicals to enhance the shelf-life of ber cv. Gola fruits. The fruits were stored at room temperature after giving the treatments. KMnO_4 was found effective in maintaining the highest ascorbic acid, while highest organoleptic rating was recorded with Kinetin+Captan and GA_3 +Captan.

Ber known as Indian plum is grown in arid and sub-tropical regions of India. Among various fruit crops, ber cultivation requires the least inputs and care. It can thrive well under the adverse conditions of salinity and drought. However, it has a short shelf-life and, therefore, cannot be stored for a longer period. Several post-harvest treatments have been reported to increase the shelf-life of fruits (Gupta *et al.*, 1980). Therefore, attempts were made to find out effective chemical/fungicide application to increase the shelf-life of ber fruits.

MATERIAL AND METHODS

The present studies were carried out during 1992 in the Department of Horticulture, CCS Haryana Agricultural University, Hisar. The uniform healthy fruits of Gola ber at colour turning stage of maturity were harvested, sorted out, and

dipped in different solutions, viz. 1000 ppm KMnO_4 , 25 ppm Kinetin, 100 ppm GA_3 , 0.1% Captan, 1000 ppm KMnO_4 +0.1% Captan, 25 ppm Kinetin+0.1% Captan, 100 ppm GA_3 +0.1% Captan and control. The treated fruits, after surface drying in shade, were packed in the perforated wooden boxes using paper cuttings as the cushioning material. Four boxes each containing 2.5 kg fruits were kept for each treatment and stored at room temperature. The observations on ascorbic acid, fruit firmness, specific gravity and organoleptic rating were recorded on alternate days. The analysis of ascorbic acid was done as per method described in AOAC (1980). Fruit firmness was measured with the help of pressure tester and specific gravity of fruits was recorded by water displacement method. The organoleptic rating was done by a panel of three judges on the basis of taste and external appearance of fruits.

TABLE 1

Effect of post-harvest treatments of various chemicals on ascorbic acid (mg/100 g fruit pulp) in ber fruits cv. Gola during storage at room temperature

Treatment	Days of storage								Mean
	0	2	4	6	8	10	12	14	
KMnO ₄ (1000 ppm)	74.82	83.10	85.20	87.60	83.30	57.10	56.30	32.70	65.02
Kinetin (25 ppm)	74.82	79.30	83.20	72.30	61.70	55.40	53.50	29.10	63.66
GA ₃ (100 ppm)	74.82	76.80	87.40	69.30	63.20	57.10	50.10	31.30	63.75
Captan (0.1%)	74.82	67.60	62.30	55.40	50.10	48.20	36.70	36.10	53.90
KMnO ₄ + Captan (1000 ppm + 0.1%)	74.82	73.70	89.20	67.40	62.30	55.40	52.30	30.10	60.85
Kinetin + Captan (25 ppm + 0.1%)	74.82	74.10	72.70	69.30	59.70	58.80	47.40	27.30	60.49
GA ₃ + Captan (100 ppm + 0.1%)	74.82	72.00	71.60	66.90	57.30	52.40	44.80	25.40	58.13
Control	74.82	78.20	89.10	68.20	64.10	59.40	54.70	29.80	64.79
Mean	74.82	75.61	77.58	67.05	60.20	55.45	59.45	30.22	

C. D. at 5%

Treatments	=	6.90
Days	=	7.43
Treatments × Days	=	11.46

TABLE 2

Effect of post-harvest treatments of various chemicals on fruit firmness (kg/cm²) of ber fruits cv. Gola during storage at room temperature

Treatment	Days of storage								Mean
	0	2	4	6	8	10	12	14	
KMnO ₄ (1000 ppm)	8.00	7.10	7.00	6.80	6.40	6.00	5.70	5.40	6.55
Kinetin (25 ppm)	8.00	7.30	7.10	7.00	6.70	6.10	5.80	5.60	6.70
GA ₃ (100 ppm)	8.00	7.80	7.70	6.90	7.50	6.30	6.10	6.00	6.90
Captan (0.1%)	8.00	7.00	6.80	6.50	6.40	5.80	5.00	4.80	6.28
KMnO ₄ + Captan (1000 ppm + 0.1%)	8.00	7.50	7.30	6.80	6.70	6.10	5.90	5.70	6.75
Kinetin + Captan (25 ppm + 0.1%)	8.00	7.60	7.40	6.70	6.60	6.20	6.00	5.80	6.78
GA ₃ + Captan (100 ppm + 0.1%)	8.00	7.90	7.70	6.80	6.60	6.40	6.20	6.10	6.96
Control	8.00	7.60	7.30	7.00	6.60	6.10	5.30	4.20	6.51
Mean	8.00	7.47	7.28	6.81	6.56	6.12	5.75	5.45	

C. D. at 5%

Treatments	=	NS
Days	=	0.02
Treatments × Days	=	NS

SHELF-LIFE OF GOLA BER

TABLE 3

Effect of post-harvest treatments of various chemicals on specific gravity (g/cc) of
ber fruits cv. Gola during storage at room temperature

Treatment	Days of storage								Mean
	0	2	4	6	8	10	12	14	
KMnO ₄ (1000 ppm)	0.89	0.99	0.94	0.93	0.91	0.87	0.85	0.82	0.91
Kinetin (25 ppm)	1.00	0.99	0.87	0.95	0.92	0.81	0.87	0.84	0.93
GA ₃ (100 ppm)	1.00	0.98	0.87	0.95	0.92	0.89	0.88	0.85	0.93
Captan (0.1%)	0.98	0.97	0.95	0.93	0.90	0.87	0.86	0.83	0.91
KMnO ₄ + Captan (1000 ppm + 0.1%)	1.02	0.99	0.97	0.96	0.92	0.89	0.87	0.84	0.93
Kinetin + Captan (25 ppm + 0.1%)	1.07	1.01	0.89	0.95	0.92	0.91	0.89	0.88	0.95
GA ₃ + Captan (100 ppm + 0.1%)	1.09	1.08	0.98	0.97	0.95	0.93	0.92	0.90	0.97
Control	1.02	0.98	0.87	0.91	0.86	0.84	0.80	0.70	0.88
Mean	1.02	0.99	0.97	0.94	0.91	0.88	0.87	0.83	

C. D. at 5%

Treatments	=	NS
Days	=	0.02
Treatments × Days	=	NS

TABLE 4

Effect of post-harvest treatments of various chemicals on organoleptic rating
(score) of ber fruits cv. Gola during storage at room temperature

Treatment	Days of storage								Mean
	0	2	4	6	8	10	12	14	
KMnO ₄ (1000 ppm)	9.00	8.70	8.50	8.10	7.90	7.80	7.40	6.80	8.02
Kinetin (25 ppm)	9.00	8.40	8.30	8.00	7.60	7.10	6.60	6.40	7.67
GA ₃ (100 ppm)	9.00	8.30	8.20	8.00	7.80	7.70	7.10	6.90	7.87
Captan (0.1%)	9.00	8.20	8.00	7.80	7.30	7.00	6.70	6.10	7.51
KMnO ₄ + Captan (1000 ppm + 0.1%)	9.00	8.60	8.50	8.30	8.00	7.80	7.20	7.10	8.08
Kinetin + Captan (25 ppm + 0.1%)	9.00	8.80	8.60	8.30	8.10	7.70	7.30	7.00	8.10
GA ₃ + Captan (100 ppm + 0.1%)	9.00	8.90	8.50	8.10	8.00	7.60	7.50	7.20	8.10
Control	9.00	8.30	8.20	7.70	7.10	6.30	5.90	5.70	7.27
Mean	9.00	8.52	8.35	8.03	7.72	7.37	6.96	6.65	

C. D. at 5%

Treatments	=	0.46
Days	=	0.51
Treatments × Days	=	0.30

RESULTS AND DISCUSSION

The different post-harvest treatments significantly influenced the ascorbic acid content of ber fruits and highest ascorbic acid content (65.02 mg/100 g pulp) was recorded with the application of KMnO_4 which was significantly higher than Captan and KMnO_4 +Kinetin, GA_3 and control (Table 1).

The increase in ascorbic acid might be due to continued activity of enzymes responsible for synthesis of ascorbic acid. The loss in ascorbic acid on prolonged storage could be attributed to the rapid conversion of ascorbic acid into dehydro-ascorbic acid in the presence of ascorbinase enzyme. These results corroborate the findings of Singh (1985) and Gupta and Mehta (1987).

A perusal of data in Table 2 reveals that various treatments did not result in any significant change with respect to fruit firmness. However, significant decrease in fruit pressure was observed as the storage period increased. Decrease in fruit firmness during storage is possible

due to change in cell wall polysaccharides and decrease in cell wall uronic acid.

The specific gravity of fruits was not affected significantly by various treatments, however, it was observed that specific gravity of the fruits consistently decreased throughout the storage period (Table 3). These findings are in agreement with those obtained by Pandey *et al.* (1973) in mango and Singh (1985) in guava.

Organoleptic rating decreased gradually with storage. The highest organoleptic rating (8.10) was recorded from fruits treated with Kinetin+Captan and GA_3 + Captan and lowest rating was observed in control (7.27) (Table 4). These observations are in conformity with the earlier report of Singh (1987).

On the basis of results obtained, it can be concluded that for preserving or retaining the good quality of ber fruits under stored conditions, these should be treated with fungicide (Captan) in combination with growth regulators (Kinetin or GA_3) or KMnO_4 (ethylene absorbent). Fruits should be washed before using them.

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HYDROLYSIS OF AMMONIUM POLYPHOSPHATE AND TETRAPOTASSIUM PYROPHOSPHATE IN CALCAREOUS SOILS

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ABSTRACT

Hydrolysis of ammonium polyphosphate (APP) and tetrapotassium pyrophosphate (TPP) was studied at $25^{\circ}\pm 2^{\circ}\text{C}$ and moisture content of 60% saturation in an Aquick Ustochrept, previously treated with 0, 1, 2, 4, 6 and 8 per cent CaCO_3 . Hydrolysis did not reach to completion during 112 days of experiment and 7.7 to 24.0 per cent of the applied condensed phosphates persisted in unhydrolysed form, showing increasing trend with CaCO_3 content. Hydrolysis of APP was more rapid than that of TPP and decreased progressively with increasing amount of CaCO_3 in soil. Hydrolysis of both the condensed phosphates was satisfactorily described by two simultaneous first order kinetic rate equations, the rate constant of first reaction ' k_1 ' was 23.56 to 37.67 fold for APP, 11.97 to 18.66 fold for TPP than that of second reaction ' k_2 '. The depressing effect of CaCO_3 was more marked and consistent on k_2 than k_1 .

Recent development of granular and liquid ammonium polyphosphates in India has stimulated interest in the research on their behaviour in soils. Ammonium polyphosphates (APP) are the ammonium salts of condensed phosphoric acid (Super phosphoric acid) having the general formula $\text{H}_{2n+1}\text{P}_n\text{O}_{3n+1}$. Evidences indicate that for making effective as phosphate fertilizer, pyro and polyphosphates (condensed phosphates) must be hydrolysed to orthophosphate at fairly rapid rates in soil (Sutton and Larsen, 1964; Sutton *et al.*, 1966). These fertilizers were found inferior to orthophosphates only when the rate of hydrolysis was slow. The hydrolysis of condensed phosphates is the result of

chemical and biological reactions (Gilliam and Sample, 1968; Busman and Tabatabai, 1985). Therefore, chemical factors which influence the activity of the enzyme or solubility of the substrate in soil may likely affect the hydrolysis. As CaCO_3 is the major sink for fixed phosphate in soils of north-west India (Tek Chand and Tomar, 1993), the present investigation was undertaken to study the effect of CaCO_3 levels on the hydrolysis of APP and TPP.

MATERIAL AND METHODS

Sample of granular APP was received from Rashtriya Chemicals and Fertilizers. It contained 12% N, 19.7% P as ortho-

phosphate, and 5.8% P as condensed phosphate. TPP (AR) contained 1.1% P as orthophosphate and 17.7% P as pyrophosphate.

A bulk surface (0-15 cm) sample of an Aquick Ustochrept was collected from Regional Rice Research Station, Kaul (Haryana). The sample had 7.8 pH, 0.44 d Sm^{-1} electrical conductivity, 0.84% organic carbon, 47.0% clay and $21.6 \mu\text{g P/g}$ in available form. Calcium carbonate (AR) was added to soil @ 0, 1, 2, 4, 6 and 8 per cent on dry weight basis and alternate wetting and drying cycles were given for six months. Rates of hydrolysis were determined in 5 g sample of air dried soil placed in 25 ml test tubes. Two ml solution of APP or TPP containing 1000 mg P/l was added in each test tube to add $400 \mu\text{g P/g}$ soil and 94.7 and $376.6 \mu\text{g P/g}$ in condensed form, respectively. Incubation was done for 112 days at $25^\circ \pm 2^\circ\text{C}$ and moisture content at 60% saturation. Three samples of each treatment were removed at 1, 3, 7, 14, 21, 28, 56, 84 and 112 days of incubation to determine the amount of condensed phosphates hydrolysed by the method of Gilliam and Sample (1968). The extraction was accomplished by thoroughly mixing the soil with about 10 ml of 0.1 N H_2SO_4 and transferring the mixture to a Buechner funnel. The soil was leached with small portions of 0.1 N H_2SO_4 until a total of 65 ml had been used. The soil sample was then leached with 125 ml of 1 N H_2SO_4 , keeping the two filtrates separate, again using several small aliquots. The flow rate for the leaching was adjusted to be completed in about one hour. The two leachates were combined in a 250 ml

flask, treated with charcoal to adsorb the organic matter, adjusted to volume and filtered.

The determination of phosphorus was made immediately following extraction, using a vanadomolybdophosphoric acid method. The procedure is specific for orthophosphate; hence, pyrophosphate is not detected until after being hydrolyzed. Pyrophosphate was hydrolyzed in the vanadomolybdophosphoric acid solution used for the orthophosphate determination by placing it on a steam bath for one hour. The difference between the analyses before and after hydrolysis was taken as the pyrophosphate content of the sample. Before calculation of the percentage hydrolysis of pyrophosphate which occurred in the soil, the amounts of orthophosphate and total phosphorus extracted were corrected by subtracting from these values the amounts of orthophosphate extracted from soils to which no phosphorus had been added.

Kinetic Model

The kinetics of hydrolysis of condensed phosphates was satisfactorily described by two parallel first order reactions producing a common product, orthophosphate.

The rate equations are :

$$\frac{dA}{dt} = k_1 A \quad \dots\dots\dots (1)$$

$$\frac{dB}{dt} = k_2 B \quad \dots\dots\dots (2)$$

Integrating equations (1) and (2), we get

$$A_t = A_0 e^{-k_1 t} \quad \dots\dots\dots (3)$$

$$B_t = B_0 e^{-k_2 t}$$

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Where, A_t and B_t are the phosphorus concentrations of component A and B at time 't' and A_0 and B_0 are the respective concentrations of A and B at 't'=0.

Concentration of condensed phosphate at any time 't' (C_t) may be given by :

$$C_t = A_t + B_t \quad \dots\dots\dots(5)$$

By utilizing equations (3) and (4), equation (5) may be written as :

$$C_t = A_0 e^{-k_1 t} + B_0 e^{-k_2 t} \quad \dots\dots\dots(6)$$

If it is postulated that component A is more and B is less labile fraction (Sorbed P) of condensed phosphate, hydrolyzing relatively at fast and slow rates, respectively. If polyphosphate in soil is assumed to consist two components, having same reaction rates, i. e. $k_1 = k_2$, a plot of log C vs. t would be linear. If on the other hand, two components of substrate have different reaction rates (i. e. $k_1 \neq k_2$), the above plot would be a

curve instead. However, after some time, the curve would be linear, because the more labile component (A) of the substrate has disappeared and the expression for C_t becomes :

$$C_t = B_t = B_0 e^{-k_2 t} \quad \dots\dots\dots(7)$$

Thus, from the intercept and slope of the regression between log C and t of equation (7) B_0 and K_2 may be determined. Subsequently concentration of B may be determined at any desired time. With these estimations A may be determined through equation (5). The intercept and slope of regression between log A and t would then yield the values of A_0 and K_1 , respectively. This model is sometimes referred to as double exponential model (Andren and Paustian, 1987).

RESULTS AND DISCUSSION

Hydrolysis of both the condensed phosphates progressively decreased with increasing levels of CaCO_3 (Table 1),

TABLE 1
Effect of CaCO_3 on hydrolysis of condensed phosphate (% of added)

CaCO_3 (%)	Time (days)								
	1	3	7	14	21	28	56	84	112
APP									
0	22.2	41.7	69.6	76.0	80.3	84.8	87.3	89.8	90.6
1	16.3	36.3	66.3	72.5	78.0	81.3	83.7	86.0	87.5
2	14.6	33.7	62.0	71.1	76.0	78.0	80.5	83.0	85.0
4	12.5	31.0	56.3	64.1	70.1	76.3	79.0	81.5	83.0
6	10.0	26.6	52.6	59.3	67.6	72.6	76.0	78.0	80.8
8	10.0	25.8	46.0	56.0	63.0	67.5	71.3	74.8	76.0
TPP									
0	20.0	37.7	61.7	66.0	76.0	86.6	88.9	91.6	92.3
1	19.7	37.3	48.3	62.7	72.7	83.7	87.7	90.0	90.9
2	16.3	34.0	45.0	60.0	69.3	81.3	86.6	87.7	88.7
4	16.0	32.7	43.0	58.0	67.3	77.0	83.3	84.0	86.3
6	11.7	29.0	39.7	65.7	63.0	72.3	78.3	81.7	83.0
8	10.3	28.0	38.3	62.0	69.3	88.6	74.3	78.0	80.3

owing to the decrease in the solubility of the applied condensed phosphate at higher levels of CaCO_3 (Gautam, 1994). In non-calcareous soil (0% CaCO_3), 22.20, 9.75, 6.98, 0.77 and 0.79 per cent of the applied APP was hydrolyzed per day at 1, 3, 7, 14 and 21 days of incubation, respectively in contrast to 10.00, 7.90, 4.80, 1.43 and 1.14 per cent at 8% CaCO_3 . The corresponding values of hydrolysis of TPP were 20.00, 8.85, 3.50, 1.90 and 1.43 per cent per day at 0% and 10.30, 8.85, 2.58, 1.98 and 1.04 per cent per day at 8% CaCO_3 . Dick and Tabatabai (1987) reported that soil

properties which increased the sorption of condensed phosphates in soil suppressed their hydrolysis.

Hydrolysis of APP was more rapid than of TPP in the first week. The soil had very high P fixing capacity owing to high clay content and CaCO_3 , which increased the fixation of APP to a greater extent than that of TPP. This was because APP contained 76% P as orthophosphate, which was preferentially adsorbed over its condensed phosphate fraction. This resulted in greater availability of condensed fraction to micro-

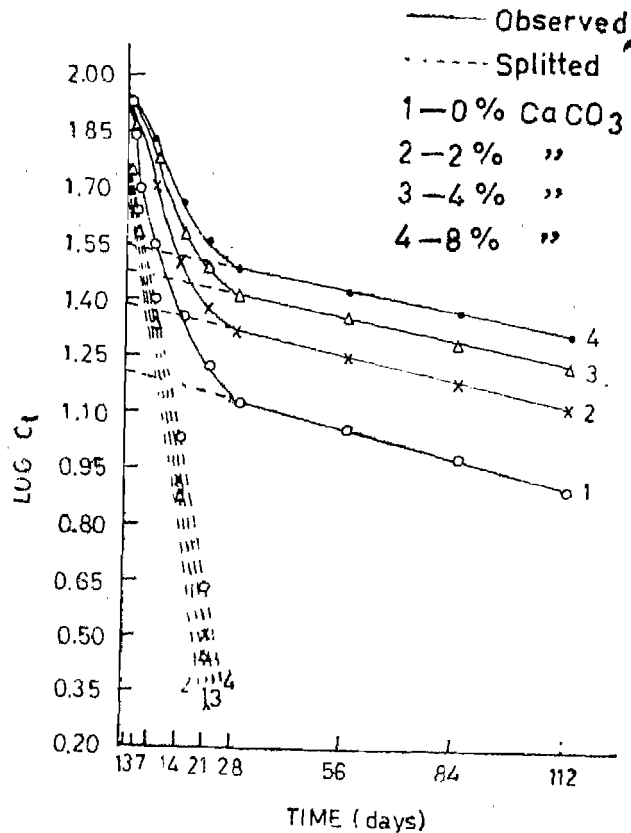


Fig. 1. Effect of CaCO_3 on the hydrolysis of APP.

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organisms and more rapid hydrolysis of APP than of TPP. Orthophosphate is known to inhibit phosphatase activity and could also affect equilibrium relationships in chemical hydrolysis of polyphosphate (Kulaev, 1979; Dick and Tabatabai, 1987). Nevertheless, in present case orthophosphate increased the hydrolysis due to high P fixing capacity of the soil.

Hydrolysis of condensed phosphate to orthophosphate in these soils did not reach to completion during 112 days of

experiment. A more stable fraction amounting 9.4 to 24.0 per cent of applied APP and 7.7 to 19.7 per cent of TPP persisted in soil in unhydrolyzed form. This is consistent with previous findings on hydrolysis (Gilliam and Sample, 1968; Hossner and Melton, 1970). The unhydrolyzed fraction tended to increase with increasing amount of CaCO_3 in soil.

Hydrolysis of APP and TPP was satisfactorily described by two parallel first order kinetic rate equations, following relatively fast and slow rates, respectively

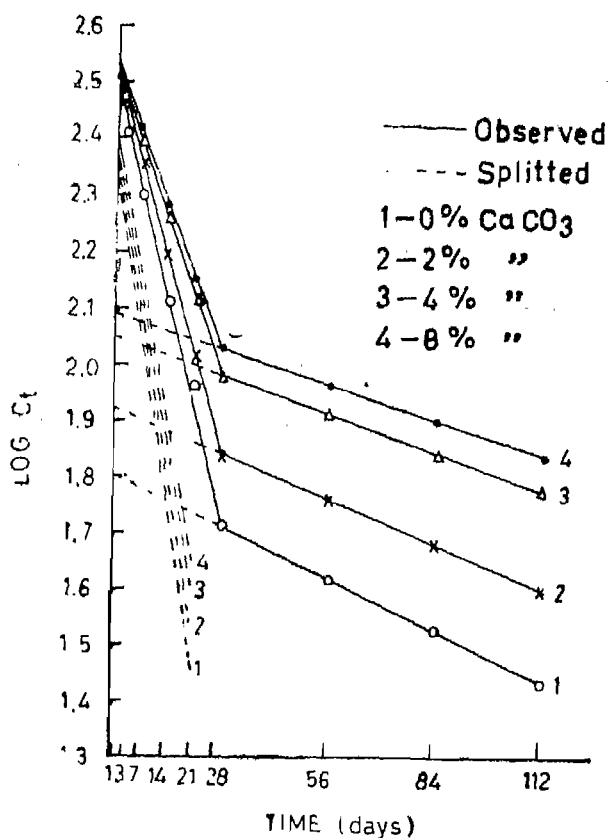


Fig. 2. Effect of CaCO_3 on the hydrolysis of TPP.

(Figs. 1 and 2). The unbroken lines represent the observed and broken lines represent the splitted curves. These two first order reactions may be the result of high and low availability of two components of condensed phosphates in soil to micro-organisms and decreased assessibility to enzymes (Dick and Tabatabal, 1986). More labile fraction hydrolyzed at rapid rate, but after some time this component disappeared, while less labile fraction continued to be hydrolyzed slowly. The regression equations and R^2 values are given in Table 2.

The rate constant for faster reaction ' k_1 ' ranged from 0.1268 to 0.1733/day for APP and 0.0839 to 0.933/day for TPP. The values of k_2 ranged from 0.0037 to 0.0059/day for APP and 0.0050 to 0.0077/day for TPP (Table 3). Rate constant ' k_1 ' was 23.56 to 37.67 fold and 11.97 to 18.66 fold than ' k_2 ' for APP and

TPP, respectively. When experimental soils were limed with different levels of CaCO_3 , the effect was to progressively reduce the ' k_2 ', while effect on ' k_1 ' was not consistent and marked. Highly negative significant regressions between levels of CaCO_3 and k_2 were obtained (Fig. 3). Liming of soil at 1 and 2 per cent CaCO_3 resulted in greater decrease in ' k_2 ' as compared to that at higher levels of CaCO_3 . The decrease in the rate of hydrolysis of less labile component of condensed phosphate at higher levels of CaCO_3 may be attributed to faster decrease in the solubility of reaction products and assessibility to micro-organisms.

From the foregoing results it is concluded that hydrolysis of APP and TPP decreased with increased calcareousness of soil owing to decrease in their solubility.

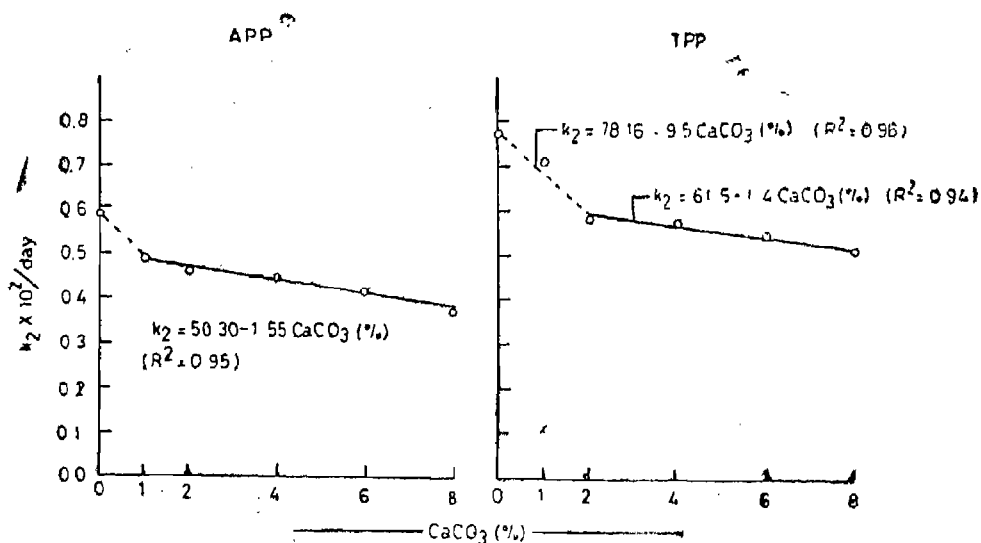


Fig. 3. Effect of CaCO_3 on the hydrolysis of APP and TPP.

HYDROLYSIS OF APP AND TPP

TABLE 2
Effect of CaCO_3 levels on the first order kinetic rate equations of APP and TPP hydrolysis

CaCO_3 (%)	Rate equation (fast)	R^2	Rate equation (slow)	R^2
APP				
0	$\log A_t = 1.79 - 0.060 t$	0.98	$\log B_t = 1.25 - 0.0026 t$	0.97
1	$\log A_t = 1.82 - 0.068 t$	0.98	$\log B_t = 1.33 - 0.0021 t$	0.99
2	$\log A_t = 1.85 - 0.075 t$	0.99	$\log B_t = 1.40 - 0.0020 t$	0.99
4	$\log A_t = 1.79 - 0.055 t$	0.96	$\log B_t = 1.43 - 0.0019 t$	0.98
6	$\log A_t = 1.79 - 0.057 t$	0.97	$\log B_t = 1.49 - 0.0018 t$	0.99
8	$\log A_t = 1.78 - 0.055 t$	0.97	$\log B_t = 1.55 - 0.0016 t$	0.97
TPP				
0	$\log A_t = 2.41 - 0.040 t$	0.98	$\log B_t = 1.81 - 0.0033 t$	0.96
1	$\log A_t = 2.40 - 0.038 t$	0.98	$\log B_t = 1.86 - 0.0031 t$	0.96
2	$\log A_t = 2.40 - 0.036 t$	0.98	$\log B_t = 1.89 - 0.0026 t$	0.98
4	$\log A_t = 2.38 - 0.038 t$	0.98	$\log B_t = 1.98 - 0.0025 t$	0.96
6	$\log A_t = 2.36 - 0.040 t$	0.99	$\log B_t = 2.07 - 0.0025 t$	0.97
8	$\log A_t = 2.31 - 0.041 t$	0.98	$\log B_t = 2.14 - 0.0026 t$	0.99

TABLE 3
Effect of CaCO_3 on the rate constants (k_1 and k_2) and time required for 50% hydrolysis ($t_{1/2}$)

CaCO ₃ (%)	Rapid rate		Slow rate		k ₁ /k ₂
	k ₁ × 10 ³ /day	t _{1/2} (days)	k ₂ × 10 ³ /day	t _{1/2} (days)	
APP					
0	13.90	4.98	0.59	117.45	23.56
1	15.75	4.40	0.49	141.42	32.14
2	17.33	4.00	0.48	150.65	37.67
4	12.68	5.47	0.45	154.00	28.18
6	13.02	5.32	0.42	165.00	31.00
8	12.72	5.45	0.37	187.29	34.38
TPP					
0	9.22	7.52	0.77	90.00	11.97
1	8.84	7.84	0.71	97.60	12.46
2	8.39	8.26	0.63	119.48	14.47
4	8.95	7.74	0.67	121.58	15.70
6	9.25	7.49	0.64	128.33	17.13
8	9.33	7.42	0.50	138.60	18.68

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RESEARCH NOTE

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EFFECT OF NITROGEN AND LEAF CUTTINGS ON SEED QUALITY AND ECONOMICS OF FENUGREEK CULTIVARS

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Fenugreek is one of the important leguminous crops, grown for its green leaves and seed. The seeds are used as condiment and are also fed to animals. It is a rich source of vitamins A, C, B₂, proteins and minerals especially iron and calcium, etc. Despite the great importance, the research work carried out in India does not provide much information about the effects of leaf cutting and nitrogen requirement of the seed crop. The present investigation was, therefore, undertaken to study the response of fenugreek cultivars to different doses of nitrogen and leaf cuttings on seed production, quality and economics of various treatments.

The experiment was carried out on sandy loam soil at the Vegetable Research Farm during the winter of 1991-92. The soil of the experimental field was normal in reaction and electrical conductivity (0.42 dS/m ECe), medium in available nitrogen (172 kg/ha), phosphorus (25 kg/ha) and very high in potash (510 kg/ha). The trial was laid out in a split-plot design, keeping four nitrogen levels, viz. 0, 30, 60 and 90 kg/ha in the main plots, two cultivars, viz. Pusa Early Bunching and Kasuri, and three cutting levels, viz.

no cutting, one cutting at 60 days after sowing and two cuttings at 60 and 80 days after sowing in the sub-plots. These 24 treatment combinations were replicated thrice. Nitrogen was supplied in the form of CAN and urea in three equal splits : at sowing, 30 and 60 days after sowing. Cuttings were done as per treatment 4 cm above the ground level. After completion of desired number of cuttings, the crop was left for seed production. The sowing was done on 31 October, 1991 by kera method in rows 30 cm apart. A uniform dose of 50 kg P₂O₅/ha was broadcasted at the time of sowing. The crop was harvested when the colour of the pods turned from green to light yellow.

The data in Table 1 reveal a significant increase in seed yield of fenugreek by the application of 60 kg N/ha, while fresh weight of foliage was higher at 90 kg N/ha in Kasuri cultivar at two cuttings as compared to Pusa Early Bunching. Higher seed yield at lower level of nitrogen application might be due to the lesser nitrogen requirement of this crop at reproductive phase. Higher levels might be encouraging vegetative growth of the plant at the expense of reproductive

TABLE 1

Effect of nitrogen and cuttings on foliage, seed yield, seed quality and economics of fenugreek cultivars

Treatments	Yield (q/ha)		Test weight (g)	Seed germination (%)	Protein content (%)	Net return (Rs./ha)
	Foliage	Seed				
Nitrogen levels (kg/ha)						
0	27.7	10.9	5.8	80.0	17.3	10920
30	32.7	12.5	6.0	83.3	20.2	13208
60	37.8	13.2	6.1	82.6	23.8	14492
90	42.0	11.3	6.1	78.9	25.2	12487
C. D. at 5%	0.5	0.9	NS	2.0	2.2	—
Cultivars						
Pusa Early Bunching	34.5	14.1	10.5	88.3	22.7	16394
Kasuri	35.6	7.9	1.5	74.1	20.6	9169
C. D. at 5%	0.4	0.8	0.2	1.8	1.3	—
Cuttings						
No cutting	—	12.5	6.0	80.6	23.9	8893
One cutting	15.4	12.6	5.9	82.0	20.6	11868
Two cuttings	54.7	10.9	6.1	81.0	20.3	17569
C. D. at 5%	0.4	0.9	NS	NS	1.6	—

phase. Similar results were also recorded by Bhati *et al.* (1987), Singh (1989) and Yawalkar (1992), in fenugreek crop. Maximum percentage of germination, recorded with the application of 30 kg N/ha being at par with 60 kg N/ha was significantly higher than other treatments. Application of 90 kg N/ha gave significantly higher content of protein followed by application of 60 kg N/ha. Higher content of protein with the application of nitrogen might be due to increased availability of nitrogen to plants and finally more translocation to seeds.

Pusa Early Bunching cultivar had significantly higher seed yield, test weight, germination percentage and protein con-

tent over Kasuri cultivar. This may probably be because of varietal variation. One cutting of leaves gave maximum seed yield of 12.6 q/ha which was at par with control (no cutting) and significantly higher over two cuttings of leaves. Poor seed yield obtained under two cuttings might be due to delayed flowering and seed setting. Similar results were also recorded by Hussain *et al.* (1970) with *Spinacia oleracea* and Saini (1975) with *Trigonella foenum-graecum*. It was observed that cutting of leaves did not show any significant effect on the germination ability of seeds. Maximum protein content was recorded when cutting of leaves was not done.

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It is evident from the data that net returns per hectare were maximum (Rs. 16,394) when Pusa Early Bunching cultivar was grown with the application of 60 kg N/ha and two leaf cuttings at 60 and 80 days after sowing.

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DIFFERENCE OF OPINION AMONG WORKING COUPLES REGARDING HOUSEHOLD WORK AND FAMILY RESPONSIBILITIES

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ABSTRACT

The study on 100 married female faculty members of CCS Haryana Agricultural University, Hisar, and their husbands having atleast one child revealed that working couples were clinging to traditionally sex-ascribed role perceptions. But increasing number of working women was expecting that their husbands should provide more help in household work than they did. Working women had significantly higher role expectation than their husbands regarding child care and household management.

For centuries, Indian women's role has been family oriented confined to home while their husbands have kept the dominant position of breadwinner. Women have been exclusively concerned with home and family responsibilities. In the last decade, there has been an increase in the gainful employment of women which has changed the role perceptions of women from that of the past. The traditional role perceptions related to household work and family obligations still do not find wide acceptance. Soni and Arora (1986) reported that husbands of working women are realising their difficulties and are sharing part of household work, while husbands of non-working women are still clinging to their traditional beliefs and attitudes of dominating husband. According to Rao and Rao (1982) neither employed nor non-employed mothers got any help from husbands. Varied results reported by researchers be-

came the basis for undertaking the present study. The specific objectives of study were :

1. To identify the role expectations of working couples regarding household work and family obligations.
2. To determine the difference of opinion among working couples regarding household work and family responsibilities.

METHODOLOGY

The study was conducted at CCS Haryana Agricultural University, Hisar. A list of married female faculty members from all the colleges of the University, engaged in professional work having atleast one child and whose working hours were from 9.00 a. m. to 4.30 p. m. was prepared. One hundred married

female faculty and their husbands comprised the sample on the basis of cent per cent selection. Both husbands and wives were the respondents of the study.

The data on role expectation of working couples were collected with the help of a five point Likert scale developed for the purpose. Role expectation of working couples was listed into five categories for the purpose of analysis : child care, kitchen management, clothing management, household management and socialization and leisure. Statements relating to household work and family responsibilities were prepared and the content validity and reliability of the same were determined. Scoring of items was done from 0 to 4, with '0' representing 'strongly disagree' and '4' 'strongly agree'. The reliability coefficient of role expectation scale computed was 0.732. The statistical methods applied to draw inferences were the sign test and percentages.

Operational Definitions

Opinion : It is defined as the beliefs or reactions of husbands and wives toward the role expectation regarding household work and family obligations.

Role expectation : It has been defined as functions or activities or actions expected of husbands and wives in carrying out the household work and family responsibilities. It has social and cultural connotations.

RESULTS AND DISCUSSION

Demographic Profile of the Working Couples

Most of the working wives (59%) and their husbands (66%) were between 31 to 40 years of age. Fiftytwo per cent of the working wives and 91% husbands possessed doctoral or a professional degree. The family type was nuclear (67%). About 70% of families had four or less than four family members. Youngest child of most of the respondents (44%) was in the age group of 3-6 years. Regarding occupation, it was found that about 54% of the working wives and 36% of their husbands were in teaching profession. About 40% of the working wives had total family income between Rs. 8,001 and 12,000 per month. Out of 96 working women who received hired help, it was for sweeping and mopping, followed by washing utensils (81.25%) and washing clothes (59.38%).

Role Expectation of Working Couples

Both the spouses were of the consensus that the following are husbands' responsibilities : helping the children with homework (wives—99%, husbands—94%), to equally share the burden of caring for a sick child (wives—99%, husbands—98%), spend sufficient time with children to discuss their interests and problems (wives—100%, husbands—97%), help in storing monthly ration (wives—78%, husbands—71%), wash their own personal clothes (wives—75%, husbands—67%), help in seasonal cleaning and arranging wardrobes (wives—71%, husbands—72%), help in seasonal activities

(wives - 72%, husbands - 65%), look after the garden and potted plants (wives - 95%, husbands - 90%), look after repairs of the house and equipment (wives - 98%, husbands - 99%), help in housework when wife is not well/away (wives - 99%, husbands - 98%), deposit of children's fees and various other bills (wives - 97%, husbands - 88%), do the purchasing of monthly ration and household necessities (wives - 85%, husbands - 82%), and plan for vacations and outings (wives - 86%, husbands - 82%).

Working couples felt that following are wives' responsibilities: look after the children's basic needs (wives - 97%, husbands - 96%), prepare bed tea (wives - 61%, husbands - 65%), iron the clothes (wives - 63%, husbands - 66%), do washing and drying of clothes (wives - 61%, husbands - 67%), keep record of household expenditure (wives - 80%, husbands - 88%), plan for organizing parties and festivals (wives - 86%, husbands - 85%), and maintain good relationship and correspond with husbands' relatives (wives - 98%, husbands - 96%).

Difference of Opinion among Working Couples

To determine whether there is a significant difference between the scores of wives and husbands for the five broad categories of role expectation, Sign test was applied. It determines the differences in extent of agreement.

Results of Sign test indicated that there was significant difference of opinion among husbands and wives regarding child care ($t = -4.06$) and household management ($t = -2.24$). Overall, wives

had higher role expectation than husbands. To some extent opinion of both spouses was similar for the categories like kitchen management, clothes management and socialization and leisure (Table 1).

Further analysis was done to assess the difference of opinion among working couples on role expectation of household work and family responsibilities itemwise (Table 2).

Child care. It was found that there was significant difference of opinion among working couples regarding the following items:

- (i) Husband should help with the homework of children ($t = -2.53$);
- (ii) Wife should look after the children's basic needs ($t = -2.41$);
- (iii) Husband should spend sufficient time with the children to discuss their interests and problems ($t = -2.33$).

In all the three cases, scores of wives were higher than that of husbands indicating that wives had significantly higher role expectation than their husbands.

Kitchen management. Results revealed significant difference of opinion among working couples regarding the following items:

- (i) Husband should prepare bed tea ($t = -2.10$);
- (ii) Husband should help in food preparation ($t = -2.73$);
- (iii) Wife should shop for daily necessities ($t = 3.60$).

OPINION OF WORKING COUPLES REGARDING HOUSEHOLD WORK

TABLE 1

Sign test showing difference of opinion among working couples

(N=100)

	Child care	Kitchen management	Clothing management	Household management	Socialization and leisure
Number of ties	30	17	18	20	37
Number of times wife scored lower than husband	18	38	34	30	24
Number of times wife scored higher than husband	52	45	48	50	39
Test statistic	-4.06**	-0.77	-1.55	-2.24*	-1.89

*, **Significant at 0.05 and 0.01 level of significance, respectively.

TABLE 2

Sign test showing difference of opinion among working couples itemwise

(N=100)

S. No.	Statement/Item	Number of ties	Number of times wife scored lower than husband	Number of times wife scored higher than husband	Test statistic
1	2	3	4	5	6
A. Child care					
1.	Husband should help with the home-work of children	60	12	28	-2.53*
2.	Wife should look after the children's basic needs	56	14	30	-2.41*
3.	Husband should equally share the burden of caring for a sick child	63	15	22	-1.15
4.	Husband should spend sufficient time with children to discuss their interests and problems	69	9	22	-2.33*
B. Kitchen management					
5.	Husband should prepare bed tea	49	18	33	-2.10*
6.	Husband should help in food preparation	41	19	40	-2.73**

contd.

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1	2	3	4	5	6
7.	Wife should shop for daily necessities	48	39	13	3.60**
8.	Husband should help in storing monthly ration	49	22	29	-0.98
9.	Husband should clean and defrost the refrigerator	42	26	32	-0.79
C. Clothing management					
10.	Husband should iron the clothes	47	19	34	-2.06*
11.	Husband should help in washing and drying of clothes	46	18	36	-2.45*
12.	Husband should wash his personal clothes	62	19	19	0.00
13.	Husband should help in seasonal cleaning and arranging of wardrobes	54	20	26	-0.88
D. Household management					
14.	Husband should help in seasonal activities like storing woollens, spring cleaning, pickling, etc.	54	16	30	-2.06*
15.	Husband should help in dusting of the house	49	16	35	-2.66**
16.	Husband should look after the garden and potted plants	64	13	23	-1.66
17.	Husband should look after the minor repairs of the house and equipment	66	19	15	0.68
18.	Husband should help in household work when wife is not well/away	56	20	24	-0.603
19.	Husband should deposit children's fees and various other bills	58	13	29	-2.47*
20.	Wife should keep record of household expenditure	47	28	25	0.412
21.	Husband should do the purchasing of monthly ration and household necessities	52	18	30	-1.73
E. Socialization and leisure					
22.	Husband should plan for vacations and outings	47	21	32	-1.511
23.	Wife should plan for organizing parties and festivals	54	20	26	-1.511
24.	Wife should maintain good relationship and correspond with husband's relatives	66	22	12	1.72

*, **Significant at 0.05 and 0.01 level of significance, respectively.

OPINION OF WORKING COUPLES REGARDING HOUSEHOLD WORK

In case of first two items, wives scored higher than husbands but in case of third item, husbands scored higher.

Clothing management. Significant difference of opinion among working couples was observed in case of the following items :

- (i) Husband should iron the clothes ($t=-2.06$);
- (ii) Husband should help in washing and drying of clothes ($t=-2.45$).

Scores of wives for both items were higher than their husbands.

Household management. Results of Sign test indicate a significant difference of opinion among working couples regarding following items :

- (i) Husband should help in seasonal activities like storing woollens, seasonal cleaning, etc. ($t=-2.06$);
- (ii) Husband should help in dusting of the house ($t=-2.66$);
- (iii) Husband should deposit children's fees and various other bills ($t=-2.47$).

In all these cases, wives scored higher than husbands.

Socialization and leisure. No significant difference of opinion among working couples was found regarding items of socialization and leisure category.

With regard to role expectation of working couples, there is inconsistency in results which may be because the data have been presented in percentage while the difference of opinion has been tested statistically using Sign test for which the data were classified into categories.

The results revealed that working wives had significantly higher role expectation than their husbands regarding child care and household management. On the whole, working couples had similar opinion regarding kitchen management, clothing management and socialization and leisure.

It is evident from the results that wives and their husbands are still clinging to traditionally sex-ascribed role perceptions. But there has been a tendency towards change in their role perceptions. Working wives expect their husbands to co-operate and contribute more towards household work and family obligations than they are doing presently. It is because employed women have dual responsibility of looking after home and job. Employment of women detracts their time and energy available for home and family roles.

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SOCIO-PERSONAL FACTORS OF ANGANWADI WORKERS AS RELATED TO DELIVERY OF HEALTH AND NUTRITION EDUCATION

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ABSTRACT

Out of the three anganwadi workers studied only one was best as she had almost complete knowledge regarding health and nutrition education activities and she was imparting this knowledge to the beneficiaries, i. e. expectant and nursing mothers of 14-44 years of age. This was because of better socio-personal profile of the anganwadi worker.

Health and nutrition education (HNE) component of the ICDS scheme aims at effective communication of certain basic health and nutrition messages such as immunization/vaccination, contagious diseases, common ailments, prenatal care, family planning, weaning practices, and personal and environmental hygiene. Nutrition and health education is required to be given to all women in the age group of 15-44 years, priority being given to the nursing and expectant mothers with a view to enhance the mother's awareness of the child's needs and her capacity to look after the child within the family environment.

Anganwadi is the focal point for the delivery of the package of services to beneficiaries right in their village. Anganwadi workers impart knowledge to the women beneficiaries regarding health, nutrition and pre-school education to children.

MATERIAL AND METHODS

Data were collected purposively from three ICDS villages, viz. Mangali, Durjanpur and Chaudhriwas of Hisar district due to easy accessibility and time constraint. One anganwadi from each village was randomly selected. To collect information regarding socio-personal variables on HNE activities of anganwadi workers, an interview schedule, informal discussions, observations and inventory were made and used.

RESULTS AND DISCUSSION

The data for socio-personal profile of anganwadi workers have been presented in Table 1.

The data reveal that out of three, two anganwadi workers belonged to higher caste and one was from lower caste community. The anganwadi workers of

TABLE 1
Socio-personal profile of the anganwadi workers

Variable	Anganwadi Centre		
	Chaudhriwas (A. W. A ₁)	Mangali (A. W. A ₂)	Durjanpur (A. W. A ₃)
Age	26 years	40 years	30 years
Caste	Punjabi	Punjabi	Carpenter
Marital status	Unmarried	Married	Married
Type of family	Joint	Joint	Nuclear
Place of living (away/near)	Away	Near	Near
Availability of conveyance	Yes	No	No
Income per month	Rs. 1500/-	Above Rs. 1000/-	Rs. 2500/-
Educational level	Matric	Matric	Middle
Training	Untrained	Trained	Trained
Refresher course	Nil	Nil	Nil
Number of years at the present centre	2	5	5½
Workshop attended	Nil	Nil	Nil
Member of organization	Nil	Nil	Nil

A₁, A₂ and A₃ anganwadis were 26, 40 and 30 years of age, respectively. Anganwadi workers of A₂ and A₃ anganwadis were married, whereas anganwadi worker of A₁ was unmarried. Regarding education, two were matriculates and one had education upto middle class only. Anganwadi workers of A₂ and A₃ anganwadis had experience of 5 and 5½ years, respectively while A₁ had experience of 2 years only. Anganwadi workers of A₂ and A₃ anganwadis were trained, whereas anganwadi worker of A₁ was untrained. All the three anganwadi workers were working in the same anganwadi since their joining jobs. None of the anganwadi workers had undergone any refresher course and were also not the members of any organization. During their work experience all the three anganwadi workers never attended any workshop or conference.

Out of three anganwadi workers two had joint families while the third belonged to a nuclear family. The approximate income of anganwadi workers varied from Rs. 1000/- to Rs. 2500/- per month.

Regarding place of living, the table indicates that two anganwadi workers stayed in the same village while one came daily from the city by bus.

During the data collection it was observed that anganwadi worker of A₃ was the best in conducting HNE activities. It was because she had more experience than other anganwadi workers although her educational level was low. She belonged to nuclear family, and therefore, she was able to devote more time for the work of anganwadi.

It can also be inferred from the results that A₁ anganwadi worker did not per-

form her duties in an excellent way. The reasons might be less experience and lack of training. Moreover she did not stay in the same village.

There are certain prescribed HNE activities which should be conducted by every anganwadi worker. Thus, an effort was made to know whether anganwadi workers were conducting all the prescribed activities or not. Table 2 provides information on HNE activities (prescribed and conducted). First activity, *i. e.* diseases, consisted of four aspects—contagious diseases, common ailments, deficiency diseases, and childhood disabilities. The anganwadi

workers were supposed to conduct activities to impart knowledge regarding symptoms, causes, prevention and care. Results indicate that all the anganwadi workers were imparting complete knowledge weekly regarding the contagious diseases and common ailments. Regarding deficiency diseases, A₁ anganwadi worker was not imparting any knowledge and A₂ anganwadi worker was imparting knowledge on symptoms and causes, whereas A₃ anganwadi worker was giving knowledge on symptoms, causes and prevention. Anganwadi workers of A₁ and A₂ anganwadis were not imparting any knowledge on childhood disabilities while A₃ anganwadi worker was giving

TABLE 2
Health and nutrition education activities in operation

S. No.	Activity	Activities conducted by anganwadi workers		
		Chaudhriwas (A. W. A ₁)	Mangali (A. W. A ₂)	Durjanpur (A. W. A ₃)
1.	Diseases			
	(a) Contagious diseases (4)*	4	4	4
	(b) Common ailments (4)	4	4	4
	(c) Deficiency diseases (4)	0	2	3
	(d) Childhood disabilities (4)	0	0	3
2.	Vaccination/immunization (4)	2	3	4
3.	Family planning (5)	3	4	5
4.	Knowledge regarding problems of pregnant and lactating mothers (2)	1	2	2
5.	Breast feeding (2)	1	2	2
6.	Importance of colostrum (1)	1	1	1
7.	Bottle feeding (2)	0	2	2
8.	Personal and environmental hygiene (4)	3	2	4
9.	Care during diarrhoea (4)	4	4	4
10.	Weaning (5)	4	3	5
11.	Supplementary feeding (1)	1	1	1

*Figures in parentheses indicate the number of aspects in each activity.

knowledge on symptoms, causes and prevention of childhood disabilities. Immunization/vaccination aspect includes importance of immunization, schedule for different doses, interval between different doses, and precautions. Regarding this aspect A₃ anganwadi worker was imparting complete knowledge on all the four aspects, whereas anganwadi workers of A₁ and A₂ anganwadis were not imparting complete knowledge.

Five aspects, viz. importance of family planning, child spacing, small family norms, sources of availability, and methods of family planning, were included in the activity of family planning. A₃ anganwadi worker was imparting complete knowledge while A₁ and A₂ anganwadi workers were imparting knowledge only on two and three aspects of family planning. Knowledge regarding pregnant and lactating mothers includes only two aspects—problems and suggestions to solve them. A₂ and A₃ anganwadi workers were imparting knowledge on both the aspects while A₁ anganwadi worker was imparting knowledge only on suggestions to solve problems faced by the beneficiaries.

Knowledge regarding personal and environmental hygiene includes aspects such as importance, methods, its effect on health and can cause diseases. Anganwadi worker of A₃ anganwadi was imparting complete knowledge while other two anganwadi workers were not taking much interest in these activities.

All the anganwadi workers were imparting complete knowledge on care

during diarrhoea which includes knowledge about oral rehydration solution (ORS), preparation of ORS, precautions while preparing ORS and other food stuffs which can be given during diarrhoea. Knowledge on breast feeding includes importance and posture during breast feeding. Anganwadi workers of A₂ and A₃ anganwadis were imparting complete knowledge, whereas A₁ imparted knowledge on single aspect. All of them were imparting knowledge on importance of colostrum. Knowledge regarding bottle feeding includes two aspects namely the starting age and cleanliness of feeder. Anganwadi workers of A₂ and A₃ anganwadis were giving complete knowledge, whereas anganwadi worker of A₁ anganwadi was not giving any knowledge on this aspect.

Knowledge on weaning includes the starting age, type of foods, methods, gradual introduction of foods, problems relating to weaning and their solutions. Only A₃ anganwadi worker was imparting complete knowledge while the other two anganwadi workers were not dealing with all these aspects. Supplementary feeding includes knowledge on types of supplementary foods and all were giving knowledge to the women beneficiaries of ICDS programme.

It can be concluded from the results that A₃ anganwadi worker was the best among three anganwadi workers. She had almost complete knowledge regarding HNE activities and was conducting these activities regularly. It is probably because she had longest experience as anganwadi worker. Although her educational level was low she was an en-

thusiastic and keen worker. She spent more time with the beneficiaries of HNE because she had less responsibilities at home and was free to devote her time and energy in anganwadi centre. Other two anganwadi workers had less interest and motivation in their job. It may be due to more responsibilities at home, low income, less experience and less devotion to work.

On the basis of present study it may be recommended that females who had good education, experience of working with mothers and young children, intelligent, keen and interested in work, and devoted to welfare activities should be recruited as anganwadi workers.

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PARTICIPATORY ROLE OF WOMEN IN GRAPE CULTIVATION

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Agriculture is the back-bone of Indian society. From the time immemorial agriculture has been a way of life and a family occupation of rural population. Although nearly 80% women are engaged in agriculture, the rate of economic participation reflects this as 20.85 per cent (1981 census). Numerous studies indicate that women take an active part in various agriculture activities mainly of transplanting, weeding, harvesting and storage. It is an irony that women's work is underestimated as it is seasonal but it is silently appreciated.

Indian agriculture is undergoing various changes. One major change has been a shift in the pattern of cultivation from cereal to vegetable and fruit cultivation. In Haryana, grape cultivation has been picked up by the farmers on a large scale and the cultivators are fetching a remunerative income ranging from Rs. 20,000 to 40,000 per acre (Dal Singh, 1989).

Haryana is a leading grape growing State in North India with Hisar district alone accounting for nearly two-third of area under grape cultivation. As this is

fairly a new crop in this area, the nature and extent of the participation of women need to be investigated.

The study was undertaken in Kurdi village of Hisar block, Haryana state. A survey was carried out to ascertain number of households engaged in grape cultivation. Out of 73 households, 50 were selected proportionately from the four land holding categories, viz. landless, small, medium and large farm households. All females in the households who were engaged in grape cultivation were selected as sample respondent. This comprised 110 women. After thorough literature survey and detailed discussion with experts from the Department of Horticulture of the University, a list of 20 main activities and their sub-activities was prepared. The role of women in terms of supervisory and as labourer was studied both separately and in joint ventures. Time spent in each activity and sub-activity was noted. Data were gathered on a pre-tested structured interview schedule.

Profile of women respondents indicates that majority of them were of

TABLE 1
Role of women in different activities of grape cultivation

S. No.	Activity	Per cent role			
		No involvement	Supervisor	Labourer	Labourer-cum-Supervisor
1.	Preparation of tillage				
	Ploughing	95.5	4.5	0.0	0.0
	Planking of field	95.5	4.5	0.0	0.0
2.	Preparation of nursery bed				
	Planting of cuttings	58.2	0.0	38.2	3.6
	Earthing of cuttings	54.2	0.0	38.6	7.2
	Irrigation	52.7	0.0	46.4	0.9
	Roguing diseased plants	80.0	0.0	18.2	1.8
3.	Layout				
	Layout of the field	94.5	5.5	0.0	0.0
	Digging and filling of pits	2.7	2.7	78.4	18.2
	Making hole in centre of pits	1.8	2.7	77.3	18.2
	Planting of plants	11.8	7.3	84.5	16.4
4.	Irrigation				
	Channel making	95.5	4.5	0.0	0.0
	Bund making in field	95.5	4.5	0.0	0.0
	Water channel making from plant to plant	95.5	4.5	0.0	0.0
5.	Manuring				
	Loading of FYM in cart	0.9	0.9	85.2	13.0
	Spread of manure	56.4	0.0	37.2	6.4
6.	Hoeling	3.6	2.7	76.4	17.3
7.	Spraying/dusting of insecticide	100.0	0.0	0.0	0.0
8.	Earthing of grape vine	54.5	0.9	38.2	6.4
9.	Gap filling of plants	36.4	1.8	55.4	6.4
10.	Training of grape vine	3.7	1.8	80.9	13.6
11.	Pruning of grape vine	9.2	1.8	80.8	8.2
12.	Quality Improvement				
	Thinning of bunches	97.3	0.0	2.7	0.0
	Gibberellic acid treatment of bunches	100.0	0.0	0.0	0.0
13.	Protection of plants from birds	90.0	0.0	20.0	0.0
14.	Picking	0.0	3.6	80.0	16.4
15.	Trimming	2.8	2.7	79.1	15.4
16.	Grading	2.8	2.7	79.1	15.4
17.	Packing	2.8	2.7	79.1	15.4
18.	Storage	100.0	0.0	0.0	0.0
19.	Marketing	100.0	0.0	0.0	0.0
20.	Miscellaneous	42.7	0.0	57.3	0.0

ROLE OF WOMEN IN GRAPE CULTIVATION

TABLE 2
Nature and extent of participation in grape cultivation

S. No.	Activity	Time spent in hours				
		No involvement	<2	2 to 4	4 to 8	8+
1.	Preparation of tillage					
	Ploughing	100.0	0.0	0.0	0.0	0.0
	Planking of field	100.0	0.0	0.0	0.0	0.0
2.	Preparation of nursery bed					
	Planting of cuttings	58.2	41.8	0.0	0.0	0.0
	Earthing of cuttings	54.5	45.5	0.0	0.0	0.0
	Irrigation	52.7	47.3	0.0	0.0	0.0
	Roguing diseased plants	81.8	18.2	0.0	0.0	0.0
3.	Layout					
	Layout of the field	100.0	0.0	0.0	0.0	0.0
	Digging and filling of pits	5.5	0.0	9.1	13.6	71.8
	Making hole in centre of pits	4.5	0.0	8.2	13.6	73.6
	Planting of plants	5.5	0.0	9.1	13.6	71.8
4.	Irrigation					
	Channel making	100.0	0.0	0.0	0.0	0.0
	Bund making in field	100.0	0.0	0.0	0.0	0.0
	Water channel making from plant to plant	100.0	0.0	0.0	0.0	0.0
5.	Manuring					
	Loading of FYM in cart	1.8	0.0	2.7	9.1	86.4
	Spread of manure	56.4	0.0	2.7	6.4	34.5
6.	Hoeing	3.6	0.0	0.0	15.5	80.9
7.	Spraying/dusting of insecticide	100.0	0.0	0.0	0.0	0.0
8.	Earthing of grape vine	46.4	0.0	9.1	12.7	31.8
9.	Gap filling of plants	36.4	0.0	10.9	24.6	28.2
10.	Training of grape vine	3.6	0.0	7.3	6.4	82.7
11.	Pruning of grape vine	8.2	0.0	0.9	8.2	82.7
12.	Quality Improvement					
	Thinning of bunches	97.3	0.0	0.0	0.0	2.7
	Gibberellic acid treatment	100.0	0.0	0.0	0.0	0.0
13.	Protection of plants from birds	100.0	0.0	0.0	0.0	0.0
14.	Picking	0.0	3.6	36.4	60.0	0.0
15.	Trimming	2.7	25.5	45.5	25.4	0.0
16.	Grading	2.7	39.1	58.2	0.0	0.0
17.	Packing	2.7	41.8	55.5	0.0	0.0
18.	Storage	100.0	0.0	0.0	0.0	0.0
19.	Marketing	100.0	0.0	0.0	0.0	0.0
20.	Miscellaneous	42.7	57.3	0.0	0.0	0.0

middle age, illiterate, had high participation in household and animal husbandry activities, were wives and family agricultural equipment possession was low.

Participatory Role of Women

It is evident from the data in Table 1 that women had no involvement in activities of spraying/dusting of insecticides, gibberellic acid treatment of bunches, storage and marketing, while their involvement remains almost negligible in thinning of bunches, ploughing, planking and all irrigation activities.

The participatory role of women in the capacity of supervisor, supervisor-cum-labourer and as labourer ranged from 0.9 to 7.3 per cent, 0.9 to 18.2 per cent and 2.7 to 85.4 per cent, respectively. Accordingly, it is interpreted that majority of the women work as labourers. Further, as labourer, they have extensive involvement, ranging from 76.0 to 85.4 per cent in activities of

digging and filling pits, making hole in centre of pits, loading of carts, hoeing, picking, trimming, grading, packing, training and pruning.

Nature and Extent of Participation

It is evident from the data in Table 2 that a large majority of women spent over 6 h in activities of digging and filling, making hole in centre of pits, planting, loading FYM, training and pruning activities. In picking activity majority of women spent 4 to 6 h while in trimming, packing and grading majority of the women spent 2 to 4 h. Activities in which less than 2 h were spent include planting of cuttings, earthing of cuttings, irrigation and roguing diseased plants.

Thus, it is concluded that majority of women work as labourers, while their involvement in various activities varies depending upon the nature of the activity. The activities in which women are involved are of manual and laborious nature.

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STUDIES ON CHROMOSOMAL HETEROMORPHISM IN ZEBU AND EXOTIC DAIRY CATTLE

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ABSTRACT

Chromosomal heteromorphism of morphometric parameters, viz. relative lengths, arm ratio and centromeric index in 36 Hariana (Zebu), 29 crossbreds ($\frac{1}{2}$ F + $\frac{1}{4}$ J + $\frac{1}{4}$ H), and 12 Holstein-Friesian dairy animals was carried out using whole blood culture technique. Diploid genome was uniform with $2N=60$ in all groups, and autosomes were acrocentric type with no significant difference in relative lengths (1.72 to 5.30 per cent). However, 'X' chromosome which was sub-metacentric type showed higher values of relative lengths in crossbreds (5.01%) than Hariana (4.83%). 'Y' chromosome in Hariana animals showed clearcut heteromorphism in shape than animals of exotic inheritance. In Zebu animals, it was small acrocentric type comparable in length to 25th autosome, while the animals of exotic blood showed it as metacentric. Chromosomal profiles of Zebu and exotic inheritance animals showed small differences in their morphometric measurements, yet analysis at the genic level will help in understanding their chromosomal architecture.

Crossbreeding programmes in India were initiated in early sixties so as to increase milk production and to lower the age of maturity of Indian breeds of cattle by incorporating exotic germplasm. A number of studies have shown quantitative differences for the economic traits in crossbred/synthetic strains in relation to native Zebu or exotic breeds. But literature on the comparison of chromosomal profiles among indigenous and exotic breeds is not adequate. Benjamin and Bhat (1977) were the first to initiate cytogenetic research on Indian cattle. In the present investigation, cytogenetic divergence in Hariana, Holstein-Friesian and crossbred animals was contemplated on the basis of morphological and bio-

metrical attributes of autosomes and sex chromosomes.

MATERIAL AND METHODS

A total of 77 animals (36 Hariana, 29 crossbreds— $\frac{1}{2}$ F + $\frac{1}{4}$ J + $\frac{1}{4}$ H, and 12 Holstein-Friesian) were used in this study. Whole blood cultures were set up for 72 h. Chromosome spreads were prepared after modifying the protocol of Moorhead *et al.* (1960). Slides stained with Giemsa (2%; pH 6.8) were scanned and well spread metaphase cells were photographed. Karyotypes were constructed with the precise examination of linear length of each chromosome in relation to centromere in a descending fashion. Dial

type vernier callipers was used for the measurement of relative lengths from the ten model karyotypes in each of three different breeds.

RESULTS AND DISCUSSION

Precise and unequivocal characterization of each chromosome is absolutely

TABLE 1

Relative length (%) of chromosomes in males of different breeds of cattle

Chromosome No.	Haryana	Crossbreds	Friesian	M. S. due to breeds
1	5.160±0.302	5.301±0.267	5.129±0.264	1.135
2	4.672±0.279	4.717±0.199	4.727±0.175	0.176
3	4.484±0.277	4.471±0.167	4.417±0.118	0.214
4	4.311±0.240	4.317±0.140	4.304±0.145	0.012
5	4.020±0.267	4.169±0.160	4.197±0.136	0.106
6	4.080±0.234	4.019±0.243	4.053±0.113	0.336
7	3.913±0.216	3.929±0.141	3.825±0.457	0.343
8	3.847±0.216	3.821±0.078	3.726±0.426	0.519
9	3.723±0.200	3.738±0.063	3.764±0.165	0.101
10	3.617±0.191	3.637±0.097	3.638±0.136	0.068
11	3.465±0.206	3.511±0.123	3.573±0.126	0.437
12	3.345±0.211	3.389±0.087	3.415±0.137	0.532
13	3.221±0.173	3.198±0.087	3.296±0.123	1.501
14	3.153±0.170	3.114±0.072	3.191±0.131	0.857
15	3.064±0.146	3.029±0.049	3.118±0.112	1.652
16	2.984±0.113	2.967±0.046	3.024±0.123	1.142
17	2.887±0.142	2.840±0.130	2.932±0.106	1.319
18	2.803±0.187	2.787±0.131	2.791±0.098	0.033
19	2.762±0.177	2.691±0.096	2.736±0.088	0.809
20	2.694±0.146	2.592±0.112	2.634±0.109	1.484
21	2.598±0.202	2.513±0.109	2.565±0.108	0.839
22	2.524±0.203	1.452±0.124	2.448±0.112	0.792
23	2.459±0.192	2.372±0.160	2.391±0.102	0.853
24	2.382±0.178	2.298±0.173	2.294±0.112	0.574
25	2.235±0.184	2.206±0.103	2.238±0.103	0.173
26	2.113±0.166	2.086±0.062	2.180±0.121	1.503
27	2.020±0.164	1.989±0.107	2.108±0.119	2.158
28	1.952±0.152	1.852±0.134	2.016±0.103	3.934
29	1.820±0.157	1.729±0.182	1.886±0.157	2.284
X	4.830±0.309	5.019±0.203	4.831±0.253	1.765
Y	2.220±0.243	2.838±0.985	2.342±0.173	3.031

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essential for the construction of reliable spread complete metaphase cells. Benja-
karyotypes. Model karyotypes of Hariana, min and Bhat (1977) reported for the
Holstein-Friesian and crossbred dairy first time autosomes as telocentric in
cattle were constructed from the well Hariana cattle. But Biggers and McFeely

TABLE 2
Relative length (%) of chromosomes in females of different breeds of cattle

Chromosome No.	Hariana	Crossbreds	Friesian	M. S. due to breeds
1	4.782±0.503	4.920±0.204	5.058±0.476	1.212
2	4.476±0.344	4.510±0.275	4.553±0.325	0.148
3	4.112±0.622	4.309±0.201	4.286±0.174	0.759
4	4.165±0.306	4.183±0.141	4.173±0.171	0.016
5	4.056±0.325	4.066±0.096	4.087±0.175	0.050
6	3.982±0.344	3.972±0.124	3.963±0.204	0.016
7	3.862±0.298	3.878±0.154	3.839±0.212	0.074
8	3.801±0.297	3.752±0.125	3.741±0.180	0.220
9	3.669±0.324	3.670±0.138	3.670±0.146	0.000
10	3.601±0.289	3.606±0.101	3.572±0.148	0.085
11	3.507±0.303	3.523±0.072	3.460±0.139	0.275
12	3.441±0.282	3.402±0.102	3.295±0.087	1.745
13	3.336±0.252	3.298±0.100	3.184±0.108	2.193
14	3.267±0.251	3.165±0.126	3.084±0.082	2.822
15	3.153±0.219	3.045±0.084	3.029±0.099	2.084
16	3.091±0.195	2.983±0.306	2.915±0.155	3.546*
17	2.986±0.193	2.826±0.143	2.805±0.146	3.716*
18	2.910±0.168	2.729±0.119	2.767±0.124	4.705*
19	2.813±0.160	2.635±0.128	2.669±0.071	5.711**
20	2.752±0.152	2.557±0.133	2.598±0.060	7.141**
21	2.657±0.147	2.427±0.104	2.557±0.069	10.790**
22	2.681±0.130	2.369±0.109	2.463±0.085	9.359**
23	2.482±0.151	2.238±0.155	2.381±0.097	7.968**
24	2.377±0.170	2.188±0.155	2.313±0.082	4.591*
25	2.298±0.191	2.121±0.137	2.252±0.097	3.900*
26	2.212±0.176	2.025±0.143	2.128±0.120	4.010*
27	2.124±0.186	1.937±0.125	2.060±0.121	4.162*
28	2.068±0.163	1.856±0.094	1.890±0.211	4.782*
29	1.986±0.139	1.760±0.076	1.767±0.233	5.160*
X ₁	4.240±0.389	4.698±0.274	4.867±0.321	9.562**
X ₂	4.313±0.427	4.871±0.362	5.207±0.358	13.832**

*P<0.05

**P<0.01

(1963), Basrur and Moon (1967), Kieffer and Cartwright (1968), and Gupta *et al* (1974) observed bovine chromosomes (autosomes) as acrocentrics. The present results show that autosomes in Haryana, Holstein-Friesian and crossbred cattle were acrocentric type and shape of 'X' chromosome was similar and submetacentric in all the breeds. The 'Y' chromosome depicted clearcut heteromorphism. It was found to be small acrocentric and comparable in length to 25th autosome in Haryana, while pure exotic animals and their crosses with Haryana were having small metacentric 'Y' chromosome.

The relative lengths of chromosomes in crossbred cattle in relation to exotic and Haryana breeds were expressed for both the sexes (Tables 1 and 2). The average relative length (%) among male karyotypes ranged from 1.84 to 5.15 per cent in Haryana; 1.72 to 5.30 per cent in crossbreds and 1.88 to 5.12 per cent in Friesian cattle for autosomes. The relative length of 'X' chromosome was higher in crossbreds (5.01%) than Haryana (4.83%). 'Y' chromosome among three breeds also depicted similar but non-significant pattern in their relative lengths. Sarkhel and Katpatal (1989) compared the sex chromosome variability in *Bos taurus*, *Bos indicus* and crossbred cattle and reported 'X' chromosome to be contributing higher to the total genome in exotic breeds than native Gir (5% vs. 4.87%). The present results showed similar chromosomal variability of 'X' chromosome in Haryana and crossbred cattle.

The relative length of crossbred females showed small significant differences for chromosome numbers 16th and

TABLE 3
Morphometric parameters of sex chromosome in different breeds of cattle

Breed	Sex chromosomes 'X'	
	Male	Female
Arm ratio		
Haryana	2.26	2.00
Crossbreds	1.78	1.87
Friesian	1.99	1.77
Centromeric index (%)		
Haryana	31.41	33.54
Crossbreds	36.54	36.06
Friesian	33.71	36.22

29th and 'X' chromosome ($P < 0.05$ and $P < 0.01$) in comparison to Haryana and Friesian. However, X_1 and X_2 chromosomes were having variation in values of average relative lengths due to late replicating nature. This corroborates the findings of Sarkhel and Katpatal (1989) and Gupta and Gupta (1991) where it was reported that Indigenous breeds differ from exotic ones in their shape and size. The other morphometric parameters, *viz.* arm ratio and centromeric index (%) were also compared in three groups of dairy cattle for sex chromosomes (X) in both the sexes (Table 3). Arm ratio was more than one depicting that 'X' chromosome was submetacentric type. However, it was found to be higher in crossbred in comparison to Haryana and Friesian cattle. This variation in shape might have been due to reciprocal translocations or rearrangement in short arm of 'X' chromosome during breed synthesis.

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EFFECT OF SALINITY ON GERMINATION, EARLY SEEDLING GROWTH, SOME BIOCHEMICAL PARAMETERS AND IONIC COMPOSITION IN TWO CULTIVARS OF WHEAT WIDELY DIFFERING IN SALT RESISTANCE

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ABSTRACT

Response of two cultivars of wheat (Kharchia-65 and C-306) differing in salt resistance was studied under predominantly chloride salinity. More radicle/coleoptile length, dry weight accumulation, moisture content in endosperm, proteins, K and N contents, and less uptake of Na and Cl ions could be identified as the guiding factor for salt resistance in Kharchia-65. These components could also be used in identifying salt resistant varieties in other crops for rapid screening programme for breeding salt tolerant varieties.

Germination of seeds under saline conditions differs from one crop to the other and even a significant variation is recorded amongst the different cultivars of the same crop (Maliwal and Paliwal, 1967, 1970; Kumar and Bhardwaj, 1981). The sensitivity of various crops also varies at seedling emergence and again at various growth stages with respect to salinity (Bhumbla and Singh, 1965; Rathert, 1983). In fact, early stages of plant growth are most critical as later development and crop production depend on effective germination and seedling emergence (Pearson and Bernstein, 1959; Wahhab, 1961). Deleterious effects of saline conditions on plant growth, in general, are attributed to two main factors, viz. increase in osmotic pressure of rooting medium (Bernstein and Hayward, 1958) and specific ion effects (Strogonov, 1964). In addition to it,

the salinization of the medium not only disturbs metabolism and declines the availability of water to the plant but also hampers the uptake of essential mineral ions apart from excessive accumulation of toxic ions, i.e. specific ion effects (Sheoran and Garg, 1978; Tal and Shannon, 1983; Sharma *et al.*, 1990). The study of these components might have varying effects in plants differing in salt resistance. An understanding of these causes might expedite breeding programmes by providing rapid screening methods. Therefore, the present study deals with the effect on germination, early seedling growth, some biochemical perturbations and mineral ion composition in salt tolerant—Kharchia-65, and salt sensitive—C-306 cultivars of wheat (*Triticum aestivum* L.) under different levels of predominantly chloride type of salinity.

MATERIAL AND METHODS

These studies were carried out in BOD incubator in the laboratory using petri plates. The seeds of cultivars Kharchia-65 (KH-65) and C-306 were surface sterilized with 0.1% sodium hypochlorite for 1 min and then thoroughly washed under running tap water. The petri plates used were oven sterilized at 200°C for 2 h and then cleaned with cotton swab soaked in absolute alcohol before use. Fifteen healthy and uniform seeds were sown in each petri plate having a filter paper (Whatman No. 1) at the bottom. Salinity treatments were given by adding 10 ml of aqueous saline solution of desired salinity prepared by using a mixture of salts. The salinity levels (0, 6, 9 and 12 dS m⁻¹ EC) were created with a mixture of NaCl, CaCl₂, MgCl₂ and MgSO₄ (using 1 : 1 Na : Ca + Mg ratio, and 1 : 3 Ca : Mg ratio; Cl : SO₄ ratio was 7 : 3 on milli-equivalent basis). The petri plates were kept in the dark in the BOD incubator maintained at 28°±1°C.

Sampling was carried out at 96 h after sowing for observations on radicle/coleoptile length, dry weight and moisture content of radicle, coleoptile and endosperm. Two petri dishes from each salinity level were sampled for total soluble carbohydrates (Yemm and Willis, 1954), insoluble proteins (Lowry *et al.*, 1951), free amino acids (Yemm and Cocking, 1955), proline (Bates *et al.*, 1973) and for mineral ions like nitrogen, potassium, sodium and chloride (according to methods cited in USDA Handbook No. 60, 1954) from radicles and coleoptiles separately.

RESULTS AND DISCUSSION

The phenological data presented in Table 1 clearly indicate that cultivar C-306 was relatively more sensitive to salinity as compared to cultivar KH-65. This was true on the basis of 20-25 per cent reduction as such and in relative magnitude of reduction in final germination, radicle and coleoptile length as well as their dry weight and a higher quantity of unutilized stored food material in the endosperm at different salinity levels as compared to control. In cultivar C-306 magnitude of reduction was more even at lower level of salinity. These results are in conformity with the observations of Babu and Kumar (1975) and Ahmed *et al.* (1987) who reported that the sensitivity to salt varied from crop to crop belonging to the taxa of the same family and exactly same was true in various cultivars of rice as far as per cent germination was concerned. However, Prisco and O'Leary (1973) have found that at low salinity levels the effect of salt on germination was ionic but at higher levels it was both ionic as well as osmotic.

On the contrary, the moisture percentage in the radicle and coleoptile (Table 1) was reduced more in case of cultivar KH-65 as compared to that in cultivar C-306, but just the reverse situation was observed in case of the endosperm. This observation is supported adequately in literature as reduction in moisture content was due to direct osmotic effects of salinity caused mainly through reduced water availability (Tur *et al.*, 1979).

The total stored carbohydrates in radicle, coleoptile and endosperm remained

TABLE 1

Effect of salinity on seed germination, dry weight and moisture percentage of radicle/coleoptile/endosperm of two cultivars of wheat

S. No.	Parameter	Salinity levels				Mean	C. D. at 5%
		S ₀	S ₁	S ₂	S ₃		
1.	Seed germination (%)						
	C ₁	98.7	84.7	75.4	55.4	77.9	0.37
	C ₂	97.7	89.5	78.4	68.0	80.9	
2.	Radicle length (cm)						
	C ₁	4.46	3.76	3.27	2.52	3.50	0.11
	C ₂	4.51	3.39	2.65	1.93	3.12	
3.	Coleoptile length (cm)						
	C ₁	4.46	4.15	3.52	2.99	3.78	0.12
	C ₂	4.44	3.87	3.04	2.61	3.49	
4.	Dry weight of radicle (mg/10 seedlings)						
	C ₁	80	67	56	45	62	9
	C ₂	82	53	38	26	50	
5.	Dry weight of coleoptile (mg/10 seedlings)						
	C ₁	95	74	63	47	70	8
	C ₂	96	59	46	32	58	
6.	Dry weight of endosperm (mg/10 seedlings)						
	C ₁	126	139	170	203	159	16
	C ₂	126	166	204	250	182	
7.	Moisture in radicles (%)						
	C ₁	87.9	88.8	86.3	83.0	86.5	0.30
	C ₂	87.5	89.2	88.0	87.1	87.9	
8.	Moisture in coleoptile (%)						
	C ₁	89.2	90.1	88.3	85.2	88.2	0.25
	C ₂	89.1	90.4	89.8	87.7	89.0	
9.	Moisture in endosperm (%)						
	C ₁	72.5	68.7	66.7	66.3	67.8	0.20
	C ₂	71.2	64.8	61.2	58.5	63.9	

C₁—Kharchia-66, C₂—C-306.

EFFECT OF SALINITY ON TWO CULTIVARS OF WHEAT

TABLE 2

Effect of salinity on total soluble carbohydrates, protein, proline, and amino acid contents in radicle/coleoptile/endosperm of two cultivars of wheat

S. No.	Parameter	Salinity levels				Mean	C. D. at 5%
		S ₀	S ₁	S ₂	S ₃		
1.	Total soluble carbohydrates in radicle (mg CHO/g tissue dry wt.)						
	C ₁	12.6	15.1	18.0	22.7	17.1	0.33
	C ₂	12.7	16.8	20.2	24.5	18.4	
2.	Total soluble carbohydrates in coleoptile (mg CHO/g tissue dry wt.)						
	C ₁	18.4	19.2	20.2	22.2	20.2	0.17
	C ₂	18.6	19.9	22.3	25.2	21.5	
3.	Total soluble carbohydrates in endosperm (mg CHO/g tissue dry wt.)						
	C ₁	38.6	16.9	12.8	9.9	19.3	0.1
	C ₂	39.0	13.8	11.4	8.2	18.1	
4.	Total protein content in radicle (mg/g tissue dry wt.)						
	C ₁	21.6	19.0	16.5	11.1	17.0	0.20
	C ₂	21.6	17.5	15.5	12.0	16.6	
5.	Total protein content in coleoptile (mg/g tissue dry wt.)						
	C ₁	27.9	26.5	24.7	21.5	25.1	0.25
	C ₂	28.3	24.5	22.3	19.8	23.7	
6.	Total protein content in endosperm (mg/g tissue dry wt.)						
	C ₁	38.5	29.8	25.1	19.6	28.3	0.22
	C ₂	38.7	24.7	20.2	13.2	24.2	
7.	Free proline in radicle (μg/g tissue dry wt.)						
	C ₁	2.39	4.14	5.69	9.15	5.34	0.13
	C ₂	2.42	4.81	7.25	10.70	6.29	
8.	Free proline in coleoptile (μg/g tissue dry wt.)						
	C ₁	2.76	4.40	7.19	10.64	6.25	0.12
	C ₂	2.81	5.30	8.48	12.82	7.35	
9.	Free proline in endosperm (μg/g tissue dry wt.)						
	C ₁	0.35	0.64	0.89	1.36	0.81	0.02
	C ₂	0.36	0.85	1.49	2.24	1.23	
10.	Amino acids in radicle (mg/g dry wt.)						
	C ₁	12.05	16.02	20.82	23.85	18.58	0.12
	C ₂	12.09	14.49	15.87	19.31	15.44	
11.	Amino acids in coleoptile (mg/g dry wt.)						
	C ₁	13.00	17.08	20.32	24.26	18.67	0.11
	C ₂	13.04	18.60	21.29	25.50	19.61	
12.	Amino acids in endosperm (mg/g dry wt.)						
	C ₁	8.79	9.96	11.93	15.36	11.51	0.12
	C ₂	8.86	10.25	11.81	14.09	11.26	

C₁—Kharchia-65, C₂—C-308.

TABLE 3

Effect of salinity on nitrogen, potassium, sodium, chloride contents and K/Na ratio in radicle and coleoptile of two cultivars of wheat

S. No.	Parameter	Salinity levels				Mean	C. D. at 5%
		S ₀	S ₁	S ₂	S ₃		
1.	Nitrogen content in radicle (mg/g dry wt.)						
	C ₁	2.89	2.74	2.36	2.02	2.51	0.14
	C ₂	2.97	2.54	1.85	1.44	2.22	
2.	Nitrogen content in coleoptile (mg/g dry wt.)						
	C ₁	4.09	3.47	2.81	2.24	3.14	0.14
	C ₂	4.15	2.98	2.34	1.51	2.74	
3.	K-content in radicle (mg/g tissue dry wt.)						
	C ₁	1.23	1.10	0.97	0.82	1.03	0.11
	C ₂	1.30	0.96	0.79	0.56	0.90	
4.	K-content in coleoptile (mg/g tissue dry wt.)						
	C ₁	1.70	1.52	1.33	1.00	1.38	0.12
	C ₂	1.84	1.35	1.07	0.72	1.24	
5.	Na content in radicle (mg/g tissue dry wt.)						
	C ₁	—	1.77	2.38	4.44	2.14	0.49
	C ₂	—	1.52	2.88	4.91	2.32	
6.	Na content in coleoptile (mg/g tissue dry wt.)						
	C ₁	—	0.27	0.57	0.84	0.42	0.15
	C ₂	—	0.29	0.65	1.08	0.60	
7.	Cl-content in radicle (mg/g tissue dry wt.)						
	C ₁	1.14	1.19	1.30	1.56	1.30	0.12
	C ₂	1.20	1.30	1.40	2.20	1.52	
8.	Cl-content in coleoptile (mg/g tissue dry wt.)						
	C ₁	1.21	1.27	1.35	1.60	1.36	0.12
	C ₂	1.25	1.37	1.57	1.98	1.54	
9.	K/Na ratio in radicle						
	C ₁	1.23	0.83	0.45	0.18	0.67	0.18
	C ₂	1.30	0.66	0.60	0.11	0.66	
10.	K/Na ratio in coleoptile						
	C ₁	1.69	6.24	2.76	1.29	2.99	0.18
	C ₂	1.83	1.75	1.88	0.83	2.32	

C₁—Kharchia-85, C₂—C-306.

—Not detectable.

unutilized and magnitude of this was more in cultivar C-306 than in cultivar KH-65 (Table 2). As sugar is the major translocatable food material in plants, under salt stress the decrease of starch content is accompanied by a spurt in the insoluble sugar content (Karadge and Chavan, 1983). Khatra *et al.* (1985), while working with the germinating seeds of grain crops reported that salinity decreased starch degradation in cotyledons and its utilization by germinating embryos and this problem was accentuated further with a lesser availability of water to the seedling or plant as such under saline conditions.

Data presented in Table 2 show that protein content in the radicle, coleoptile and endosperm decreased relatively more in cultivar C-306 as compared to cultivar KH-65, whereas amino acids (in coleoptile) including free proline got accumulated in excess. The nitrogen accumulation could not be maintained which consequently diminished. These results suggest that protein synthetic machinery was relatively more affected in sensitive cultivar C-306 than in cultivar KH-65 which explicitly maintained higher protein synthesis even under saline conditions. These results corroborate the classic work of Strogonov (1964) and other workers (Garg and Garg, 1982), who have found a depletion in protein content in plant tissues under saline conditions. They attributed it to either non-availability of amino acids for protein synthesis or to increase of amino acid pool by depression in protein synthetic machinery or to

degradation/hydrolysis of proteins to amino acids.

Data in Table 3 reveal that potassium content in the radicle, coleoptile and endosperm decreased relatively more in sensitive cultivar C-306 as compared to that in salt resistant cultivar KH-65. It created deficiency of this essential nutrient with simultaneous accumulation of more sodium in sensitive cultivar C-306. Similarly chloride content in coleoptile and radicle was observed to be more in salt sensitive cultivar C-306 in comparison to cultivar KH-65. Likewise, relatively lower K/Na ratio and deficiency of phosphorus (an essential nutrient) were observed to be other factors responsible for rendering salt sensitivity to cultivar C-306. These results concurred with the general trend of results in various crop plants like gram, lentil, Jojoba, wheat, rice, sorghum and grape vines (Shah and Nadeem, 1976; Tal *et al.*, 1979; Sharma *et al.*, 1984; Fageria, 1985; Sinha *et al.*, 1986). These workers have found a decreased uptake of K^+ , Ca^{2+} , and Mg^{2+} under saline conditions. Moreover, K^+ was directly exchangeable or replaceable with Na^+ under salt stress. Even maintenance of high K/Na ratio has been shown to impart salt resistance in a number of crops (Datta *et al.*, 1993). Thus, salt resistance in KH-65 could be ascribed to : (a) restricted entry of Na^+ and Cl^- ions while maintaining higher concentration of K^+ , and (b) a concomitant retention of higher protein content especially in coleoptile and endosperm of seedlings.

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EFFECT OF WEED CONTROL ON DIRECT SEEDED PUDDLED RICE

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ABSTRACT

In a field experiment conducted to study the effect of weed control on direct seeded puddled rice, significantly higher panicles/m², grains/panicle, grain yield, and lower weed dry weight were recorded in hand weeding treatment which remained significantly better than the remaining treatments except weed free during 1989. Hand weeding proved as effective as herbicide checks, anilofos 0.45 (5 and 10 DAS) and 0.60 kg (10 DAS) in respect of above mentioned characters during 1990. Weed free was found better than hand weeding during both the years in most of the characters.

Rice grows in an environment conducive for intense weed infestation during the kharif season. Weeds grow almost simultaneously and compete with rice to ranging degree. However, losses caused by weeds go unnoticed. Yield reduction to the extent of 50-60 per cent and sometimes complete failure of the crop due to infestation of weeds have been reported by Poonia (1983). The weeds are similar to rice seedlings in their earlier stages of growth, hence, manual removal of weeds is very difficult, costly and time consuming. Keeping all this in mind, the present investigation was planned to find out the effect of weed control on direct seeded puddled rice.

MATERIAL AND METHODS

A field experiment was conducted during kharif 1989 and 1990 at H. P.

Krishi Vishvavidyalaya, Palampur on silty clay loam soil with acidic reaction (pH 5.4). The soil fertility was medium with available nitrogen 302.0 kg/ha, phosphorus 17.9 kg/ha and potassium 260.4 kg/ha. Three rates of anilofos (0.30, 0.45 and 0.60 kg/ha), three timings of its application (5, 10 and 15 days after sowing), three herbicide checks (oxadiazon 0.50 kg, butachlor 1.0 kg and pretilachlor 0.75 kg/ha), and three mechanical checks (hand weeding twice, weed free upto 70 days after sowing and unweeded) constituting 15 treatments were applied to the crop in randomised block design with three replications. Recommended package of practices were followed for raising the crop except weed control treatments. Rice crop in puddled soil was sown on 16 and 26 May, during 1989 and 1990, respectively. Puddling was done manually during 1989 and with

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WEED CONTROL IN DIRECT SEEDED PUDDLED RICE

TABLE 1
Effect of treatments on weed dry weight (g/m²) at 80 DAS, yield attributes and yield of rice

Treatment	Dose (kg/ha)	Time of application	Weed dry wt.		Panicles/m ²		Grains/panicle		Grain yield (kg/ha)	
			1989	1990	1989	1990	1989	1990	1989	1990
1. Anilofos	0.30	5 DAS	20.15 (406.0)	16.37 (267.9)	145.3	308.0	45.7	52.5	12.21 (151.5)	1496
2. Anilofos	0.30	10 DAS	22.86 (522.3)	18.65 (347.9)	82.7	245.3	32.0	46.9	5.86 (35.3)	730
3. Anilofos	0.30	15 DAS	23.78 (565.6)	20.02 (400.5)	46.7	198.7	29.8	40.6	0.71 (0.0)	448
4. Anilofos	0.45	5 DAS	19.95 (397.0)	11.96 (142.9)	161.3	401.3	47.2	59.5	16.16 (262.6)	2441
5. Anilofos	0.45	10 DAS	22.10 (487.0)	11.95 (142.5)	96.0	413.3	38.4	60.6	8.13 (70.6)	2508
6. Anilofos	0.45	15 DAS	22.72 (516.0)	19.20 (368.5)	64.0	254.8	31.8	49.0	2.32 (10.1)	1010
7. Anilofos	0.60	5 DAS	19.15 (366.7)	12.50 (156.8)	184.0	198.7	46.9	58.0	19.29 (373.7)	860
8. Anilofos	0.60	10 DAS	19.61 (384.0)	12.09 (146.0)	165.3	410.7	48.0	59.8	17.25 (298.0)	2347
9. Anilofos	0.60	15 DAS	22.41 (502.1)	19.00 (361.0)	85.3	246.7	32.3	48.6	4.57 (30.3)	945
10. Oxadiazon	0.50	PE	18.40 (339.3)	11.27 (126.6)	184.0	404.0	47.4	58.7	19.90 (399.0)	2323
11. Butachlor	1.00	PE	17.45 (304.3)	12.02 (144.1)	196.0	406.7	47.8	59.4	22.94 (530.3)	2437
12. Pretilachlor	0.75	PE	19.15 (368.0)	11.16 (124.3)	158.7	400.0	46.7	58.6	15.69 (247.5)	2289
13. Hand weeding	30 and 60 DAS		10.05 (101.0)	10.30 (106.0)	260.0	416.3	49.9	60.2	33.28 (1111.1)	2522
14. Weed free	upto 70 DAS		6.15 (37.5)	6.20 (38.1)	353.0	440.0	52.7	61.3	41.43 (1717.2)	3057
15. Unweeded check	—		24.31 (590.3)	20.94 (438.7)	38.7	189.3	30.6	39.5	0.71 (0.0)	284
S. Em±			0.45	0.43	6.19	8.11	0.82	0.91	1.23	087
C. D. at 5%			1.32	1.24	17.9	23.5	2.4	2.7	3.56	253

DAS—Days after sowing. PE—Pre-emergence.
Figures in parentheses are original values.

a power tiller during 1990. As per treatments, two hand weeding at 30 and 60 DAS were given in the crop. Weed free conditions were maintained upto 70 DAS by uprooting the weeds as and when appeared. Pre-emergence application of herbicides, viz. butachlor, oxadiazon and pretilachlor was made the next day of sowing with the help of knapsack sprayer using 600 litres of water per hectare. Anilofos was applied at 5, 10 and 15 DAS as per treatments. The weed dry weight data during both the years of study and grain yield data during 1989 were analysed after subjecting to square root ($\sqrt{x+0.5}$) transformation.

RESULTS AND DISCUSSION

The predominant weed species infesting the direct seeded puddled rice were *Echinochloa colona* (L.) Link and *Cyperus iria* L. during both the years. Other weed species like *Setaria glauca* (L.) Beauv, *Panicum repens* L. and *Commelina benghalensis* L. were observed during first year only.

Effect on Weed Dry Weight

Total weed dry weight was lowest in weed free and highest in unweeded check during both the years (Table 1). Hand weeding proved the next best treatment in reducing total weed weight during 1989. During this year, due to poor puddling and water management, the efficiency of herbicides was lower. Significant reduction in total weed dry weight was brought with anilofos 0.60 kg (5 DAS) and remained statistically similar to oxadiazon, pretilachlor, anilofos

0.45 (5 DAS) and 0.60 kg (10 DAS) during both the years and also with butachlor and anilofos 0.45 kg (10 DAS) during 1990. Late application (15 DAS) of anilofos proved less effective even during second year due to early post-emergence nature of herbicide.

Effect on Yield Attributes

During 1989, the number of panicles/m² and grains per panicle recorded in weed free treatment were significantly highest of all treatments. Hand weeding was the next best treatment which also proved superior over others in respect of panicles/m² (Table 1). Anilofos 0.45 (5 & 10 DAS) and 0.60 kg (10 DAS) and herbicide checks were as effective as hand weeding in increasing the panicles/m² and number of grains per panicle during 1990. Kumar and Gautam (1986) also observed an increase in panicles/m² and grains/panicle compared with weedy check by the application of butachlor and anilofos to direct seeded puddled rice.

Effect on Grain Yield

Weed free treatment recorded the highest grain yield and it was followed by hand weeding during both the years. However, hand weeding remained at par with anilofos 0.45 kg (5 and 10 DAS), 0.60 kg (10 DAS) and herbicide checks during 1990 only. Anilofos 0.60 kg (5 DAS) did not increase the yield over control due to its phytotoxicity during 1990. In general, late application of anilofos was found less effective during both the years (Table 1).

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EFFECT OF TIME AND METHOD OF ISOPROTURON APPLICATION ON WEEDS IN WHEAT

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ABSTRACT

Efficacy of isoproturon formulation was tested against weeds with time and method of application during winter seasons of 1991-92 and 1992-93. Wettable powder formulation of isoproturon was more toxic to weeds. It reduced the density and dry matter accumulation of weeds and consequently produced higher grain yield of wheat than flowable formulation during both the seasons. Spraying was the better method of isoproturon application than broadcasting with sand or urea. Early application (20 days before first irrigation) of isoproturon was better than late application (30 days after first irrigation) for satisfactory control of wild oat.

Isoproturon is reported to be an effective herbicide for wild oat (*Avena ludoviciana* Durieu) and canary grass (*Phalaris minor* Retz) control in wheat (Balyan *et al.*, 1988). It also controls lambsquarter to the extent of 50-60 per cent (Balyan *et al.*, 1988). The efficacy of a herbicide can be affected by time and method of application, soil moisture, soil type and other environmental factors (Fryer and Makepeace, 1977). The effectiveness of isoproturon and metoxuron was found to be better when applied at 2-4-leaf stage (Gill *et al.*, 1981; Gupta *et al.*, 1990). In India, herbicidal weed control in cereals is increasing day by day and more than 50% growers are using this. However, either due to lack of funds or because of easier herbicide application, many farmers don't use sprayer and apply herbicides by the broadcasting method. Broadcasting is generally done by mixing the herbicide

with urea or sand. The efficacy of tralkoxydim applied by different methods varied significantly (Balyan *et al.*, 1992). The effectiveness of isoproturon formulations with different methods was studied here.

MATERIAL AND METHODS

Field experiments were conducted at the Research Farm, CCS Haryana Agricultural University, Hisar on sandy loam soil (Typic Ustochrepts) with 60% sand, 22% silt, 18% clay, 0.37% organic carbon and pH of 8.1. Experiments were conducted in the winter seasons of 1991-92 and 1992-93. Wheat variety WH-283 was drilled on 20 and 19 November during 1991 and 1992, respectively. Fertilizer @ 100 kg N, 50 kg P_2O_5 and 25 kg $ZnSO_4$ per hectare and four irrigations were applied. The herbicide was sprayed with knapsack

TABLE 1
Visual toxicity and density of weeds as influenced by isoproturon application

Herbicide	Dose (kg a.i./ha)	Time of appli- cation (DAS)	Method of application	Visual toxicity (%)			Weed density (number/m ²)					
				Grassy Weeds		Broad leaf weeds	Grassy weeds		Broad leaf weeds			
				1991-92	1992-93	1991-92	1992-93	1991-92	1992-93	1991-92	1992-93	
Isoproturon WP	0.75	20	SP	(72)57.9	(87)68.8	(83)65.9	(77)61.7	(12)3.6	(2)1.6	(11)2.4	(10)3.3	
Isoproturon FL	1.00	20	SP	(38)38.2	(63)52.7	(68)55.8	(70)56.8	(25)5.0	(33)5.8	(14)3.9	(23)4.7	
Isoproturon WP	1.00	30	SP	(40)38.8	(40)57.9	(97)81.4	(82)64.7	(25)5.1	(35)5.9	(3)1.9	(0)1.0	
Isoproturon FL	1.50	30	SP	(13)21.3	(68)56.0	(68)56.1	(78)62.3	(57)7.6	(58)7.7	(5)3.0	(2)1.4	
Isoproturon WP	0.75	20	SM	(52)45.9	(68)55.9	(63)52.8	(65)53.8	(24)4.9	(35)5.9	(12)3.6	(8)2.9	
Isoproturon FL	1.00	20	SM	(55)47.8	(62)45.9	(68)55.8	(58)49.8	(27)5.2	(87)9.3	(17)4.2	(37)6.2	
Isoproturon WP	0.75	20	UM	(27)30.9	(62)51.8	(60)50.8	(62)51.9	(63)7.9	(47)6.9	(23)4.8	(43)6.6	
Isoproturon FL	1.00	20	UM	(12)19.9	(66)53.8	(77)61.3	(67)54.9	(66)8.2	(53)7.4	(27)5.3	(9)3.1	
Isoproturon WP	1.00	30	SM	(25)29.9	(65)53.8	(57)48.9	(78)62.3	(101)10.1	(31)5.6	(23)4.8	(19)4.5	
Isoproturon FL	1.50	30	SM	(20)26.4	(33)35.2	(60)50.8	(68)55.8	(112)10.6	(103)10.2	(32)5.6	(47)6.9	
Isoproturon WP	1.00	30	UM	(30)33.2	(62)40.1	(77)61.3	(57)48.9	(68)8.3	(127)11.3	(43)6.6	(11)3.5	
Isoproturon FL	1.50	30	UM	(15)22.6	(37)37.2	(60)50.8	(52)45.9	(85)9.3	(153)12.4	(54)7.4	(10)3.3	
Isoproturon + tralkoxydim	0.375 + 0.25	20	SP	(80)63.5	(83)67.0	(67)54.8	(80)63.5	(7)2.7	(5)2.5	(5)2.5	(8)2.8	
Unweeded check				(0)0.0	(0)0.0	(0)0.0	(0)0.0	(47)21.7	(247)15.7	(32)5.7	(37)6.1	
Weed free check				(100)90.0	(100)90.0	(100)90.0	(100)90.0	(0)1.0	(0)1.0	(0)1.0	(0)1.0	
L. S. D. (P=0.05)				— 6.3	— 8.6	— 8.2	— 5.9	— 1.3	— 0.9	— 0.8	— 0.6	

WP=Waterable Powder, FL=Flowable, SP=Spraying, SM=Seed mix broadcasting, UM=Urea mix broadcasting.
The original data on visual per cent control and weed counts are in parentheses which have been transformed to arcsin and $\sqrt{n+1}$ transformation, respectively.

TABLE 2
Dry weight of weeds, effective tillers and grain yield of wheat as influenced by isoproturon application

Herbicide	Dose (kg a.i./ha)	Time of application (DAS)	Method of application	Weed dry weight (g/m ²)			Effective tillers (number/m ²)			Grain yield (kg/ha)	
				Grassy weeds	Broad leaf weeds		1991-92	1992-93	1991-92	1992-93	
Isoproturon WP	0.75	20	SP	53.5	36.1	60.3	34.0	88	89	4671	5173
Isoproturon FL	1.00	20	SP	169.1	140.0	110.0	54.9	81	79	3596	4680
Isoproturon WP	1.00	30	SP	149.3	106.0	93.6	17.2	82	88	4547	5040
Isoproturon FL	1.50	30	SP	215.9	195.4	186.8	41.5	79	85	1704	4690
Isoproturon WP	0.75	20	SM	71.5	64.5	90.3	79.2	88	77	4007	4946
Isoproturon FL	1.00	20	SM	184.1	282.2	95.4	85.6	86	71	3457	4393
Isoproturon WP	0.75	20	UM	231.7	139.5	104.5	101.2	80	77	3303	4650
Isoproturon FL	1.00	20	UM	289.5	372.0	181.3	134.1	73	67	2917	4333
Isoproturon WP	1.00	30	SM	189.5	155.0	67.5	46.5	74	82	2868	4933
Isoproturon FL	1.50	30	SM	270.9	178.7	100.1	95.2	74	46	2062	3887
Isoproturon WP	1.00	30	UM	182.9	130.2	69.8	88.1	89	81	2447	4290
Isoproturon FL	1.50	30	UM	298.5	193.8	103.6	95.1	80	72	2435	3520
Isoproturon + tralkoxydim	0.375 + 0.25	20	SP	28.4	11.6	53.5	39.4	90	89	4651	5212
Unweeded check				517.3	387.6	419.5	216.0	54	66	1000	2066
Weed free check				0	0	0	0	91	93	4852	5400
L. S. D. (P=0.05)				83.4	98.6	67.5	37.3	7	10	497	424

sprayer using 500 l water/ha. Per cent control of weeds was rated visually 50 days after sowing. To obtain the data on weed emergence, 0.25 m² quadrat was placed randomly at three spots in each plot 50 days after sowing. Actual weed counts were transformed to $\sqrt{n+1}$ to normalize data prior to analysis. Wheat grain yield was recorded at crop harvest from 6 m x 2 m size plots. Per cent control data were also transformed by arcsin transformation.

RESULTS AND DISCUSSION

The data in Table 1 reveal that visual phytotoxicity on weeds of wettable powder formulation of isoproturon was higher than flowable formulation during both the seasons. Early application of isoproturon formulations was more toxic to weeds than late application. Among different methods, spraying of both the formulations proved significantly more toxic than broadcasting with urea or sand at both the stages of crop growth.

Density and dry weight of weeds (Tables 1 and 2) showed almost identical trend to that of visual toxicity. Isoproturon (WP) and tralkoxydim combination at 0.375 kg and 0.25 kg/ha sprayed 20

DAS reduced the density and dry weight of weeds drastically followed closely by isoproturon (WP) 0.75 kg spraying at 20 DAS (Table 2). Maximum grain yield of wheat (4852 and 5400 kg/ha during 1992 and 1993, respectively) was recorded in season long weed free conditions. Isoproturon wettable powder formulation sprayed at 20 and 30 DAS and combination of isoproturon and tralkoxydim at 0.375 kg and 0.25 kg/ha produced statistically same yield to that of weed free yield. Rest of the treatments produced significantly lower grain yield than weed free plots (Table 2). Application at 20 DAS produced higher yield than 30 DAS. Similarly, wettable powder formulation provided higher yield than flowable; and spraying method of isoproturon was better than broadcasting. Significantly good control of weeds and consequently better crop character and grain yield of wheat with wettable powder formulation spraying at 20 days stage was due to better kill of weeds owing to their young age and uniform spray of isoproturon. Gill *et al.* (1981) and Gupta *et al.* (1990) also observed that application of metoxuron and isoproturon at early stages of wild oat (2-3 leaf) provided excellent control.

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EFFECT OF POLLEN STORAGE ON ITS VIABILITY IN JOJOBA (*SIMMONDSIA CHINENSIS* (LINK.) SCHNEIDER)

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ABSTRACT

Pollen grains of two Jojoba strains, viz. EC 124381 and EC 99691 were collected and stored at room temperature (12°-27°C) for 100 days, and stained with aceto-carmin (1%) at different intervals. About 67% pollen grains of EC 124381 and 80% of EC 99691 got darkly stained, but these were not physiologically viable because they did not set seeds when used to pollinate female flowers bagged at bud stage to restrict entrance of foreign pollen. However, considerable seed setting resulted using 45 and 60 days old pollen grains. It ranged from 78 (EC 99691) to 90 per cent (EC 124381) using 45 days old and 50 (EC 99691) to 82 per cent (EC 124381) using 60 days old pollen grains. Obviously, pollen stainability and viability are uncorrelated in Jojoba. However, longer viability may be effectively utilized in Jojoba improvement programmes in various ways.

Jojoba (*Simmondsia chinensis* (Link.) Schneider) is a dioecious oil yielding shrub adapted to desert conditions. It takes 2-4 years to flower after transplanting and generally flowers from November to April. Male plants flower about one month earlier than female plants (Anonymous, 1985; Chhabra *et al.*, 1991). The pollination occurs through wind. Female plants produce seeds containing 45-50 per cent oil of economic importance which is unique in plant kingdom as a substitute of sperm whale oil (Anonymous, 1985).

Insufficient seed availability of elite genotypes is the major bottleneck in the development of Jojoba at commercial scale. Non-synchronization of male and female flowering is a hinderance in this direction. Plant breeding can aid in the

development of promising Jojoba strains through selection and hybridization. Therefore, selection of superior males which result in higher seed set, shed pollen in abundance over a longer period with longer viability need priority for research. Keeping this in view, the present studies were carried out on pollen viability and effect of pollen storage.

MATERIAL AND METHODS

Male plants started flowering in October-November, whereas female plants flowered from December to April in 1990. Pollen was available in abundance during mid-December. Therefore, bulk amount of pollen was collected from two Jojoba strains (EC 99691 and EC 124381) on 15 and 19 December, and stored in parch-

ment paper bags at room temperature. The temperature during storage varied from 12°-27°C (December to March). Pollen grains were stained with aceto-carmin (1%) at different intervals, *i. e.* after 10, 20, 30, 45, 60, 75, 90 and 100 days of collection, and simultaneously these pollen grains were also used to pollinate 20-25 female flowers depending upon the availability. These pistillate flowers were bagged with parchment paper bags at the bud stage to avoid contamination by any foreign pollen (twenty of these were not artificially pollinated). Bags were removed when the fruit development initiated. Per cent fruit set was calculated at maturity.

RESULTS AND DISCUSSION

Results of pollen staining and seed setting using stored pollen are presented in Fig. 1. Fresh pollen set 90-100 per

cent seeds. Pollen staining at various intervals showed that majority of 100 days old pollen got darkly stained with aceto-carmin (1%). The pollen stainability ranged from 67 (EC 124381) to 80 per cent (EC 99691). However, seed setting using 100 days old pollen was negligible. It was worth noting that 45 days old pollen fertilized 78-90 per cent of female flowers which is usually not the case with other cultivated crops. Female flowers which were not artificially pollinated, did not set seeds. Therefore, pollen stainability is not indicative of pollen viability in the present case.

Lee *et al.* (1985) reported that when Jojoba pollen grains were stored at room temperature (22°-25°C), the initial pollen viability was decreased to 50% in three weeks and completely lost after ten weeks. But they studied the pollen viability by testing germination on various

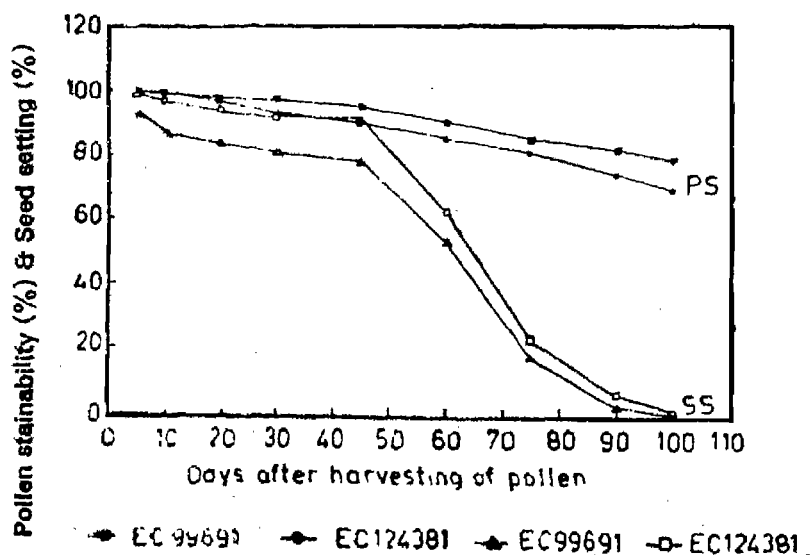


Fig. 1. Pollen stainability (PS) and seed setting (SS) in Jojoba.

VIABILITY OF POLLEN IN JOJOBA

artificial media with a pH of 4-8. On the other hand, the present results are based on the experiment conducted under normal conditions providing the pollen natural conditions to fertilize the ovum.

Thus, the problem of non-synchronizing flowering behaviour in Jojoba (male plants flowering in October-November and female plants flowering in December to April) can be overcome by preserving the

pollen in parchment paper bags at room temperature and using the same (upto 45 days) to pollinate female flowers as and when they emerge. This way 78-90 per cent fertilization in female flowers is possible. Present study also hints that pollen stainability, which was as high as 67-80 per cent in 100 days old pollen, is not indicative of corresponding pollen viability.

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FREQUENCY AND INCIDENCE OF WEED FUNGI ENCOUNTERED DURING CULTIVATION OF *AGARICUS BISPORUS* (LANGE) IMBACH

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ABSTRACT

During survey of different mushroom units located in Himachal Pradesh and Haryana, 11 weed fungi were recorded. Occurrence of *Papulaspora byssina*, *Trichoderma viride*, *Myceliophthora lutea*, *Trichothecium roseum* and *Chaetomium globosum* was frequent at various mushroom units during 1991 and 1992. In general, all the weed fungi were more frequent during rainy season as compared to winter season barring *Sepedonium* sp. and *C. globosum*. Incidence of *P. byssina* was found to be highest (78%).

Various species of weed fungi causing considerable mushroom crop losses have been reported by different workers (Fergus *et al.*, 1963; Fletcher, 1987; Thapa *et al.*, 1991). In addition to competition for nutrients, water and space, some weed fungi are antagonistic to the mushroom mycelium and once established prevent the mushroom mycelium for growing into the affected compost. The objective of the present study was to record the incidence and frequency of occurrence of weed fungi encountered during various production cycles of *A. bisporus*.

MATERIAL AND METHODS

A regular survey of the mushroom units at different locations in Himachal Pradesh (Chail, Shimla and Solan) and Haryana (Sonapat and Kurukshetra) was conducted during different seasons (rainy

and winter) of 1991 and 1992. The samples of compost and casing material infected with various weed fungi were collected in polythene bags and kept in a refrigerator (3°-5°C) for isolations.

The different weed fungi collected on compost and/or casing material from various units were employed for establishing pure cultures. Bits of infested compost and casing material were directly picked and placed in the centre of a petriplate containing sterilized potato dextrose agar (PDA) medium amended with 50 µg/l streptomycin. The cultures were further purified by standard hyphal tip method.

Based on macroscopic appearance (type of sporulation and/or mycelium seen in the compost/casing material) as well as various microscopic characteristics (Barnett and Hunter, 1972) the identity of different weed fungi was ascertained.

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The per cent incidence of each weed fungus was calculated by using the following equation :

Per cent incidence=

$$\frac{\text{No. of infected bags/trays in a unit}}{\text{Total no. of bags/trays in a unit}} \times 100$$

and average per cent incidence of the weed fungus at different mushroom units in a particular locality was worked out.

The frequency of occurrence of different weed fungi was recorded on the basis of number of mushroom units infected during particular season.

RESULTS AND DISCUSSION

Frequency of Occurrence

It is apparent from the data in Table 1 that in all 11 weed fungi were recorded at mushroom units surveyed. Among

TABLE 1

Frequency of occurrence of various weed fungi at different mushroom units during 1991

Weed fungi	Frequency							
	Locations		Chail		Shimla		Solan	
	Units surveyed		4		4		5	
	Season		W	R	W	R	W	R
<i>Trichothecium roseum</i>			1 (2)	2 (2)	1 (2)	3 (3)	1 (1)	2 (3)
<i>Trichoderma viride</i>			1 (2)	4 (4)	1 (4)	4 (4)	2 (5)	5 (5)
<i>Chaetomium globosum</i>			1 (2)	2 (1)	2 (1)	2 (2)	2 (1)	3 (1)
<i>Coprinus</i> sp.			— (1)	2 (2)	1 (—)	3 (2)	1 (1)	2 (3)
<i>Dicliomyces microsporus</i>			— (—)	1 (3)	— (—)	1 (1)	1 (1)	1 (3)
<i>Oedocephalum</i> sp.			1 (1)	2 (1)	— (1)	2 (2)	1 (1)	1 (3)
<i>Papulaspora byssina</i>			4 (4)	4 (4)	3 (2)	4 (4)	5 (4)	5 (5)
<i>Pythium</i> sp.			1 (—)	2 (1)	— (1)	1 (2)	2 (1)	2 (3)
<i>Mycellophthora lutea</i>			1 (3)	2 (4)	1 (1)	2 (2)	4 (4)	4 (4)
<i>Sepedonium</i> sp.			1 (1)	1 (1)	— (2)	1 (2)	2 (2)	1 (1)
<i>Sporendonema</i> sp.			— (1)	1 (2)	2 (1)	3 (1)	1 (2)	1 (3)

Figures in parentheses represent frequency during 1992.

W=Winter, R=Rainy, —=not detected.

TABLE 2

Incidence of various weed fungi at different mushroom units during 1991

Weed fungi	Average per cent incidence							
	Chail		Shimla		Solan		Sonepat Kurukshetra	
	Units surveyed		4		5		6	
Season	W	R	W	R	W	R	W	W
<i>Trichothecium roseum</i>	10.0 (20.5)	17.5 (22.0)	22.0 (12.0)	35.5 (15.5)	18.5 (14.0)	40.0 (65.0)	12.0 (34.0)	10.0 (4.5)
<i>Trichoderma viride</i>	12.5 (15.0)	58.5 (60.0)	18.5 (45.0)	70.0 (14.5)	15.0 (22.5)	46.0 (70.0)	45.5 (24.0)	42.0 (26.0)
<i>Chaetomium globosum</i>	30.0 (12.0)	10.0 (10.0)	15.0 (12.0)	25.0 (10.0)	3.0 (15.0)	25.0 (54.0)	15.0 (18.0)	12.0 (8.0)
<i>Coprinus</i> sp.	— (1.5)	2.0 (4.0)	1.0 (—)	3.5 (8.0)	4.0 (2.5)	10.0 (14.0)	14.5 (12.0)	14.0 (2.0)
<i>Diehliomyces microsporus</i>	— (—)	20.0 (45.0)	— (—)	10.0 (25.5)	2.0 (4.0)	10.0 (25.0)	12.0 (7.5)	— (—)
<i>Oedocephalum</i> sp.	5.0 (3.0)	15.0 (12.0)	— (2.5)	10.0 (8.0)	2.0 (3.0)	5.0 (19.0)	4.0 (12.0)	2.0 (—)
<i>Papulaspora byssina</i>	18.0 (10.0)	30.0 (34.0)	20.0 (28.0)	60.0 (76.0)	34.0 (30.0)	70.0 (55.0)	64.0 (78.0)	34.0 (66.0)
<i>Pythium</i> sp.	2.0 (—)	8.0 (3.0)	— (1.0)	4.0 (10.5)	2.0 (1.5)	8.0 (12.0)	10.0 (4.0)	4.0 (5.0)
<i>Myceliophthora lutea</i>	2.0 (17.0)	12.0 (38.0)	10.0 (3.0)	40.0 (22.0)	45.0 (50.0)	25.0 (35.0)	5.0 (18.0)	25.0 (14.0)
<i>Sepedonium</i> sp.	3.0 (1.5)	7.0 (5.0)	— (2.0)	5.0 (12.0)	7.5 (4.5)	2.5 (10.0)	4.0 (12.0)	2.0 (2.0)
<i>Sporendonema</i> sp.	— (11.5)	2.0 (15.0)	5.0 (1.5)	15.0 (4.0)	1.5 (4.0)	5.0 (11.5)	— (—)	— (—)

Figures in parentheses represent incidence during 1992.

W=Winter. R=Rainy —=not detected.

different weed fungi observed, *Papulaspora byssina* was most frequently encountered almost in all the mushroom units in both the years during different seasons. The other most frequently recorded weed fungi were *Trichoderma viride*, *Myceliophthora lutea*, *Trichothecium roseum* and *Chaetomium globosum* in decreasing order at various mushroom units during different years. However, *Diehliomyces microsporus* could not be detected at Chail and Shimla during winter in both the years. Even this weed fungus could not be detected during 1992 winter at Sonepat and Kurukshetra. In general, all the weed fungi were encoun-

tered more frequently during rainy season as compared to winter season barring *Sepedonium* sp. and *C. globosum*. Sinden (1971) published a list of 15 moulds with their effects on mushroom mycelium. Many more have been added to this list and the most frequently mentioned moulds occurring in mushroom crop in U. K. (Fletcher, 1987). Occurrence of different weed fungi at various mushroom units in India and abroad has been reported by many workers (Sinden, 1971; Munjal and Seth, 1974; Seth and Bhardwaj, 1989; Tewari and Singh, 1991) and the present investigations are no exception to their occurrence.

Incidence

Maximum per cent incidence (Table 2) was recorded during rainy season irrespective of mushroom units and years except in case of *C. globosum* and *M. lutea*, incidence of which was comparatively less during rainy season as compared to winter season in both the years at Chail and Solan, respectively. In general, among different weed fungi recorded, incidence of *P. byssina* was highest followed by *T. viride*, *T. roseum*, *C. globosum* and *M. lutea* in descending order. Incidence of species of *Coprinus* and *Pythium* was minimum (1%) during 1991 and 1992 winter season, respectively at Shimla, whereas incidence of *P. byssina* was maximum (78%). *Sporandonema* sp. was not observed during 1991 and 1992 winter seasons in various mushroom units located at

Sonepat and Kurukshetra, whereas *D. microsporus* could not be recorded during winter seasons of 1991 and 1992 in different mushroom units located at Chail, Shimla and Kurukshetra. Thapa and Seth (1986-87) reported the incidence of *M. lutea* ranging from 20 to 60 per cent at Shimla, Chail, Solan and Kasauli during 1981-83. Tewari and Singh (1991) observed that incidence of undesirable fungi (*T. harzianum*, *T. longibrachiatum*, *C. globosum* and *Epicocum nigrum*) in mushroom beds varied from 20 to 40 per cent at different places surveyed. The variation in incidence of different weed fungi at different places may be attributed to variation in compost parameters (pH, temperature, moisture, ammonia) and over- and under-composting as well as growing conditions coupled with general hygiene in and around the mushroom units.

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A COMPARISON OF GENETIC VARIABILITY GENERATED BY FIVE SELECTION PROCEDURES IN WHEAT

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ABSTRACT

Five F_2 populations produced by applying single plant selection (SPS), single spike selection (SSS), single seed descent (SSD), selection on yield *per se* (SOY) and mechanical mass selection (MMS) in two wheat (*Triticum aestivum* L. em. Thell) crosses, viz. (WCB 74 × HD 2285) HFW 28, and (WCB 73 × HD 2329) WH 559 and F_2 populations of these crosses were compared for their mean performance and three variability parameters (range, variance and coefficient of variation) for six metric traits, viz. days to heading, plant height (cm), tiller number, grain number, 1000-grain weight (g), and grain yield per plant (g). Selection based on single plant followed by single spike selection proved better than other selection procedures in terms of mean performance. F_2 , F_2 SSD, and F_2 SSS, in order, exhibited high range of distribution. Maximum variance and coefficient of variation were observed for F_2 SSD followed by F_2 SSS and F_2 SPS.

Selection procedures assume considerable importance in varietal improvement programmes of self-fertilized crops like wheat. Several selection procedures and related modifications such as pedigree, simplified pedigree selection, single spike selection, single seed descent, multiple seed descent, mechanical mass selection and selection on yield *per se* have been proposed for the genetic improvement in wheat crop (Knott and Kumar, 1975; Snee *et al.*, 1979; Pawar *et al.*, 1986; Ndondi, 1987; Pawar *et al.*, 1991). Nevertheless, pedigree selection has been applied most extensively. However, genetic improvement to be achieved depends upon carefully chosen parents, extent of genetic variability present in early segregating generations and the efficiency of a selection procedure

used to handle segregating populations because individuals having all the desirable loci in either homozygous or heterozygous condition occur most often in early generations. Keeping this in view, the present study was carried out to compare genetic variability generated by five selection procedures in early segregating generations of two wheat crosses.

MATERIAL AND METHODS

Five selection procedures, viz. single plant selection (SPS), single spike selection (SSS), single seed descent (SSD), selection on yield *per se* (SOY) and mechanical mass selection (MMS) were exercised in large F_2 populations (5000 plants) of two wheat crosses, viz. (WCB

74×HD 2285) HFW 28, and (WCB 73×HD 2329) WH 559 grown in two lots during rabi 1991-92. Under SSD selection method, the unit of selection was one seed from every F_2 plant. In single plant selection, 5% of individual plants in each cross were selected on the basis of plant vigour, number of tillers, ear and seed characteristics, and disease resistance to raise F_3 (SPS) progenies. In case of mechanical mass selection, F_2 bulk seed including representative seed from 5% top yielding plants was subjected to mechanical mass selection for grain size using a sieve of the size 4×4 mm and thus constituted F_3 (MMS) population. In single spike selection, seeds from one ear head from each selected plant were bulked to generate F_3 (SSS) population. For selection on yield *per se*, the actual yields of F_2 plants from second lot were recorded and about 5% top yielding plants were selected. Finally, six populations of each of the two crosses, *viz.* F_3 and F_3 SPS, F_3 SSS, F_3 SSD, F_3 MMS, and F_3 SOY generated through different selection procedures were evaluated during rabi 1992-93 at CCS Haryana Agricultural University Research Farm in a randomized block design with four replications allotting 3 m long 30 rows to each of F_2 and F_3 populations per replication. The rows were spaced at 25 cm apart with 10 cm distance between plants. The data were recorded on 150 randomly selected plants in each of the six populations from each replication in both crosses for six characters, *viz.* days to heading, plant height (cm), number of effective tillers per plant, number of grains per ear, 1000-grain weight (g), and grain yield per plant (g). Data were subjected to

statistical analysis following the method of Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

Comparison of Mean Performance

The mean values of F_2 , F_3 SPS, F_3 SSS, F_3 SSD, F_3 SOY and F_3 MMS for both the crosses are presented in Table 1. The mean values of F_3 population generated through single plant selection were significantly better than those of other populations except F_3 SSS population, whereas F_3 SPS proved significantly superior to F_3 SSS in three cases only (grains per ear in cross 1, tiller number and grain yield in cross 2), while in rest of the cases, both were equally effective. This indicated preponderance of additive gene effects for these traits. Effectiveness of selection for yield and its component traits has also been reported by Alessandroni and Scalfati (1973), Whan *et al.* (1982), Alexander *et al.* (1984), Pawar *et al.* (1986), Nass (1987), Srivastava *et al.* (1989) and Matuz *et al.* (1992). Single spike selection (SSS) method was significantly superior in terms of mean performance to its original SSD version for plant height in cross 2, grain yield in cross 1 and for days to heading in both the crosses. SSD method showed significant superiority for mean performance over SOY for plant height and tillers per plant in cross 1 and for grain yield in cross 2. The SSD method has been found better than bulk method by Pawar *et al.* (1985, 1986) and Srivastava *et al.* (1989). They suggested the use of SSD procedure as an effective supplement to pedigree method of selection. A comparison of selection on yield *per se* with mechanical mass selection

TABLE 1

Mean values for six metric traits in F_2 and F_3 populations developed through different selection procedures in two wheat crosses, 1—(WCB 74×HD 2285) HFW 28, and 2—(WCB 73×HD 2329) WH 559

Trait	Cross	F_2 population	Single plant selection	Single spike selection	Single seed descent	Selection on yield <i>per se</i>	Mechani- cal mass selection	LSD (5%)
Days to heading	1	102.10	88.12	92.56	98.42	101.31	104.15	4.47
	2	98.26	91.86	88.35	101.21	99.62	100.84	3.44
Plant height	1	104.58	98.73	102.46	100.41	104.80	106.36	3.83
	2	107.18	102.52	100.74	107.83	106.92	109.11	4.13
Tiller number	1	8.37	14.51	12.64	11.82	8.73	7.46	2.27
	2	10.61	16.83	14.21	12.64	12.21	11.24	2.25
Grain number	1	53.12	59.80	55.19	52.47	53.84	51.62	4.21
	2	47.31	57.61	54.72	50.32	51.36	49.53	4.64
1000-grain weight	1	43.13	42.56	41.28	40.13	42.41	46.36	3.21
	2	40.26	39.37	42.41	41.71	40.22	43.94	3.64
Grain yield per plant	1	22.67	29.32	26.76	22.36	20.18	18.51	4.30
	2	24.29	33.30	30.17	28.69	25.42	22.87	2.97

TABLE 2

Range of distribution for six metric traits in F_2 and F_3 populations developed through different selection procedures in two wheat crosses, 1—(WCB 74×HD 2285) HFW 28, and 2—(WCB 73×HD 2329) WH 559

Trait	Cross	F_2 population	Single plant selection	Single spike selection	Single seed descent	Selection on yield <i>per se</i>	Mechanical mass selection
Days to heading	1	89-106	87-102	86-104	85-105	89-104	89-105
	2	86-100	84-96	83-98	83-101	86-98	86-100
Plant height	1	95-114	92-109	93-109	91-112	95-110	96-112
	2	98-118	91-106	90-106	89-109	98-107	97-109
Tiller number	1	5-27	8-26	7-24	6-25	7-21	7-22
	2	4-32	7-23	6-22	4-22	6-18	5-16
Grain number	1	32-74	37-69	36-62	35-63	39-58	36-53
	2	36-68	40-66	38-58	39-58	38-51	39-52
1000-grain weight	1	36-59	38-59	38-60	36-58	36-56	36-59
	2	34-58	41-57	40-56	39-56	38-53	40-58
Grain yield per plant	1	10-42	15-34	14-32	11-29	13-26	14-25
	2	13-47	19-46	16-41	12-40	15-29	12-28

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TABLE 3

Variances for six metric traits in F_2 and F_3 populations developed through different selection procedures in two wheat crosses, 1—(WCB 74×HD 2285) HFW 28, and 2—(WCB 73×HD 2329) WH 559

Trait	Cross	F_2 population	Single plant selection	Single spike selection	Single seed descent	Selection on yield per se	Mechanical mass selection
Days to heading	1	107.60	54.40	49.74	87.78	33.22	42.91
	2	159.67	72.68	51.72	75.58	40.26	32.69
Plant height	1	230.26	131.39	146.42	159.04	88.37	97.21
	2	182.95	87.61	107.45	157.53	99.08	128.51
Tiller number	1	6.81	4.13	3.76	4.38	1.33	0.84
	2	9.43	6.82	5.24	4.04	2.31	1.52
Grain number	1	114.79	61.46	70.65	82.21	60.69	42.30
	2	78.18	67.48	60.29	60.21	35.07	25.47
1000-grain weight	1	49.24	25.17	28.04	29.17	27.70	29.62
	2	33.79	23.25	23.73	24.26	21.49	33.18
Grain yield per plant	1	101.95	85.84	75.49	71.89	31.49	23.78
	2	90.80	81.01	81.59	86.35	54.83	31.16

TABLE 4

Coefficient of variation (%) for six metric traits in F_2 and F_3 populations developed through different selection procedures in two wheat crosses, 1—(WCB 74×HD 2285) HFW 28, and 2—(WCB 73×HD 2329) WH 559

Trait	Cross	F_2 population	Single plant selection	Single spike selection	Single seed descent	Selection on yield per se	Mechanical mass selection
Days to heading	1	10.15	8.36	7.61	9.51	5.68	6.28
	2	12.85	9.27	8.13	8.58	6.36	5.66
Plant height	1	14.50	11.60	11.30	12.55	8.96	9.28
	2	12.61	9.12	10.28	11.63	9.30	10.38
Tiller number	1	31.06	13.99	15.34	17.68	13.17	12.33
	2	28.93	15.50	16.04	15.90	12.44	10.94
Grain number	1	20.16	13.09	15.22	17.26	14.46	12.59
	2	18.68	14.25	14.18	15.40	11.52	10.17
1000-grain weight	1	16.25	11.77	12.81	13.45	12.40	11.73
	2	14.43	12.24	11.55	11.79	11.61	13.10
Grain yield per plant	1	44.51	31.58	32.43	37.88	27.79	26.31
	2	39.19	27.02	29.93	32.38	29.11	24.39

Indicated non-significant differences for mean values for all the characters except for 1000-grain weight in both the crosses. In the latter case, MMS was found to be superior to the former method. Effectiveness of MMS has also been reported by Rana *et al.* (1983) and Srivastava *et al.* (1989). On the basis of mean performance, it can be concluded that selections based on single plant and single spike, in order, were found superior, in general, to other selection procedures except mechanical mass selection which proved better for 1000-grain weight.

Comparison of Variability

The range of distribution for six metric traits in six different populations of two crosses has been given in Table 2. The maximum range for all the traits in both the crosses was exhibited by F_2 population, whereas the minimum range was observed for F_2 SOY. The greater range limits were maintained by F_2 SSD, F_2 SSS and F_2 SPS in order, in almost all the cases. The F_2 SOY and F_2 MMS, in general, had almost the same range. Therefore, the three methods, single seed descent, single spike selection and single plant selection proved effective for maintaining sufficient range values.

Variances and coefficients of variation (%) for six characters in six different populations have been given in Tables 3 and 4. Variances and coefficient of varia-

tion in single seed descent, single spike selection and single plant selection, in order, proved superior to selection on yield *per se* and mechanical mass selection in terms of retaining relatively higher variability for different traits in the populations. The range and variances in F_2 SPS population were comparatively lower than F_2 SSD and F_2 SSS populations for all the cases except for tiller and grain number in cross 2 and grain yield in cross 1 for which values of variances were higher in F_2 SPS population. It is because of the fact that selection of the single plants was only for superior types which reduced the range and variability for different traits. Further, single spike selection showed reasonably high means as well as high variances as compared to other methods. Knott and Kumar (1975), Tee and Qualset (1975), Srivastava *et al.* (1989) and Pawar and Singh (1991) also found SSD method better or equal to pedigree selection for maintaining genetic variability.

Hence, on the basis of results of the present study, it can be suggested that single seed descent or rather more practical option, that is, single spike descent seemed to be an effective supplement to traditional pedigree selection in early segregating generations where it is difficult for a breeder to handle large number of crosses owing to limited available resources (land, labour, time, etc.).

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AN ECONOMIC ANALYSIS OF GRAPE CULTIVATION IN HISAR DISTRICT OF HARYANA STATE

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ABSTRACT

An economic analysis of grape cultivation has been done on the basis of primary data collected from three blocks of Hisar district. On an average, the establishment cost of grape orchard came out to be Rs. 88,164 per hectare. The operational cost increases with the age of orchard upto 7th year and thereafter it becomes almost stagnant. The grape orchard starts paying positive returns in the 4th year of its establishment. The net discounted returns came to be Rs. 61,734.53, internal rate of return 23%, payback period 8 years and benefit-cost ratio 1.18. On the basis of NPV it may be concluded that grape cultivation is an economically viable venture. Hence, every effort should be made to make this enterprise a more paying by providing incentives and creation of required marketing and processing infrastructures.

Grape is one of the major commercial fruit crops grown in India. It is one of the delicious and nutritive fruits. It contains high percentage of glucose content—an easily digestible form of sugar. It is also rich in iron, calcium and vitamins. Grape cultivation is gaining importance in parts of Haryana, Punjab, Rajasthan and other regions of the country.

In Haryana state, grape cultivation has gained momentum and now-a-days, it is considered one of the major fruit crops, with substantial contribution to the economy of the State.

Grapes are grown successfully in all the districts of the State except Ambala, Karnal and Kurukshetra. Its cultivation is most suited to sandy loam, well

drained and fairly fertile soils containing a fair amount of organic matter.

No doubt, grape cultivation is profitable but it requires heavy initial investment in the form of capital, labour and skilled management. To examine the economic feasibility of grape cultivation, it is necessary to know the initial cost in establishing a grape orchard, method of financing such long term investments, average cost of production and returns, the amortising capacity of such an orchard and profitability of grape cultivation. So in the present study, an attempt has been made to study the economics of grape cultivation.

METHODOLOGY

The present study was conducted in Haryana state. Hisar district (highest

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grape growing area in the State) was purposively selected to study the cost of production in the State during 1990-91.

Multistage stratified random sampling technique was adopted to select the ultimate unit of the sample.

On the basis of available irrigation facilities, Hisar district was divided into three zones to have a better representation of the whole district. 'A' zone covered the blocks of Tohana, Fatehabad and Ratia having high assured irrigation facilities. 'B' zone comprised Hisar I, Hisar II, Adampur, Agroha and Bhattu blocks having less assured irrigation. 'C' zone consisted Barwala, Uklana, Bhuna, Narnaund, Hansi and Bass blocks having moderate assured irrigation facilities. One block was selected from each zone purposively keeping in view the highest area under grape bearing orchards. In this way, amongst 14 blocks in the district, three blocks, viz. Ratia, Hisar II and Barwala were selected from zones 'A', 'B' and 'C', respectively. Three villages were selected from each selected block by applying the probability proportion to size (pps) technique where the area under grape acted as a size. Thus, three villages each from block Ratia (Nangal, Lali and Sardarewala), Hisar II (Dobhi, Kharla and Arya Nagar), and Barwala (Juglan, Behbalpur and Daulatpur) were selected. About 20% of the grape bearing orchardists were randomly selected from each selected village. Thus, in all a sample of 72 grape growers was selected randomly from the sample villages. Primary data pertaining to the year of 1990-91 were collected from the selected respondents by conducting

personal interviews on a specifically designed schedule.

RESULTS AND DISCUSSION

Economics of Grape Cultivation

Opportunity Cost Land Rent

The land rent in Hisar district, on an average, was observed as Rs. 5545 per hectare per annum.

Establishment Cost

The total cost of establishing a grape orchard in Hisar district during the year 1990-91 worked out to be Rs. 88,164 (Table 1). Sundaresan and Thanaskaran (1984) analysed the cost and returns of cultivation of Muscat grapes in Madurai district and found that an average of Rs. 49,467 per hectare was required for establishing vines to bearing age.

Operational Cost

After establishment of a grape orchard, other costs such as application of manures and fertilizers, interculture and hoeing, pruning and training, irrigation and plant protection, etc. are incurred. The operational costs observed were Rs. 4062 (1st year), Rs. 5552 (2nd year), Rs. 6752 (3rd year), Rs. 7084 (4th year), Rs. 7272 (5th year), Rs. 7509 (6th year), and Rs. 7514 (7th year) for the first seven years of the establishment of grape orchard (Table 2). It was observed that the operating costs per hectare increased over years because of higher expenses incurred on manures and fertilizers. This increase may be attributed to the direct

TABLE 1
Establishment cost of an orchard

S. No.	Operation	Cost (Rs./ha)	Percentage to total establishment cost
1.	Preparation of land and layout	405	0.46
2.	Digging of pits	2,550	2.89
3.	Cost of plants and plant material	2,240	2.54
4.	Planting	515	0.58
5.	Construction of supporting structure and fencing	80,033	90.78
6.	Manures and fertilizers	2,086	2.37
7.	BHC 10% dust	85	0.10
8.	Miscellaneous (Scateur, etc.)	250	0.28
Total		88,164	100.00

TABLE 2
Operational cost (Rs./ha) of grape orchard

Item	Year						
	1	2	3	4	5	6	7
Manures and fertilizers	2197 (54.09)	3010 (54.22)	3397 (50.31)	3640 (51.38)	3865 (53.15)	4085 (54.40)	4097 (54.52)
Interculture and hoeing	760 (18.71)	748 (13.47)	753 (11.15)	758 (10.70)	745 (10.24)	781 (10.40)	772 (10.27)
Irrigation	650 (16.00)	677 (12.19)	680 (10.07)	742 (10.47)	735 (10.11)	721 (09.50)	727 (09.68)
Pruning and training	—	350 (08.30)	787 (11.66)	782 (11.04)	795 (10.93)	780 (10.39)	768 (10.22)
Insecticides and fungicides	455 (11.20)	767 (13.82)	1135 (16.81)	1182 (16.41)	1132 (15.57)	1142 (15.21)	1150 (15.31)
Total	4082 (100.00)	5552 (100.00)	6752 (100.00)	7084 (100.00)	7272 (100.00)	7509 (100.00)	7514 (100.00)

Figures in parentheses are percentages to total of the respective year.

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relationship between the physical requirement and age of the plants. The operating cost during third year and onwards is higher as compared to initial two years because of requirement of pruning and training of the vines and more plant protection expenses in the later stages. These results are consistent with those of Singh and Sidhu (1986).

Net Returns

Taking into account the rental value of land, operational costs, expected depreciation on fixed investment, interest on fixed capital less its depreciation, interest on operational costs and the marketing costs, the net returns per hectare have been worked out over time and presented in Table 3.

TABLE 3
Costs and returns (Rs./ha) from grape orchard

	Year						
	1	2	3	4	5	6	7
Production (q)	—	—	68	172	227	331	347
Gross return* (GR)	—	—	13321.2	33694.8	44469.3	64842.9	67977.30
Land rent (opportunity cost)	5545	5545	5545	5545	5545	5545	5545
Operational cost	4062	5562	6752	7084	7272	7509	7514
Expected depreciation on fixed investment @ 3.333%	2938.80	2938.80	2938.80	2938.80	2938.80	2938.80	2938.80
Interest on expenditure							
On fixed investment less depreciation @ 13%	11461.32	11079.28	10697.23	10215.19	9933.14	9651.1	9169.06
On operational cost for half period @ 10%	203.1	277.6	337.6	354.2	363.6	375.45	375.70
Total annual cost (TC)	24210.22	25392.68	26270.63	26237.19	26052.54	25919.35	25542.56
Marketing cost (MC)	—	—	2874.36	7270.44	9595.29	13991.37	14667.69
Net returns (GR-TC-MC)	-24210.22	-25392.68	-16823.79	187.17	8821.47	24932.18	27767.05

*Price received by the grower has been worked out as Rs. 195.90/q by taking the arrivals and prices from Hissar, Ratia, Barwala and Uklana.

The initial investment on grape orchard establishment is very high having a gestation period of 2-3 years. The benefits are reaped for about 30 years, thus, the depreciation and interest on fixed investment are justified as the similar methodology was adopted by Singh and Sidhu (1986).

As evident from the data, an orchard-ist has to bear a loss in the first, second and third years. During the fourth year, the net return becomes positive and worked out to be Rs. 187.17. The net return increases upto seventh year (Rs. 27,767.05) due to the increase in production and after that, it becomes more or less stable upto the age of 30 years because of the stability of the size of the produce and all types of costs.

Economic Viability of Grape Orchard

To examine the economic feasibility of grape orchard, four indicators were used, viz. net present value (NPV), Internal rate of return (IRR), benefit-cost ratio and pay back period. Sivanandan *et al.* (1981) studied the returns to investment in forest plantations by using these four methods.

Net Present Value

Net return figures in Table 3 do not serve as true guide for making choice to go for grape orchard. Hence, it is necessary to estimate the net present value of future returns which can be determined by discounting both the costs as well as returns at the prevailing rate of interest. It is obvious from the data in Table 4, that the net discounted returns at 13% for one hectare grape orchard came to Rs. 61,734.53 for the entire expected life of 30 years. The present worth of an annuity of Re. 1.00 for 30 years at 13% is Rs. 7.4956. Thus, the grape growing is economically feasible enterprise.

Internal Rate of Return

It is defined as the rate of discount or

the earning power of the investment which equalises discounted benefits or returns (B) with the discounted cost (C), i. e. the rate of discount which satisfies the relationship, $B-C=0$.

In estimating the internal rate of return, the investment costs from first to seventh year, i. e. Rs. 24,210.22, Rs. 25,392.68, Rs. 29,144.99, Rs. 33,507.63, Rs. 35,647.83, Rs. 39,910.72 and Rs. 40,210.25 and the incremental gross returns from third to seventh year, i. e. Rs. 13,321.20, Rs. 33,694.80, Rs. 44,469.30, Rs. 64,842.90 and Rs. 67,977.30 were calculated. For each year, expenditure was subtracted from gross return and the result was obtained as a single value for each year.

The net cash flow was obtained by using these single values which may have negative and positive signs depending on the quantum of costs and benefits or return in each year. To find out the present value, the discounted rate was found by using this method until the difference between the sums of discounted streams of positive and negative values is reduced either to zero or to a lowest minimum. Finally, it was found at the rate of 23% the sum of the corresponding present values reduced to a lowest minimum. Thus, the internal rate of return or earning power of one hectare grape orchard was found to be as high as 23 per cent (Table 5). Therefore, investment on grape orchard is economically viable. The results are consistent with the studies conducted by Sivanandan *et al.* (1981) and Gupta and George (1974).

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TABLE 4
Per hectare net present value of grape orchard ($r=13\%$)

Year	Net return (Rs.)		Discount co-efficient $\frac{1}{(1+r)^n}$	Net present value (Rs.)	
	(-)	(+)		(-)	(+)
1	24210.22	—	0.8848	21423.62	—
2	26392.68	—	0.7831	19885.01	—
3	15823.79	—	0.6930	10865.89	—
4	—	187.17	0.6133	—	114.79
5	—	8821.47	0.5427	—	4787.41
6	—	24932.18	0.4803	—	11974.93
7 and onwards (upto 30 years)	—	27767.05	3.4981	—	97131.92
Total	65426.69	81707.87	—	52274.52	114009.05

The net discounted returns at 13% for one hectare grape orchard came to be Rs. 81734.53 (114009.05—52274.52).

The net return after 7th year is assumed to be stable as the decrease in interest in succeeding years will be nullified by the increasing marketing cost. The similar methodology was adopted by Singh and Sidhu (1986).

TABLE 5
Internal rate of return from one hectare grape orchard

Year	Cost (Rs.)	Annual gross return (Rs.)	Net cash flow (Rs.)		Present value co-efficient $(r=23\%)$ $\frac{1}{(1+r)^n}$	Corresponding present value (Rs.)	
			(-)	(+)		(-)	(+)
1	24210.22	—	24210.22	—	0.8130	19682.91	—
2	26392.68	—	26392.68	—	0.6610	16784.58	—
3	29144.99	13321.2	15823.79	—	0.5374	8803.70	—
4	33507.63	33694.8	—	187.17	0.4389	—	81.77
5	36647.83	44469.3	—	8821.47	0.3562	—	3133.39
6	39910.72	64842.9	—	24932.18	0.2888	—	7200.41
7 and onwards (upto 30 years)	40210.25	67977.3	—	27767.05	1.2468	—	34619.86
Total	—	—	—	—	—	44971.17	45035.53

The internal rate of return or earning power of one hectare grape orchard was found to be as high as 23 per cent.

Benefit-cost Ratio

The benefit-cost ratio is the ratio between the sums of discounted net benefits of returns (R) which is Rs. 61,734.53 and the sum of discounted cost (K), which is Rs. 52,274.52. At the discounted rate of 13%, the obtained benefit-cost ratio is equal to 1.18. It indicates that at the prevailing rate of interest of 13% per annum an investment of Re. 1.00 would fetch a return of Rs. 1.18. As this ratio is greater than one, it shows that the investment in grape orchard is economically viable. Gangwar and Godara (1982) also studied the economic feasibility of grape cultivation and observed that an investment of Re. 1.00 in a grape orchard unit fetches a return of Rs. 2.47. Gupta and George (1974) in their study on the profitability of santra in Nagpur district of Maharashtra observed that the benefit-cost ratio even at high discount rate as 12% varies from 1.85 to 2.64 according to the size of the grove. Similar results were observed by Gangwar (1982).

Pay Back Period

It is the period within which the cost of the grape orchard is fully recovered from its own returns. For this condition, the following relationship must be used :

$$\sum_{i=1}^n R_i = K$$

$i=1, 2, \dots, n$

where R indicates the returns over a

number of years and K indicates the cost of the grape orchard.

The net cost incurred during the first three years of the grape orchard is Rs. 65,426.69 and this cost is more than the return of Rs. 61,707.87 during the next four years. This shows that the returns would be more than the cost in the next five years, i. e. eighth year of the grape orchard. Thus, the pay back period of one hectare grape orchard is eight years. Gangwar and Godara (1982) observed that the capital cost of grape orchard is recovered in a period of seven years. Gupta and George (1974) observed that the investment for cultivation of santra in Nagpur district of Maharashtra has a pay back period of 7 to 9 years. Gangwar (1982) observed that capital cost of ber orchard in Haryana is recoverable in a period of six years. Hence, the grape growing is economically feasible.

In the light of above discussion, it may be said that although the initial investment in grape orchard establishment is very high yet it is an economically viable enterprise. It has a vital potential in increasing the income and gainful employment of the farming community. Grape growing is a step towards the diversification and commercialisation of agriculture farming in the State. Hence, every effort should be made to make this enterprise a more paying through incentives and creation of required marketing and processing infrastructures.

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GENETICS OF BRACHYTIC LEAF IN CHICKPEA (*CICER ARIETINUM* L.)

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In chickpea, leaves are normally compound, pseudo-imparipinnate with 10-15 leaflets per rachis arranged between 2-4 leaflets/cm without any important variation. However, many variation patterns of leaf shape and their inheritance have been reported by many research workers (Ekbote, 1942; Vachhani, 1942; Athwal and Brar, 1964; Pundir *et al.*, 1990). But information is lacking about inheritance of brachytic leaf of a spontaneous brachytic mutant E 100 ym (Dahiya *et al.*, 1990) and this information has a lot of relevance in crop improvement programme particularly for selection of desirable plant type in segregating generations.

The mode of inheritance of brachytic leaf has been studied in segregating and non-segregating generations (F_1 and F_2) of three crosses involving four diverse parents, *viz.* Bhim (normal, bold seeded kabuli with simple leaf), Arjun (normal, bold seeded kabuli with normal compound leaf), H 87-113 (desi type, brachytic leaf derivative of E 100 ym) and spontaneous mutant E 100 ym (brachytic mutant with compound leaf) (Fig. 1, Table 1).

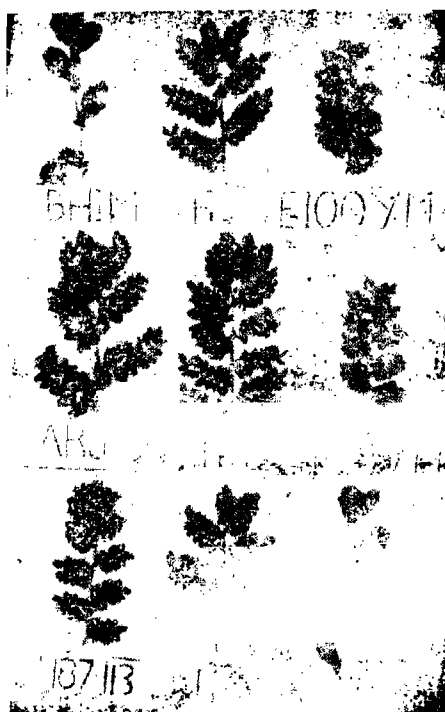


Fig. 1. Leaf types in three chickpea parents and their F_1 generation.

The crosses, involving parents with simple leaf and brachytic leaf (Bhim $\times$ E 100 ym, and Bhim $\times$ H 87-113), produced hybrids having normal com-

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GENETICS OF BRACHYTIC LEAF IN CHICKPEA

TABLE 1

Classification for leaf type in F_1 and F_2 generations of three crosses (Bhim $\times$ E 100 ym, Bhim $\times$ H 87-113, and Arjun $\times$ E 100 ym)

S. No.	Cross	Generation	Number of plants in different classes			Ratio	χ^2 (Chi-square value)
			Simple	Normal (Compound)	Brachytic		
1.	Bhim $\times$ E 100 ym SISl brBr $\times$ slsl BrBr	F_1	All compound and normal			4 : 9 : 3	2.27
		F_2	70	137	57	(9 : 3 : 4)	
2.	Arjun $\times$ E 100 ym SISl BrBr $\times$ slsl BrBr	F_1	All compound and normal			3 : 1	0.64
		F_2	—	210	88		
3.	H 87-113 $\times$ Bhim slsl BrBr $\times$ SSII brbr	F_1	All compound and normal			4 : 9 : 3	2.80
		F_2	61	174	52	(9 : 3 : 4)	

At 5% for 1 d. f. = 3.84

At 1% for 2 d. f. = 5.99.

pound leaves and the F_2 generation segregated for normal, brachytic and simple leaf types in the ratio 9 : 3 : 4, respectively. Therefore, the development of normal compound leaf depends on the presence of two genes 'SISl' 'BrBr' in dominant condition. The gene 'SISl' alone in dominant condition produced simple leaf and gene 'BrBr' produced brachytic leaf when present in dominant condition. The double recessive condition 'slsl brbr' also produced simple leaf.

In a cross, between normal compound leaf shape parent (Arjun) and brachytic leaf parent (E 100 ym), the F_2 segregated following simple mode of monogenic inheritance (3 normal : 1 brachytic). Therefore, leaf shape proved to be governed by two genes (slsl, brbr), which showed dihybrid supplementary gene action and homozygous recessive epistasis. Similar findings have been reported earlier by Vachhani (1942) and Pundir *et al.* (1990) in respect of other leaf variants.

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EFFECT OF PLANTING DATE ON YIELD AND QUALITY IN DURUM VARIETIES OF WHEAT

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A wider range of planting dates is helpful to growers during the critical fall period, when many competing activities demand attention. The objective of the present study was to evaluate the performance and adaptability of new durum wheat (*Triticum durum*) varieties under different dates of sowing. A field experiment was conducted in split plot design in sandy loam soil which was low in organic matter (0.33%), low in phosphorus (10 kg P₂O₅/ha) and high in potash (447 kg K₂O/ha) having pH 8.5 during rabi season of 1992-93. Three dates of sowing (early, normal and late) in main plots and seven varieties in subplots were replicated four times (Table 1). A uniform dose of 120 kg N and 60 kg P₂O₅/ha was applied. The crude protein and B-carotene contents were estimated by microkjeldahl method (N×5.7) and spectro-photometrically, respectively.

Effect of Sowing Dates

Date of sowing had marked effect on grain and straw yields. The highest mean grain yield (42.02 q/ha) was obtained by sowing wheat on 5 November. There was no significant difference in grain

yield when the crop was sown on 5 and 18 November. The poor grain and straw yields of late sown wheat (10 December) might be attributed to reduction in ears/m, number of grains/ear and 1000-grain weight. Higher temperature and strong winds during the month of April had caused forced maturity of late sown crop and resulted in lower yield. These findings are in conformity with the findings of Samra *et al.* (1989). However, late sown crop has shown maximum protein percentage (11.55) and B-carotene content (4.99) which are significantly superior over normal and early sown crop. These findings corroborate the results reported by Augustine (1993).

Performance of Varieties

The wheat varieties recorded significant increase in grain and straw yields. The varieties PDW 234 and PDW 232 significantly outyielded all other varieties by producing 42.02 and 41.81 q/ha grain yield, respectively. The higher grain yield of these varieties might be due to more number of ears/m and grains/ear (Table 1). In straw yield, the performance of PDW 215, WH 896, PDW 235 and

EFFECT OF PLANTING DATE IN DURUM WHEAT

TABLE 1

Yield attributes, yield and quality of wheat as influenced by dates of sowing and varieties

Treatment	Yield attributes			Yield (q/ha)		Quality	
	Ears/m	Number of grains/ear	1000-grain weight (g)	Grain	Straw	Protein content (%)	B-carotene content (ppm)
Sowing dates							
5 November	100.46	59.00	46.78	42.04	86.63	10.78	4.64
18 November	112.03	57.20	47.00	41.61	86.94	11.04	4.29
10 December	98.67	56.60	46.78	37.05	79.07	11.55	4.99
SEm±	1.72	0.23	0.34	0.41	0.87	0.08	0.11
C. D. (P=0.05)	5.96	0.79	NS	1.45	3.10	0.24	0.32
C. V. (%)	8.82	2.10	3.91	5.53	5.46	5.06	4.06
Varieties							
PDW 232	107.83	60.50	45.50	41.81	81.36	11.38	4.53
PDW 233	103.60	58.70	44.92	39.33	75.76	10.84	5.53
PDW 234	107.67	60.90	44.00	42.02	83.63	11.27	4.68
PDW 235	98.25	58.40	51.08	39.54	86.73	11.12	5.68
WH 896	106.67	57.30	46.33	40.36	89.63	11.08	4.70
PDW 216	98.67	50.20	51.17	38.09	80.04	11.13	5.04
HD 2329	103.25	59.20	45.00	40.57	81.56	11.81	2.96
SEm±	2.25	0.27	0.27	0.14	2.48	0.13	0.17
C. D. (P=0.05)	6.34	0.78	0.78	0.41	7.04	0.37	0.49
C. V. (%)	7.52	1.65	2.05	1.26	10.27	4.27	5.27

TABLE 2

Interaction effect of time of sowing and varieties on grain yield of wheat (q/ha)

Time of sowing	Varieties						
	PDW 232	PDW 233	PDW 234	PDW 235	WH 896	PDW 216	HD 2329
5 November	46.83	42.43	41.66	42.42	42.68	38.55	40.88
18 November	40.88	42.95	46.83	39.85	38.03	38.55	43.72
10 December	37.52	32.60	37.78	37.26	40.36	37.00	37.26
SEm±	0.25						
C. D. (P=0.05)	0.62						
C. V. (%)	1.26						

PDW 234 was at par. The differential behaviour of wheat varieties under different sowing dates has also been reported by Kumpawat and Rathore (1989). Variety HD 2329 had shown significantly highest protein percentage (11.81), PDW 235 and PDW 233 recorded significantly highest B-carotene content thereby showing good macronutrient qualities which in turn would fetch higher price in the international market.

The variety PDW 232, PDW 234 and WH 896 performed better when planted on 5 November, 18 November and 10 December, respectively (Table 2). There was minimum reduction in yield due to time of planting in variety PDW 215. It is concluded that the sowing of all these varieties must be completed by the mid of November.

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EFFECT OF SEED RATE AND DAP APPLICATION ON LENTIL (*LENS CULINARIS* (L.) MEDIK)

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A field experiment was conducted at the Research Farm of CCS Haryana Agricultural University, Hisar during rabi season of 1990-91. The treatment combinations of four genotypes (PL 81-17, PL-639, LH 84-8 and L-4076), two levels of fertility (9+23 and 18+46 kg N+P₂O₅/ha) applied through DAP, and two seed rates (40 and 60 kg/ha) were replicated thrice in randomised block design. The soil of the field was sandy loam in texture, low in available N (115 kg/ha) and available P (10 kg/ha), but rich in available K (395 kg/ha). Sowing was done on 19 November, 1990. The whole quantity of DAP, as per treatment, was applied at the time of sowing. The crop was irrigated once at pre-flowering stage, i. e. 65 days after sowing.

The genotypic differences for yield attributes and yield were found to be significant except number of grains/pod (Table 1). Genotype PL-639 significantly outyielded all the genotypes which were at par with each other and the magnitude of increase was 23, 20 and 15 per cent over PL 81-17, L-4076 and LH 84-8, respectively. The higher yield of PL-639 was due to significantly more number of

Pods/plant (Table 1). Variety LH 84-8 being at par with PL-639 produced significantly more straw yield than rest of the varieties and it was attributed to more plant height attained by the plants of this variety. Significantly bolder seeds were produced by LH 84-8.

Increased seed rate from 40 to 60 kg/ha produced significantly more yield and this might be due to higher plant stands maintained with higher seed rate and due to bolder seeds produced under this treatment. Similar effect of seed rate on yield was also reported by Watt and Singh (1992). Number of pods was, however, significantly more with lower seed rate (40 kg/ha). Less pods under higher seed rate might be the result of competition between plants for space, moisture, nutrients and light. The improved pod bearing at low seed rate does not seem to compensate for higher yield obtained through increased plant stands with higher seed rates.

Application of 18+46 kg N+P₂O₅/ha significantly increased plant height and number of pods/plant over 9+23 kg N+P₂O₅/ha and their beneficial effect was

TABLE 1

Yield and its attributes of lentil as affected by seed rate and DAP application

Treatment	Yield (q/ha)		Number of pods per plant	Number of grains per pod	100-seed weight (g)	Plant height (cm)
	Grain	Straw				
Genotype						
PL 81-17	13.71	18.30	25.64	1.53	1.58	33.85
PL-639	16.88	21.92	44.63	1.48	1.62	35.84
LH 84-8	14.89	23.25	36.80	1.60	1.97	40.11
L-4076	14.11	20.42	30.47	1.53	2.33	35.50
SEm±	0.62	0.80	1.55	0.07	0.07	1.41
C. D. at 5%	1.49	2.40	4.45	NS	0.19	4.06
Seed rate (kg/ha)						
40	13.74	20.68	40.55	1.54	1.78	37.32
60	18.08	21.27	28.16	1.53	1.97	38.41
SEm±	0.36	0.60	1.09	0.06	0.06	0.99
C. D. at 5%	1.05	NS	3.15	NS	0.13	NS
Fertility levels/ha						
9+23 kg N+P ₂ O ₅	14.13	20.07	31.22	1.50	1.83	34.29
18+46 kg N+P ₂ O ₅	15.67	21.88	37.50	1.58	1.91	38.41
SEm±	0.36	0.60	1.09	0.05	0.05	0.99
C. D. at 5%	1.05	1.67	3.15	NS	NS	2.87

reflected into increased straw and grain yields, respectively (Table 1). The results are in conformity with Singh *et al.* (1988).

It is concluded that lentil crop (PL-639) may be grown by adopting 60 kg seeds/ha and 18+46 kg N+P₂O₅/ha under Haryana conditions.

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INFLUENCE OF SOCIO-ECONOMIC AND FAMILY ENVIRONMENT ON PHYSICAL GROWTH OF RURAL AND URBAN CHILDREN IN HARYANA

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ABSTRACT

The study was conducted on 140 children of rural and urban areas. The data revealed that the physical growth of 10-12 years old children of Haryana, irrespective of sex, is better than national average, given by ICMR. Surprisingly sex difference in physical growth was not prominent in Haryana state.

The child grows and develops best in an environment of love and security, with adequate food and health care to survive as a useful human being (Boerme, 1971). Physical development is an essential component of child's overall well being. General pattern of growth and development varies according to age and sex. Kamin (1978) noticed that mental and physical growth are affected by both heredity and environment. The environment consists of nutrition, child care, family atmosphere and parental socio-economic status which play a significant role in overall physical growth of child (Swaminathan, 1971). Family relationship, educational awareness, availability of opportunity, family habits, interaction, attitude of parents and cultural environment are other important factors associated with child's growth and development (Bradley and Caldwell, 1980; Longstreth *et al.*, 1981). In Haryana, growth and development of children during late child-

hood (10-12 years) has not been adequately studied. As such a need to thoroughly investigate the anthropometric growth and associated factors of rural and urban children is called for. Therefore, the present study was undertaken on school going children to measure the influence of their parental socio-economic status and family environment on physical growth.

MATERIAL AND METHODS

A total of 140 respondents of 10-12 years of age were selected at random from two selected schools of Hisar city and two schools of rural areas, with equal number of male and female respondents.

The physical growth of children was measured on five parameters, *i. e.* height, weight, circumference of chest, head and mid-arm. To measure socio-economic factors affecting family

TABLE 1
Profile of respondents

	Urban	Rural
	(in percentage)	
Father's occupation		
(i) Farm labour, Animal Husbandry, etc.	—	10.00
(ii) Small scale	11.36	4.28
(iii) Business and shopkeeper	14.28	14.28
(iv) Agriculture	—	67.14
(v) Professionals (Medical/Engg./Teaching)	62.28	—
(vi) Administrators	1.42	—
(vii) Any other	10.00	14.28
Mother's occupation		
(i) In their own farms	—	71.42
(ii) Farm labourers	—	28.66
(iii) Housewives	50.00	—
(iv) Professionals	50.00	—
Father's education		
(i) Illiterate	—	27.14
(ii) Only read and write	—	24.28
(iii) Primary	—	14.28
(iv) Middle	—	18.57
(v) High school	12.85	14.28
(vi) Graduate	30.00	1.42
(vii) Post-graduate	57.14	—
Mother's education		
(i) Illiterate	—	66.61
(ii) Primary	—	10.00
(iii) Middle	—	4.28
(iv) High school	8.57	—
(v) Graduate	78.57	—
(vi) Post-graduate	12.25	—
Social participation (members of any organization)		
(i) Social	31.42	—
(ii) Business	18.57	—
(iii) Any other	4.28	—
(iv) No organization	45.44	100.00
Type of house		
(i) Kucha	—	68.57
(ii) Kucha and Pakka house	—	28.57
(iii) Pakka house	44.28	62.85
(iv) Rented	55.72	—
Family income (per month)		
(i) Upto Rs. 200/-	—	7.14
(ii) 200/- to 500/-	—	31.44
(iii) 500/- to 1000/-	10.00	22.85
(iv) 1000/- to 2000/-	5.71	38.57
(v) More than 2000/-	84.28	—
Magazine/Newspaper		
(i) Routinely	100.00	5.71
(ii) Occasionally	—	12.85
(iii) Never	—	81.42

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environment and physical growth, the scale developed by Kulshreshtha (1980) was used. The scale was administered individually on parents of respondents. Family environment was measured using Home Environment Inventory (HEI) of Mishra (1989). The HEI has ten dimensions, viz. control, protectiveness, punishment, conformity, social isolation, reward, deprivation of privileges, nurturance, rejection and permissiveness. Each of these dimensions has ten items belonging to it. The respondents were asked about parent child interaction behaviour perceived by them in their homes.

The qualitative data were quantified and according to standards laid down, the data were coded, tabulated and analysed using student's T-test and analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Respondents Profile

A comprehensive analysis of rural and urban children showed difference in family

background (Table 1). The rural respondents belonged to the families whose main occupation was agriculture and parents were partly literate. Parents of majority of urban respondents were literate and worked as professionals and businessmen. Mothers of 67% urban children were educated upto graduation. Income of urban families was higher than rural families. More than 50% of urban parents were members of some organization while rural parents had less formal social participation. The urban respondents had a better media exposure than the rural.

Physical Growth

Socio-demographic and sex-wise comparisons show that rural-urban and male-female children do not differ significantly on arm circumference, height and weight. However, rural boys excelled on head circumference when compared with rural girls who themselves were behind their urban counterparts. Regarding chest circumference urban girls were superior to their rural counterparts (Table 2). In

TABLE 2

Physical measurements of 10-12 years old rural and urban respondents

Physical measurement	Boys		Girls	
	Rural	Urban	Rural	Urban
Head circumference (Inches)	^a 20.86±0.83	20.75±0.82	19.35±1.30	^a 20.66±0.84
Arm circumference (Inches)	7.98±1.72	7.92±2.15	8.05±0.60	8.05±1.65
Chest circumference (Inches)	26.30±2.20	26.96±2.45	26.46±3.17	^a 28.25±1.92
Height (Inches)	54.50±4.66	53.91±4.65	52.50±4.44	54.17±4.33
Weight (kg)	26.50±4.34	27.09±6.43	26.18±6.00	27.52±5.33

Values with superscript 'a' differ significantly at $P < 0.05$.

TABLE 3

Score of ten dimensions of Home Environment Inventory of 10-12 years old rural and urban respondents

S. No.	Dimension	Boys		Girls	
		Rural	Urban	Rural	Urban
1.	Control	21.20±5.44	24.05±5.22	18.54±5.38 ^a	25.08±3.03 ^a
2.	Protectiveness	22.13±5.75 ^b	30.86±4.66 ^b	21.58±6.55 ^c	29.91±3.15 ^c
3.	Punishment	28.62±5.80	29.45±5.22	34.10±7.66 ^d	28.55±4.60 ^d
4.	Conformity	23.40±5.54	30.68±4.04	28.76±5.90	32.82±4.42
5.	Social isolation	19.10±6.32 ^e	14.04±6.34 ^e	15.16±6.51	14.54±5.99
6.	Reward	26.96±6.72 ^f	35.17±3.52 ^g	50.12±4.18 ^g	32.56±31.62 ^g
7.	Deprivation	19.83±5.06	13.06±5.36	18.00±5.45	14.62±5.31
8.	Nurturance	21.48±5.84	27.37±4.23	23.26±5.08 ^h	25.27±3.99 ^h
9.	Rejection	17.30±5.68 ⁱ	8.47±4.69	15.20±5.62	11.68±7.45
10.	Permissiveness	19.30±5.49	17.07±6.18	21.22±6.83	18.72±6.63

Values with similar superscripts differ significantly at $P < 0.05$.

general, rural and urban children (10-12 years of age) had similar anthropometric growth irrespective of their socio-economic status and family environment. However, Banik (1982) observed that it is possible to have better physical growth potential with better socio-economic status. Similarly, Chaudhary (1985) found that physical growth of 9-10 years old non-slum children of Hisar city was much better than slum dwellers and was mainly affected by socio-economic status of their families besides other related factors. Anthropometric growth of rural children with low socio-economic status similar to their urban counterparts with higher socio-economic status was probably due to proper nutrition through adequate availability of milk and other agricultural byproducts in rural areas of Haryana. Boys and girls, in our study, showed similar physical development in contrast to that observed by Parvathi *et al.* (1972). Chopdar and Nabarro (1981) in new born, Bishnoi (1983) and

Chawla and Puri (1983) in pre-school children noticed greater physical development of male children than the females. However, significant differences on chest and head circumference, which are also important indicator of physical growth, may be due to use of different kind of diet as stressed by Boorme (1971) and Swaminathan (1971). Boys get better care in our rural areas because of high value given to male child, whereas urban children have more access to the resources.

TABLE 4

Correlation between physical growth and socio-economic status

Parameter	Correlation
Head circumference	0.11
Arm circumference	-0.20
Chest circumference	0.26*
Height	0.13
Weight	0.14

*Significant in girls at $P < 0.05$.

TABLE 5
Correlation between ten dimensions of Home Environment Inventory and physical growth

Parameter	Dimensions of HEI									
	Control	Protectiveness	Punishment	Conformity	Social isolation	Reward	Deprivation	Nurturance	Rejection	Permissiveness
Head circumference	-0.03	0.02	0.04	-0.05	-0.04	-0.08	-0.05	-0.10	0.00	0.08
Arm circumference	0.02	0.03	-0.13	0.13	0.14	0.00	0.17*	-0.08	0.07	0.04
Chest circumference	0.04	0.08	0.12	0.17*	0.07	0.00	-0.02	0.07	-0.10	-0.12
Height	-0.01	0.08	-0.10	-0.17*	0.02	-0.02	0.04	0.00	0.04	0.04
Weight	0.04	0.07	-0.03	-0.09	0.07	-0.11	-0.04	-0.08	0.00	0.00

*Significant at $P < 0.05$.

Family Environment

Statistical analysis of mean scores of all the dimensions of home environment suggested that rural and urban respondents lived in different type of home environment. The urban girls get not only protection but also control, punishment, nurturance and reward. Rural parents on the contrary exercise less control and protection but more deprivation and rejection for girls (Table 3). The mean scores of rural and urban boys differed markedly on protectiveness, social isolation, reward, and rejection, whereas on rest of the dimensions rural and urban parents had similar attitude towards their sons. In home environment it appeared that urban parents were more careful about the behavioural development of their daughters while rural girls were either rejected or deprived of various facilities as a measure of control expressed by their parents. Urban parents gave more importance to positive reinforcement of behaviour, whereas rural parents used negative reinforcement like social isolation and rejection. Moolgaokar (1980) has also revealed that deprivation and exploitation of children in rural and semi-urban areas were due to ignorance of parents and other family environment factors.

Socio-Economic Status and Physical Growth

Although there was significant difference in socio-economic status of rural and urban families, it could not result in unequal physical development of respondents. However, chest circumference in girls was positively correlated with socio-economic status and was more in urban than rural girls (Table 4). Another interesting observation made during this study was that overall physical growth of all the respondents from Haryana was better than the national average given by ICMR. It was, thus, concluded that inspite of differences in socio-economic status and family environment, the anthropometric growth of 10-12 years old children belonging to rural and urban areas of Haryana was similar.

Home Environment and Physical Growth

The ten dimensions of home environment compared with five parameters of physical growth, dimension conformity showed significant positive correlation with chest circumference and negative correlation with height while dimension deprivation was significantly positively related with arm circumference (Table 5). Other dimensions of home environment could not influence the five parameters of physical growth.

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EFFECT OF EDUCATIONAL STATUS AND FAMILY SIZE ON NUTRIENT INTAKE OF PREGNANT WOMEN

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ABSTRACT

The study carried out on 139 pregnant women from rural and suburban areas of Hisar district revealed that the diets of pregnant women were deficient in almost all the nutrients, as compared to RDA, and energy was the most limiting nutrient. Educational status of spouses had a bearing on nutrient intake. Subjects and their spouses with high academic qualifications had significantly higher intake of nutrients than those with lower educational status. Suburban women from smaller families consumed more amount of nutrients and the differences were statistically significant. In rural subjects, family size had no significant influence on nutrient intake.

The overall development of a child is determined to a greater extent by the type of nourishment it receives right from conception (Devadas *et al.*, 1987). Research workers endorse the truth of the age old saying "Infant feeding begins in uterus" and "at birth an infant is nutritionally nine months of age". During pregnancy, the mother requires nutrients not only for developing the foetus and placenta, but also for storing vital nutrients in her body tissues for subsequent milk production (Jelliffe, 1966). The diet consumed by mother during prenatal period has a definite effect on her own health. Therefore, an improvement in the nutritional status of pregnant women is of paramount importance. The starting point towards this improvement is to study the existing food consumption pattern and associated socio-economic factors. Family size and educational status of spouses are the important factors

which affect the food consumption pattern. Various research workers in India have studied the nutritional status of pregnant women. However, only a little data are available regarding the influence of such factors on nutrient intake of pregnant women in Haryana. Therefore, a study was designed to collect data related to the effect of educational status of spouses and family size on food consumption pattern of pregnant women.

METHODOLOGY

Four villages adopted by Directorate of Extension Education, CCS Haryana Agricultural University, Hisar, for implementing lab to land programme were selected for the present study. Two suburban areas of Hisar city were selected on the presumption that the large segment of population from lower strata lived in

these areas. A preliminary survey was conducted to get the information about the number of pregnant women in second and third trimester of pregnancy. All the expectant women (number 139) in above mentioned period of pregnancy from suburban and rural areas were selected for the present study. This period of pregnancy was selected because nutrient requirements are increased during this period. The study was carried out from August to December, 1993.

A pretested structured respondent schedule was used to collect the required information. The data on their food intake were collected for three consecutive days using 24 h recall method. Nutrient content of raw food consumed was calculated using food composition tables (Gopalan *et al*, 1989).

To see the effect of level of education of spouses on nutrient intake, suburban subjects were classified into two categories. Matric pass husbands and wives formed one category while those having qualification upto graduation formed the second category. Suburban and rural subjects were grouped into two categories with small and large families. Families with 3.9 or less Consumption Unit (CU) constituted a small family and those with more than 3.9 CU were grouped under large family. Data were statistically analysed using 't' test of variance.

Recommended dietary allowances of protein and energy during second and third trimesters of pregnancy were calculated on the basis that these cover the additional needs for development and

growth of foetus, placenta, maternal tissue and also to meet additional needs due to increase in basal metabolic rate. On this basis, additional amounts of 14 g protein and 300 Kcal energy are recommended during second and third trimesters of pregnancy. RDA for B-complex vitamins has been expressed in relation to energy intake. Increased energy intake during this period will also take care of additional needs of B-complex vitamins.

RESULTS AND DISCUSSION

The data on socio-personal and economic profile of respondents are presented in Table 1. Majority of the respondents in both areas was in the age group of 20-30 years. More than half of the respondents in suburbs lived in nuclear families, whereas reverse was true for rural subjects. About 66% of suburban subjects were educated upto matric, whereas 34% of women had level of education upto graduation and above. Husbands were more educated than their wives. Higher percentage of rural subjects belonged to large families, whereas a higher percentage (60) of suburban subjects belonged to small families. Majority of the subjects and their spouses in rural areas were illiterate. About 80-90 per cent of respondents in suburbs and rural areas did only household work, while the remainder subjects in suburbs were engaged in some occupation outside the home besides doing household chores and those in rural areas worked on farms and also did household work. As regards the income, majority had income less than Rs. 1000/- per month.

TABLE 1

Socio-personal and economic profile of respondents

Attribute	Frequency	
	Suburban	Rural
Age (years)		
Below 20	—	5 (9)
20-30	64 (80)	36 (61)
Above 30	16 (20)	18 (30)
Family type		
Joint	36 (45)	36 (61)
Nuclear	44 (55)	23 (39)
Family size		
3-5 members (CU 3.9)	48 (60)	14 (24)
Above 5 members (CU above 3.9)	32 (40)	45 (76)
Education of respondents		
Illiterate	16 (20)	44 (75)
Primary	10 (12)	7 (12)
Middle	13 (16)	2 (3)
Matric	14 (18)	6 (10)
Graduate	21 (26)	—
Post-graduate	6 (8)	—
Education of husband		
Illiterate	4 (5)	21 (36)
Primary	7 (9)	12 (20)
Middle	8 (10)	7 (12)
Matric	26 (32)	15 (25)
Graduate	16 (20)	4 (7)
Post-graduate	19 (24)	—
Occupation of respondents		
Household work	64 (80)	53 (90)
Household and service	16 (20)	—
Household and assistance in farming	—	6 (10)
Family income/month (Rs.)		
Below 1000	34 (49)	27 (46)
1000-2000	21 (26)	21 (36)
Above 2000	20 (25)	11 (18)

Figures in parentheses are the percentages.

CU = Consumption Unit.

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TABLE 2

Pattern of expenditure on different foods

Area	Per cent of total income spent on food	Expenditure on different food items (per cent)							
		Cereals	Pulses	Vegetables	Fruits	Flesh foods	Fats and oils	Milk and milk products	Sugar and jaggery
Rural	39.5	27.8	2.0	5.8	1.5	—	24.8	29.6	9.5
Suburban	44.4	24.0	2.6	12.7	6.6	0.7	19.7	28.6	5.1

Data in Table 2 reveal that a large proportion of the income was spent on food. Expenditure on items as cereals, fats and oils, and milk and milk products was highest and that on pulses, vegetables, fruits and flesh foods was the least.

Nutrient Intake in Relation to Educational Level of Spouses

The data on daily intake of different nutrients in relation to academic status of spouses are presented in Table 3. Perusal of data reveals that the diets of pregnant women were deficient in most of the nutrients as compared to recommended dietary allowances (ICMR, 1989). However, nutrient intake was significantly affected by the educational level of spouses. Expectant women with academic qualifications graduate and above consumed protein, calcium, thiamine, riboflavin and vitamin C in amounts adequate to meet the RDA for these nutrients. Adequate intake of these was due to the consumption of milk, eggs, pulses and legumes, and fruits in sufficient amounts. However, the diets of pregnant women having low academic qualification were deficient in all the nutrients when compared to RDA. Expectant women whose husbands were

graduate and above consumed significantly more of protein, energy, calcium, thiamine and iron as compared to those whose husbands had educational level upto matriculation. It was because of the consumption of milk, fat, pulses and vegetables in more amounts by the former. The pregnant women in all the educational groups consumed all the nutrients in inadequate amounts as compared to RDAs (ICMR, 1989) except calcium, thiamine, riboflavin and vitamin C. Adequate intake of these nutrients was due to consumption of milk and milk products, whole pulses and vitamin C rich foods such as guava. The results of present investigation are in agreement with the findings of Payton *et al.* (1960), Malentnfema and Bavu (1984) and Hunt *et al.* (1986).

Nutrient Intake vs. Family Size

Data on nutrient intake of subjects in rural and suburban areas in relation to family size are presented in Table 4. The results reveal that the diets of pregnant women in both the categories were deficient in almost all the nutrients except thiamine and vitamin C as compared to RDA. However, suburban subjects with

TABLE 3
Nutrient intake in relation to educational status of spouses

Nutrient	Educational status of subjects (N=80)		t' value	Educational status of husbands (N=80)		t' value	RDA 1989
	Low (n=53)	High (n=27)		Low (n=45)	High (n=35)		
Protein (g)	42.8±1.44 (86.0)	56.1±2.35 (86.0)	5.05**	41.7±2.06 (64.0)	52.5±1.76 (80.0)	3.22**	66
Energy (Kcal)	1684±48.55 (67.0)	2162±85.60 (85.0)	4.99**	1612±64.55 (63.0)	1998±63.58 (79.0)	3.24**	2625
Calcium (mg)	699±48.59 (70.0)	1136±92.56 (113.0)	4.22**	578±65.38 (58.0)	1001±64.53 (100.0)	3.49**	1000
Iron (mg)	26.7±1.05 (71.0)	30.4±1.34 (80.0)	2.20**	27.9±1.53 (73.0)	28.5±1.02 (75.0)	NS	38
Thiamine (mg)	1.30±0.05 (100.0)	1.59±0.07 (122.0)	3.62**	1.29±0.01 (99.0)	1.49±0.05 (114.0)	2.00*	1.3
Riboflavin (mg)	1.09±0.06 (72.0)	1.49±0.10 (99.0)	3.64**	1.05±0.10 (70.0)	1.34±0.07 (89.0)	2.23*	1.5
Niacin (mg)	10.04±0.37 (62.0)	11.38±0.41 (71.0)	2.36*	10.29±0.54 (64.0)	12.76±0.35 (79.0)	2.10*	16
Vitamin A (µg)	363±23.04 (60.0)	508±32.50 (84.0)	3.51**	365±19.02 (60.0)	402±28.02 (57.0)	2.12*	600
Vitamin C (mg)	31.3±9.66 (78.0)	90.6±20.86 (225.0)	2.75**	22.9±7.94 (57.0)	67.7±14.43 (174.0)	2.01*	40

Figures in parentheses are the percentage of RDA.

*P<0.05

**P<0.01

NS=Non-significant

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TABLE 4
Nutrient intake of suburban and rural subjects in relation to family size

Nutrient	Suburban (n=80)		t' value	Rural (n=59)		t' value	RDA 1989
	Small family (n=48)	Large family (n=32)		Small family (n=14)	Large family (n=45)		
Protein (g)	52.5±2.36 (80.0)	44.8±1.41 (59.0)	2.70**	50.0±2.23 (76.0)	42.4±3.19 (65.0)	NS	65
Energy (Kcal)	1922±86.6 (76.0)	1559±45.42 (62.0)	2.51**	1546±77.23 (61.0)	1423±96.30 (56.0)	NS	2525
Calcium (mg)	921±67.3 (92.0)	692±67.37 (69.0)	2.62*	783±59.22 (78.0)	566±73.80 (57.0)	2.32*	1000
Iron (mg)	29.0±0.43 (76.0)	27.6±1.19 (72.0)	NS	34.1±2.15 (89.0)	32.6±2.80 (85.0)	NS	38
Thiamine (mg)	1.52±0.06 (116.0)	1.32±0.05 (101.0)	NS	1.52±0.08 (116.0)	1.48±0.12 (113.0)	NS	1.3
Riboflavin (mg)	1.45±0.09 (96.0)	1.18±0.05 (78.0)	2.23*	1.34±0.06 (89.0)	1.06±0.08 (70.0)	2.01*	1.5
Niacin (mg)	11.16±0.40 (69.0)	10.02±0.41 (82.0)	1.99*	12.41±0.74 (83.0)	11.09±0.96 (69.0)	NS	16
Vitamin A (µg)	4.68±30.18 (78.0)	322±13.12 (54.0)	2.15*	392±1511 (65.0)	298±8.42 (49.0)	2.35*	600
Vitamin C (mg)	65.7±16.10 (164.0)	36.6±15.38 (96.0)	2.11*	19.1±4.49 (47.0)	6.8±1.03 (17.0)	1.98*	40

Figures in parentheses are the percentage of RDA.

*P<0.05

**P<0.01

NS=Non-significant.

small family consumed significantly more amount of protein, energy, calcium, thiamine, riboflavin, vitamin A and vitamin C than those living in large families. In rural areas, nutrient intake of the subjects from small as well as large families was inadequate as compared to RDA. Main reason of inadequate food intake was low purchasing power. Other important reason was lack of nutritional knowledge as most of the pregnant women especially in rural areas had the opinion that food intake should not be increased during pregnancy because of the fear of producing large baby leading to difficult delivery. Nutrient intake of rural subjects from small family was not significantly different from large family, except for calcium, riboflavin, vitamin A and C. Intake of these nutrients was higher among subjects from small families due

to the consumption of milk, ghee (butter fat) and guava in higher amounts than those in large families.

The results of this study are supported by the findings of Rao and Gopalan (1969), Aujla *et al.* (1983), Santoo and Salgado (1989), and Golati and Mann (1991) who also reported that nutrient intake and family size are interrelated.

It is evident from the results that educational level of spouses and family size are important factors which affect the food consumption pattern of pregnant women. Thus, improving the level of education and limiting the size of family can go a long way in improving the nutritional status of one of the most vulnerable sections of population that is the pregnant women.

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