

TITLE/SUBJECT/AUTHOR INDEX

VOL. XV, 1985

COMPILED BY

S. P. Goyal

HARYANA AGRICULTURAL UNIVERSITY
**JOURNAL
OF
RESEARCH**

PUBLISHED QUARTERLY BY
THE DIRECTORATE OF PUBLICATIONS
HARYANA AGRICULTURAL UNIVERSITY
HISAR
INDIA

HARYANA AGRICULTURAL UNIVERSITY

JOURNAL OF RESEARCH

Vol. XV, No. 1

March 1985

CONTENTS

Animal and Veterinary Sciences

1. Performance of starting commercial pullets on different protein and energy levels in Haryana
—V. P. Saxena and R. S. Thakur 1
2. Efficacy of certain antibacterial intrauterine infusions on the reproductive efficiency in postpartum cows
—T. S. Manju, Umed Singh, A. K. Sinha, S. K. Verma and R. C. Gupta 7
3. Effect of light colour on the reproductive performance of Japanese quail
—Suraj Bhan Phogat and C. K. Aggarwal 10

Basic Sciences

4. Variability in protein, tryptophan and methionine contents in *Phaseolus* and *Vigna* spp.
—Bhagwan Singh and O. P. S. Rana 15
5. Variation in the level of essential oil in *Cymbopogon martini* var. *motia* at different harvestings and growth stages, in various plant parts and on ageing the harvested crop
—N. K. Sangwan, K. S. Dhindsa, O. P. Malik, G. D. Sharma and R. S. Paroda 21
6. Kinetics of soluble and immobilised amyloglucosidase
—Ashok Kumar and H. S. Nainawatee 26

Crop Sciences

7. Yield, total productivity, water-use efficiency and returns as affected by intercropping in castor in semi-arid tropics
—B. P. Singh and H. C. Sharma 29
8. Effect of growth regulators on flowering and fruiting of bottle gourd
—S. K. Arora, M. L. Pandita and K. S. Baswana 36
9. Seasonal fluctuations in incidence of ber fruitfly *Carpomyia vesuviana* Costa (Diptera: Tephritidae) under agro-climatic conditions of Hisar
—R. K. Lakra and Zile Singh 42
10. Irrigation production functions for Ludhiana conditions
—Ranvir Kumar, S. D. Kheper and K. N. Duggal 51
11. Soils of N. E. S. block Ganaur of district Sonapat, Haryana—their problems and management
—S. P. S. Karwasra, J. P. Sangwan and M. S. Kuhad 57

12. Pathological analyses of national and regional <u>pearl millet</u> genepool for major diseases under multiple disease sick-plot	64
—D. P. Thakur and N. Mehta	
13. Variation in leaf diffusive resistance in <u>wheat</u> cultivars	71
—S. D. Dhiman, D. P. Singh, Phool Singh and V. P. Singh	
14. Effect of growth regulators on rooting of <u>lemon cuttings</u> with and without leaves	77
—R. K. Arora and R. Yamdagni	
15. Effect of moisture stress, sowing methods and nitrogen levels on the quality and oil yield of <u>mustard</u>	82
—G. M. Khan and S. K. Agarwal	
16. Response of paddy to nitrogen sources, their application time and nitrification inhibitors	87
—Dalel Singh, R. S. Antil, Vinod Kumar and Mahendra Singh	
17. Nutrient status of <u>ber</u> (<i>Zizyphus mauritiana</i> L.) orchards in Mahendragarh district of Haryana	94
—R. Yamdagni, V. P. Ahlawat and V. S. Chauhan	
18. Observations on the extent of decline in different cultivars of citrus	97
—R. K. Arora, V. P. Ahlawat and R. Yamdagni	
19. A new record of occurrence of <i>Ephestia cautella</i> (Wlk) on stored cotton seed in Haryana	99
—A. S. Nandal, V. S. Malik and Zile Singh	
20. Powdery mildew on <i>Capsicum annum</i> in Haryana	100
—Luxmi Chand Saini and J. N. Chand	
21. Nature and extent of damage of <i>Heliothis armigera</i> (Hubner) in seed crop of onion	102
—R. K. Kashyap and M. L. Pandita	

Social Sciences

22. Vocational interests of final year high school girls	105
—Saroj Kashyap and K. Kumar	
23. Planning small farms under varying capital	110
—P. K. Sardana and B. S. Panghal	
24. Factors influencing farm modernization in Haryana	115
—B. S. Bangarwa, Raj Singh and R. S. Kadian	
25. Drop-outs among scheduled castes in Haryana	119
—J. K. Khairwal and Raj Singh	

HARYANA AGRICULTURAL UNIVERSITY

JOURNAL OF RESEARCH

Vol. XV, No. 2

June 1985

CONTENTS

Animal and Veterinary Sciences

1. Calcium, phosphorus, manganese and zinc retention in broilers given maize and sorghum based diets with different energy and protein levels
—V. P. Saxena 125
2. An appraisal of edible and non-edible organs of Nali and its crossbred lambs
—K. S. Sangwan and Shri Ram 133
3. Effect of physical exercise on peripheral cortisol levels in buffalo calves
—S. P. Agarwal, V. K. Agarwal and P. K. Dwaraknath 138

Basic Sciences

4. Effect of artificial aging on the levels of protease, lipase, ribonuclease, total lipid and free fatty acids from soybean seeds differing in storage potential
—A. S. Rao and D. S. Wagle 141
5. Ureides and enzymes of their metabolism in nodules of mungbean as influenced by plant genotype and rhizobial strain
—D. Singh, A. S. Rao, H. S. Nainawatee and R. Singh 148
6. Cytogenetic effects of food additives in barley. 1. Food dyes
—Hari Om Mehra and P. K. Sareen 153

Crop Sciences

7. Grain growth of wheat as influenced by time of sowing and nitrogen fertilization
—S. D. Dhiman, D. P. Singh and H. C. Sharma 158
8. Effect of growth regulators on fruit-set, final retention and fruit quality in sweet lime (*Citrus limettoides* Tanaka.)
—R. K. Arora and R. Yamdagni 164
9. Water table decline and quality trend in the vicinity of Lower Ghaggar basin
—Joginder Singh and Ranvir Kumar 170
10. Effect of thinning on fruit-drop, ripening, fruit quality and yield in Beauty Seedless grapes
—V. S. Chauhan 177
11. Productivity and water-use of pearl millet in dryland as affected by crop geometry
—B. P. Singh 181
12. Effect of seeding time, seed-rate and row spacing on seed yield and water-use efficiency of dryland gram in South-West Haryana
—B. P. Singh, H. C. Sharma and B. P. Chugh 186

13. Studies on the significance of dew fall at Hisar region
—S. K. Agarwal and V. Umamaheswara Rao 191
14. Influence of irrigation and phosphorus fertilization on arhar and moong crops
—B. S. Malik, M. L. Batra and Jagdev Singh 195
15. Effect of long term application of farm yard manure and nitrogen. II. Mineral P fractions
—R. S. Antil, D. S. Ruhel and Mahendra Singh 200
16. Tomato fruit quality during storage as influenced by nitrogen doses and irrigation intensities
—D. K. Bhatnagar, B. R. Batra and M. L. Pandita 206
17. Studies on *Meloidogyne javanica* (Treub, 1885) Chitwood, 1949 infecting chickpea in Haryana
—D. C. Gupta and D. S. Dhangar 213
18. Relationship between fruit weight and seed content in grapes
—S. S. Sharma, Suneel Sharma and V. P. Ahlawat 216
19. Bioefficacy and economics of synthetic pyrethroids in cotton under Haryana conditions
—A. S. Nandal, R. K. Saini and Zile Singh 218
20. Studies on cross pollination at various distances in rapeseed and mustard
—Hari Singh, T. P. Yadava and V. S. Lather 221

Home Science

21. Extent of child labour and its impact on the height and weight of children in rural Haryana
—Jasbir Kaur, M. Nath and S. N. Laharia 223
22. A study of physically handicapped children
—Shanti Devi Kharangar and M. Nath 232

Social Sciences

23. Comparative profile of the rural women key-communicators and their recipients
—Damyanti and Hira Nand 236

Haryana Agricultural University, Haryana
110 004
Acc. No. 190404 Date 15/4/85
Borrower's Name
Lib. No. & Date
Pages 85

[Signature]

190404



15: 1985

HARYANA AGRICULTURAL UNIVERSITY

JOURNAL OF RESEARCH

Vol. XV, No. 3

September 1985

CONTENTS

Animal and Veterinary Sciences

1. Physiological changes during electroanaesthesia
—D. K. Sharma and Hariwir Singh 241
2. Relative efficiency of selection on part and annual records
—B. S. Chhikara, R. S. Meen and S. C. Chopra 248
3. Utilization of agro-industrial byproducts by livestock and poultry. VI. Nutritive value of gram (*Cicer arietinum*) chuni for cattle
—V. K. Paliwal, S. S. Khirwar and K. R. Yadav 257

Basic Sciences

4. Effect of accelerated aging of soybean seeds of differential storage potential on phospho- and glycolipids
—A. S. Rao and D. S. Wagla 260
5. Studies on multiple antibiotic resistance pattern and plasmid curing in *Rhizobium trifolii*
—R. K. Vashishat and A. S. Yadav 265
6. Cytogenetic effects of food additives in barley. 2. Citric acid, acetic acid and potassium metabisulphite
—Hari Om Mehra, P. K. Sareen and R. K. Aggarwal 271

Crop Sciences

7. Relative efficacy of different fungitoxicants against *Claviceps fusiformis* (Loveless) *in vitro* and *in vivo*
—V. S. Pahl and D. P. Thakur 279
8. Effect of different pollinizers on fruit set, final retention and quality of fruits in sweet lime
—R. K. Arora and R. Yamdagni 284
9. Effect of seeding time and plant geometry on the seed yield and water-use of taramira in dryland
—B. P. Singh, H. C. Sharma and B. P. Chugh 289
10. Morpho-physiological attributes in relation to seed yield in Indian mustard
—Hari Singh, A. K. Yadav, T. P. Yadava and V. S. Lather 295
11. Genetic analysis of heading and maturity in barley (*Hordeum vulgare* L.) in a range of environments
—C. R. Bainiwal, R. R. Karwasra and D. S. Jatasra 300
12. Potato yield in relation to seed size and plant density
—Y. S. Malik, K. P. Singh, M. L. Pandita, K. K. Thakral and S. Lal 305

13. Efficacy of gramoxone, bolls eye and sodium chlorate as defoliants to improve the yield and quality of cotton H 777
—S. N. Nagwekar, S. D. Pai, Vireshwar Singh and M. S. Kairon 309
14. Effect of different heights of stacks of cotton sticks on the survival of overwintering *Pectinophora gossypiella* (Saunders) larvae
—A. S. Nandal and Zile Singh 313
15. Incidence, biology and nature of damage by *Nephoterix infusella* Meyrick (= *Phycita infusella* Meyrick) on cotton in Haryana
—R. K. Saini 317
16. Interaction between seed rate, crop stand and sowing machinery in cotton
—N. K. Bansal, D. N. Sharma and M. L. Jain 323
17. Effect of seedling treatment and foliar application of cytozyme on growth and yield of tomato, brinjal and chilli
—R. S. Hooda, A. S. Sidhu and M. L. Pandita 329
18. Interference of *Amaranthus tricolor* with the growth and development of *Vigna radiata*
—Arun Bhaskar, Kalpana G. Vyas and B. K. Singhal 336
19. Pollination in relation to seed yield in sunflower
—Hari Singh and A. K. Yadav 341
20. Effect of culture media, temperature and pH on growth and sporulation of fungal foliar pathogens of cotton
—B. K. Sharma and M. S. Chauhan 344
21. Effect of carbofuran on paddy infected with rice-root nematode, *Hirschmanniella oryzae*
—R. K. Walia and D. S. Bhatti 350

Home Science

22. Study of self-disclosure in rural and urban boys
—S. Punia and T. R. Verma 353

Social Sciences

23. Pattern of spatial mobility in Haryana : a sociological analysis
—Savita Mehra, M. L. Sharma and T. M. Dak 357
24. Economic efficiency of subsidised loans disbursed under rural development programmes in Haryana
—U. K. Pandey, K. S. Suhag and O. P. Chhikara 364
25. Agricultural Development Officers' perception of suitability of extension education input in their under-graduate training
—V. B. Dixit, V. K. Makhija and Hira Nand 374

HARYANA AGRICULTURAL UNIVERSITY

JOURNAL OF RESEARCH

Vol. XV, No. 4

December 1985

CONTENTS

Animal and Veterinary Sciences

1. Effect of early protein restriction on body weight, physical measurements, cooking loss and chemical composition of sexed birds
—*M. K. Chaudhary, C. K. Aggarwal, S. P. Pruthi and S. K. Chopra* 381
2. Histomorphological studies on the endometrial epithelium of buffalo during estrous cycle
—*Harcharan Singh and D. N. Sharma* 395

Basic Sciences

3. Damage reduction with gibberellic acid post-treatment in gamma irradiated caryopses of *Avena fatua* L.
—*N. Moherchandani and M. Vasudeva* 399
4. Production of hydrolytic enzymes in wild-type and non-nodulating strains of *Rhizobium trifolii*
—*R. K. Vashishat, A. S. Yadav and Kamla Chaudhary* 403

Crop Sciences

5. Gene effects studies of curd compactness in cauliflower
—*R. N. Vashistha, Sabita Jyoti Neog and M. L. Pandita* 406
6. Effect of girdling on the storage behaviour of grapes
—*O. P. Gupta, Suneel Sharma, R. Yamdagni and Neena Mehta* 410
7. Evaluation of aldicarb (Temik 10 G) and malathion sprays against aphids in seed crop of radish
—*R. K. Kashyap, J. P. Bhanot, U. C. Pandey and S. Lal* 414
8. Functional classification of dry agricultural lands of tehsil Bawanikhara of Bhiwani district (Haryana)
—*Daya Ram* 418
9. Effect of time of sowing on growth and yield of pigeonpea-cultivars
—*Gurmeet Singh, H. S. Mavi and K. K. Dhingra* 427
10. Preliminary classification of broad bean germplasm lines
—*Ashok Chhabra, Madupuri R. Naidu and V. P. Singh* 431
11. Fine sand mineralogy under different landforms of a part of southern Haryana
—*V. P. Goyal, V. N. Garalapuri and Mahendra Singh* 436
12. Performance of pearl millet hybrids/synthetic varieties under varying plant populations and date of planting
—*P. S. Gill and S. L. Salni* 446

13. Numerical approximation of steady state movement of Na^+ in Ca^{2+} saturated soil columns
 —*Raj Pal, A. K. Kapoor and S. Joshi* 451
14. Comparative efficacy of some systemic insecticides against sugarcane whitefly, *Aleurolobus barodensis* Mask. (Homoptera : Aleurodidae)
 —*J. P. Chaudhary, S. R. Yadav and J. N. Gupta* 457
15. Prevalence of pigeon-pea cyst nematode, *Heterodera cajani* Koshy, 1967 in Bhiwani district (Haryana) alongwith a new host record
 —*R. K. Walia, Harish K. Bajaj and D. C. Gupta* 463
16. Reaction of potato varieties and hybrids to early blight disease
 —*M. S. Chauhan* 465
17. Combining ability and genetic architecture of oil content in Indian mustard
 —*S. K. Gupta, S. K. Thakral, T. P. Yadava and Parkash Kumar* 467
18. *Carcelia* sp. parasitising *Spilosoma obliqua* (Walker)
 —*V. K. Kalra* 471
19. Record of isabgol wilt from Haryana
 —*Naresh Mehta, R. L. Madan and D. P. Thakur* 473

Home Science

20. Attitude of medical practitioners towards nutrition
 —*Neeraj Suneja and C. M. Bhat* 475
21. Differential knowledge and source utilization pattern of rural and urban mothers regarding child rearing practices
 —*T. Verma and S. Agarwal* 479

Social Sciences

22. Effect of regional advancement on the social mobility pattern—a study of rural Haryana
 —*Savita Mehra, M. L. Sharma and T. M. Dak* 486
23. Study of patterns of social interaction among preadolescents
 —*Praveen Kaur and M. L. Sharma* 497

PERFORMANCE OF STARTING COMMERCIAL PULLETS ON DIFFERENT PROTEIN AND ENERGY LEVELS IN HARYANA

V. P. SAXENA and R. S. THAKUR

Department of Animal Nutrition

Haryana Agricultural University, Hisar

(Received : April 7, 1982; Revised : October 6, 1984)

ABSTRACT

A feeding trial involving 468 day-old commercial egg-type pullets was conducted for studying the effect of different levels of protein and energy during 0-8 weeks (starting period) on growth, feed consumption and feed efficiency. The study revealed no difference with respect to different parameters with 18, 20 and 22% crude protein, each level containing 2800, 2900 and 3000 Kcal metabolizable energy/kg, respectively, indicating that the commercial egg-type chicks can perform satisfactorily on diets containing 18% protein and 2800 Kcal ME/kg diet under agro-climatic conditions of Hisar.

The National Academy of Sciences of USA (NRC, 1971) has advocated the crude protein level of 20% with a metabolizable energy of 2900 Kcal/kg replacement pullet starter (0-6 weeks) diet. On the other hand, the requirements prescribed by I. S. I. (1977) for starting chicks (0-8 weeks) state crude protein to be 22% with 2700 Kcal ME/kg diet under Indian environmental conditions but, in general, these requirements essentially vary with respect to different agro-climatic conditions and regions in India. Different levels of protein and energy so far studied and reported by various Indian workers have been duly streamlined while discussing the present results.

From the feeding trials conducted by Malik *et al.* (1966a), Reddy *et al.* (1971, 1972) and Sadagopan *et al.* (1971a), the requirements for White Leghorn (WL) starter chicks (0-8 weeks) seem

(as per Panda and Reddy, 1976) to be 20-22% protein at an energy concentration of 2700-2800 Kcal ME/kg ration. The work on commercial layer-type chick is, however, of much recent origin. In this context, Ichhponani *et al.* (1973) observed that the commercial chicks upto 10 weeks of age require 24% protein for optimum growth in summer. The later experiments conducted by Ichhponani *et al.* (1974) revealed that the feed efficiency ratios improved only upto 2860 Kcal ME/kg beyond which poor growth was resulted. Nevertheless, Cilly *et al.* (1973) observed that the performance of commercial WL female chicks appeared better with 22% protein at 2400 and 2700 Kcal ME/kg diet. Again, Jalora and Sharma (1975) obtained the most efficient feed conversion on diets bearing protein : calorie ratios as 1 : 116 and 1 : 143 in winter reared and spring reared starting chicks, respectively.

Thus, most of the findings investigated are quite contradictory primarily because the agro-climatic conditions vastly vary from region to region in India. In view of this, it was felt necessary that the requirements of protein and energy should also be studied under agro-climatic conditions of Hisar (Haryana) for availing particularly the optimum liveweight of starting replacement pullets with maximum feed efficiency.

MATERIAL AND METHODS

Day-old commercial (Keystone) starting egg-type pullets vaccinated against Ranikhet were used. The average weight was 55 g each. They were distributed into 18 groups of 26 chicks each. Nine diets (Table 1) having three protein levels (18, 20 and 22 per cent) containing 2800, 2900 and 3000 Kcal/kg ME in diet, respectively, were randomly offered during their starting period (0-8 weeks) for duplicate groups from 23 May to 18 July, 1976. The maximum and minimum environmental temperatures of poultry shed during the experimental period ranged from 84° to 112°F and 70° to 88°F with averages of 101.29° and 79.04°F, respectively. The relative humidity (%) varied from 24 to 100 within the period. Diets were analysed for proximate principles (AOAC, 1970).

Data on weight gain, feed intake and mortality were recorded and analysed statistically as per Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

The average liveweight gain (g), feed intake (g), feed efficiency and mortality

rate (%) during the experimental period have been presented in Table 2.

Average liveweight gain ranged from 444.8 to 485.3 g for the various groups, but the differences amongst these values were insignificant ($P < 0.05$). Data indicated that diet containing 18% protein with 2800 Kcal ME/kg supports optimum liveweight gains in commercial egg-type pullet starters under the described agro-climatic conditions. On the other hand, Nagabhushanam *et al.* (1979) observed that the protein : calorie ratios ranging from 1 : 94 to 1 : 105 supported maximum weight gains besides feed efficiency.

Feed Consumption and Feed Efficiency

Average feed intake/bird and feed efficiency varied from 2165 to 3063 g and 0.1488 to 0.1762, respectively, for the different treatments. Nevertheless, the differences amongst these relative values were found to be insignificant ($P < 0.05$). Again, the level as low as 18% protein with 2800 Kcal ME/kg diet resulted in requisite feed intake and feed efficiency concerning to starting pullets.

Quite differently, from another investigation, it has been reported (Anonymous, 1972-75) that for the optimum liveweight gain and feed efficiency the egg-type starting chickens require 24% protein and 2900 to 3000 Kcal ME/kg diet in summer months (April to September). Earlier, Malik *et al.* (1966b) also studied the effect of different levels of energy and protein on growth rate and feed efficiency in White Leghorn chickens (0-8 weeks). A protein level of

TABLE 1

Composition of experimental rations for starting pullets (0-8 weeks)

	Crude protein 22%						Crude protein 20%						Crude protein 18%					
	ME : 2800			ME : 2900			ME : 2800			ME : 2900			ME : 2800			ME : 2900		
	Kcal/kg	I	II	Kcal/kg	I	III	Kcal/kg	I	II	Kcal/kg	I	III	Kcal/kg	I	II	Kcal/kg	I	III
Maize (kg)	25		25		25		29.5		29.5		29.5		29.5		29.5		29.5	
Wheat bran (kg)	10		10		10		10		10		10		10		10		10	
Rice polish (kg)	20		20		20		20		20		20.5		20.5		20.5		20.5	
Molasses (kg)	3.6		3.1		0.7		3.9		2.4		3.6		3.6		2.1		0.6	
Groundnut cake (kg)	18		18		18		18		18		18		18		18		18	
Corn gluten meal (kg)	12.8		12.8		12.8		8.3		8.3		7.8		7.8		7.8		7.8	
Fish meal (kg)	6		6		6		6		6		6		6		6		6	
Lime stone (kg)	1		1		1		1		1		1		1		1		1	
Lard (kg)	1.1		2.6		4.0		0.8		2.3		1.1		2.6		2.6		4.1	
Biominidit ¹ (kg)	2.5		2.5		2.5		2.5		2.5		2.5		2.5		2.5		2.5	
Rovimix ² AB ₂ D ₂ (g)	40		40		40		40		40		40		40		40		40	
Rovibe ³ (g)	25		25		25		25		25		25		25		25		25	
Bifuran ⁴ (g)	50		50		50		50		50		50		50		50		50	
Crude protein (%)	22.09		22.09		22.00		20.09		20.09		20.04		18.04		18.03		18.00	
Calculated ME (Kcal/kg)	2807.82		2900.66		3000.26		2801.89		2901.89		3000.19		2803.41		2903.01		3002.61	

1. Biominidit (Boots Drug House) contained Ca 28%, P 5%, Cu 100 ppm, Co 50 ppm, Mn 2000 ppm, I 10 ppm, Fe 35 ppm, NaCl 20% and Aureomycin 0.04%.
2. Each g of Rovimix (Roche) supplied Vitamin A 40,000 IU, vitamin B₂ 20 mg and vitamin D₃ 5,000 IU.
3. Each g of Rovibe (Roche) supplied Vitamin B₁ 4 mg, Vitamin B₆ 8 mg, Vitamin B₁₂ 40 mg, Niacin 60 mg, Cal. pantothenate 40 mg and Vitamin E 40 mg.
4. Coccidiostat (SK & F) contained 25% W/W nitrofurazone and 3.6% W/W furazolidone.

TABLE 2
Performance of chicks on experimental diets

Crude protein (%)	ME (Kcal/kg)	Av. liveweight gain within 0-8 weeks (g)	Av. feed intake/ bird in 0-8 weeks (g)	Feed efficiency	Mortality rate (%)
18	2800	456.5	2839	0.169	0.00
"	2900	482.9	3063	0.158	9.61
"	3000	444.8	2767	0.161	0.00
20	2800	474.4	2692	0.176	13.46
"	2900	448.4	2786	0.161	7.69
"	3000	448.6	2615	0.172	1.92
22	2800	485.3	2674	0.169	3.34
"	2900	481.3	2920	0.165	3.84
"	3000	450.9	3029	0.149	11.53

24.5% at 3185 Kcal ME/kg diet was found to be optimum in both sexes. Again, Sadagopan *et al.* (1971b) observed that the overall growth response of chicks on the diets with 24% protein at 3072 Kcal ME/kg or 21% protein at 2688 Kcal ME/kg, was superior compared to all other levels, the former set of values being more or less similar to those reported by Malik *et al.* (1966b). On the other hand, Reddy *et al.* (1972) concluded that for the optimum weight gains, the quantitative requirements of protein and energy were not over 20% and 2860 Kcal ME/kg, respectively, for WLH female chicks upto 8 weeks of their age. Moreover, it was observed by Reddy *et al.* (1972) that a 20% protein level with only 2640 Kcal ME/kg sufficed well for adequate weight gain in such pullets. Again

considering overall performance, Reddy *et al.* (1977) found a level of 20% protein with an energy level of 2430 Kcal ME/kg to be optimum.

The results of present investigation are quite different than the aforestated findings, basically because the agro-climatic dispositions in India greatly vary from region to region.

Mortality Rate

The rate of mortality varied from 0.00 to 13.46 per cent relative to different groups denoting its no trend with respect to various dietary treatments. However, the mortality was nil in the group taking 18% protein with 2900 or 3000 Kcal ME/kg diet.

REFERENCES

- AOAC. 1970. Official Methods of Analysis. 11th edn. Association of Official Agricultural Chemists, Washington, D. C.
- Anonymous. 1972-1975. Amino acids, minerals and vitamin requirements of different categories of chicken in relation to energy content of feeds under tropical conditions: Energy and protein requirements of poultry under changing seasons in tropics, Punjab Agricultural University, Ludhiana.
- Cilly, V. K., Lodhi, G. N. and Ichhponani, J. S. 1973. Influence of climatic conditions on protein and energy requirements of poultry. 1. Effect of different levels of protein and energy on the performance of starter chicks. *Indian J. anim. Sci.* **43** : 408-16.
- Ichhponani, J. S., Chawla, J. S., Ahuja, A. K. and Chauhan, T. R. 1973. Amino acids, minerals and vitamin requirements of different categories of chickens in relation to energy content of feeds under tropical conditions. Annual Report 1972-73, ICAR Scheme, Punjab Agricultural University, Ludhiana.
- Ichhponani, J. S., Chawla, J. S., Ahuja, A. K. and Chauhan, T. R. 1974. Amino acids, minerals and vitamin requirements of different categories of chickens in relation to energy content of feeds under tropical conditions. Annual Report 1973-74, ICAR Scheme, Punjab Agricultural University, Ludhiana.
- ISI. 1977. Indian Standards Specification : Nutrients requirements for chicken feeds (IS : 1374). Indian Standard Institution, Manak Bhawan, 9, Bhadurshah Zafar Marg, New Delhi 1.
- Jalora, M. L. and Sharma, V. V. 1975. Protein and energy levels in poultry starting diets. Growth response in winter and spring reared chicks. *Indian J. anim. Sci.* **45** : 224-33.
- Malik, N. S., Pal, K. K. and Bose, S. 1966a. *Indian J. Poult. Sci.* **1** : 12 (Cited from : Saikia, A. Paper 65 Balanced and economic rations for poultry for eggs and meat presented in III Animal Nutrition research workers conference, Jabalpur from 22 to 24 Feb., 1973).

- Malik, N. S., Pal, K. K. and Bose, S. 1966b. Studies on energy protein ratio in poultry. 2. Influence of energy protein ratio on growth rate, feed efficiency and nitrogen retention in White Leghorn chicks using molasses and animal fat as an extra source of energy. *Indian J. Poult. Sci.* **1** : 24-33.
- Nagabhushanam, N., Reddy, V. R. and Reddy, C. V. 1979. A study on protein and energy relationship in the diets of starter chicks. *Indian J. Poult. Sci.* **14**(1) : 32-42.
- NRC. 1971. Nutrient requirements of domestic animals. No. 1. Nutrient requirements of poultry. National Academy of Sciences, Washington, D. C.
- Panda, B. and Reddy, V. R. 1976. A review of work done in India on nutrient requirements of chicken. *World's Poult. Sci. J.* **32** : 322-32.
- Reddy, B. V., Siddiqui, S. M. and Reddy, C. V. 1971. The evaluation of protein requirements for starter chicks. Part I. Quantitative protein requirement. *Indian J. Poult. Sci.* **6** : 39-44.
- Reddy, B. V., Siddiqui, S. M. and Reddy, C. V. 1972. An evaluation of protein requirements for starter chicks. Part 2. Requirements of some critical amino acids. *Indian J. Poult. Sci.* **7**(2) : 13-18.
- Reddy, C. V., Rao, M. R., Reddy, V. R. and Siddiqui, S. M. 1977. Influence of protein and energy ratio on the performance of starter chicks. *Indian J. Poult. Sci.* **12**(11) : 21-26.
- Reddy, V. R., Siddiqui, S. M. and Reddy, C. R. 1972. A study on the quantitative requirements of protein for starter chicks with special reference to protein energy inter-relationship. *Indian vet. J.* **49** : 688-98.
- Sadagopan, V. R., Bose, S. and Pal, K. K. 1971a. Studies on determination of optimum metabolizable energy : protein ratio of poultry ration for growth and feed efficiency in White Leghorn birds. *Indian vet. J.* **48** : 614-24.
- Sadagopan, V. R., Bose, S. and Pal, K. K. 1971b. Studies on determination of optimum metabolizable energy : protein ratio of poultry rations for growth and egg production. III. The influence of varying energy and protein levels on egg production and feed efficiency in White Leghorn pullets. *Indian vet. J.* **48** : 381-89.
- Snedecor, G. W. and Cochran, W. G. 1967. *Statistical Methods*. 6th edn. The Iowa State University Press, Ames, Iowa, U. S. A.

EFFICACY OF CERTAIN ANTIBACTERIAL INTRAUTERINE INFUSIONS ON THE REPRODUCTIVE EFFICIENCY IN POSTPARTUM COWS

T. S. MANJU, UMED SINGH, A. K. SINHA, S. K. VERMA and R. C. GUPTA

Department of Veterinary Gynaecology & Obstetrics

Haryana Agricultural University, Hisar

(Received : March 30, 1983; Revised : October 23, 1984)

ABSTRACT

The study revealed that there was some improvement in conception rate in cattle with the intrauterine infusion of Flagyl within 21-28 days postpartum. The occurrence of first estrus and fertile estrus was earlier as compared to control. In other treatment groups the duration of fertile oestrus was, however, reduced and the conception rate was lower as compared to the control group of animals. It appears that postpartum treatment with Flagyl may help in reducing the service period and increasing the conception rate.

The importance of a regular and routine examination of the postpartum uterus in maintaining the stipulated calving interval and conception rate has been recognised world over. Several studies indicate that the uterine involution is completed sometime between 25-50 days (Morrow *et al.*, 1966; Johanns *et al.*, 1967; Gier and Marion, 1968). Studies on the microbial flora of the postpartum uterus have revealed that almost all cows acquire some uterine infections, postpartum (Johanns *et al.*, 1967; Elliot *et al.*, 1968). However, intrauterine infusions with a variety of antibiotics, chemotherapeutics and antiseptics have been frequently employed in an attempt to improve the involution of the uterus and subsequent fertility in a postpartum cow. The present study was taken up with the object of comparing the efficacy of certain intrauterine infusions on the onset of postpartum oestrus, fertile oestrus and conception rate.

MATERIAL AND METHODS

The present study was undertaken on 69 animals, maintained at the Animal Farm, College of Animal Sciences, Hisar. The animals selected for the study had a history of normal parturition and expulsion of the placenta. The animals were maintained under standard managerial practices and constant veterinary care. The animals were treated under different groups, and one of the groups was kept as control in which no treatment was instituted. The intrauterine infusions in all the animals under treatment were made once between 21-28 days postpartum and the animals were let loose with the rest of the herd where regular heat detection, both in the morning and afternoon was done with the help of vasectomised bulls and trained attendants. The animals were bred artificially after a rest period of 45 days postpartum. The non-return animals were checked regularly

for pregnancy after 45 days of last insemination. Table 1 shows different groups, treatments adopted, dose and number of animals in each group.

RESULTS AND DISCUSSION

Table 2 presents the average days of onset of first observed postpartum oestrus, fertile oestrus and per cent conception rate in the treated and control groups.

The average first postpartum oestrus was observed as early as 26.6 days in the group treated with a combination of Flagyl and Terramycin. This was followed by those treated with Flagyl alone (42.7 days); while those treated with Lugol's solution had longest interval between parturition and onset of postpartum oestrus (64.1 days). The onset of postpartum oestrus in the control group, on the other hand, was observed on an aver-

TABLE 1

Details of treatment groups, dose of the drug infused and number of animals used in each group

Group	Drug	Dose	Amount infused	No. of animals
1.	Flagyl*	1.0 g	100 ml	10
2.	Antrima**			
	Sulfadiazine	2.5 g	100 ml	10
	Trimethoprim	0.5 g		
3.	Flagyl + Terramycin***	1.0 g	100 ml	9
		1.0 g		
4.	Steclin	1.0 g	100 ml	12
5.	Lugol's solution	1.10	100 ml	15
6.	No treatment		Control	13

*Flagyl May & Baker, Bombay 400 mg Metronidazole tabs.

**Antrima May & Baker, Bombay 1.0g Sulfadiazine
200 mg Trimethoprim

***Terramycin Pfizer, Bombay 500 mg tablets (Oxytetracycline hydrochloride)
+ Steclin Sarabhai Chemicals, Bombay 500 mg tablets (Tetracycline hydrochloride)

TABLE 2

Conception rate in various treatment groups

Drug	First oestrus (in days)	Fertile oestrus (in days)	No. conceived	No. unconceived	Per cent conception
Flagyl	42.7	89.5	8	2	80
Antrima	50.6	109.8	5	6	50
Flagyl + Terramycin	26.6	88.6	6	3	66.66
Steclin	57.9	67.2	5	7	41.66
Lugol's solution	64.1	84.5	7	8	46.6
Control	52.2	116.2	9	4	69.23

EFFICACY OF ANTIBACTERIAL INTRAUTERINE INFUSIONS

age of 52.2 days and comparable figures were obtained in animals treated with Antrima (50.6 days) and Steclin bolus (57.9 days). However, the average fertile oestrus period was observed to be lowest (67.20) in the animals treated with Steclin bolus followed by Lugol's solution (84.57 days), Flagyl+ Terramycin (88.6 days) and Flagyl (89.5 days). The animals under control group, on the other hand, exhibited the fertile oestrus as late as 116.2 days. In the present study, the conception rate was found to be the lowest in Steclin treated group (41.66%) and highest in Flagyl treated group (80%) wherein majority of the animals conceived within 90 days as compared to the animals under control group, in which the animals conceived as late as 116 days on an average. Hukeri *et al.* (1982) reported encouraging results with intrauterine Flagyl infusion in cases of repeat breeder, metritis and abortion harbouring anaerobic organisms.

The present study revealed that there was considerable improvement in the days

of onset of fertile oestrus following intrauterine therapy which was less in all the groups as compared to control. However, Fuquay *et al.* (1975) reported increase in the duration of postpartum fertility after postpartum intrauterine medication. Therefore, it appears that postpartum intrauterine therapy with antibiotics may not be of much value as far as conception rate is concerned.

However, the treatment with antibiotics may help in reducing the service period considerably. Nevertheless, treatment with Flagyl has shown some improvement in conception rate as compared to all other treatments as well as control. These findings need further investigation on a comparatively larger population of animals.

ACKNOWLEDGEMENT

The authors are thankful to Dr. S. C. Chopra, Chief Scientist, Animal Breeding, College of Animal Sciences, for providing the necessary facilities.

REFERENCES

- Elliot, L., McMohan, K. J., Gier, H. T. and Marion, G. B. 1968. Uterus of the cow after parturition bacterial content. *Am. J. vet. Res.* 29 : 77-81.
- Fuquay, J. W., Harris, R. A., McGee, W. H., Beatty, J. F. and Arnold, B. L. 1975. Routine postpartum treatment of dairy cattle with intrauterine neomycin sulphate boluses. *J. dairy Sci.* 58 : 1367-69.
- Gier, H. T. and Marion, G. B. 1968. Uterus of the cow after parturition. Involutional changes. *Am. J. vet. Res.* 29 : 83-96.
- Hukeri, V. B., Paranjape, V. L., Paranjape, V. V. and Saxena, B. R. 1982. Anaerobic genital infections in buffaloes with remedial measure—A preliminary report. *Indian J. anim. Rep.* 2 : 15-17.
- Johanns, C. J., Clark, T. L. and Herrick, J. B. 1967. Factors affecting calving interval. *J. Am. Vet. Med. Assoc.* 151 : 1692-1704.
- Morrow, D. A., Roberts, S. J., McEntee, K. and Gray, H. G. 1966. Postpartum ovarian activity and uterine involution in dairy cattle. *J. Am. Vet. Med. Assoc.* 149 : 1596-1609.

EFFECT OF LIGHT COLOUR ON THE REPRODUCTIVE PERFORMANCE ON JAPANESE QUAIL

SURAJ BHAN PHOGAT and C. K. AGGARWAL

Department of Livestock Production & Management

Haryana Agricultural University, Hisar

(Received : November 11, 1983; Revised : July 3, 1984)

ABSTRACT

The effects of red, green and incandescent light colour on age at sexual maturity, egg weight and egg production were investigated. The birds raised under red coloured light had earlier sexual maturity, higher egg production and bigger egg size than the birds belonging to other two groups.

Although quails have been introduced only recently, its egg and meat have been widely accepted especially in the affluent society. Quail raising has also added advantage of short generation interval and less space and feed requirement compared to chicken. In order that commercial raising of quails becomes a feasible proposition there is a need for standardising the managerial practices for maximizing profit. Since the effect of coloured lights on quails has not been studied in sufficient quantity, the present study was undertaken to find the effect of red, green and incandescent light on the performance of quails.

MATERIAL AND METHODS

The study was conducted in two trials (March-November; October-June). The eggs collected from a random-bred flock of quails were hatched in four hatches in each trial. Birds of each hatch were randomly divided into three groups and kept in three different decks of a battery brooder. Separate brooding batteries

were used for each hatch. The three decks of the brooding battery were provided red, green and incandescent light for 24 h daily, throughout the experiment and the wattage of the bulbs was adjusted according to weather conditions in the beginning and later 15 watt bulb was used from 5-week of age and during laying period. The data for age at 5% production, egg production, egg weight and costs of various items like feed and chick were recorded. Means and standard errors were calculated and analysis of variance was made using usual statistical methods and the pair-wise comparison of means was made using Duncan's Multiple Range Test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The age at 5 and 50% production and egg size at these ages have been presented in Table 1. The age at 5 and 50% production was significantly lower in birds reared in red or incandescent lights during first period (March-November).

EFFECT OF COLOURED LIGHTS IN QUAILS

However, in the second period (October-June) significant difference was observed for these traits. The birds raised during second period matured a little earlier than those raised during first period. A general trend noted in both the periods was that birds reared under red light matured earliest followed by incandescent and green lights. Woodard *et al.* (1969)

reported that sexual maturity and 50% rate of lay of quails are hastened in birds under red light compared to those provided with green light. In turkey, duck and sparrows, the reproductive activity was found to be stimulated when kept under red light by Bissonette (1932), Scott and Payne (1937) and Benoit and Off (1944). These workers have reported

TABLE 1

Age at 5 and 50 per cent egg production and egg size of quails reared under three different coloured lights during two different seasons

Trait	1st period			2nd period		
	Red	Green	Incandescent	Red	Green	Incandescent
Age at 5% production (days)	47±2 ^a (110)	51±3 ^b (150)	48±2 ^a (156)	44±2 ^a (108)	48±2 ^a (100)	47±1 ^a (90)
Age at 50% production (days)	55±2 ^a	62±3 ^a	62±3 ^a	54±3 ^a	58±2 ^a	56±3 ^a
Average egg weight at 5% production (g)	9±0.07 ^a	8±0.02 ^b	9±0.01 ^a	9±0.06 ^a	9±0.02 ^a	9±0.03 ^a
Average egg weight at 50% production (g)	11±0.16 ^a	11±0.06 ^a	11±0.04 ^a	10±0.09 ^a	11±0.09 ^a	11±0.09 ^a

Figures having superscripts in common within a row do not differ significantly from each other at 5% level of significance, for each season separately. Within parentheses are number of females studied.

TABLE 2

Cumulative hen housed egg production per quail for 28-day period from age at 5% production

Periods	1st period			2nd period		
	Red	Green	Incandescent	Red	Green	Incandescent
I	13±0.32 ^b	8±0.66 ^a	7±0.71 ^a	12±0.42 ^a	11±0.48 ^a	11±0.17 ^a
II	27±1.20 ^b	20±0.83 ^a	19±1.37 ^a	31±1.33 ^b	26±0.65 ^a	25±0.66 ^a
III	43±1.62 ^b	34±2.06 ^a	31±1.22 ^a	50±1.82 ^b	41±0.80 ^a	40±0.23 ^a
IV	59±2.29 ^b	49±3.28 ^{ab}	42±2.16 ^a	68±2.88 ^b	55±1.57 ^a	53±0.88 ^a
V	73±3.31 ^b	60±3.45 ^a	53±1.53 ^a	85±1.89 ^b	71±1.51 ^a	67±1.46 ^a
200-day age	79±3.77 ^b	65±2.56 ^a	61±4.09 ^a	86±4.80 ^b	72±3.48 ^b	69±2.05 ^a

TABLE 3
Comparative cost (Rs.) of egg production when quails are maintained upto 200-day age during two different periods of study under three coloured lights

	1st period			2nd period		
	Red	Green	Incandescent	Red	Green	Incandescent
1. Number of females started	113	156	156	109	106	97
2. Cost per 6-week old *quail	2.31	2.17	2.17	2.20	2.20	2.23
3. Total cost of 6-week old quails (A)	261.03	338.52	327.67	239.80	233.20	216.31
4. Cost** of feeding from 6 weeks to 200-day age @ Rs. 2.20 per kg feed (B)	790.33	1015.05	976.05	764.45	991.82	745.86
5. Total expenditure from 6 weeks to 200-day age (A+B)	1051.38	1354.26	1303.72	1004.45	1225.02	962.14
6. No. of quails alive at 200-day age	84	137	141	102	99	81
7. Income from sale of 200-day old quails @ Rs. 3 each (C)	252	411	423	306	297	243
8. Net expenditure (A+B-C)	799.38	943.26	880.72	698.25	928.25	719.17
9. Total eggs produced from 6 weeks to 200-day age	8641	9445	8930	10806	8418	7569
10. Cost per egg	0.09	0.10	0.10	0.06	0.11	0.9

*Phogat, 1983

**Includes cost of feed ingredients, interest and handling charges.

that the white, blue and green lights had little or no effect on the reproductive activities of birds. Harrison *et al.* (1969), however, obtained different results in the White Leghorn birds. The birds exposed to blue or green light matured earlier than those exposed to red light.

The egg weight was not affected by the colour of light except that the egg weight at 5% production was significantly lower in birds raised under green light. Woodard *et al.* (1969) also observed that egg weight of quails was unaffected by colour of light. Harrison *et al.* (1969) reported that egg weight was related to rate of egg production rather than to a direct spectral effect.

The cumulative hen housed egg production for the five 28-day periods from age at 5% production as well as egg production upto 200-day age lay have been presented in Table 2. The birds reared under red light laid at the highest rate followed by green and incandescent lights in both the trials. The differences between the performance of birds raised

under green or incandescent lights were non-significant in most of the cases but the performance of birds raised under red light was significantly better. Ronald and Jay (1971) obtained a higher rate of lay from chickens maintained under red tape light compared to those under white and green tape lights.

The cost of producing an egg was also estimated to find the overall superiority of different treatments after adjusting for feed consumption and mortality percentage (Table 3). The cost of egg production after 200-day lay was much lower (6 paise) for the group of birds raised under red light during 2nd period followed by red light during 1st period (9 paise), incandescent light during 1st period (9 paise), green and incandescent light during 2nd period (10 paise) and green light during the 1st period (11 paise).

Thus, it can be inferred that quails should be raised under red light for higher egg production, early maturity and larger egg size.

REFERENCES

- Benoit, J. and Off, L. 1944. External and internal factors in sexual activity. Effect of irradiation and different wave lengths on the mechanisms of photostimulation of the hypophysis and antesticular growth in the immature duck. *Vale. J. Biol. Med.* 17 : 27-46 (c. f. *Poult. Sci.* 48 : 118-23).
- Bissonette, T. H. 1932. Studies on the sexual cycle in birds. Effects of white, green and red lights of equal luminous intensity on the testes activity of the European starling (*Sturnus vulgaris*). *Physiol. Zool.* 5 : 92-123 (c. f. *Poult. Sci.* 48 : 878-83).
- Harrison, P. C., Mc Ginnis, J., Schumaier, G., Pettiobone, C. A. and Lauber, J. 1969. The influence of rearing pullets under coloured light on subsequent reproductive performance. Washington Farm Electrification Committee, 1966 Progress Report (c. f. *Poult. Sci.* 48 : 118-23).
- Phogat, S. B. 1983. Effect of red and green lights on growth and reproduction of *Coturnix Coturnix japonica* (Japanese quail). M Sc. thesis, Haryana Agricultural University, Hisar.

PHOGAT AND AGGARWAL

- Ronald, A. P. and Jay, E. 1971. Performance of laying hen maintained in colony cages under low intensity. *Poult. Sci.* **50** : 291-93.
- Scott, H. M. and Payne, L. E. 1937. Light in relation to the experimental modification of the breeding season of turkey. *Poult. Sci.* **16** : 90-96.
- Steel, R. G. D. and Torrie, J. H. 1980. *Principles and Procedures of Statistics*. Mc-Graw Hill Book Company, INC, New York.
- Woodard, A. W., Moore, J. A. and Wilson, W. O. 1969. Effect of wave length on growth (*Coturnix Coturnix japonica*), *Poult. Sci.* **48** : 118-23.

VARIABILITY IN PROTEIN, TRYPTOPHAN AND METHIONINE CONTENTS IN *PHASEOLUS* AND *VIGNA* SPP.

BHAGWAN SINGH and O. P. S. RANA

Department of Genetics

Haryana Agricultural University, Hisar

(Received : March 5, 1983; Revised : December 28, 1983)

ABSTRACT

The seeds of different genotypes belonging to four *Phaseolus* spp. and four *Vigna* spp. were evaluated for their proteins, tryptophan and methionine contents. The results show that large variability is present for protein, tryptophan and methionine contents between different species. All the cultivated species viz., *V. mungo*, *V. radiata*, *V. umbellata*, *V. aconitifolia* and *P. acutifolius* have higher protein, tryptophan and methionine contents in comparison to the wild species viz., *P. lathyroides*, *P. trilobus* and *P. sublobatus*.

Pulses, in view of their relatively high concentration of storage proteins and wide acceptance as part of the human diet, offer the most practical means of eradicating protein malnutrition in developing countries like India.

For improving the quality and seed yield, breeders have to look for the genetic variability. In this study, the variation in protein and its major fractions and the most limiting amino acids tryptophan and methionine in some cultivated and wild species of *Phaseolus* and *Vigna* species is reported.

MATERIAL AND METHODS

The material for the present study comprised nine genotypes belonging to four *Phaseolus* spp. and eight genotypes belonging to four *Vigna* spp. The seeds of these species were procured from National Bureau of Plant Genetic Resources, New Delhi. These genotypes have

been given in Table 1 alongwith their accession numbers and place of collection.

The seeds of different species were sown on two dates (26 June and 19 July, 1980) in the field in a randomized block design in three replications. The freshly harvested and mature dry seeds were used for the chemical analyses. The seeds of each genotype from five plants, harvested separately to record other seed characters, were pooled together and a sample was taken to make the flour for chemical analyses. In all six samples of each species taken from each of the three replications and two sowings were analysed. The standard sample size was taken for the analyses as described in the procedures given below :

Protein percent was determined by modified Microkjeldahl's method as suggested by AOAC (1970). Different protein fractions viz., albumins, globulins,

TABLE 1
Genotypes of *Phaseolus* and *Vigna* used in present study

S. No.	Species	Accession No.	Place of collection
1.	<i>V. aconitifolia</i> (Jacq)	Ph. 68-04	not known
2.	<i>V. aconitifolia</i> (Jacq)	222	not known
3.	<i>V. mungo</i> (L.) Hepper	DEU 90	Kanpur (Uttar Pradesh)
4.	<i>V. mungo</i> (L.) Hepper	DLU 487	Una (Himachal Pradesh)
5.	<i>V. radiata</i> (L.) Wilczek	1290	not known
6.	<i>V. radiata</i> (L.) Wilczek	IC 19414	Mahasing, Nuagaon Phulbani (Orissa)
7.	<i>V. umbellata</i> (Thumb.)	not known	not known
8.	<i>V. umbellata</i> (Thumb.)	IC 25935	Bhaishuri, Kapkot (Almora, U. P.)
9.	<i>P. acutifolius</i> A. Gray	not known	not known
10.	<i>P. acutifolius</i> A. Gray	EC 98456	not known
11.	<i>P. lathyroides</i> (L.)	EC 33694	Italy
12.	<i>P. lathyroides</i> (L.)	EC 27631	Australia
13.	<i>P. trilobus</i> (Ait.)	494	Majholi, Sihora (Rajasthan)
14.	<i>P. trilobus</i> (Ait.)	132	Santalpur (Rajasthan)
15.	<i>P. trilobus</i> (Ait.)	394	Mundanthurai (Maharashtra)
16.	<i>P. trilobus</i> (Ait.)	IW 1364	Ujinagar (Orissa)
17.	<i>P. sublobatus</i> (Roxb.)	416	Chiplin (Maharashtra)

prolamins and glutelins were separated by the modified Mendel Osborne method as described by Nagy *et al.* (1941). The tryptophan and methionine contents were estimated on g/16 g N basis by colorimetric methods given by Spies and Chambers (1949) and Horn *et al.* (1946), respectively. The results presented are the mean values of six samples analysed.

RESULTS AND DISCUSSION

Large variation for protein content was observed between different species (Tables 2 and 3). The lowest protein content (8.42%) was found in wild species *P. lathyroides* and the highest (26.59%) in cultivated species *V. mungo*. The protein content in cultivated species ranged from 21.34% in *V. aconitifolia*

to 26.59% in *V. mungo*. The range in protein content within the cultivated species and wild species was less in comparison to the range between the wild and cultivated species. The exception to this statement is *P. sublobatus* which has been considered as the wild progenitor of *V. mungo* and *V. radiata*. *P. sublobatus* has been given a varietal status i.e., *V. radiata* (L.) Wilczek var. *sublobata* (Roxb.) Verdt. The genotype used in the present study is from category I resembling to *Urid* (Arora *et al.*, 1973). Similar results have been reported by Amirshahi and Tavakoli (1970), Kadwe *et al.* (1974), Imam (1979), Singh *et al.* (1980) and Gill *et al.* (1975). The smaller seed size in wild species may be one of the reasons for lower protein content.

PROTEIN VARIABILITY IN PHASEOLUS AND VIGNA

TABLE 2

Total protein content and major protein fractions in *Phaseolus* and *Vigna* in early sowing (26 June 1980)

S. No.	Species	Total protein (%)	Albumins (%)	Globulins (%)	Prolamins (%)	Glutelins (%)
1.	<i>V. aconitifolia</i>	21.50	7.15 (38.86)	3.10 (16.85)	3.35 (18.20)	4.80 (26.08)
2.	<i>V. aconitifolia</i>	21.34	7.25 (38.98)	3.20 (17.20)	3.15 (16.93)	5.20 (27.97)
3.	<i>V. mungo</i>	26.40	8.85 (36.12)	4.50 (18.36)	4.25 (17.35)	6.90 (28.16)
4.	<i>V. mungo</i>	26.59	9.01 (36.46)	4.75 (19.22)	4.15 (16.49)	6.80 (27.52)
5.	<i>V. radiata</i>	23.60	7.95 (39.06)	3.25 (15.97)	4.05 (19.90)	5.10 (25.06)
6.	<i>V. radiata</i>	24.19	8.10 (38.64)	3.50 (16.69)	3.56 (16.98)	5.80 (27.67)
7.	<i>V. umbellata</i>	23.16	7.85 (37.96)	3.50 (16.92)	3.53 (17.07)	5.80 (28.05)
8.	<i>V. umbellata</i>	23.94	7.85 (37.74)	3.55 (17.06)	3.50 (16.82)	5.90 (28.36)
9.	<i>P. lathyroides</i>	8.42	2.56 (45.96)	1.15 (8.85)	0.85 (9.93)	1.55 (34.40)
10.	<i>P. trilobus</i>	8.46	3.50 (47.62)	0.50 (6.86)	0.45 (6.12)	2.90 (39.45)
11.	<i>P. trilobus</i>	9.22	3.25 (49.24)	0.60 (9.90)	0.35 (5.30)	2.40 (36.36)
12.	<i>P. trilobus</i>	8.54	2.55 (38.06)	0.90 (13.43)	0.60 (8.95)	2.65 (39.55)
13.	<i>P. trilobus</i>	10.29	3.50 (41.18)	0.95 (11.17)	0.85 (10.00)	3.20 (37.64)
14.	<i>P. sublobatus</i>	20.80	6.25 (33.87)	3.10 (16.80)	3.30 (17.88)	5.86 (31.44)

*Figures in parantheses indicate per cent of total protein present as each fraction.

Sowing time also affected the protein content to some extent. Seeds harvested from late sown plants had low protein content than the seeds from early sown plants (Table 3). Amirshahi and Tavakoli (1970) also reported that protein content within a genotype varies in different

locations, showing that the environmental conditions also affect the protein content. However, genotypes with higher protein content in one environment also gave higher protein content in the other environment.

TABLE 3

Total protein content and major protein fractions in *Phaseolus* and *Vigna* genotypes in late sowing (19 July 1980)

S. No.	Species	Total protein (%)	Albumins (%)	Globulins (%)	Prolamins (%)	Glutelins (%)
1.	<i>V. aconitifolia</i>	19.41	6.75 (41.03)	2.50 (15.19)	3.05 (18.54)	4.15 (25.23)
2.	<i>V. mungo</i>	25.50	7.75 (35.74)	4.05 (18.68)	3.95 (18.22)	5.93 (27.35)
3.	<i>V. mungo</i>	25.78	8.49 (36.61)	4.70 (20.27)	4.00 (17.25)	6.30 (27.17)
4.	<i>V. radiata</i>	23.33	7.95 (39.06)	3.25 (15.97)	4.05 (19.90)	5.10 (25.06)
5.	<i>V. umbellata</i>	21.30	6.25 (38.87)	3.10 (16.00)	3.30 (17.88)	5.80 (31.43)
6.	<i>V. umbellata</i>	21.50	7.15 (35.75)	3.10 (19.50)	3.00 (15.00)	5.75 (28.75)
7.	<i>P. acutifolius</i>	19.75	6.05 (35.69)	2.95 (17.40)	3.05 (17.99)	4.90 (28.90)
8.	<i>P. acutifolius</i>	20.06	7.00 (40.93)	2.25 (13.15)	3.10 (18.12)	4.75 (27.77)
9.	<i>P. trilobus</i>	8.93	3.25 (49.24)	0.60 (9.09)	0.25 (5.30)	2.40 (36.36)
10.	<i>P. trilobus</i>	8.63	2.55 (38.05)	0.90 (13.43)	0.60 (8.90)	2.65 (39.55)
11.	<i>P. trilobus</i>	7.13	1.15 (27.43)	0.80 (14.16)	0.75 (13.27)	2.65 (45.13)
12.	<i>P. trilobus</i>	8.80	2.45 (38.89)	0.95 (15.08)	0.65 (10.31)	2.25 (35.71)

*Figures in parentheses indicate per cent of total protein present as each fraction.

The major protein fractions i.e. albumins, globulins, prolamins and glutelins in different species are given in Tables 2 and 3. It is evident from the data that albumins and glutelins together comprised the major portion in comparison to the globulins and prolamins. The per cent values for albumins ranged from 2.55 to 9.01, globulins from 0.50 to 6.90, glutelins from 1.55 to 6.90 and prolamins from 0.35 to 4.25. *V. mungo* has

the highest quantity for all four protein fractions while *P. trilobus* has the lowest albumins and prolamins content and *P. lathyroides* has the lowest globulins and glutelins content. Larson (1967) also found large differences in the levels of albumins and globulins among common bean varieties.

The comparison of different protein fractions in different species expressed as

PROTEIN VARIABILITY IN PHASEOLUS AND VIGNA

per cent of the fraction protein shows that these values are lower for globulins and prolamins but higher for albumin and glutelin in wild species, viz., *P. lathyroides* and *P. trilobus* than the values for corresponding fractions in the cultivated species, viz., *P. aconitifolia*, *P. acutifolius*, *V. mungo*, *V. radiata* and *V. umbellata*.

The information on the amino acid composition is more important in assessing the nutritive value of different proteins. The maximum tryptophan and methionine contents (g/16 gN basis) were found in *V. mungo* and the minimum in *P. lathyroides*. The values ranged from 1.303 to 0.397 g for tryptophan and from 1.620 to 0.938 g for methionine

(Table 4). The wild species were poor in tryptophan and methionine. *V. mungo* had high content of protein as well as methionine, contrary to the findings of Yohe and Poehlman (1972) who observed in mungbean that the strains high in methionine tended to be low in protein.

Methionine content was found to be higher in comparison to tryptophan in all the species, whereas Singh *et al.* (1980) have reported higher tryptophan than methionine in *V. umbellata*. The tryptophan and methionine contents also decreased as the protein content in late sowing.

It is evident from the above results that the wild species are poor in the

TABLE 4

Tryptophan and methionine contents in *Phaseolus* and *Vigna* genotypes

S. No.	Species	Tryptophan (g/16 g N)		Methionine (g/16 g N)	
		Early sowing	Late sowing	Early sowing	Late sowing
1.	<i>V. aconitifolia</i>	1.067	1.010	1.323	1.303
2.	<i>V. aconitifolia</i>	1.137		1.347	
3.	<i>V. mungo</i>	1.280	1.117	1.583	1.510
4.	<i>V. mungo</i>	1.303	1.213	1.620	1.610
5.	<i>V. radiata</i>	1.180		1.510	
6.	<i>V. radiata</i>	1.163	1.090	1.510	1.460
7.	<i>V. umbellata</i>	1.103	1.017	1.433	1.390
8.	<i>V. umbellata</i>	1.033	0.937	1.457	1.390
9.	<i>P. acutifolius</i>		1.017		1.300
10.	<i>P. acutifolius</i>		0.996		1.217
11.	<i>P. lathyroides</i>	0.397		0.938	
12.	<i>P. lathyroides</i>	0.467		0.993	
13.	<i>P. trilobus</i>	0.523	0.463	1.002	0.943
14.	<i>P. trilobus</i>		0.477		0.872
15.	<i>P. trilobus</i>	0.550	0.507	0.995	0.942
16.	<i>P. trilobus</i>	0.573	0.520	0.977	0.890
17.	<i>P. sublobatus</i>	1.113		1.400	

quality traits and should not be tried for improving the protein content and quality in the cultivated species through inter-specific hybridization and selection. It is suggested that screening large number of strains of cultivated species for high protein content and quality may be more advantageous than looking for variability for quality traits in wild species.

ACKNOWLEDGEMENTS

The authors are thankful to Dr. J. B.

Chowdhury, Dean, College of Basic Sciences & Humanities and Dr. K. S. Dhindsa, Incharge, Quality Testing Laboratory for providing the facilities for this work. The authors also wish to thank Dr. N. Maherchandani, Associate Professor for going through the manuscript and making valuable suggestions. The senior author is grateful to ICAR, New Delhi, for the financial help in the form of a Junior Research Fellowship.

REFERENCES

- Amirshahi, M. C. and Tavakoli, M. 1970. Protein content of different varieties of five species of pulse crops. Proc. Symp. Improving Plant Protein by Nuclear Techniques, held at Vienna, 1970. I. A. E. A. Vienna, Austria : pp 331-35.
- Arora, R. K., Chandel, K. P. S. and Joshi, B. S. 1973. Morphological diversity in *Phaseolus sublobatus* Roxb. *Curr. Sci.* **42** : 359-61.
- AOAC. 1970. Official Methods of Analysis. 11th edn. Association of Official Agricultural Chemists, Washington, D. C.
- Gill, K. S., Sandhu, T. S., Singh, Kuldip and Brar, J. S. 1975. Evaluation of mungbean (*V. radiata* L. Wilczek) germplasm. *Crop Improv.* **2** : 99-104.
- Horn, M. J., Jones, D. B. and Blum, A. E. 1946. Colorimetric determination of methionine in proteins and foods. *J. Biol. Chem.* **166** : 313-20.
- Imam, M. M. 1979. Variability in protein content of locally cultivated *Phaseolus* and *Vigna* spp. Proc. Symp. Seed Protein Improvement in Cereals and Grain Legumes, held at Neuherberg, 1978. I. A. E. A. Vienna, Austria : pp. 119-26.
- Kadwe, R. S., Thakre, K. K. and Badhe, N. N. 1974. A note on the protein content and mineral composition of twenty five varieties of pulses. *Indian J. Nutr. Dietet.* **11** : 83-85.
- Larson, A. L. 1967. Electrophoretic differences in seed proteins among varieties of soybean, *Glycine max* (L.) Merrill. *Crop Sci.* **7** : 311-13.
- Nagy, D., Weidlien, W. and Hixon, R. M. 1941. Factors affecting the solubility of corn proteins. *Cereal Chem.* **18** : 514-23.
- Singh, S. P., Mishra, B. K., Chandel, K. P. S. and Pant, K. C. 1980. Major food constituents of rice-bean (*V. umbellata*). *J. Food Sci. Technol.* **17** : 238-40.
- Spies, J. R. and Chambers, D. C. 1949. Chemical determination of tryptophan and proteins. *Anal. Chem.* **21** : 1249-66.
- Yohe, J. M. and Poehlman, J. M. 1972. Genetic variability in mungbean (*V. radiata* L. Wilczek). *Crop Sci.* **12** : 461-64.

VARIATION IN THE LEVEL OF ESSENTIAL OIL IN *CYMBOPOGON MARTINI* VAR. *MOTIA* AT DIFFERENT HARVESTINGS AND GROWTH STAGES, IN VARIOUS PLANT PARTS AND ON AGEING THE HARVESTED CROP

N. K. SANGWAN, K. S. DHINDSA, O. P. MALIK, G. D. SHARMA* and R. S. PARODA*

Department of Chemistry & Biochemistry
Haryana Agricultural University, Hisar

(Received : May 10, 1983; Revised : May 3, 1984)

ABSTRACT

Cymbopogon martini var. *motia* (palmarosa grass), grown for an adaptability trial under agro-climatic conditions of Hisar (Haryana), was studied for the variation in the level of essential oil upto five successive harvestings. The results reveal that the crop contained 0.24 to 0.56 per cent essential oil at different harvestings. The essential oil content was higher at the initiation of flowering stage than at the vegetative stage or at bloom period with most flowers open. The flowers were found to contain higher level of essential oil than leaves, while stem contained only traces. The investigations on level of essential oil on ageing the harvested crop under field and laboratory conditions reveal that it increased upto 6th day after harvesting and then decreased when aged in laboratory, but increased only upto 4th to 5th day and then became almost constant when aged in field.

Cymbopogon martini var. *motia* (palmarosa grass), a wild perennial under-shrub, yields an important oil with a rose like aroma which is extensively used in cosmetics and perfumery industry in place of expensive rose oil and in medicine externally as a remedy for lumbago, stiff joints, skin diseases and baldness and internally in small doses for bilious complaints (Anonymous, 1953). Several studies regarding the germplasm evaluation (Gupta *et al.*, 1980; Pareek *et al.*, 1980), the oil content in various plant parts, the stage of maximum oil content, geraniol content in different harvests and harvesting stages, composition and odour

of oil at various growth periods (Pareek *et al.*, 1981), the effect of method of sowing and fertilisers on yield, oil content and its composition (Gupta *et al.*, 1978) in various agro-climatic conditions have been made. Such studies on the crop cultivated under the agro-climatic conditions of Hisar (Haryana) have not been made though the crop was found well adapted under these conditions (Paroda *et al.*, 1981). In our initial efforts, we have studied the essential oil content in the crop at different harvestings and growth stages and in different parts of the plant alongwith the effect of ageing the harvested crop under laboratory and

*Department of Plant Breeding.

field conditions on essential oil content. These studies will help in introducing the crop in Haryana and making specific recommendations to get good yield as it is not found in cultivated or wild form in this State.

MATERIAL AND METHODS

Palmarosa grass was raised at the Research Farm of Haryana Agricultural University, Hisar by transplanting the nursery sown in the first week of July 1980 at a distance of 60×60 cm in ten beds of 10×3 m to which a pre-application of FYM (40-50 cart-loads/ha) and 10% BHC (20 kg/ha) was made. The nursery was transplanted on two different dates to five beds each on August 10 and 24, 1980 which were labelled as group A and group B, respectively, to study the effect of transplanting period on essential oil content. A basal dose of 20 kg N, 40 kg P₂O₅ and 20 kg K/ha was applied at the time of transplanting, while 20 kg N/ha was applied as top-dressing after each harvesting. However, after third harvesting, the growth of the crop was found to be very poor and hence to maintain the crop 40 kg N/ha was applied as top dressing. Just after transplanting, three frequent but light irrigations were given to establish the seedlings and later on one irrigation per month on an average was given. The crop was found to be free from insects, pests and diseases and hence no specific plant protection measures were made.

Crop samples from each harvest were distilled in a laboratory hydrodistillation unit (Guenther, 1972) and percentage essential oil content was calculated on v/w basis. To study the effect of ageing

the harvested crop on essential oil content, samples of known weight of the plant material at bloom period with most flowers open were aged for different days in laboratory and field and the percentage of essential oil content was determined on all the days. The plants at various stages of growth i.e. vegetative stage, commencement of flowering, and at bloom stage with most flowers open; and in various plant parts viz., flowers, leaves, leaf lamina, leaf sheath and stem in first and second harvestings at bloom period with most flowers open were also investigated for the essential oil content.

RESULTS AND DISCUSSION

Essential oil content was found to be at a higher level in the first three harvestings in the crop transplanted at a later date (group B) as compared to that transplanted earlier (group A). Further, it was maximum in the first harvesting and then decreased in the successive harvestings (Table 1). However, after the third harvesting, top-dressing dose of N fertiliser was increased from 20 to 40 kg/ha. This resulted in the increase of the oil content in the fourth harvesting indicating a positive correlation between application of N fertiliser and oil content in the crop. However, in the fifth harvesting it showed a declining trend. In fourth and fifth harvestings the level of essential oil content was higher in group A than that of group B. On an average essential oil content in group B was higher than that of group A indicating that nursery should be approximately 45 days old at the time of transplanting to get a better yield of essential oil.

On ageing the harvested crop in laboratory, the essential oil content increased

ESSENTIAL OIL IN PALMAROSA GRASS

TABLE 1

Essential oil content^a (%) in fresh samples of palmarosa grass at bloom period with most flowers open at various harvestings

Harvesting	Date of harvesting	Group A	Group B
I	November 10, 1980	0.37	0.50
II	April 4, 1981	0.30	0.44
III	October 3, 1981	0.27	0.36
IV	May 29, 1982	0.56	0.44
V	September 28, 1982	0.34	0.24

^aMean of three replications

A—Date of transplanting August 10, 1980

B—Date of transplanting August 24, 1980.

TABLE 2

Essential oil content^a (%) in palmarosa grass on ageing the harvested crop at bloom period with most flowers open in laboratory and field

Day after harvesting	Group A				Group B			
	Aged in laboratory		Aged in field		Aged in laboratory		Aged in field	
	F	D	F	D	F	D	F	D
0	0.38	—	—	—	0.50	—	—	—
1	0.39	0.44	0.38	0.46	0.53	0.61	0.44	0.51
2	0.41	0.56	0.40	0.53	0.53	0.66	0.47	0.64
3	0.53	0.67	0.41	0.58	0.52	0.73	0.54	0.76
4	0.55	0.67	0.37	0.56	0.56	0.80	0.59	0.80
5	0.56	0.83	0.38	0.63	0.58	0.86	0.58	0.88
6	0.66	1.08	0.42	0.63	0.70	1.11	0.57	0.82
7	0.44	0.67	0.45	0.70	0.47	0.79	0.56	0.89
8	0.48	0.58	0.42	0.67	0.44	0.71	0.47	0.89

^aMean of three replications

A—Date of transplanting August 10, 1980

B—Date of transplanting August 24, 1980

F—On fresh weight basis

D—On dry weight basis.

upto six days and then started decreasing. But, when aged in field, the essential oil content increased upto 4-5 days and then became almost constant (Table 2). The increase in the essential oil content on dry weight* basis on storage in field and laboratory may be due to the loss of weight of the plant by transpiration. This is evident from Table 2, that the essential oil content does not increase appreciably on fresh weight** basis of the plant. However, the small increase in the essential oil content on fresh weight basis on ageing is indicative of some other factors, probably biochemical or chemical involved in it. The essential oil content was at a higher level upto six days in the plants stored in laboratory than those stored in the field (Table 2). Thus, it seemed probable that during storage in the field oil was also lost. But after six days, the level of the essential oil in the plants stored in the laboratory was lower than those stored in the field. This might be due to more water loss in the plants stored in the field and chemical reactions like oxidation and photochemical involved in it as was indicated by some disagreeable smell, increase in colour intensity and decrease in pH of the oil which need further detailed studies. Similar results were reported by Nichols (1938) and suggested that the smell of the oil was best when the material was distilled in a fresh condition.

The data in Table 3 reveal that flowers had a comparatively higher level of essential oil (1.7%) than that of leaves (1.1%), while stem contained only traces of essential oil. In the leaves, the leaf

lamina had comparable essential oil content (1.6%) to that of flowers, while leaf sheath had only 0.62% of essential oil. These findings suggested that only flowers and leaves can be used for extraction of essential oil. In comparison to this, Muthukrishnan *et al.* (1981) have reported lower yields of essential oil in leaves (0.28%) and flowers (0.76%), but an appreciable yield in stem (0.22%) and suggested that whole plant can be used for the extraction of the essential oil.

TABLE 3

Essential oil content^a (%) in various plant parts of palmarosa grass at bloom period with most flowers open

Plant part	I harvesting	II harvesting
Flower	1.76	1.67
Leaf	1.07	1.10
Stem	traces	traces
Leaf lamina	—	1.58
Leaf sheath	—	0.62

^aMean of three replications.

TABLE 4

Essential oil content^a (%) at different growth stages in palmarosa grass

Harvesting	Vegetative stage	Initiation of flowering stage	Bloom period with most flowers open
I	0.40	0.41	0.50
II	0.52	0.60	0.44
III	0.42	0.49	0.36
IV	0.30	0.28	0.44
V	0.34	0.24	0.24

^aMean of three replications.

*Dry weight of the sample means the weight of the sample at the time of its hydrodistillation.

**Fresh weight of the sample means the weight of the sample at the time of harvesting.

Investigations on the essential oil content at various growth stages viz., vegetative stage, commencement of flowering stage and bloom period with most flowers open revealed that the oil content in the plants at commencement of flowering was appreciably higher than that in the plants at vegetative stage or at bloom period with most flowers open (Table 4).

From the studies it can be concluded that for maximum yield of essential oil, the palmarosa grass crop should be harvested at commencement of flowering stage and the harvested crop should not be stored for longer periods prior to its hydrodistillation. However, if necessary, it should be stored in shade only.

REFERENCES

- Anonymous. 1953. *The Wealth of India—Industrial Products* Part III : D-E. Council of Scientific and Industrial Research, New Delhi. p. 218.
- Guenther, E. 1972. *The Essential Oils*. Vol. 1. D. Van Nostrand, New York.
- Gupta, R., Maheshwari, M. L., Singh, R. P., Mohan J. and Gupta, G. K. 1978. Effect of fertiliser on yield, oil content and oil composition of palmarosa as influenced by seasonal variations. *Indian Perfumer* 22 : 79-87.
- Gupta, R., Trivedi, K. C., Joshi, B. G., Pareek, S. K. and Maheshwari, M. L. 1980. Study of palmarosa grass germplasm : Part I. Exploration of wild growing types in Madhya Pradesh and Maharashtra States. *Indian Perfumer* 24 : 134-41.
- Muthukrishnan, C. R., Muthuswami, S. and Sayed, S. 1981. A preliminary note on the trial of *Cymbopogon* grasses at Tamil Nadu Agricultural University, Coimbatore. Proc.
- Fourth All India Workshop on Medicinal and Aromatic Plants, held at Tamil Nadu Agricultural University, Madurai, Aug. 31-Sep. 3, 1981.
- Nichols, A. F. 1938. Annual Report of Department of Agriculture, Seycheller p. 7-20. *Chem. Abstr.* 34 : 3448(2).
- Pareek, S. K., Mandal, S., Maheshwari, M. L. and Gupta, R. 1980. Study of palmarosa grass germplasm : Part II. Cultivation for identifying superior genotypes. *Indian Perfumer* 24 : 175-81.
- Pareek, S. K., Saxena, D. B., Maheshwari, M. L. and Gupta, R. 1981. Study of palmarosa oil grass for higher yield of oil and its quality under cultivation. *Indian Perfumer* 25 : 64-70.
- Paroda, R. S., Sharma, G. D. and Kansal, K. K. 1981. Roshagrass—an aromatic plant of economic importance for the farmers in Haryana. *Haryana Farming* 10 (10) : 9, 14.

KINETICS OF SOLUBLE AND IMMOBILISED AMYLOGLUCOSIDASE

ASHOK KUMAR and H. S. NAINAWATEE

Department of Chemistry & Biochemistry

Haryana Agricultural University, Hisar

(Received : May 5, 1983; Revised : April 3, 1984)

Immobilised enzymes have potential application in several biotechnology processes in agriculture, industry and medicine. Several enzymes have already been immobilised by adsorption on inert carriers, covalent cross linking to a bifunctional reagent, covalent binding to a water insoluble carrier and by occlusion into gel lattices (Chibata, 1978; Carr and Bower, 1980). Amyloglucosidase hydrolyses starch to glucose and in this note kinetic properties of this enzyme immobilised by three different carriers are reported.

Amyloglucosidase was occluded into the lattices of polyacrylamide gel during polymerisation (Bernfeld and Wan, 1963). After polymerisation the gel was extruded through a hypodermic needle and washed with 0.1M acetate buffer (pH 4.8). For binding to CNBr-Sepharose-4B, amyloglucosidase was dissolved in coupling buffer (0.1M NaHCO₃ pH 8.3, containing 0.5M NaCl) and incubated with CNBr-Sepharose-4B reswelled in 1mM HCl for two hours (Axen *et al.*, 1967). Uncoupled enzyme was removed by washing the gel with coupling buffer and the blocking of remaining active group was done by 0.1M Tris-HCl (pH 8.0). Coupling of the

enzyme to CH-Sepharose-4B was done in the presence of carbodiimide (Sheehan and Hess, 1955). Excess ligands, urea derivatives and unreacted carbodiimide were washed with water followed by 0.1M acetate buffer (pH 4.8). The enzyme activity of both soluble and immobilised amyloglucosidase was assayed by the estimation of reducing sugars formed by the degradation of starch (Bernfeld, 1955). For re-usability studies, immobilised enzyme was recovered by centrifugation of reaction mixture at 10,000xg for 15 min at 4°C and the pellet obtained was suspended in 0.1M acetate buffer (pH 4.8) for subsequent use.

Properties of amyloglucosidase immobilised by three different methods were studied and compared with the soluble enzyme. Optimum pH of both soluble and immobilised enzyme was observed to be 4.8. However, the immobilised enzyme was more sensitive to pH changes compared to that of the soluble enzyme. Baum (1975) also reported a reduction in stability of enzyme after immobilisation towards pH changes. The temperature optima of both immobilised and soluble enzymes was identical (60°C). Maeda *et al.* (1974) have also reported a similar

IMMOBILISED AMYLOGLucosIDASE

optimum temperature for immobilised amyloglucosidase. Immobilisation of enzyme resulted in an increase in its stability in response to temperature variations. Increase in temperature stability of enzymes after immobilisation has been reported by several workers (Dahlqvist *et al.*, 1973; Maeda *et al.*, 1974; Sundstrom *et al.*, 1981).

With the exception of CH-Sepharose-4B linked enzyme, immobilised amyloglucosidase was found to retain a fairly good activity during one month storage period at -14°C (Fig. 1). The activity of soluble enzyme declined gradually during this period. In some cases, an increase was also observed in the activity of immobilised enzyme, which could be due to irregular exposure of active sites and destruction of enzyme inhibitors on storage. Repeated usability is one of the important applications of immobilised enzymes. Re-usability of the immobilised amyloglucosidase was studied by re-employing the enzyme for starch hydrolysis. Table 1 indicates that enzyme

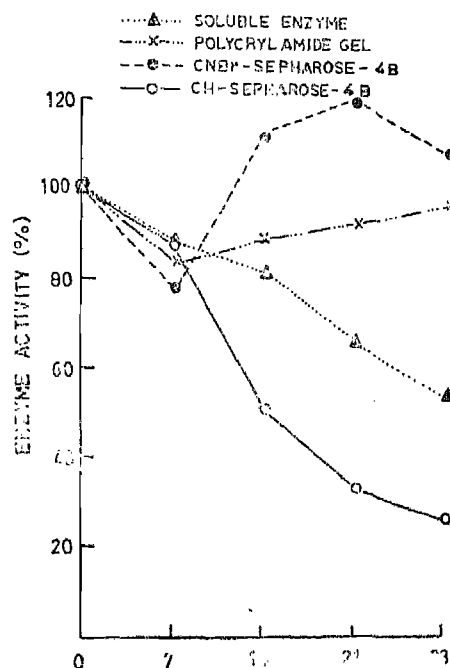


Fig. 1. Effect of storage on enzyme activity.

immobilised with CNBr-Sepharose-4B and CH-Sepharose-4B retained higher activity, even at fourth re-usability step. Polyacrylamide gel occluded enzyme also had appreciable activity after the fourth cycle of reaction. Solomon and Levin (1974) also reported that amyloglucosidase immobilised with DEAE-cellulose showed good re-usability and it retained appreciable activity for a longer period. Thus, the immobilisation process greatly enhances the catalytic utility of amyloglucosidase.

TABLE 1

Re-usability of immobilised amyloglucosidase

Immobilisation	Re-usable activity (%)		
	First	Second	Third
Polyacrylamide	73.2	42.2	28.9
CNBr-Sepharose	64.8	42.2	38.7
CH-Sepharose	52.7	44.3	39.4

REFERENCES

- Axen, R., Porath, J. and Ernback, S. 1967. Chemical coupling of peptide and proteins to polysaccharides by means of cyanogen halides. *Nature (Lond.)* 214 : 1302-04.
- Baum, G. 1975. Enzyme immobilisation on macroreticular polystyrene. *Biotechnol. Bioeng.* 17 : 253-70.

- Bernfeld, P. 1955. Amylases α and β . In : *Method in Enzymology*, Vol 1, p. 149, Colowick, S. P. and Kaplan, N. O. (eds.), Academic Press, New York.
- Bernfeld, P. and Wan, J. 1963. Antigens and enzymes made insoluble by entrapping them into lattices of synthetic polymer. *Science* **142** : 678-79.
- Carr, P. W. and Bower, L. D. 1980. Immobilisation of active biochemical. In : *Immobilised Enzymes in Analytical and Clinical Chemistry*, p. 148, Carr, P. W. and Bower, L. D. (eds.). John Wiley Interscience, USA.
- Chibata, I. 1978. Properties of immobilised enzyme and microbial cell. In : *Immobilised Enzyme Research*, p. 108, Chibata, I (ed.). John Wiley, New York.
- Dahlqvist, A., Mattiason, B. and Mosback, K. 1973. Hydrolysis of β -galactosides using polymer entrapped lactase. A study towards producing lactose free milk. *Biotechnol. Bioeng.* **15** : 395-402.
- Maeda, H., Suzuki, H., Yamauchi, A. and Sakimae, A. 1974. Preparation of immobilised enzymes by N-vinyl pyrrolidone and the general properties of glucoamylase gel. *Biotechnol. Bioeng.* **16** : 1517-28.
- Sheehan, J. C. and Hess, G. P. 1955. A new method for forming peptide bonds. *J. Am. Chem. Soc.* **77** : 1067-72.
- Sofomon, B. and Levin, Y. 1974. Studies on adsorption of amyloglucosidase on ion exchange resin. *Biotechnol. Bioeng.* **16** : 1161-77.
- Sundstrom, D. W., Klei, H. E., Coughlin, R. W., Biederman, G. J. and Brouwer, C. A. 1981. Enzymatic hydrolysis of cellulose to glucose using immobilised β -glucosidase. *Biotechnol. Bioeng.* **23** : 473-85.

YIELD, TOTAL PRODUCTIVITY, WATER-USE EFFICIENCY AND RETURNS AS AFFECTED BY INTERCROPPING IN CASTOR IN SEMI-ARID TROPICS

B. P. SINGH and H. C. SHARMA
Haryana Agricultural University
Dry Farming Research Centre, Bawal

(Received : July 16, 1982; Revised : August 27, 1984)

ABSTRACT

Studies on paired-rows planting systems in castor to facilitate intercrops were conducted in 1977-78 and 1978-79. The paired-rows system of planting of castor (two rows of castor spaced at 30 cm with an interspace of 70 cm between two pairs) along with intercrop of green gram (1 row) led to 5.8% more productivity with an additional monetary returns of Rs. 439 per ha over the conventional planting system and exhibited greater water-use efficiency.

The object of intercropping system is to maintain fertility and conserve the maximum amount of rain water in the soil to enhance the water-use efficiency for rich harvest of the crop. It is also a safeguard against the failure of one of the crops in dry farming areas. The modern system of growing of two or more crops simultaneously in the same area in the rows of definite geometrical pattern is pronounced as intercropping. On the other hand mixed cropping as traditional system means growing two or more crops in the same area without any arrangement. Singh *et al.* (1978) have observed that paired-rows system of planting of **bajra** (*Pennisetum americanum* L.) gave higher grain yield, additional monetary returns and efficient utilization of soil moisture than the conventional (uniform) system of planting. Tomar and Saini (1979) have obtained about 4 q per ha greater seed yield of green gram from the space left in paired-rows without sacrificy-

ing the seed yield of **bajra**. The information on planting system and intercropping in castor (*Ricinus communis* L.) seems to be meagre.

MATERIAL AND METHODS

The experiment conducted at Dry Farming Research Centre, Bawal, of Haryana Agricultural University during kharif 1977 and 1978, consisted of the following treatments :

- T₁—Uniform system of planting of castor at 50 cm inter-row spacing (timely sown).
- T₂—Paired-rows system of planting of castor (two rows spaced at 30 cm with an interspace of 70 cm between two pairs), one row of mung bean taken in interspace.
- T₃—T₂+one row of groundnut taken in interspace.

T₄—T₂+two rows of mung bean taken in interspace.

T₅—T₃+two rows of groundnut taken in interspace.

T₆—Uniform system of planting of castor at 50 cm inter-rows spacing (crop sown after one month of normal sown crop).

T₇—Uniform system of planting of green gram at an interspacing of 30 cm.

T₈—Uniform system of planting of groundnut at an interspacing of 30 cm.

The population of castor was uniform (66,666 plants per ha). In intercrop of mung bean and groundnut, the population was 66,666 and 44,400 plants per ha in one row and 1,32,200 and 88,900 plants per ha in two rows sown in between the paired-rows of base crop. In sole crop of mung bean and groundnut, the population was 3,33,000 and 2,22,000 plants per ha, respectively. The experiment was conducted in randomized block design with three replications each year. Cultivar 'Aruna' for castor, 'S 9' for mungbean and 'M 145' for groundnut were sown on 24th July in 1977 and 14th July in 1978. The plot size was 9.3×3.3 m in both the years. The soil of the experimental field was loamy sand with 0.24% organic carbon, 8 kg P per ha and 204 kg/ha (P and K expressed in elemental form). The field capacity and wilting co-efficient percentage were 15.4 and 3.6 per cent, respectively. The crops were rainfed, receiving 776.7 and 597.8 mm of rainfall during 1977-78 and 1978-79, respectively (Table 1). The rainfall

was more favourable during 1978-79 with 55 rainy days as against 43 rainy days in 1977-78. The picking of castor was done twice during 1977-78 and four times during 1978-79, due to good supply of moisture. The castor crop was finally harvested each year in the third week of April, the mung bean and groundnut at 65 and 115 days of age. Monitoring of soil moisture at three depths (0-30, 30-60 and 60-100 cm) of the soil profile under each treatment, was done gravimetrically in both the years of investigation.

RESULTS AND DISCUSSION

Yield and Total Productivity

Data in Table 2 show that growing of castor in paired-rows had no adverse effect on its seed yield, haulm production and seed weight (1000 seeds) in either of the years, indicating the possibility of utilizing the interspace for intercrop production. Tarhalkar and Rao (1975) also made similar observations while working with sorghum, castor and pigeon pea. Growing of green gram and groundnut either in single row or in double rows in the interspace has not affected the seed yield of the base crop. The intercrop yields of green gram were 2.62, 1.01 and 2.62, 1.52 q per ha with single and double rows during 1977-78 and 1978-79, respectively (Table 4). Groundnut as intercrop in single and double rows during 1977-78 and 1978-79 produced 0.28, 1.16 and 0.14, 2.62 q pods per ha, respectively.

The seed yield of castor was low during 1977-78 because of high degree of moisture stress during last week of September to first week of February and

YIELD, WUE AND RETURNS IN CASTOR INTERCROPPING

TABLE 1

Total rainfall, number of rainy days and rainfall periods during crop seasons of 1977-78 and 1978-79

Period	Meteorologi- cal weeks	Rainfall received (mm)		Rainy days	
		1977-78	1978-79	1977-78	1978-79
16 July-29 July	29, 30	164.5	135.2	10	9
30 July-12 Aug.	31, 32	344.4	62.8	11	9
13 Aug.-26 Aug.	33, 34	9.7	198.0	3	13
27 Aug.-9 Sep.	35, 36	80.6	104.7	6	4
10 Sep.-23 Sep.	37, 38	88.4	4.1	4	2
24 Sep.-7 Oct.	39, 40	Nil	3.0	Nil	1
26 Nov.-7 Dec.	48, 49	Nil	3.1	Nil	1
8 Jan.-21 Jan.	2, 3	Nil	20.0	Nil	4
22 Jan.-4 Feb.	4, 5	Nil	5.2	Nil	1
5 Feb.-18 Feb.	6, 7	25.4	26.8	3	3
19 Feb.-4 Mar.	8, 9	45.2	12.4	2	4
5 Mar.-18 Mar.	10, 11	13.3	16.4	1	1
19 Mar.-1 Apr.	12, 13	1.1	Nil	1	Nil
2 Apr.-22 Apr.	14, 15, 16	2.1	6.1	2	3
Total		776.7	597.8	43	55

TABLE 2

Seed yield, production of haulm and seed weight of castor as affected by planting system

Treatment	Seed yield (q/ha)		Production of haulm (q/ha)		1000-seed weight (g)	
	1977-78	1978-79	1977-78	1978-79	1977-78	1978-79
T ₁	15.71	43.22	124.38	176.98	235.5	255.00
T ₂	15.61	42.77	125.92	178.24	228.8	242.8
T ₃	12.99	42.22	128.00	180.89	225.8	240.0
T ₄	14.04	43.27	126.08	179.78	230.6	242.0
T ₅	11.14	43.88	123.08	178.86	225.0	245.0
T ₆	16.33	44.11	122.32	173.06	232.0	247.0
SEM ±	2.50	1.84	4.30	2.82	6.28	8.78
LSD 5%	NS	NS	NS	NS	NS	NS

also due to competition from green gram and groundnut at the initial stage of growth due to good rainfall, thus, resulting in short supply of moisture at later stage. In 1978-79, due to sufficiently well distributed rainfall, continuously moisture was available. Thus, very little competition was offered by intercrops (Table 2). On an average, the yields of castor were higher in 1978-79 than in 1977-78. In the latter year a moisture stress brought yield level low and only two pickings were possible, while in 1978-79, a well distributed rainfall allowed four pickings and thus resulted in higher yields (Tables 1 and 2).

Sole crop of green gram and groundnut produced 9.05, 15.66 q per ha and 4.65, 4.57 q per ha seed and pod yield during 1977 and 1978, respectively (Table 4). During 1978, both the crops faced moisture stress at maturity and thus seed yields were low (Table 1). The paired-rows system of planting of castor (treatments T₂ to T₅) led to the higher total productivity (Table 4). Mean increase of 0.47 q per ha with the paired-rows system of planting over conventional system of sowing of castor was recorded. However, the late sown castor showed

increase of 0.34 q per ha over paired-rows planting.

Monetary Returns

Growing of one row of green gram in the interspaces of paired-rows of castor gave the maximum gross return of Rs. 6333 per ha followed by the treatment of one row of groundnut in interspace of paired-row of castor (Rs. 6249 per ha). Castor planted in uniform rows (conventional system) gave gross returns of Rs. 5894 and 6044 per ha for normal and late sown crops, respectively. The paired-rows system of planting of castor along with intercrop of green gram (one row) gave additional monetary returns of Rs. 439 per ha over the conventional system of planting. The results are in conformity with those reported by Singh *et al.* (1972). Krantz *et al.* (1976) also reported that, when compared with phased cropping, intercropping of legumes and non-legumes gave higher monetary returns on both black and red soils of Hyderabad regions. Chinnappan and Palaniappan (1980) also obtained maximum net return from castor (I tier), sorghum (II tier), black gram (III tier) combination at Coimbatore, whereas castor pure crop was least remunerative.

TABLE 3

Consumptive use and water-use efficiency as influenced by system of planting

Treatment	Consumptive use (mm)		Water-use efficiency (kg/mm/ha)	
	1977-78	1978-79	1977-78	1978-79
T ₁	250.6	320.0	6.28	13.94
T ₂	258.0	312.8	7.19	13.99
T ₃	264.0	316.0	5.02	13.72
T ₄	258.6	319.0	6.44	14.04
T ₅	259.0	324.6	4.35	14.32
T ₆	248.0	308.0	6.58	14.32

TABLE 4
Seed yield, total productivity and gross returns as influenced by system of planting

Treatment	Castor			Seed yield (q./ha)		Groundnut		Mean yield (q./ha)			Total mean productivity (q./ha)	Gross returns (Rs./ha)
	1977-78		1978-79		Green gram	1977-78	1978-79	Castor	Green gram	Groundnut		
	1977-78		1978-79		1977-78		1978-79					
T ₁	15.71	43.22	—	—	—	—	—	29.47	—	—	29.47	5894
T ₂	15.61	42.77	2.62	1.01	—	—	—	29.19	1.98	—	31.17	6333
T ₃	12.99	42.22	—	—	0.28	1.16	—	27.61	—	0.72	28.33	5622
T ₄	14.04	43.27	2.62	1.52	—	—	—	29.56	2.07	—	30.73	6249
T ₅	11.14	43.88	—	—	0.14	2.62	—	27.51	—	1.88	29.39	5972
T ₆	16.33	44.11	—	—	—	—	—	30.22	—	—	30.22	6044
T ₇	—	—	9.05	4.65	—	—	—	—	6.85	—	6.85	1712
T ₈	—	—	—	—	15.66	4.57	—	—	—	10.12	10.12	2530

Castor, mung bean and groundnut were valued @ Rs. 2.00, Rs. 2.50 and Rs. 2.50 per kg, respectively.

Water-use Efficiency

In both the years, the values of consumptive use obtained under paired-rows planting system (T_2 and T_4) were higher than those obtained in uniform system of planting castor except when sown late (Table 3). Among all treatments, the paired-rows planting system having green gram (1 row) as intercrop exhibited the maximum water-use efficiency (7.19 kg/mm/ha) followed by paired-rows system of planting with groundnut (1 row) crop as intercrop (6.44 kg/mm/ha) during 1977-78. During 1978-79, treatment T_2 and T_4 gave W.U.E. of 13.99 kg/mm/ha and 14.04 kg/mm/ha, whereas maximum W.U.E. of 14.32 kg/mm/ha was recorded in paired rows planting of castor with two rows of groundnut (T_5). Paired rows planting system carried a distinct advantage over the conventional system, when seed yield and W.U.E. were considered. Singh *et al.* (1978) reported similar findings from Jodhpur. The crop grown in paired or compressed rows developed a deeper root system enabling it to extract water from deeper layers of soil profile (Singh and Sharma, 1981) for efficient utilization

of available soil moisture, through more absorption of net radiation by plants (Yao and Shaw, 1964). Singh *et al.* (1978) and Tomar and Saini (1979) found that higher amount of energy was absorbed in the planted space than in the inter-space when planted in compressed rows, resulting in higher seed yield and water-use efficiency. Greater seed yields under the closer row spacing were obtained when moisture was not a limiting factor for crop growth (Stickler, 1964; Singh *et al.*, 1978; Tomar and Saini, 1979). The same situation was recorded during 1978-79 when rainfall was not a limiting factor for crop growth. During 1977-78, a dry spell of 140 days (September to February) adversely affected the castor production, but sufficient supply of soil moisture from July to September benefitted the intercrop and resulted in higher total productivity. These findings are in conformity with Blum (1970).

ACKNOWLEDGEMENT

Authors are grateful to the Director of Research, Haryana Agricultural University, Hisar for facilities.

REFERENCES

- Blum, A. 1970. Effect of plant density and growth duration on grain sorghum yield under limited water supply. *Agron. J.* 62 : 336-40.
- Chinnappan, K. and Palaniappan, S. P. 1980. Multitier cropping in castor. *Indian J. agric. Sci.* 50 : 342-45.
- Krantz, B. A., Virmani, S. M., Singh, S. and Rao, M. R. 1976. Intercropping for increased and more stable agricultural production in semi-arid tropics. Symp. Intercropping in Semi-Arid Areas of Morogoro, Tanzania. pp. 13.
- Singh, B. P. and Sharma, H. C. 1981. Intercropping of pearl millet with green gram and groundnut in dryland. *Nat. Symp. Crop Man. Chal. Indian Soc. Agron.* pp. 77-83.
- Singh, B. P., Singh, R. P., Singh, M. and Yadava, T. P. 1972. Studies on mixed cropping in linseed and gram. *Haryana agric. Univ. J. Res.* 2 : 180-83.

YIELD, WUE AND RETURNS IN CASTOR INTERCROPPING

- Singh, R. P., Singh, K. C. and Rama Krishna, Y. S. 1978. Effect of systems of planting pearl-millet on the yield, total productivity, moisture use and monetary returns. *Indian J. agric. Sci.* **48** : 138-42.
- Stickler, F. C. 1964. Stand establishment and grain yield of sorghum as affected by method of planting and use of press wheels. *Agron. J.* **56** : 33-36.
- Tarhalkar, P. P. and Rao, N. G. P. 1975. Changing concepts and practices of cropping system. *Indian Farm.* **25** : 5-7.
- Tomar, P. S. and Saini, S. L. 1979. Crop geometry and intercropping in rainfed pearl millet. *Indian J. agric. Sci.* **49** : 627-33.
- Yao, A. Y. and Shaw, R. H. 1964. Effect of plant population and planting pattern of corn on the distribution of net radiation. *Agron. J.* **56** : 165-69.

EFFECT OF GROWTH REGULATORS ON FLOWERING AND FRUITING OF BOTTLE GOURD

S. K. ARORA, M. L. PANDITA and K. S. BASWANA

Department of Vegetable Crops
Haryana Agricultural University, Hisar

(Received : November 25, 1982; Revised : July 28, 1983)

ABSTRACT

Influence of ethrel, GA, MH, NAA and TIBA on the flowering and yield of bottle gourd was studied during the rainy and summer seasons of 1980 and 1981, respectively. Earliness in flowering was exhibited by MH at 150 mg/l, whereas NAA 50 mg/l delayed flowering in bottle gourd plants. Maximum number of pistillate flowers and fruits resulting in a higher total yield of the crop was found in the case of MH 150 mg/l which showed a great promise for large scale production of bottle gourd. This was followed by MH 50 mg/l and ethrel 250 mg/l. GA, NAA and TIBA did not influence fruit yield, while MH and ethrel did.

Bottle gourd (*Lagenaria siceraria* (Mol) Standl.) is one of the most common cucurbits cultivated in India. Among its various problems, flowering and fruiting have generally been of considerable interest to plant scientists. The bottle gourd is monoecious, and there is highly variable range in the male to female ratio. The production of staminate flowers is normally much more than pistillate flowers. However, ultimately only pistillate flowers contribute to the yield especially in cucurbits in which fruits are harvested at immature stage. It is highly important to achieve a shift in favour of the pistillate flowers in bottle gourd because female flowers appear upto last harvest date and an increase in female flowers would invariably increase the productivity. Certain growth regulators have been reported to influence the sex-expression in various cucurbits, leading to

either suppression of male flowers or an increase in the number of female flowers (Saimbhi and Thakur, 1973; Shannon and Robinson, 1978) or to an increase in the number of male flowers (Kalloo and Franken, 1978). However, little information is available regarding the effect of growth regulators on the sex expression and yield of bottle gourd. The present investigation was, therefore, undertaken to evaluate the potentiality of ethrel (CEPA), gibberellic acid (GA₃), maleic hydrazide (MH), naphthalene acetic acid (NAA) and 2, 3, 5-tri-iodobenzoic acid (TIBA) for increasing the number of female flowers in order to improve the total yield of the crop.

MATERIAL AND METHODS

The investigations were conducted at the Vegetable Research Farm, Haryana

RESPONSE OF BOTTLE GOURD TO GROWTH REGULATORS

Agricultural University, Hisar, during the rainy and summer seasons of 1980 and 1981, respectively. The seeds of Pusa Summer Prolific Long (bottle gourd) were sown on one side of 2.5 m wide and 4.0 m long raised beds with plant to plant spacing of 60 cm. The net plot size for treatment was 4.0×5.0 m. The date of sowing was 12 July, 1980 for rainy, and 15 March, 1981 for summer season crops. The treatments, besides control (sprayed with canal water), were 100 and 250 mg/l ethrel; 10 and 25 mg/l GA₃; 50 and 150 mg/l MH; 50 and 100 mg/l NAA or 50 and 100 mg/l TIBA during both seasons. Tween-20 (Polyoxyethylene sorbitan monolaurate) @ 0.005% was used as a surfactant for uniform spread of the solution on the leaves. Two aqueous sprays of each treatment were made at the 2- and 4-true leaf stages at an interval of 7 days.

The experiment was laid out in a randomized block design with three replications during both seasons. The number of plants per treatment was 12. Observations were recorded on various flowering and yield characteristics.

RESULTS AND DISCUSSION

Number of nodes for appearance of first staminate flower was significantly influenced by treatments during rainy season but had no effect in summer season (Table 1). Staminate flower appeared on the lower node in unsprayed control plants, whereas it appeared on the higher node with GA₃ at 10 mg/l. Number of node to first pistillate flower was significantly influenced by treatments during both the seasons. First pistillate flower appeared on the lower node by

MH 150 mg/l, whereas it appeared at higher node number in unsprayed control plants which is in agreement with the earlier findings of Choudhury and Singh (1970) in cucumber.

Number of days to first staminate and pistillate flower was significantly affected by the treatments during both the seasons. Earliest appearance of first staminate and pistillate flowers was observed with MH 150 mg/l which confirms the findings of Sidhu *et al.* (1981), who observed earlier appearance of pistillate flowers with MH 50 and 100 mg/l in round melon. NAA 50 mg/l delayed the appearance of first staminate and pistillate flowers (Table 1). In general, staminate and pistillate flowers appeared earlier in the rainy season as compared to summer season.

The sex-ratio was significantly influenced by the treatments during both rainy and summer seasons (Table 1). Average of two seasons data showed that MH 150 mg/l followed by ethrel 250 mg/l significantly lowered the sex-ratio, whereas it was highest in unsprayed control plants (Fig. 1). There was no significant difference in the sex-ratios between the two concentrations of MH. However, sex-ratio was lower at the higher concentration of MH. These results agree with the reports of Arora *et al.* (1982) in round bottle gourd. The possible reason for reduction in sex-ratio with MH application was due to suppression in the number of staminate flowers and promotion in the number of pistillate flowers (Choudhury and Singh, 1970) (Fig. 2). In general, the sex-ratio was higher during the rainy season than in the summer season.

TABLE 1
Effect of growth regulators on flowering and sex-ratio in bottle gourd during rainy (R) and summer (S) seasons

Treatment (mg/l)	Number of node to first staminate flower			Number of node to first pistillate flower			Number of days to first staminate flower			Number of days to first pistillate flower			Sex-ratio (Male : Female)	
	R	S	Av.	R	S	Av.	R	S	Av.	R	S	Av.	R	S
Control (unsprayed)	10.5	6.7	8.6	23.1	14.7	18.9	46.3	53.2	49.8	58.9	59.6	59.3	6.4	5.9
Ethrel 100	13.1	7.5	10.3	20.9	9.9	15.4	47.7	53.9	50.8	50.9	56.1	53.5	2.7	2.0
250	11.9	8.8	10.4	16.4	10.7	13.6	48.8	55.0	51.9	46.7	57.4	52.1	2.3	2.0
GA 10	16.1	6.4	11.3	22.9	11.5	17.2	46.7	52.5	49.6	58.2	57.8	58.0	5.5	3.2
25	14.1	8.1	11.1	20.6	14.3	17.5	46.9	55.7	51.3	56.9	61.4	59.2	5.2	3.6
MH 50	12.9	8.0	10.5	20.3	12.1	16.2	46.8	54.3	50.6	53.5	58.3	55.9	2.9	1.9
150	11.3	6.7	9.0	16.5	10.3	13.4	48.2	49.2	48.7	47.2	51.7	49.5	2.3	1.6
NAA 50	13.1	7.3	10.2	19.8	11.3	15.6	52.6	58.1	55.4	58.5	62.5	60.5	4.3	2.5
100	11.2	6.9	9.1	21.1	10.1	15.6	50.8	56.8	53.8	58.1	60.1	59.1	4.0	3.1
TIBA 50	10.2	7.6	8.9	19.3	11.3	15.3	52.1	56.3	54.2	54.7	58.4	56.6	4.7	3.9
100	10.8	8.1	9.5	19.0	16.7	17.8	50.8	56.0	53.4	53.1	56.9	55.0	5.3	4.8
C. D. at 5%	2.2	NS		2.1	1.9		3.3	3.5		4.9	4.6		0.6	0.7

TABLE 2
Effect of growth regulators on fruit set and yield in bottle gourd during rainy (R) and summer (S) seasons

Treatment (mg/l)	Number of fruits per plant from early yield			Early yield* (kg/plant)			Total number of fruits per plant			Total yield (kg/plant)			Total yield (q/ha)		
	R	S	Av.	R	S	Av.	R	S	Av.	R	S	Av.	R	S	Av.
Control (unsprayed)	0.7	0.2	0.5	0.52	0.13	0.33	4.1	0.8	2.5	2.20	0.41	1.31	132.0	24.8	78.4
Ethrel 100	1.4	0.4	0.9	0.82	0.24	0.53	6.8	1.9	4.4	3.13	1.02	2.08	187.6	61.2	124.4
250	1.4	0.5	1.0	1.15	0.33	0.74	8.0	2.1	5.1	4.56	1.49	3.03	273.6	89.4	181.5
GA 10	1.4	0.7	1.1	0.75	0.54	0.62	5.0	1.8	3.4	2.60	1.26	1.93	155.7	75.8	115.8
25	1.2	0.4	0.8	0.69	0.33	0.51	4.9	1.4	3.2	3.16	1.16	2.16	189.5	69.4	129.5
MH 50	2.6	0.9	1.8	1.62	0.61	1.12	9.8	2.1	6.0	4.89	1.76	3.33	293.1	105.8	199.5
150	3.0	1.8	2.4	2.90	1.19	2.05	12.4	4.9	8.7	6.90	3.64	5.27	414.0	218.6	316.3
NAA 50	1.0	0.2	0.6	0.71	0.07	0.39	5.0	1.0	3.0	2.79	0.66	1.73	167.4	39.8	103.6
150	1.1	0.5	0.8	0.65	0.36	0.51	6.3	1.3	3.8	3.24	0.96	2.10	194.2	57.6	125.9
TIBA 50	0.5	0.4	0.5	0.47	0.38	0.43	5.3	2.0	3.7	3.01	1.61	2.31	180.6	96.6	138.6
100	0.7	0.5	0.6	0.42	0.40	0.41	5.0	1.5	3.3	2.87	1.11	1.99	172.2	66.6	119.4
C. D. at 5%	0.6	0.3		0.53	0.33		3.4	1.2		1.30	0.72		90.4	60.8	

*Average of five pickings made from 4.9.80 to 29.9.80 in the rainy season and from 13.5.81 to 27.5.81 in the summer season.



Figs. 1-3. Comparison of water sprayed control plants (1) with foliar sprays of MH 150 mg/l on flowering (2) and fruit set (3) in bottle gourd.

Number and weight of fruits from early yield were significantly affected by the treatments (Table 2). MH 150 mg/l gave highest number and weight of fruits from early yield during both the seasons, whereas least number of fruits per plant was recorded from unsprayed control plants followed by TIBA 50 mg/l and lowest early yield from unsprayed control

plants and NAA at 50 mg/l. However, Borkowski (1972) recorded an increase in early yield of cucurbits with NAA application @ 25 mg/l. Increase in early yield with MH 150 mg/l was due to production of early pistillate flowers on the secondary branches resulting in early fruit set and higher early yield.

RESPONSE OF BOTTLE GOURD TO GROWTH REGULATORS

Total yield by number and weight was significantly influenced by the treatments of growth regulators during both the seasons (Table 2). The number and weight of fruits was highest with MH 150 mg/l (Fig. 3) followed by 50 mg/l in both the seasons. Increase in concentration of MH raised the total yield by number and weight. Similar results have been reported by Pandey and Singh (1973) in bottle gourd but are contrary to the earlier findings of Singh and Randhawa (1969) who recorded higher total yield of bottle gourd with NAA 25 mg/l. Least fruit yield by number and weight was recorded

from unsprayed control plants during both the seasons. The increase in number of fruits per plant with MH at 150 mg/l spray may be attributed to the production of more pistillate flowers setting into fruits (Kalia and Dhillon, 1966). Fruit yield by weight was also significantly enhanced by MH 150 mg/l during both the seasons because of more fruit number harvested per plant. MH 150 mg/l was superior in improving fruit yield in the rainy season. Similar results were earlier obtained by Sidhu *et al.* (1981) in round melon.

REFERENCES

- Arora, S. K., Pandita, M. L. and Sidhu, A. S. 1982. Effect of maleic hydrazide on vegetative growth, flowering and fruiting of bottle gourd. *Sci. Hortic.* **17** : 211-15.
- Borkowski, J. 1972. The effect of NAA on flowering and cropping in cucurbits. *Blul. Warzywniczy* **12** : 165-70 (*Hortic. Abstr.* **42** : 7751).
- Choudhury, B. and Singh, N. 1970. Chemical sex modification and its effect on fruiting in cucumber (*Cucumis sativus* L.) at three locations. *Indian J. Hortic.* **27** : 180-83.
- Kalia, H. R. and Dhillon, H. S. 1966. Comparative efficacy of asafetida as a sex-regulant in *Lagenaria siceraria* (Mol) Standl. *J. Res. Punjab agric. Univ.* **3** : 13-22.
- Kalloo and Franken, S. 1978. Chemical induction of staminate flowers in four determinate gynoeceous lines of pickling cucumber. *Gartenbauwissenschaft* **43** : 280-82.
- Pandey, R. P. and Singh, K. 1973. Note on the effect of nitrogen and maleic hydrazide on sex-expression, sex ratio and yield of bottle gourd (*Lagenaria siceraria* (Mol) Standl.). *Indian J. agric. Sci.* **43** : 883-85.
- Saimbhi, M. S. and Thakur, M. R. 1973. Growth, sex expression and yield of *Citrullus vulgaris* var. *fistulosus* influenced by ethrel, TIBA and CCC. *Physiol. Plant* **28** : 383-84.
- Shannon, S. and Robinson, R. W. 1978. Genetic differences in sex-expression and response to ethephon in summer squash (*Cucurbita pepo* L.). *Cucurbit Genet. Coop.* **1** : 33.
- Sidhu, A. S., Pandita, M. L. and Arora, S. K. 1981. Effect of various plant growth regulators on growth, sex-expression and yield in round melon (*Citrullus vulgaris* var. *fistulosus*). *Haryana agric. Univ. J. Res.* **11** : 486-89.
- Singh, K. and Randhawa, K. S. 1969. Vegetative growth, flowering and fruiting of bottle gourd (*Lagenaria siceraria* (Mol) Standl.) as affected by certain plant growth substances. *J. Res. Punjab agric. Univ.* **6** : 793-800.

SEASONAL FLUCTUATIONS IN INCIDENCE OF BER FRUITFLY *CARPOMYIA VESUVIANA* COSTA (DIPTERA : TEPHRITIDAE) UNDER AGRO-CLIMATIC CONDITIONS OF HISAR

R. K. LAKRA and ZILE SINGH
Department of Entomology
Haryana Agricultural University, Hisar

(Received : January 8, 1983; Revised : December 3, 1983)

ABSTRACT

Population dynamics of *Carpomyia vesuviana* Costa (Diptera : Tephritidae)—a regular pest of jujube fruits was studied for two years under field conditions at Hisar (Haryana). Various stages of the pest continued their activity almost uninterrupted under the temperature and relative humidity ranges of -1.7° to 46.7°C and 5 to 100 per cent, respectively. Extremes of weather conditions had a greater bearing on the adults than internally dwelling maggots. The surviving population of flies determined the intensity of its incidence in subsequent periods. The rise in daily maximum temperature above 40°C , coupled with low relative humidity (20 to 30 per cent) proved unfavourable for the fruitflies. Fall in temperature below 5°C prolonged the development duration of immature stages.

The incidence of the fruitfly attained first peak in August/September when over 35% fruits (a maximum of 76.82% of *Zizyphus nummularia* and 47.37% of *Z. mauritiana*) were wallowed by its maggots. Intermittent light rains of 20 to 40 mm intensity/week during July-August promoted greater emergence of adults, whereas moderate to heavy rainfall of 50 to 120 mm/week curtailed their activity. On cultivated fruits, the fly attained two peaks, one in January and the other in April, which synchronised with early and late ripening cultivars, respectively. The gradual decline/rise in mean weekly minimum and maximum temperatures, from 25° to 10°C and 40° to 25°C and vice-versa, respectively; accompanied with evening and morning relative humidities of 25 to 90 per cent (corresponding from setting to ripening of off season/seasonal fruits) proved to be ideal for the ber fruitfly activity. *Biosteres* sp., *B. longicauda* (Thompson) and *Gastrosericus electus* Nurse, the larval/pupal parasites of *Carpomyia*, appeared in negligible proportions.

The ber fruitfly, *Carpomyia vesuviana* Costa is an important pest of jujube (*Zizyphus* spp.). In India the Tephritid brings about a loss of 80% at times (Batra, 1953) with a range of 2 to 100 per cent (Cherian and Sundaram, 1941).

In Haryana, it is reported to cause 16.84% damage (Lakra *et al.*, 1979) which varies according to season, from 5.48 to 42.9 per cent (Lakra and Singh, 1981). The fruitfly is equally destructive outside India.

INCIDENCE OF BER FRUITFLY

The wide variations in the fruitfly incidence at various places is believed to be due to variations in the population density resulting from differential environmental effects. Some work on the biology of this insect has been done (Khare, 1923; Batra, 1953; Tominic, 1954; Lakra, 1981) but information on its ecology is scanty. Khare (1923) emphasized that the greater the emergence of adults the greater was the damage to fruits. The activity of the insect is reported to be influenced by heat (Pruthi and Batra, 1938), rainfall (Basha, 1952) and relative humidity (Batra, 1953). Shinde *et al.* (1978) observed two peaks of the pest in Rajasthan, one with early picking and the other in last picking of the season. Lakra and Singh (1981), however, reported *C. vesuviana* to be practically active almost throughout the year in Haryana.

Thus, the understanding of the factors which determine the abundance of the Tephritid population is very little despite the severe losses caused by it. And yet, such information is essential for the application of integrated pest management strategy. Therefore, population ecology studies of *C. vesuviana* were done under agro-climatic conditions of Hisar (Haryana).

MATERIAL AND METHODS

Systematic studies on population dynamics of *C. vesuviana* were carried out under natural field conditions at Hisar during 1979-81. Assessment in the fluctuations of fly population was made on the basis of percentage incidence of the fly in fruits collected from 9 local orchards of

cultivated trees (*Zizyphus mauritiana* Lamk.), besides fruits collected from 7 barren/uncultivated areas predominantly having flora of wild trees/bushes (*Z. rotundifolia* Lamk./*Z. nummularia* Burm.). Such sites were chosen from different geographical directions of Hisar city, extending over 5 to 8 km, preferably along canals, roads, railway tracks and some compact pockets in undulated areas. Hisar is situated at a latitude of 29° .10' N, longitude 75° .46' E and 215.2 m above sea level.

The incidence of the pest was assessed both in off-season (monthly intervals) and season's (fortnightly intervals) fruits from 1st June to 31st October and 1st November to 16th April, respectively, during both the years. The incidence was also examined in fruits of wild bushes from 1st June to 31st December at fortnightly intervals. A variable number of fruits was plucked from each orchard/locality depending upon the intensity of plants in fruit bearing stage in each locality and availability and accessibility to fruits. The number of fruits in each sample at each interval progressively increased with increase in setting on plants and vice-versa, and hence, fewer fruits comprised a sample both in the beginning and towards the end of the season. Samples varying from 350 to 1100 fruits during 1979-80 and 175 to 400 during 1980-81 from an unspecified number of wild bushes/trees were collected every fortnight, from each locality. Similarly from the cultivated trees, 125 to 750 fruits during 1979-80 and 300 to 400 during 1980-81 were plucked from a group of experimental trees (5 to 15)

earmarked in each orchard, each fortnight during the main season (November to April) and 65 to 125 at monthly intervals during the off-season (June to October). From each tree/bush older and earlier set fruits which were comparatively bigger in size were picked each time.

The observational trees including wild ber plantations were kept free from pesticides application during the course of study. The fruits were picked up randomly from different directions and heights of plants. All such fruits of a single site or orchard were brought in the laboratory and dissected with a knife by peeling off their outer skin all around carefully. Fruits possessing gallery/galleries, maggot/maggots or exit hole/holes were taken as fruitfly attacked. Percentage incidence of *C. vesuviana* was thus worked out. Meteorological data on fortnightly means of ambient air temperature (maximum and minimum), relative humidity (morning and evening), sunshine hours, etc., were obtained from the Observatory of the Department of Agronomy. The amount of rainfall received during each fortnight was also taken. The fortnightly means of the above (except rainfall) were plotted in the graphs alongwith the percentage incidence of *C. vesuviana* in the respective fortnights, and the correlations were then worked out.

RESULTS AND DISCUSSION

The data pertaining to incidence of *C. vesuviana* in fruits of various *Zizyphus* spp. alongwith meteorological data of the respective periods are presented in Fig. 1 for the year 1979-80 and Fig. 2 for 1980-81.

It can be inferred from Figs. 1 and 2 that the fruitfly remained on the scene practically throughout the year. Its incidence fluctuated a great deal not only from year to year but from month to month in different *Zizyphus* spp. However, the general trend of its attack was more or less the same during both the years, except that a much higher infestation occurred in off-season fruits during 1980-81. The peak incidence of the fly was attained in August/September in off-season rather than on seasonal fruits. On main season crop, the pest attained another two peaks, one in January—synchronising with earlier ripening fruits; and the second in April—coinciding with late maturing cultivars. An unprecedented decrease in its incidence occurred once during October-November and then in March when prevailing climatic conditions seemed more salubrious for the fruitfly activity. Of the three larval/pupal parasites which were found associated with the Tephritid, the two Braconids—*Blasteres longicauda* (Thompson) and *Blasteres* sp. and a Spicid—*Gastrosericus electus* Nurse; none occurred in noticeable numbers and hence they hardly seemed to play any significant role in regulating the pest population.

The data in Figs. 1 and 2 reveal that the fruitfly started its activity soon after the harvest of main season crop i.e. in beginning of June when the newly but scarce off-season fruits became available to harbour its maggots. Such untimely attack in all localities/orchards clearly indicate the survival potential of *C. vesuviana* adults in nature, even during the heat of May and June, when the

INCIDENCE OF BER FRUITFLY

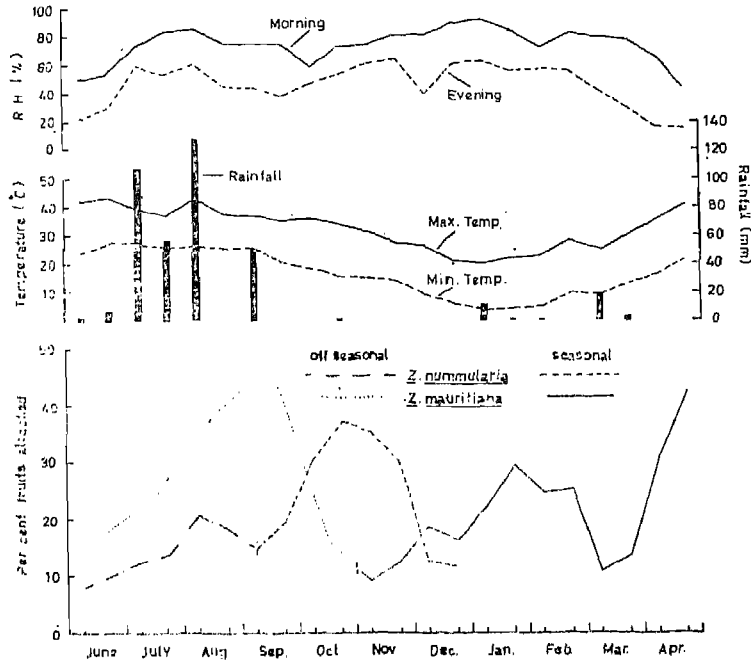


Fig. 1. Incidence of ber fruitfly in relation to weather conditions during 1979-80.

mean weekly minimum and maximum temperatures and evening and morning relative humidities during 1979-80 and 1980-81 ranged from 19.4° to 44.7°C and 23.8° to 42.7°C, and 12 to 60 and 10 to 84 per cent, respectively. Such uninterrupted activity of the Tephritid, which subsided after harvest of the season's fruits in April, is contrary to all earlier reports except the observations of Lakra and Singh (1981).

The flies were earlier reported to emerge during June to November at Nagpur (Khare, 1923), after a few showers during July in Madras (Basha, 1952), in August to December in Punjab (Rehman, 1938), in September in Delhi (Batra, 1953) and in September-October

in Rajasthan (Shinde *et al.*, 1978). Khare (1923) and Batra (1953) failed to discover the manner in which the flies could tide over the early period of emergence and presumed that many of them died.

It appeared that the surviving population of adults would largely determine the intensity of its incidence in subsequent period. More flies led to higher infestation as noticed during 1980-81 (Fig. 2) when 33.01 and 20.68 per cent fruits of *Z. nummularia* and *Z. mauritiana*, respectively, harboured its maggots in early June as against 7.99 and 16.49 per cent in the corresponding period of 1979-80 (Fig. 1). This finds support from Khare (1923) who mentioned that the greater

LAKRA AND SINGH

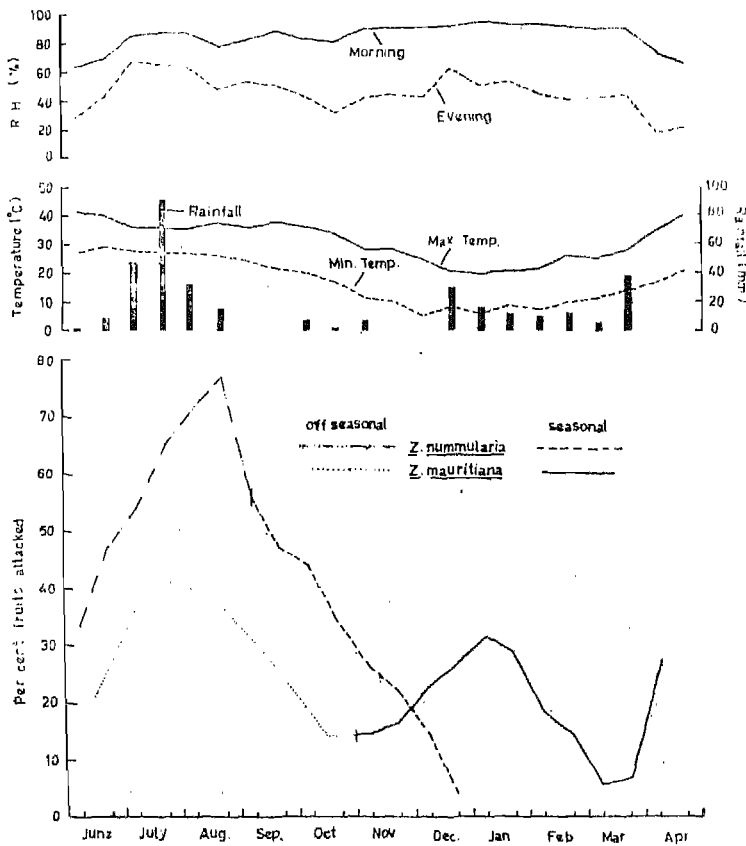


Fig. 2. Incidence of ber fruitfly in relation to weather conditions during 1980-81.

the emergence of flies the greater was the attack in subsequent months and vice-versa. Temperature above 40°C in general and 45°C in particular, with low relative humidity of 20 to 30 per cent proved fatal for the adults as most of them died under caged field conditions on the day when these conditions prevailed. Pruthi and Batra (1938) also reported that excessive heat of June subsided the Tephritid activity. Outside temperature and humidity did not affect the maggots inside the fruits as these continued development uninterruptedly

under these conditions. Batra (1953) observed that the maggots when kept at constant temperature of 33°C remained unaffected. The development stage of the fruit could, however, possibly have a bearing on the development of maggot as pointed by Lakra (1981).

The increasing availability of suitable fruits on a fairly large number of plants after monsoon rain, followed by softening climatic conditions of July-August (fall in maximum temperature and increase in relative humidity), proved suitable for *C. vesuviana*. This resulted into a rapid

INCIDENCE OF BER FRUITFLY

rise in its incidence in both types of fruits leading into peak attack during August when about 20% fruits of *Z. nummularia* during 1979-80 (Fig. 1) and 73% during 1980-81 (Fig. 2) were wallowed by its maggots. The first peak in *Z. mauritiana* was attained in September during 1979-80 and in July during 1980-81 when 47.37 and 41.69 per cent fruits harboured its maggots, respectively. The differences in occurrence of peak incidence in two categories of fruits could be attributed to variable population of adults, variations in size of fruits in different samples and suitability of available fruits, which in turn depended upon prevailing climatic conditions. There was a progressive increase in the pest incidence from June to August/September in both types of fruits during both the years. This revealed that the mean weekly minimum and maximum temperatures, and evening and morning relative humidities from July to September which varied from 19.2° to 40.4°C and 33 to 88 per cent (1979-80) and 19.4° to 38.2°C and 41 to 90 per cent (1980-81), respectively, equally suited the multiplication of the fruitfly.

The results are in partial agreement with the observations of Basha (1952) who recorded a major emergence of adult flies after a few showers in July and further apprehended these to live long to lay eggs by September, though such activity was scarcely perceivable at this early stage. Batra (1953) also suspected that those flies which emerged early in the season would live longer or probably died and further opined that some did try to breed in fruits of *Z. nummularia* but success was low. Hence the present

finding that *C. vesuviana* did breed successfully in scarcely available sub-acidic luscious off-season fruits of various *Zizyphus* spp. is contrary to earlier reports of Khare (1923), Basha (1952) and Batra (1953).

The incidence curves (Figs. 1 and 2) in relation to rainfall and relative humidity records of July and August show that moderate rainfall of 20 to 40 mm with evenly weekly spread in the year 1980-81 proved more conducive for the multiplication of the fruitfly than the moderate-heavy rains of 50 to 120 mm intensity restricted to a few weeks during 1979-80. Intermittent light showers possibly promoted greater emergence of adults resulting in higher incidence from July to September when 53.45 to 76.82 per cent fruits of *Z. nummularia* and 27.99 to 41.69 per cent of *Z. mauritiana* were seen riddled by *C. vesuviana* maggots during 1980-81. On the other hand, heavy downpour apart from restricting the flies emergence also caused their mortality, which obviously resulted into their lower incidence of 12.2 to 20.79 per cent in *Z. nummularia* and 24.07 to 47.37 per cent in *Z. mauritiana* during 1979-80. The occurrence of *B. longicauda*—a maggot/pupal parasite of the fruitfly was also observed under conditions of high humidity and high temperature but in negligible numbers. Thus, the amount of rainfall and relative humidity acted as one of the important factors in determining the incidence of *Carpomyia* at Hisar. Batra (1953) found that higher humidity was congenial to the Tephritid.

After September, the Tephritid switched over its activity to cultivated

fruits which by then were of size fit enough ($9-12 \times 4.5-5.5$ mm) to support the developing maggots. The successful breeding of the fly on off-season fruits (June to September) resulted into higher population of adult flies during fruit set of main crop and consequently a higher level of infestation. The extent of larval/pupal parasitizations of *Carpomyia* by the Braconid, *Biosteres* sp. and Specid, *G. electus* which appeared during September-October were also of no significance as these appeared in far less proportions. Thus, the prevailing climate from mid August to mid November (mean weekly minimum and maximum temperatures and evening and morning relative humidities varied from 14.3° to 38.5°C and 30 to 76 per cent during 1979-80, and 9.9° to 38.2°C and 28 to 90 per cent during 1980-81, respectively) proved to be more favourable for the build up of *C. vesuviana* under Hisar conditions.

From the foregoing account it may be generalised that the gradual decline in weekly minimum (25° to 10°C) and maximum (40° to 25°C) temperatures over a period of about 3 months, accompanied by the evening and morning relative humidities from 28 to 90 per cent, from fruit set till ripening of off-season/seasonal fruits, provided the most congenial conditions for the build up of the Tephritid. In areas, as in Haryana with a large number of wild bushes/trees bearing considerable number of off-season fruits enable the fruitfly to carry over to the main cultivated ber. Lakra and Singh (1981) opined that such carryover of the fly could form by far the most important basis for developing a pest management system.

Z. nummularia fruits which had set in June ripened and were harvested by September. The newly set seasonal fruits were too small for the Tephritid incidence. Such an unsuitability of the available fruits because of their small size might have led to a decline in *Carpomyia* incidence during September even though the climatic conditions from August to November were conducive for the fly. The incidence increased during October-November in the year 1979-80 (Fig. 1), whereas there was no such rise during 1980-81 (Fig. 2). There were two peaks of the fruitfly incidence during 1979-80 one each in off-season (August) and seasonal fruits (October), whereas there was a single peak of heavy infestation (70%) in August 1980-81.

Almost identical pattern of fruitfly attack was observed in off season and season's *Z. mauritiana* fruits (Figs. 1 and 2). The incidence was slightly higher in off-season than in season's fruits during both the years. Among the seasonal fruits, greater infestation was observed during 1980-81 (Fig. 2) than in 1979-80 (Fig. 1). The incidence of the Tephritid when plotted in the graph presented a somewhat 'W-shaped' curve (Figs. 1 and 2) showing three distinct peaks. The first peak synchronised with ripening of off-season fruits (August) was the most serious (destroyed over 38% fruits). A sudden steep decline in its infestation occurred afterwards.

The incidence of *C. vesuviana* on cultivated season's fruits started increasing progressively with increase in fruit size after November. It attained a second peak during January when nearly 30% of the developing fruits were found

INCIDENCE OF BER FRUITFLY

damaged. This is in consonance with the observations of Lakra *et al.* (1979) who reported a peak incidence of the pest in January. The decline in incidence during February-March could be attributed to fewer emergence of adult flies in the preceding winter months, apart from frequent harvesting/dropping of ripe fruits. During winter (December to mid February), the mean weekly minimum and maximum temperatures ranged from 1.7° to 26.8°C (lowest being—1.7°C) during the two years. Low temperature particularly below 0°C besides prolonging the duration of various immature stages, also adversely affected the adults which resulted in lower Tephritid incidence in succeeding months of February-March.

The gradual rise in atmospheric temperature during spring caused massive emergence of adult flies which led to a steep rise in its incidence during April. The third and the last peak coincided with late ripening cultivars. Almost all the cultivars ripened by mid April in Hisar and a few fruits which remained on the trees were most severely attacked

(42.9%). The prevailing climatic conditions of March-April when the mean weekly minimum and maximum temperatures and evening and morning relative humidities varied from 10.1° to 43.2°C and 11 to 81 per cent during 1979-80 and 10.8° to 39.8°C and 14 to 91 per cent during 1980-81, respectively, proved to be highly congenial for the fruitfly. Thus, it can be concluded that the gradual rise in mean weekly minimum and maximum temperatures from 10° to 25°C and 25° to 40°C, respectively, accompanied by mean relative humidity of 25 to 75 per cent, which prevailed during March-April—synchronising with ripening of ber, were greatly conducive for *C. vesuviana*.

ACKNOWLEDGEMENTS

Heartfelt thanks are extended to ber Orchardists of Hisar for allowing to carry out the studies; Dr. N. C. Pant, Director, Commonwealth Institute of Entomology, London, for identification of the insects and Dr. O. P. Pareek, Project Coordinator, Cell III (ICAR), for critically going through the manuscript.

REFERENCES

- Basha, J. M. G. 1952. Experiments on the control of the fruit borers of jujube (*Zizyphus* spp.), *Carpomyia vesuviana* Costa and *Meridarchis scyroides* Meyr. in South India. *Indian J. Entomol.* **14** : 229-38.
- Batra, H. N. 1953. Biology and control of *Dacus diversus* Coquillett and *Carpomyia vesuviana* Costa and important notes on other fruit flies in India. *Indian J. agric. Sci.* **23** : 87-112.
- Cherian, M. C. and Sundaram, C. V. 1941. The ber fruitfly—*Carpomyia vesuviana* A. Costa and its control. *Proc. 28th Indian Sci. Congr.* III : pp. 191.
- Khare, J. L. 1923. Ber (*Zizyphus jujube*) fruit and its fly pest. *Agric. Res. Inst. Pusa, Bull.* No. **143** : 1-16.
- Lakra, R. K. 1981. Bionomics and control of ber fruitfly, *Carpomyia vesuviana* Costa. Ph.D. thesis, Haryana Agricultural University, Hisar.

LAKRA AND SINGH

- Lakra, R. K., Kharub, W. S. and Singh, Zile. 1979. Relationships of shedding of ber fruits and the incidence of ber fruitfly and bird damage. *Indian J. Ecol.* 6 : 68-72.
- Lakra, R. K. and Singh, Zile. 1981. Seasonal activity of ber fruitfly, *Carpomyia vesuviana* Costa (Diptera : Tephritidae). 1st National Workshop on Arid Zone Fruit Research (ICAR), held at Haryana Agricultural University, Hisar, April 27-29, 1981.
- Pruthi, H. S. and Batra, H. N. 1938. A preliminary annotated list of fruit pests of the North West Frontier Province. *Misc. Bull. Imp. Coun. Agric. Res. (India)* No. 19 : 22.
- Rehman, K. A. 1938. Annual Report of the Combined Entomological Scheme, Punjab and N.W.F.P. for the year 1937-38, Simla : pp. 18.
- Shinde, V. K. R., Puri, M. K. and Sharma, S. K. 1978. Comparative toxicity of some insecticides to maggots of *Carpomyia vesuviana* Costa. *Indian J. Plant Prot.* 6 : 23-25.
- Tomic, A. 1954. Biological investigations on *Carpomyia vesuviana* A. Costa. *Plant Prot.* 24 : 92-97.

IRRIGATION PRODUCTION FUNCTIONS FOR LUDHIANA CONDITIONS

RANVIR KUMAR, S. D. KHEPER* and K. N. DUGGAL**

Department of Agricultural Engineering

Haryana Agricultural University, Hisar

(Received : January 11, 1983; Revised : January 31, 1984)

ABSTRACT

The quadratic and square root functions which are considered to be the most suitable production functions for agricultural studies, were developed for six crops viz., wheat, gram, raya (oilseeds), berseem, sugarcane and cotton for Ludhiana conditions using experimental data on crop response to water input based on least square technique. Better fit function for each crop was selected on the basis of the highest value of R^2 (coefficient of multiple determination). F test was applied to test the significance of the function.

Considerable amount of research has been conducted to estimate the crop yield responses to water inputs. The data have been analysed mainly in a qualitative manner and very little on quantitative basis. Moore (1961) developed an analytical methodology to estimate the production functions for crops using irrigation water. The moisture release curve for a specific soil describing the available moisture within the range from field capacity to wilting point was used as an indicator of the relative growth rate of the plant. The actual yield was then estimated by multiplying potential yield and index of relative plant growth rate derived from moisture release curve. Yaron (1971) developed quadratic and third degree polynomial production functions for sorghum, and related gram yield and net water applied. It was found that these equations fitted for a given crop in a

specific location could not predict crop yields for different years in the same location. Minhas *et al.* (1974) estimated from experimental data the mathematical form of a water use function and then computed the time profiles of actual water use for two crops; wheat in Delhi and alfa alfa in Ohio, U. S. A. The relationship between wheat yield and dated inputs of water was also determined for the estimated time profiles of consumptive use. Mussick *et al.* (1976) developed quadratic production functions for sorghum, wheat and soyabean, relating gram yield and soil water depletion from 0-120 cm root depth. Gulati (1977) developed first, second and third degree polynomials for different crops and selected best fit polynomial for each crop. Tyagi (1980) also developed quadratic production functions for few crops based on data from experiments conducted at

*Department of Soil and Water Engineering, Punjab Agricultural University, Ludhiana.

**Department of Civil Engineering, Punjab Agricultural University, Ludhiana.

Central Soil Salinity Research Institute,
Karnal.

The agricultural production functions developed by different workers pertain to a few crops for a particular soil and climatic conditions. But the production functions have to be developed for all possible crops which are either grown or can be grown in that particular area for which the mathematical models are to be applied for optimization and decision making. Therefore, in the present study, square root and quadratic functions which are considered to be the most suitable for agricultural production were developed for six crops viz., wheat, gram, raya (oil-seeds), berseem, sugarcane and cotton for Ludhiana conditions using experimental data on crop response to water input based on least square technique. Statistical tests were applied to test the significance of the function and the best fit function for each crop was selected.

The square root and quadratic functions are given by following relationships (Heady and Dillon, 1960) :

$$Y = a + bX + cX^{0.5} \text{ (for square root function)}$$

$$Y = a + bX + cX^2 \text{ (for quadratic function)}$$

where

Y = Yield response (q/ha)

X = Quantity of water applied (mm/ha)

a, b and c = Coefficients of the function.

METHODOLOGY

The production functions were fitted using inbuilt programme based on least square technique on HP-41-C programmable calculator. R^2 (coefficient of multiple determination) test was applied to determine the suitability of the fitted functions to the set of observed data. F test was also applied to test the significance of the function.

The data for wheat, gram, raya (oil-seeds), berseem and sugarcane were

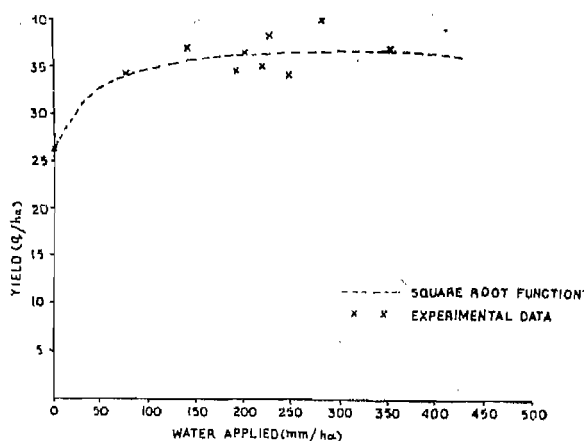


Fig. 1. Irrigation production function of wheat.

IRRIGATION PRODUCTION FUNCTIONS

taken from Anonymous (1972-77). The data for cotton were taken from Dastane *et al.* (1970).

RESULTS AND DISCUSSION

The selected irrigation production functions (square root and quadratic) for different crops and experimental data are shown in Figs. 1-6. The selected square root and quadratic functions are given in Tables 1 and 2, respectively.

It can be seen from the figures that the crop yield increased with the increase in application of irrigation water, reached maximum value and then with further increase in irrigation water, the yield showed a declining trend.

The differences in R^2 value between square root and quadratic functions for berseem, sugarcane and cotton were very

small, therefore, both the functions could be used. But, in case of wheat, gram and raya (oilseeds), the difference in R^2 value was large which implied that one

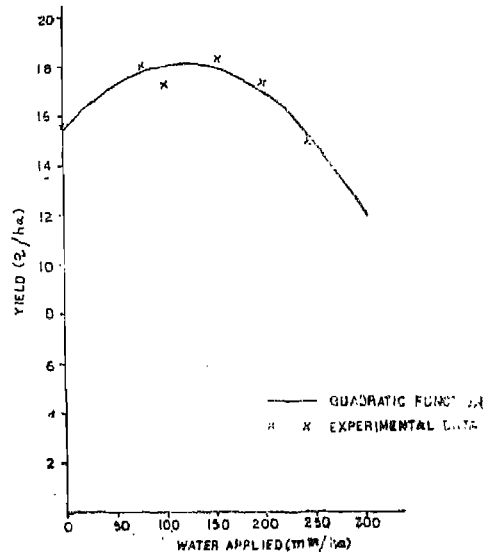


Fig. 2. Irrigation production function of gram.

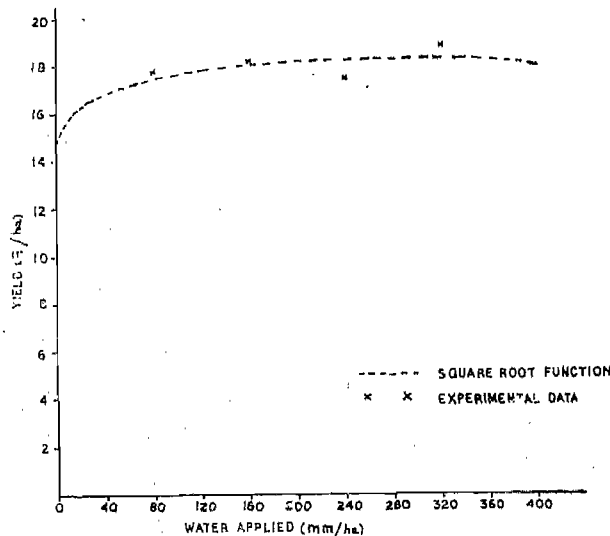


Fig. 3. Irrigation production function of raya.

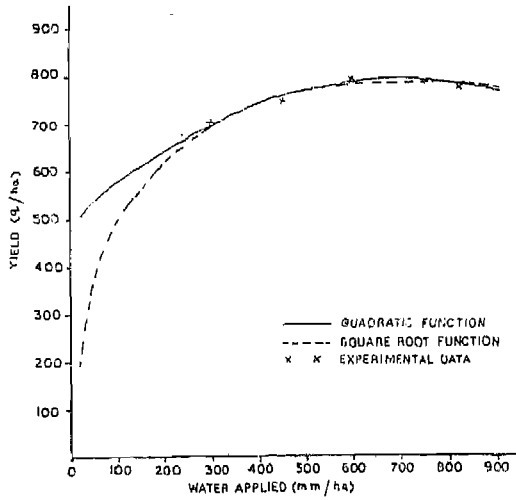


Fig. 4. Irrigation production function of berseem.

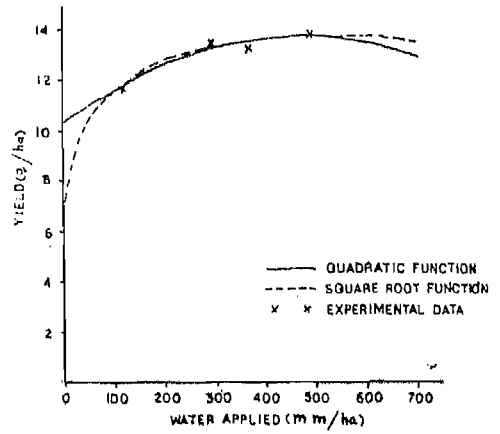


Fig. 5. Irrigation production function of cotton.

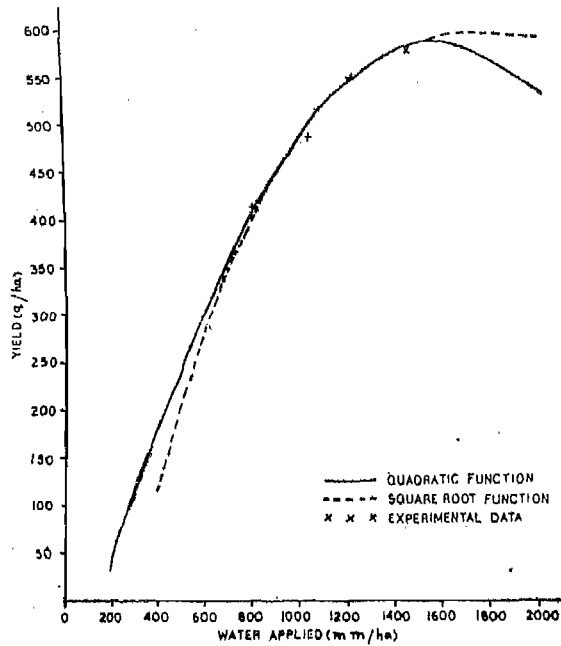


Fig. 6. Irrigation production function of sugarcane.

IRRIGATION PRODUCTION FUNCTIONS

TABLE 1

Selected square root irrigation production functions of different crops

S. No.	Crop	Coefficients of functions			R ²	F test statistics
		a	b	c		
1.	Wheat (Kalyan Sona)	26.52	0.03	1.50	0.64 (0.55)	S*
2.	Raya (oilseeds) (RLM-198)	14.75	0.01	0.41	0.90 (0.77)	S*
3.	Berseem	20.86	1.08	57.64	0.98 (0.99)	S*
4.	Cotton (MCU-1)	6.58	0.01	0.63	0.96 (0.94)	S*
5.	Sugarcane (Co-1148)	-1160.11	0.99	83.60	0.99 (1.00)	S*

Values in parentheses are R² values for quadratic functions.

*Significant at 5% level of significance.

TABLE 2

Selected quadratic irrigation production functions of different crops

S. No.	Crop	Coefficients of functions			R ²	F test statistics
		a	b	c		
1.	Gram (C-235)	15.48	0.05	0.00019	0.86 (0.68)	S*
2.	Berseem	493.72	0.86	0.000611	0.99 (0.98)	S*
3.	Sugarcane (Co-1148)	-142.71	0.92	0.000293	1.00 (0.99)	S*
4.	Cotton (MCU-1)	10.27	0.01	0.0000156	0.94 (0.96)	S*

Values in parentheses are R² values for square-root functions.

*Significant at 5% level of significance.

function had a definite edge over the other. For wheat and raya (oilseeds), square root function was found to be better than quadratic function, while quadratic function fitted better for gram crop.

Therefore, it is very clear that a particular type of function cannot be used for all the crops. All the irrigation production functions were found to be statistically significant.

REFERENCES

- Anonymous, 1972-77. Annual Progress Report of ICAR scheme on integrated project for research on water management and soil salinity, Punjab Agricultural University, Ludhiana.
- Dastane, N. G., Singh, M., Hukkeri, S. B. and Vanadevan, V. K. 1970. Review of work done on water requirements of crops in India. Indian Agricultural Research Institute, New Delhi.
- Gulati, H. S. 1977. A production function based model for canal water optimization. M. Tech. (Agril. Engg.) thesis, Punjab Agricultural University, Ludhiana.
- Heady, E. O. and Dillon, J. L. 1960. *Agricultural Production Functions*. Kalyani Publishers, Ludhiana.
- Minhas, B. S., Parikh, K. S. and Srinivasan, T. 1974. Towards the structure of production function for wheat yields with dated inputs of irrigation water. *Water Resour. Res.* 10 : 383-93.
- Moore, C. V. A. 1961. General analytical framework for estimating the production function for crops using irrigation water. *J. Farm Econ.* 43 : 873-83.
- Mussick, J. T., New, L. L. and Dusek, D. A. 1976. Soil water depletion yield relationship of irrigation-sorghum, wheat and soyabean. *Trans. Am. Soc. Agric. Engin.* 19 : 489-95.
- Tyagi, N. K. 1980. Crop planning and water resources management in salt-affected soils. A system approach. Ph. D. thesis, J. N. Technological University, Hyderabad.
- Yaron, D. 1971. Estimating and use of water production function in crops. Journal of Irrigation and Drainage Division. Proc. American Society of Civil Engineers, pp. 291-303.

SOILS OF N E. S. BLOCK GANAUR OF DISTRICT SONEPAT, HARYANA—THEIR PROBLEMS AND MANAGEMENT

S. P. S. KARWASRA, J. P. SANGWAN and M. S. KUHAD

Department of Soils

Haryana Agricultural University, Hisar

(Received : February 17, 1983; Revised : October 3, 1983)

ABSTRACT

Morphology and physico-chemical characteristics of four soil series (Datauli, Pipilkhera, Purkhas and Kheri Gujran) established during reconnaissance soil survey of Ganaur block have been studied and the soils have been classified according to U. S. Soil Taxonomy. The nature and intensity of problems associated with the different soil series have been clearly brought out. The management requirements of each of the soil series with regard to improvement of physical conditions, building up soil fertility and reclamation of saline-alkali soils have been specified.

One of the most important factors in the agricultural development potential of an area is its soil resource. Soil surveys that provide information on morphology and physico-chemical characteristics of soil series are the primary source of such basic data. Studies on the soils in an area like Ganaur block (District Sonapat) in Haryana warrant immediate attention of the soil scientists, where once productive lands are fast turning almost to barren due to the twin problems of salinity and waterlogging.

DESCRIPTION OF THE AREA

Ganaur block of district Sonapat (Haryana) lies between latitude 29°2'55" to 29°12'5" N and longitude 76°42'30" to 77°9'30" E, and covers an area of about 350 sq. km and comprises 74 villages. The area forms a part of the Indo-Gangetic plains. The Yamuna flows on the eastern border of the block.

Topographically, the area is generally flat and mean sea level ranges between 221.5 to 223.5 m, over the entire block. The area comes under the hot and semi-arid, south-eastern zone of Haryana (Duggal, 1970). Mean annual rainfall is between 500-700 mm and most of it, about 70%, is received in the months of July and August. Temperature generally remains high during most part of the year. June is the hottest month averaging 40.2°C and January is the coldest with average mean minimum temperature 6.7°C. Natural vegetation comprises deciduous type. Nearly 75% of the total cropped area is under food grains. Wheat, gram, rice, maize, bajra and sugarcane are the main crops in the area.

MATERIAL AND METHODS

The area was first broadly traversed to have a general picture of topography, physiography, soils, vegetation, present

landuse, etc. Then, a low intensity standard soil survey using 1" to 1 mile scale map was conducted as per procedure laid down in the soil survey manual (Soil Survey Staff, 1970). Soil boundaries were delineated on the basis of systematic traversing over the area, making auger observations at regular intervals and profiles examination. The relationship found to be existing between physiography and soils in the area was also used for delineating soil series boundaries.

Representative soils were further studied upto 150 cm or more in open pits (profiles) and morphological characteristics like colour, texture, structure, consistence, horizon thickness and boundary, clay films, biological activities, etc. were described based on FAO (1966). The classification of soil was based on the field and laboratory data as per USDA (1975).

Representative air-dry fine earth samples were employed for analysis of particle size distribution by international pipette method (Piper, 1966), pH using Backman glass electrode pH meter (Jackson, 1970), organic carbon by Walkley and Black's wet digestion method (Jackson, 1970), available nitrogen (Subbiah and Asija, 1956), available phosphorus (Olsen *et al.*, 1954) and available potassium by turbidimetric method (Datta *et al.*, 1966).

RESULTS AND DISCUSSION

During the course of reconnaissance soil survey of Ganaur block, four soil series were recognised based on the arrangements of horizons and similarities in the profile characteristics. These are Datauli, Piplikhera, Purkhas and Kheri Gujran. The series boundaries were extrapolated (Fig. 1). Although series

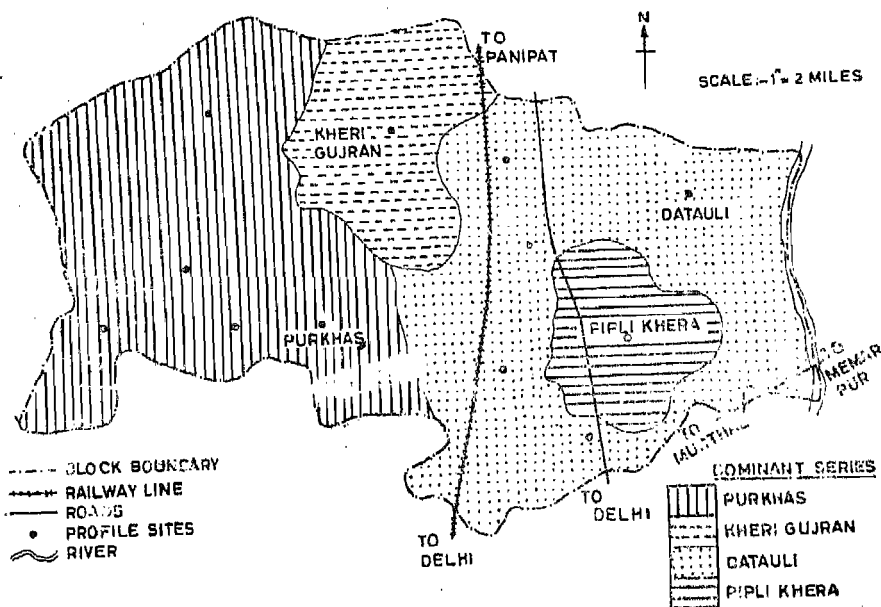


Fig. 1. Areas with dominant soil series in N.E.S. block Ganaur (Sonepat).

SOILS OF GANAUR BLOCK

TABLE 1
Analytical data of the soil series identified in Ganaur block (District Sonapat)

Depth (cm)	pH (1:2)	E. C. (1:2) (mmhos/cm)	CaCO ₃ (%)	O.C. (%)	Sand (%)	Silt (%)	Clay (%)	E. S. P.	N (kg/ha)	P (kg/ha)	K (kg/ha)
1. Datauli series											
0-15	7.6	0.35	2.90	0.30	70.1	14.6	12.1	10.8	191.2	5	275
15-40	7.6	1.26	1.40	0.19	69.8	15.0	13.2	12.6	123.2	12	200
40-90	8.0	0.66	1.55	0.08	69.0	16.0	14.5	14.4	112.2	26	160
90-132	7.7	0.33	3.50	0.07	69.0	15.0	12.3	13.1			
132-150	8.1	0.42	1.50	0.02	75.8	12.0	10.8	8.8			
2. Piplikhara series											
0-15	8.7	2.10	3.25	0.07	69.2	18.8	12.0	103.0	39.0	36	435
15-37	9.1	2.01	3.10	0.16	64.8	20.6	14.6	72.0	44.8	17	310
37-65	9.2	3.27	9.00	0.11	58.9	22.1	18.0	101.0	39.2	34	340
65-105	9.3	5.04	3.75	0.07	56.6	26.0	16.4	84.3			
105-150	10.1	1.82	1.00	0.05	62.5	25.4	12.1	86.3			
3. Purkhas series											
0-20	7.5	2.52	2.88	0.24	73.4	14.8	12.6	13.0	107.0	7	275
20-60	7.6	1.04	6.50	0.16	76.3	15.9	12.8	10.0	140.0	24	260
60-90	7.3	0.90	1.75	0.11	63.4	20.2	16.4	8.9	42.0	33	240
90-125	7.9	0.68	1.70	0.08	62.5	20.0	17.5	10.7			
125-150	7.0	0.66	2.80	0.06	70.1	18.0	11.9	10.8			
4. Kheri Gujran series											
0-15	7.5	0.88	3.00	0.23	63.8	16.0	20.2	10.7	162.0	30	612
15-50	7.6	0.96	1.00	0.19	60.4	18.6	21.0	9.3	151.2	26	500
50-90	8.2	1.20	3.25	0.16	62.0	18.0	20.0	13.1	89.6	24	350
90-135	8.1	1.20	1.62	0.13	42.4	30.4	28.2	11.5			
135-150	7.5	1.02	2.00	0.13	41.5	30.0	28.5	7.3			

association was observed in all blocks of landscape, but the four blocks of landscape position represent only the dominant series which occupied more than 60% of the area of block landscape.

Results of physico-chemical analysis are presented in Table 1, for a typifying pedon from each of the four series. A general description of soils under each series, their range of characteristics and the problems associated with each are described below.

Datauli Series

Datauli series consists of young soils with little or no horizon differentiation and profile development. These are deep to very deep, moderately well-drained to well-drained, coarse loamy soils formed on sandy alluvium of relatively recent deposition in the first and second order flood plains of the Yamuna.

The ground water level is at a depth of 8 to 10 m and does not affect much the soil conditions. These soils are free from any lime concretion but strong to violent effervescence with dilute HCl indicates the calcareous nature of the alluvium.

Typifying Pedon

Depth (cm)	Morphological description
0-15	Grayish brown (10 YR 5/2) loamy sand; single grain structureless; loose, non-sticky and non-plastic; many roots; no concretions; strong effervescences.
15-40	Grayish brown (10 YR 5/2) loamy sand; fine weak subangular blocky; soft (dry), very friable (moist), non-sticky and non-plastic (wet); many fine and medium roots; many fine and medium pores; no concretions; strong effervescence; gradual smooth boundary.
40-90	Brown (10 YR 5/3) loamy sand; single grain; very friable (moist); non-sticky and non-plastic (wet); few fine roots; porous; strong effervescence; no concretions; diffuse boundary.
90-132	Dark brown (10 YR 4/3) moist loamy sand; single grain; structureless; loose; non-sticky; no roots; strong effervescence.
132-150	Sub divided only for sampling; description same as above.

These soils have about 15 to 20 cm thick sandy loam surface horizon (Ap) or grayish brown to yellowish brown over dark brown sandy loam sub-surface soil. In general, these are alkaline, calcareous and in places somewhat salty too.

These are mostly well-drained with rapid permeability but as these occur in the flood plains of the river Yamuna, these are susceptible to few short duration floods during rainy season in some years.

The soils are low in organic carbon, low in inherent soil fertility (N and P) and low to medium in available water holding capacity. Most of these soils are cultivated lands under tubewell irrigations. The major crops grown are wheat, sugarcane and sorghum for fodder and summer vegetables.

The results of demonstrations conducted under the multiple cropping scheme of ICAR have shown that these soils give good response to the application of manures and fertilizers. Higher yields are obtainable through better soil and water management coupled with other package of practices.

This series is a member of coarse loamy, calcareous, mixed, hyperthermic family of Typic Ustorthents.

Piplikhera Series

Piplikhera series includes soils which are currently uncultivable waste lands due to the setting in of the process of salinization. Only in the recent past, these were normal soils. These soils which mostly confined to the east-central part in the block were the first to be affected because of rise in water table brought about firstly by the advent of irrigation system and secondly by the blockage of natural surface drainage by roads, canals, etc.

The main distinguishing features of soils in this series are the presence of a compact and hard layer of lime concretions at a depth in the profile varying

from 37 to 65 cm, very high percentage of soluble salts, very low permeability and very high exchangeable sodium percentage. In summer months, these are easily identifiable by the presence of white salt encrustation at the surface.

To put back these soils under normal cultivation requires efforts jointly by the State Departments and farmers in the area. Lowering down of water table to a depth of 1-5 m by improving surface and sub-surface drainage, proper levelling and bunding of fields, use of gypsum as soil amendments, selection of salt tolerant crops (paddy-wheat-dhaincha), green manuring, application of manures and fertilizers and sound water management are steps needed to be taken.

Typifying Pedon

Depth (cm)	Morphological description
0-15	Light gray (10 YR 7/2) loamy sand; medium; moderate; sub-angular blocky; sticky and slightly plastic (wet); a few fine roots; strong effervescence; few fine lime concretions.
15-37	Very pale brown (10 YR 6/3) sandy loam; medium, moderate columns; roots absent; violent effervescences; many medium concretions.
37-65	Brown (10 YR 5/3) moist sandy clay loam; firm (moist); sticky and plastic (wet); no roots; common coarse lime concretions; violent effervescences.
65-105	Pale brown (10 YR 6/3) moist; sandy loam; friable (moist), sticky and plastic (wet); few fine lime concretions.
105-150	Pale brown (10 YR 6/3) moist sandy loam; very hard compact layer of lime concretions and rest same as for above horizon.

Purkhas Series

Purkhas series includes very deep, moderately well-drained to well-drained, light to medium textured soils occurring on almost flat lands.

Mostly these are grayish brown, sandy loam, calcareous soils having concentra-

tion of lime concretion below the surface at depth varying 50 to 75 cm.

These are normal soils with pH near neutral to slightly alkaline. The soils are well-drained suited for growing wide range of crops. The underground water in the area is slightly brackish and thus

requires sound water management practices to be adopted.

The soils are also low in inherent soil fertility and thus for obtaining high yields fertilizers application is needed.

Purkhas series is fairly well distributed in the area. Associated series are Piplikhara and Kheri Gujran.

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

Typifying Pedon

Depth (cm)	Morphological description
0-20	Pale brown (10 YR 6/3) loamy sand; crumb to massive structure; non-sticky and non-plastic (wet), slightly hard (dry) and friable (moist); many fine impeded roots; slight effervescence; clear smooth boundary.
20-60	Very pale brown (10 YR 7/3) sandy loam; weak fine subangular blocky; slightly hard (dry), friable (moist), slightly plastic (wet); common, fine roots; few fine lime concretions; strong effervescence; clear smooth boundary.
60-90	Brown (10 YR 5/3) moist sandy loam; medium subangular; friable (moist), slightly sticky and slightly plastic (wet); few fine roots; common, medium lime concretions; strong effervescence; gradual diffuse boundary.
90-125	Grayish brown (10 YR 5/2) moist sandy loam; fine, weak subangular blocky; friable (moist) slightly sticky and slightly plastic (wet); no roots; many, medium to coarse lime concretions; violent effervescence; gradual smooth boundary.
125-150	Grayish brown (10 YR 5/2) moist sandy loam; fine weak subangular blocky; few fine concretions; strong effervescence.

Kheri Gujran Series

Kheri Gujran series comprises very deep, moderately well drained, pale brown to brown, medium heavy-textured soils developed on old Indo-gangetic alluvium. Sandy clay loam to clay loam soils occurring in slight depressional sands in the relict wedge plain physiographic sub-division in the north central part of the block.

The sub-soil is heavy with a strong coarse sub-angular blocky structure. These soils are generally free from lime

concretion but give effervescence with dilute HCl throughout the profile. The ground water table is 10 to 12 m deep and does not affect the soil conditions much.

Soils in Kheri Gujran series are normal as these have slight alkaline pH and calcareous in nature. They are well distributed over significant areas in the block.

The soils are low in organic carbon and inherent soil fertility. These have low nitrogen, low phosphorus and high

SOILS OF GANAUR BLOCK

potassium status. The available water holding capacity is medium. The area is under cultivation of crops like wheat, **bajra**, paddy, sugarcane, etc. in irrigated condition. The soils give good response to application of manures and fertilizers

containing N and P.

At family level, these are classified as fine loamy, calcareous, hyperthermic Typic Camborthids.

Typifying Pedon

Depth (cm)	Morphological description
0-15	Very pale brown (10 YR 7/3) sandy clay loam; moderate, medium subangular blocky; very firm (moist), sticky and plastic (wet); many fine, few coarse roots; no lime concretions; slight effervescence; clear, smooth boundary.
15-50	Light grayish brown (10 YR 6/2) sandy clay loam; medium subangular blocky to angular blocky; sticky and plastic (wet); common, fine roots; few fine tabular pores; no lime concretions; slight effervescence; clear smooth boundary.
50-90	Gray (10 YR 4/2) moist, sandy clay loam; massive slightly hard (dry), friable (moist), slightly plastic and slightly sticky (wet); few fine fibrous roots; many very fine interstitial pores; strong effervescence; clear smooth boundary.
90-135	Brown (10 YR 5/3) moist clay loam; massive and hard breaking; angular to sub-angular blocky peds; hard (dry), firm (moist), sticky and plastic (wet); no roots; slight effervescence; diffuse smooth boundary.
135-160	Brown (10 YR 5/3) moist clay loam; massive and hard breaking to coarse angular blocks to sub-angular blocks; no roots; common fine and very fine tabular pores.

REFERENCES

- Datta, N. P., Kheja, M. S. and Saini, T. R. 1966. Phosphorus and test based upon correlation with inorganic phosphorus fractions and greenhouse test. *J. Indian Soc. Soil Sci.* 4 : 119.
- Duggal, S. L. 1970. *Soil Geographical Zones of Haryana*. Haryana Agricultural University, Hisar.
- FAO 1966. Guidelines for soil profile description. FAO, Rome.
- Jackson, M. L. 1960. *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi
- Olsen, S. R., Cole, C. V., Watanabe, F. S. and Dean, L. A. 1954. Estimation of available phosphorus in soil by extracting with sodium bicarbonate. *Circ. U.S.D.A.* 939.
- Piper, C. S. 1966. *Soil and Plant Analysis*. Hans Publishers, Bombay.
- Soil Survey Staff. 1970. *Soil Survey Manual*. Indian Agricultural Research Institute, New Delhi.
- Subbiah, B. V. and Asija, G. L. 1956. A rapid procedure for the determination of available nitrogen in soils. *Curr. Sci.* 25 : 258.
- U.S.D.A. 1975. *Soil Taxonomy*. A basic system of soil classification for making and interpreting soil surveys. Agriculture Handbook No. 436.

PATHOLOGICAL ANALYSES OF NATIONAL AND REGIONAL PEARL MILLET GENEPOOL FOR MAJOR DISEASES UNDER MULTIPLE DISEASE SICK-PLOT

D. P. THAKUR and N. MEHTA
Department of Plant Pathology
Haryana Agricultural University, Hisar

(Received : February 28, 1983; Revised : February 1, 1984)

ABSTRACT

Fiftyone pearl millet entries representing hybrids and populations (synthetics and composites) drawn from various Pearl Millet Breeding Stations of India were put under rigorous screening for downy mildew, ergot and smut diseases under artificially created multiple disease sick-plot. Results over three crop seasons revealed that only two hybrids MBH-110 and MBH-131 remained free from downy mildew. None of the entries was free from ergot and smut infection. However, four entries viz., hybrid MBH-133 and populations PSB-15 (MP-51), MP-81 and VCC-75 contracted less than 5% ergot florets/earhead and as such these were tolerant to ergot. The least incidence of smut (1%) was on DEC-1 which could be termed as tolerant. Pearl millet entries evolved at Jalna contracted least downy mildew and those from Coimbatore and Delhi contracted minimum ergot and smut, respectively.

Pearl millet, used as a staple food by 20% of the world population including 10% of Indian population in the states of Andhra Pradesh, Gujarat, Maharashtra, Rajasthan, parts of Uttar Pradesh, Haryana and Punjab, suffers from several diseases viz., downy mildew, ergot, smut, leaf blast and rust. With the introduction of hybrid varieties in 1966, the annual grain production of pearl millet in India increased from 5.3 to 8 metric tons, which was reduced to 5.25 metric tons by 1969-70. The reasons for such a steep decrease in grain production are the extreme susceptibility of the male sterile line used for hybrid production (TF-23A/TF-23D₂A) to all the major diseases, the rapid spread of susceptible hybrids like HB-1, HB-2, HB-3

and HB-4 increased the natural inoculum build-up which resulted in the breakdown of the resistance even in the desi/tolerant cultivars and due to the disease epidemic, area under hybrid varieties came down to only 17% from 26 per cent.

In India three major diseases viz., downy mildew/green ear, ergot and smut cause considerable loss in grain yield (Mitter and Tandon, 1930; Mathur and Delela, 1971; Natarajan *et al.*, 1974; Thakur *et al.*, 1976, 1978). Though the search for resistant sources to these diseases was intensified over past several years, yet the success on these investigations could not be achieved until the

NATIONAL AND REGIONAL PEARL MILLET GENEPOOL

development of sick-plot for downy mildew, ergot and smut diseases at Haryana Agricultural University, Hisar.

In the present paper, the results of intensive analyses of advanced national and regional pearl millet gene pool for three major diseases over three crop seasons of 1980, 1981 and 1982 are given in respect of multiple disease sick-plot testing at Haryana Agricultural University Farm, Hisar.

MATERIAL AND METHODS

Fiftyone genotypes including hybrids, parents, pollinators, etc. were screened against three major diseases viz., downy mildew/green-ear (*Sclerospora graminicola* (Sacc.) Schroet), ergot (*Claviceps fusiformis* Loveless) and smut (*Tolyposporium pennicillariae* Bref.) by artificial inoculation method during the three crop seasons.

For downy mildew screening, sick-plot preparation technique developed by Thakur and Kanwar (1977) was followed which comprised soil inoculation, advance

sowing of susceptible infector rows (NHB-3) after every two rows of candidate lines and inoculation infector rows with sporangial suspension. Disease reaction for downy mildew was observed on candidate lines twice viz., 25 and 45 days after sowing.

For ergot and smut screening, earheads were separately inoculated at preprotogynae stage for three successive days with viable conidial/chlamydosporial suspension of the respective ergot and smut fungi (nearly 2000 infective propagules per ml) and covered with water-proof selfing bags to avoid pollen interference in ergot development (Thakur, 1978). High humidity was provided continuously for 7 days by spraying water over the inoculated earheads 3 to 4 times a day. Ergot and smut intensity was recorded 15 days after inoculation of earheads.

On the basis of infection intensity, the following grading system was used for characterising the entries into resistant, tolerant, susceptible and highly susceptible categories :

Disease	Resistant	Tolerant	Susceptible	Highly susceptible
Downy mildew	No infection	Below 0.5% downy mildew plants	Between 0.5-1% downy mildew plants	More than 5% downy mildew plants
Ergot	No infection	Below 5% ergoty florets/earhead	Between 5-9% ergoty florets/earhead	More than 10% ergoty florets/earhead
Smut	No infection	Below 5% smut sori/earhead	Between 5-9% smut sori/earhead	More than 20% smut sori/earhead

RESULTS AND DISCUSSION

Out of 51 entries (Table 1), the disease evaluation analyses are available for three continuous seasons in respect of 18 entries (star marked) and for 33 entries results are available for two crop seasons. From Table 2, it is evident that only two hybrids, MBH-131 and MBH-110 remain-

ed free from downy mildew. None of the entries was tolerant while 35 entries emerged as susceptible and 14, entries as highly susceptible to downy mildew. The downy mildew incidence remained 80.5 and 23.5 per cent, respectively, for NBH-3 (23A x J-104) and BJ-104 (5141A x J-104) in the permanent downy mildew sick-plot.

TABLE 1

Reaction of national and regional pearl millet entries to downy mildew, ergot and smut diseases

S. No.	Code No.	Pedigree	Location	Downy mildew plants (%)	Per cent per earhead Ergoty florets	Smut sori
1	2	3	4	5	6	7
1.	MH-29	5141A x J 1188	Jam Nagar	0.6	31.2	31.9
2.	MH-34	MBH-116	Jalna	4.3	21.3	21.5
3.	MH-60*	NBH-121	Jalna	2.1	61.7	34.3
4.	MH-64	5141A x ICP-276	ICRISAT	3.7	80.0	32.9
5.	MH-65*	5054A x ICP-251	ICRISAT	6.1	37.0	39.3
6.	MH-80	5141A x RIB-58	Durgapura	6.5	35.0	39.2
7.	MH-82	111A x PIB-1325	Ludhiana	1.5	35.0	40.6
8.	MH-86*	MBH-128	Jalna	3.1	13.1	31.2
9.	MH-88*	MBH-130	Jalna	1.6	19.7	10.9
10.	MH-90	5141A x RIB-517	Durgapura	3.5	55.0	24.7
11.	MH-91*	5141A x ICP-220	ICRISAT	2.6	45.0	27.6
12.	MH-94	5141A x 78/753	Hisar	1.6	23.0	26.5
13.	MH-96*	3383A x D-60	Delhi	5.9	46.0	25.8
14.	MH-97	5141A x D-115	Delhi	10.5	65.0	8.8
15.	MH-98	5141A x AIB 6	Aurangabad	4.3	35.4	25.1
16.	MH-103	111A x PIB-1223	Ludhiana	2.6	20.0	39.2
17.	MH-106	MBH-131	Jalna	0.0	24.5	06.2
18.	MH-107	MBH-132	Jalna	1.0	6.0	31.9
19.	MH-108*	MBH-133	Jalna	6.6	3.1	9.8
20.	MH-109	111A x PIB-1244	Ludhiana	2.2	28.0	20.6
21.	MH-111	111A x PIB-1225	Ludhiana	4.8	9.1	31.1
22.	MH-116	UCH-9	Coimbatore	3.9	6.1	15.5
23.	MH-117	UCH-10	Coimbatore	1.9	23.4	10.0
24.	MP-15*	ICMS-7703	ICRISAT	3.3	33.1	47.2
25.	MP-19*	HC-4	Hisar	4.9	17.5	12.8
26.	MP-31	RHR-1	Rahuri	2.1	22.8	26.4
27.	MP-35*	IVS-P-77	ICRISAT	1.9	27.0	12.7
28.	MP-36*	WC-B-77	ICRISAT	1.5	28.0	22.9
29.	MP-47*	RCB-2	Durgapura	5.5	24.8	21.3

NATIONAL AND REGIONAL PEARL MILLET GENEPOOL

1	2	3	4	5	6	7
30.	MP-51	PSB-15	Ludhiana	2.4	3.7	9.5
31.	MP-60*	IVS-5454	ICRISAT	3.5	19.5	10.0
32.	MP-61	ICMS-7805	ICRISAT	2.6	45.0	13.6
33.	MP-62*	ICMS-7704	ICRISAT	2.9	44.1	17.4
34.	MP-63*	HC-6	Hisar	6.2	15.6	13.3
35.	MP-64*	HC-7	Hisar	6.0	14.6	24.9
36.	MP-66	AMP-6	Aurangabad	2.3	30.0	6.2
37.	MP-69	ICMS-7818	ICRISAT	1.9	13.6	16.8
38.	MP-70	ICMS-7835	ICRISAT	6.0	15.5	15.6
39.	MP-71	NELC-P-79	ICRISAT	2.8	20.0	7.8
40.	MP-73	PCB-1180	Ludhiana	1.9	6.7	14.5
41.	MP-76	AMP-8	Aurangabad	1.9	8.2	19.9
42.	MP-80	M-78	Jodhpur	5.5	7.6	8.7
43.	MP-81	DEC-1	Delhi	32.2	3.3	1.0
44.	HS-1	Synthetic	Hisar	11.7	37.0	37.2
45.	HHB-45	5141A1 × 90/4-5-1	Hisar	2.1	10.0	29.0
46.	HHB-46	5141A1 × 78/833-2	Hisar	3.4	26.0	33.2
47.	PSB-8	Synthetic	Ludhiana	2.4	7.0	12.7
48.	WCC-75	Composite declared	ICRISAT	1.1	2.5	6.8
49.	MBH-110	Not declared	Jalna	0.0	0.0	10.6
Location mean of 49 entries				1.97	26.6	21.1
50.	BJ-104 (Check)*	5041A × J-104	Delhi	23.5	21.6	22.9
51.	HB-3 (Check)*	5071A × J-104	Jam Nagar	80.5	17.0	26.0

*Mean of three seasons.

None of the entries remained free from both of ergot and smut together. MBH-110 remained free from both downy mildew and ergot. However, four entries viz., one hybrid—MH-108 (MBH-133) and 3 populations—PSB-15 (MP-51), MP-81 (DEC-1) and WCC-75 contracted less than 5% ergoty florets/earhead and could be termed as tolerant to ergot incidence. Another 7 entries which contracted 5-9% ergot florets/earhead were susceptible which were MH-107, (MBH-132), MH-111 (111A × PIB-1225), MH-116 (UCH-9), MP-73 (PCB-1180), MP-76, (AMP-8), MP-80 (M-78) and PSB-8. Rest all the 40 entries were found to be highly susceptible to ergot

incidence which ranged upto 65% ergoty florets/earhead.

So far smut is concerned, no entry was free. However, a population from Delhi MP-81 (DEC-1) contracted 1% smut sori/earhead and was found to be tolerant to smut incidence. Another 6 entries contracting smut sori between 5-9% earhead were hybrids—MH-97 (5141A × D-115) and MH-106 (MBH-131); and populations—MP-66 (AMP-6), MP-71 (NELC-P-79), MP-80 (M-78) and WCC-75. These could be termed as susceptible to smut disease because the smut sori/earhead on these entries ranged between 10-47 per cent.

TABLE 2

National and regional pearl millet entries into disease reaction groups

Disease	Resistant	Tolerant	Susceptible	Highly susceptible
Downy mildew	2*	Nil	35	14
Ergot	Nil	4***	7	40
Smut	Nil	1***	6	44

*MH-106 (MBH-131) and MBH-110.

**MH-108 (MBH-133), MP-51 (PSB-15), MP-81 (DEC-1) and WCC-75.

***MP-81 (DEC-1).

It is interesting to note that among the populations (MP-series entries), though MP-81 (DEC-4) from Delhi was not completely free from all the three diseases, it was tolerant to both ergot and smut infection contracting only 3.3% ergoty florets and 1% smut sori per earhead. However, this entry was highly susceptible to downy mildew. If this entry is fortified with induced resistance against downy mildew, this could be an ideal breeding source for multiple disease resistance against all the three major diseases for Haryana. Similarly, the synthetic variety WCC-75 (ICRISAT) proved tolerant to ergot but susceptible to smut (6.8% smut sori/earhead), is also a good choice for the ergot and smut diseases.

Performance of Pearl Millet Evolution Centres for Disease Spectrum

The performance of important pearl-millet breeding centres for major disease evaluation is given in Table 3. From available results the entries evolved at Jalna contracted least incidence of downy mildew if number of entries is considered more than one. This was followed by

that of Ludhiana, Aurangabad and Coimbatore. The maximum extent of downy mildew susceptibility was observed on entries evolved at Delhi. Similarly, the lowest incidence of ergot was recorded in the entries of Coimbatore followed by that of Ludhiana and Jalna. The entries from Delhi contracted lowest smut incidence followed closely by Coimbatore. Maximum ergot and smut intensities were observed in the entries developed at Durgapura.

Among 7 entries developed at Hisar, three hybrids viz., MH-94, HHB-45 and HHB-46 contracted slightly less incidence of downy mildew i.e. 1.6, 2.1 and 3.4 per cent downy mildew plants, respectively, but these were susceptible to floral infection of ergot and smut. It is desirable to have hybrids made from MS lines other than MS 5141A because the hybrids made from other MS lines such as those of MBH-series are better from disease point of view. Thus, for a hybrid to be resistant to downy mildew, it is essential that both the parents should possess resistance (Dang and Thakur, 1981).

TABLE 3

Performance of pearl millet evolution centres for disease spectrum

Location	Candidate entries (No.)	Downy mildew plants (%)		% Intensity per earhead			
		Range	Mean	Ergot		Smut	
				Range	Mean	Range	Mean
Aurangabad	3	1.9—4.3	2.8	8.2—35.4	24.5	8.2—25.1	17.7
Coimbatore	2	1.9—3.9	2.9	6.1—23.4	14.7	10.0—15.5	12.7
Delhi	3	5.9—32.2	16.2	3.3—65.0	38.1	1.0—25.8	11.9
Durgapura	3	3.5—6.5	5.1	24.8—55.0	38.3	21.3—39.2	28.4
Hisar	7	1.6—11.7	5.1	10.0—37.0	20.5	12.8—37.2	25.3
ICRISAT	13	1.1—6.1	3.1	2.5—80.0	31.6	6.8—39.3	20.8
Jalna	8	0.0—6.6	2.3	0.0—61.7	18.7	6.2—34.3	19.6
Jamnagar	1	—	0.6	—	31.2	—	31.3
Jodhpur	1	—	5.4	—	7.6	—	8.7
Ludhiana	7	1.5—4.8	2.5	3.7—35.0	15.6	12.7—40.6	24.0
Rahuri	1	—	2.1	—	22.8	—	26.4
Mean	—	2.2—9.4	4.4	7.3—42.2	24.5	9.9—32.1	20.7

From the average intensities of various diseases, it is evident that even for downy mildew, the resistance breeding programme has to be strengthened. Similarly, for ergot and smut diseases, the effort required is to bring down these diseases to less than 5% infected florets/earhead.

ACKNOWLEDGEMENTS

Authors are thankful to Dr. R. S. Paroda and Dr. J. N. Chand, Professor & Head, Departments of Plant Breeding and Plant Pathology, respectively, for kindly providing physical and technical facilities to accomplish this study.

REFERENCES

- Dang, J. K. and Thakur, D. P. 1981. Genetic analysis of downy mildew resistance in pearl millet. Proc. 3rd International Symposium on Plant Pathology, Dec. 14-18, 1981, New Delhi, pp. 134.
- Mathur, R. L. and Delela, G. G. 1971. Estimation of losses from green ear disease of *bajra* and grain smut of *jawar* in Rajasthan. *Indian Phytopathol.* **24** : 101-04.
- Mitter, N. H. and Tandon, R. N. 1930. A note on *Sclerospora graminicola* (Sacc.) Schroet in Allahabad. *J. Indian bot. Soc.* **9** : 243.
- Natarajan, U. S., Gurnswamy Raja, V. D., Selvaraj, S. and Parambaramani, C. 1974. Grain loss due to ergot disease in *bajra* hybrids. *Indian Phytopathol.* **27** : 103.
- Thakur, D. P. 1978. Highlights of Millets Pathological Investigations under All India Coordinated Project on Millets Improvement (1977-78). Technical Project Leader's (Millet Pathology) Report presented in the group meeting of millets workers at Mysore University, Mysore, April 20-22, 1978.

THAKUR AND MEHTA

- Thakur, D. P. and Kanwar, Z. S. 1977. Method of create sick-plot for screening bajra germplasm against downy mildew caused by *Sclerospora graminicola*. *Indian Phytopathol.* **30** : 146-47.
- Thakur, D. P., Kanwar, Z. S. and Maheshwari, S. K. 1976. Loss in grain yield of bajra due to green-ear and downy mildew caused by *Sclerospora graminicola*. *Indian Phytopathol.* **29** : 254-56.
- Thakur, D. P., Kanwar, Z. S. and Maheshwari, S. K. 1978. Effects of downy mildew/green-ear disease (*Sclerospora graminicola*) (Sacc.) Schroet on yield and other plant characters of bajra (*Pennisetum typhoides*) (Burn.) Stapf. et Hubb. *Haryana agric. Univ. J. Res.* **8** : 82-85.

VARIATION IN LEAF DIFFUSIVE RESISTANCE IN WHEAT CULTIVARS

S. D. DHIMAN, D. P. SINGH, PHOOL SINGH and V. P. SINGH

Department of Agronomy
Haryana Agricultural University, Hisar

(Received : February 25, 1983; Revised : December 9, 1983)

ABSTRACT

Extent of variation for leaf diffusive resistance (LDR) has been recorded among 56 genotypes of *aestivum* and *durum* wheats. LDR values were higher under unirrigated than irrigated conditions. Mid-day hours of clear day and abaxial leaf surfaces were more suitable for obtaining a greater genetic variability of LDR in wheat. LDR varied from 3.2 to 16.0 s cm^{-1} among different wheat genotypes during two seasons.

Stomatal behaviour has been suggested as a potentially useful criterion in developing crop plants with improved water use efficiency. Levitt (1972) has discussed how stomatal behaviour might affect a plant's water use efficiency under semi-arid conditions. He speculated that both types of plants, viz. water savers (exhibiting higher stomatal resistance during the day) and water spenders (exhibiting lower stomatal resistance during the day), may adapt to semi-arid climate. Sullivan (1971) and Blum (1974) also considered stomatal sensitivity as a component of drought resistance. A high stomatal or leaf diffusive resistance is one of the means of achieving crop water economy (Levitt, 1972; Teare *et al.*, 1973; Jones, 1979). Although intra-specific differences for LDR for many crops have been shown to exist (Begg and Turner, 1976), but the varietal difference in respect of this trait has been demonstrated in a few crops, viz. sorghum (Henzell *et al.*, 1976), cotton (Roark and Quisenberry, 1977) and mustard (Singh

et al., 1982). There are also reports of varietal differences for stomatal pattern (Teare *et al.*, 1971) and stomatal conductance in wheat (Morgan, 1977; Jones, 1979) and alfalfa (Cole and Dobrenz, 1970). No such data are, however, available on Indian wheat cultivars.

MATERIAL AND METHODS

Field experiments were conducted during 1977-78 and 1978-79 on sandy loam soil at Haryana Agricultural University Farm, Hisar, to study the variation in leaf diffusive resistance (LDR) among wheat cultivars. During 1977-78, sixteen wheat varieties were tested for LDR under unirrigated (no post-sowing irrigation) as well as irrigated (five post-sowing irrigations) conditions. In 1978-79 season, thirty varieties in one experiment and ten varieties in another experiment were studied for LDR under irrigated conditions. Leaf Diffusive Resistance Meter (Model LI-60 LICOR, Lincoln, Nebraska, U. S. A.) was used for measur-

ing LDR of flag leaves on abaxial and adaxial surfaces from anthesis to early grain filling stages of growth during two winter seasons. Environmental conditions for the days of LDR measurements were also recorded. All the measurements were made on clear sunny days.

RESULTS AND DISCUSSION

Effect of Time of Day and Leaf Surface

LDR measured on flag leaves of different wheat cultivars under unirrigated conditions during 1977-78 season was affected by the time of day and leaf surface (Fig. 1). LDR values recorded during mid-day hours were higher and had a greater range of genotypic variability than those recorded during morning hours. Roark and Quisenberry (1977) also observed the dominance of genetic component for LDR at mid-day in cotton.

LDR values from abaxial leaf surface were higher and had a greater range of variability than those from adaxial leaf surface. Morgan (1977) working on wheat under greenhouse conditions also reported less variability in conductance of adaxial surface than that of abaxial leaf surface.

Thus, the mid-day hours and abaxial leaf surfaces seem to be more appropriate for evaluating the genetic variability for LDR in wheat.

Effect of Irrigation

The data for LDR measured on abaxial surface of flag leaves during noon hours under unirrigated and irrigated conditions

during 1977-78 and 1978-79 seasons have been depicted in Figs. 2 and 3. It is evident that the soil water status had a marked effect on LDR of wheat cultivars. The LDR values were higher under unirrigated conditions as compared to irrigated conditions (Fig. 2). Blum (1974) and Begg and Turner (1976) have also reported similar effects of water supply on stomatal behaviour of crop plants.

Some genotypes viz., WL 711 and S-308 showed slightly higher LDR than other varieties under irrigated conditions (Fig. 2). Such genotypes may be expected to attain a higher water use efficiency through efficient seasonal control of the total water supply (Levitt, 1972). Teare *et al.* (1973) reported that under similar atmospheric demand for water, sorghum was able to close its stomata more than soybean and thus conserved more soil water even though it had a large root system. The water use efficiency of sorghum was almost three times that of soybean on dry matter or grain yield basis.

Effect of Genotypes

The range of LDR among wheat genotypes is depicted in Figs. 2-4. Under unirrigated conditions during 1977-78 LDR varied from 3.2 s cm^{-1} in Kalyansona (K. S.) to 9.5 s cm^{-1} in HD 2234 (Fig. 2). During 1978-79 under one post-sowing irrigation, it varied from 6.1 s cm^{-1} in WH-157 to 16.0 s cm^{-1} in WH 242 (Fig. 3). In another experiment during 1978-79 which was late sown but irrigated (5 post-sowing irrigations based on physiological stages), LDR ranged from 6.5 s cm^{-1} in UP 154 to 12.5 s cm^{-1} in WL 711 (Fig. 4). Genetic variability for LDR has also been reported in sorg-

LDR IN WHEAT

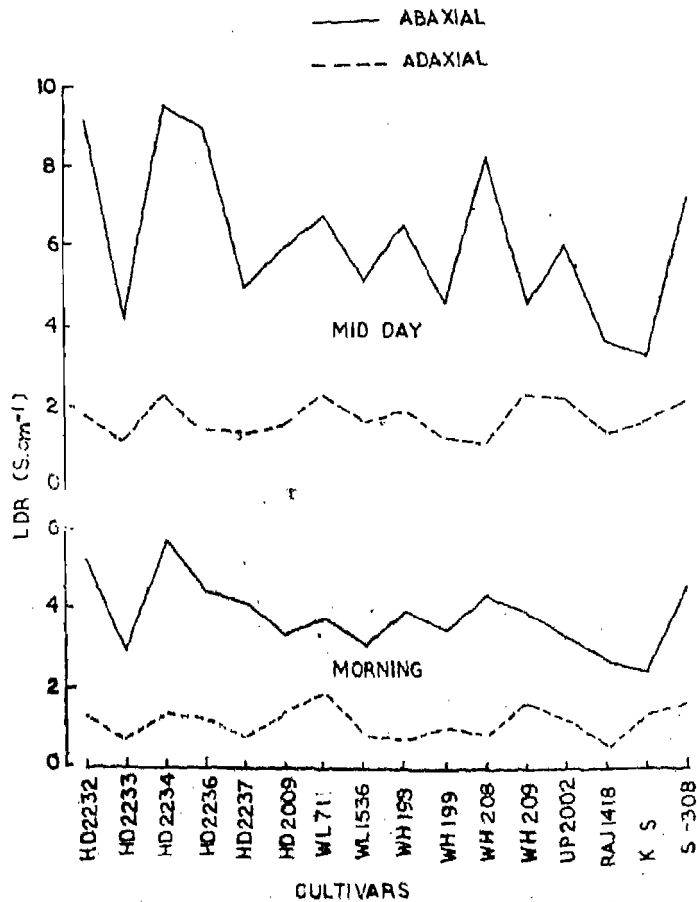


Fig 1. Leaf diffusive resistance (LDR) of wheat genotypes as influenced by time of day and leaf surface. The measurements were made on 2-3 flag leaves at anthesis (1-2-78). The crop was sown on 13-11-77. Air temperature and photosynthetically active radiation (400-700 nm) respectively were $17.5^{\circ}\pm 1^{\circ}C$ and $1000\pm 50\mu Em^{-2}s^{-1}$ during morning hours (9-10 h), and $23\pm 0.5^{\circ}C$ and $1400\pm 30\mu Em^{-2}s^{-1}$ during mid-day hours (12-14 h). Soil profile down to 100 cm contained 5.2 cm available water at the time of measurements.

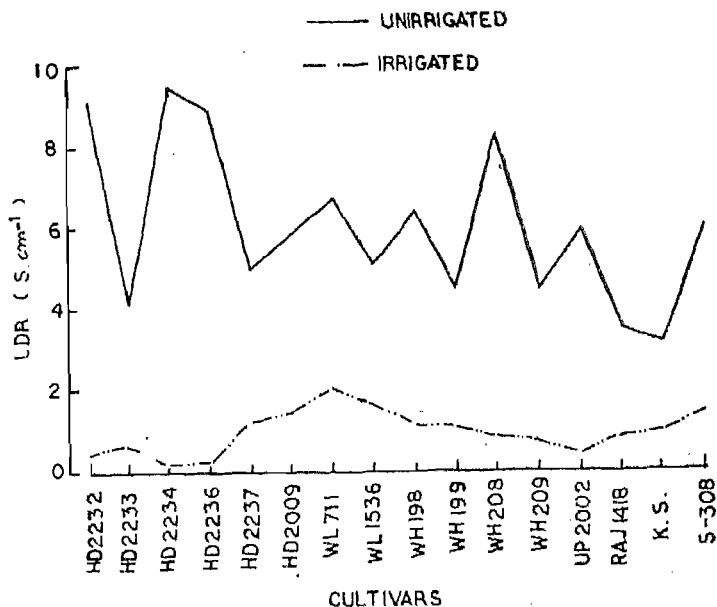


Fig. 2. Diffusive resistance of abaxial flag leaf surface (LDR) under irrigated and unirrigated conditions. The measurements were made during mid-day at anthesis (1-2-78). Soil profile down to 100 cm contained 5.2 cm and 15.7 cm available water under unirrigated and irrigated conditions, respectively. Other conditions were similar as in Fig. 1.

hum by Blum (1974) and Henzell *et al.* (1975, 1976), in cotton by Roark and Quisenberry (1977) and in mustard by Singh *et al.* (1982).

Henzell *et al.* (1976) have suggested that the variability in stomatal sensitivity may be an important element for screening drought resistant genotypes in sorghum. Blum (1974) has observed that a better seasonal water use pattern and increased water use efficiency by sorghum genotypes resulted where initial (prior to anthesis) amounts of soil moisture extracted were relatively small. Levitt (1972) has suggested that 'water savers'

avoid drought by higher stomatal resistance during the day even though soil water supply is adequate. They achieve high water use efficiency through efficient seasonal control of the total water supply. 'Water spenders' on the other hand, avoid drought by extracting larger quantity of water from the soil, keep their stomata more open throughout the day, assimilate more CO_2 , and therefore, have a more rapid growth rate than 'water savers'. Levitt (1972) speculates that mesophytic plants that have succeeded in relatively dry climates have some of these adaptabilities. Assuming that Levitt's concepts about role of

LDR IN WHEAT

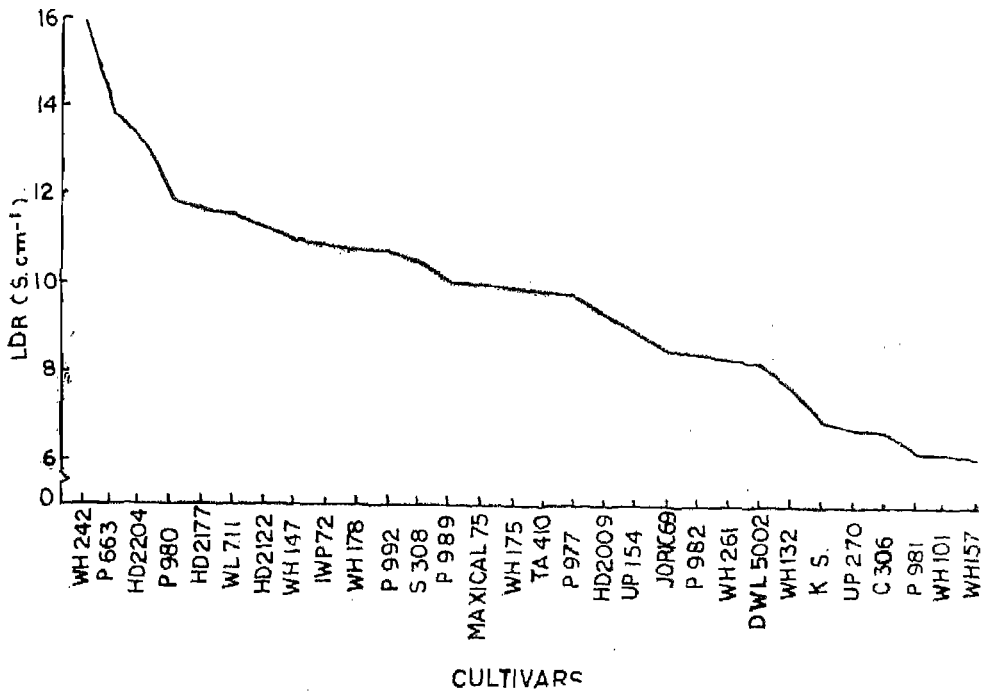


Fig. 3. Diffusive resistance of abaxial flag leaf surface (LDR) in wheat genotypes. The measurements were made on 2-3 leaves at mid-day (12-14 h) during grain filling stage (27-3-79). The crop was sown on 29-11-78. Air temperature and photosynthetically active radiation (400-700 nm) were $30 \pm 0.5^\circ\text{C}$ and $1600 \pm 30 \mu\text{Em}^{-2} \text{s}^{-1}$, respectively. Soil profile down to 100 cm contained 7.8 cm available water at the time of measurements. The values of $\text{Sem} \pm$ for LDR ranged between 0.22 (cv. P 663) and 2.86 s cm^{-1} (cv. HD 2009) among wheat genotypes.

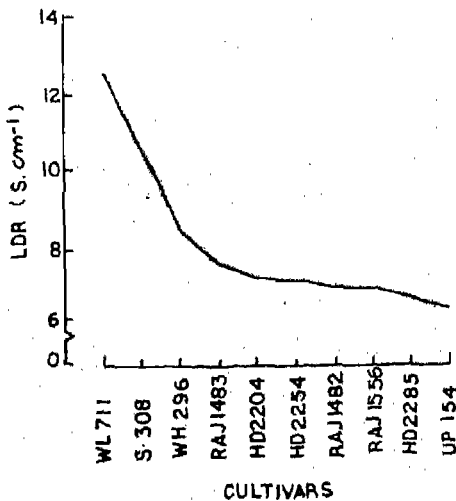


Fig. 4. Diffusive resistance of abaxial flag leaf surface (LDR) in wheat genotypes under late sown irrigated conditions. The crop was sown on 23-12-78. The measurements were made on 2-3 leaves at mid-day (12-14h) during grain filling stage (7-4-79). Air temperature and photosynthetically active radiation (400-700 nm) were $32 \pm 0.6^\circ\text{C}$ and $1675 \pm 25 \mu\text{Em}^{-2} \text{s}^{-1}$, respectively. Soil profile down to 100 cm contained 11.5 cm available water at the time of measurements. The values of $\text{Sem} \pm$ for LDR ranged between 0.17 (cv. Raj 1482) and 1.72 s cm^{-1} (cv. S-308) among wheat genotypes.

stomatal behaviour are valid, sufficient genetic variability exists among wheat genotypes for possible use in a breeding programme aimed at transferring such traits in high yielding and agronomically superior wheat cultivars. However, the present study is only a preliminary one and there is need for more detailed studies to determine the leaf water status and root zone soil moisture status alongwith LDR in wheat genotypes for identification of the exact characters responsible for their adaptation to arid environment.

Such information will make it possible to characterise the genotypes as 'water savers' or 'water spenders' and will indicate their use under specific water availability situations.

ACKNOWLEDGEMENT

Authors are thankful to Prof. Dhani Ram Vasudeva, Department of Plant Breeding for providing wheat genotypes used in this study.

REFERENCES

- Begg, J. E. and Turner, N. C. 1976. Crop water deficits. *Adv. Agron.* **28** : 161-217.
- Blum, A. 1974. Genetic responses in sorghum to drought stress. I. Response to soil moisture stress. *Crop Sci.* **14** : 361-64.
- Cole, D. F. and Dobrenz, A. K. 1970. Stomatal density of alfalfa (*Medicago sativa* L.). *Crop Sci.* **10** : 61-63.
- Henzell, R. G., Mc Cree, K. J., Van Bavel, C. H. M. and Schertz, K. F. 1975. Method for screening sorghum genotypes for stomatal sensitivity to water deficit. *Crop Sci.* **15** : 516-18.
- Henzell, R. G., Mc Cree, K. J., Van Bavel, C. H. M. and Schertz, K. F. 1976. Sorghum genotype variation in stomatal sensitivity to leaf water deficit. *Crop Sci.* **16** : 660-62.
- Jones, H. G. 1979. Stomatal behaviour and breeding for drought resistance. In : *Stress Physiology in Crop Plants*, pp. 407-28, Mussell, H. and Staples, R. C. (eds.), Wiley-Interscience, New York-Chichester-Brisbane-Toronto.
- Levitt, J. 1972. *Responses of Plant to Environmental Stress*. Academic Press, New York.
- Morgan, J. M. 1977. Changes in diffusive conductance and water potential of wheat plants before and after anthesis. *Aust. J. Plant Physiol.* **4** : 75-86.
- Roark, B. and Quisenberry, J. E. 1977. Environmental and genetic components of stomatal behaviour in two genotypes of upland cotton. *Plant Physiol.* **59** : 354-56.
- Singh, D. P., Singh, P. and Singh, M. 1982. Screening of genotypes of *Brassica juncea* L. for leaf conductance under field conditions. *J. Exp. Bot.* **33** : 381-87.
- Sullivan, C. Y. 1971. Techniques for measuring plant drought stress. In : *Drought Injury and Resistance in Crops*. CSSA Special Pub. No. 2, pp. 1-18.
- Teare, I. D., Kanemasum, D. T., Powers, W. L. and Jacobs, H. S. 1793. Water use efficiency and its relation to crop canopy and stomatal regulation and root distribution. *Agron. J.* **65** : 207-11.
- Teare, I. D., Peterson, G. J. and Law, A. G. 1971. Size and frequency of leaf stomata in cultivars of *Triticum aestivum* and other *Triticum* species. *Crop Sci.* **11** : 496-98.

EFFECT OF GROWTH REGULATORS ON ROOTING OF LEMON CUTTINGS WITH AND WITHOUT LEAVES

R. K. ARORA and R. YAMDAGNI

Department of Horticulture

Haryana Agricultural University, Hisar

(Received : March 4, 1983; Revised : November 17, 1983)

ABSTRACT

Application of Naphthalene acetic acid (NAA) at 2000 ppm to the lemon cuttings with leaves in Baramasi and Kagzi-Kalan and at 3000 ppm to the Eureka lemon cultivar were best treatments for better rooting and survival. However, in case of cuttings without leaves, NAA at 4000, 3000 and 2000 ppm for Baramasi, Kagzi-Kalan and Eureka lemon, respectively were ideal concentrations for increased rooting and final survival. Naphthalene acetamide (NAD) had the poor effect on rooting of cuttings.

Among citrus fruits, lemon cultivation is adapted to varying agro-climatic conditions, which is on consistent increase in Punjab and Haryana. The common method of propagation is either budding or layering, which is labour and time intensive. Moreover, large variation in the propagated material can be avoided (Singh, 1962). However, rooting success is often a problem in this method. It is therefore planned to achieve better success in rooting of lemon cuttings with the use of growth regulators.

MATERIAL AND METHODS

Semi hardwood cuttings of last season's growth of three cultivars of lemon, viz. Baramasi, Kagzi-Kalan and Eureka were taken just before flush in the last week of February 1980. The length of cuttings was 25 cm with and without leaves. The lower 1/3rd portion of cuttings with leaves was defoliated. Three

chemicals, i.e., Indole butyric acid (IBA), Naphthalene acetic acid and Naphthalene acetamide each at four concentrations, i.e., 1000, 2000, 3000 and 4000 ppm were prepared in 70% alcohol. There were three replications in each treatment and each replication constituted one hundred cuttings. Control cuttings numbering 300 were treated with water. On the whole 3900 cuttings in each cultivar were taken including control.

The cuttings were dipped in open mouth container for half a minute and were planted in 27 plots of 5 x 5 m size and irrigated. Weeding and irrigation operations were done at regular intervals.

The number of cuttings which grew more than 10 cm was counted in the month of July in all the treatments. The per cent final survival was calculated on the basis of hundred cuttings.

RESULTS AND DISCUSSION

Cuttings with Leaves

The data in Table 1 reveal that per cent final survival was higher in the treated cuttings as compared to control. Of the three plant growth regulators tried, NAA was found to be the most effective in final establishment of the plant followed by IBA and NAD.

Among the cultivars, Baramasi had the highest percentage of final establishment as compared to Kagzi-Kalan, whereas Eureka lemon had significantly the lowest survival.

The interaction of cultivars $\times$ chemicals was significant. Kagzi-Kalan cultivar treated with NAA gave the highest survival (69.7%) followed by Baramasi (62.9%). Among the concentrations, NAA at 2000 ppm was the most effective treatment which gave the highest survival percentage over control and other treatments. It was followed by NAA at 3000 ppm and IBA at 2000 ppm. NAD had the least effect. Rathore (1973) also observed that 2500 ppm of NAA produced significantly the maximum number of primary roots in Karna Khatta cuttings as compared to other treatments. Similar results were reported by Hitchcock and Zimmerman (1939) and Cooper (1940).

The interaction among varieties $\times$ chemicals $\times$ concentrations were also significant. The data in table show that NAA (2000 ppm) had significantly the highest final plant survival in Kagzi-Kalan (95.7%) and Baramasi (80.3%) as compared to the other treatments including control. However, NAD (3000 ppm) gave the lowest (34.4%) survival rate in Eureka

and Kagzi-Kalan cultivars of lemon. IBA (2000 ppm) treatment to Baramasi and Kagzi-Kalan cuttings, showed significantly higher per cent final survival as compared to the other concentrations of IBA in both the cultivars. There was no significant difference in survival with 1000, 3000 and 4000 ppm of IBA treatment to Baramasi cuttings. The per cent success reduced with the increase in concentration of IBA. Hartman and Hansen (1958) and Jawanda *et al.* (1979) also reported similar results in plums.

The differences in per cent success of cuttings were significant when compared among all the concentrations of NAA in Baramasi and Kagzi-Kalan. However, in Eureka lemon these differences were non-significant when response of 2000 ppm and 3000 ppm of NAA was compared. All the concentrations of NAA except 3000 ppm treatment to Kagzi-Kalan cuttings had significantly higher percentage of final success over that in Baramasi and Eureka lemon.

NAD application at 4000 ppm in Baramasi cuttings had significantly the higher per cent success relative to all other concentrations.

Cuttings without Leaves

The data in Table 2 indicate that the per cent success was significantly higher in Baramasi than Kagzi-Kalan and Eureka. However, the differences in success in Kagzi-Kalan and Eureka were non-significant.

Chemicals and their concentrations had significant effect, though its interaction with cultivars was non-significant. Among the chemicals, NAA and IBA were

ROOTING OF LEMON CUTTINGS

TABLE 1
Effect of growth regulators on per cent final survival of lemon cuttings with leaves

Cultivars	IBA (ppm)					NAA (ppm)					NAD (ppm)					Total mean	Water treated control
	1000	2000	3000	4000	Mean	1000	2000	3000	4000	Mean	1000	2000	3000	4000	Mean		
Baramasi	53.0 (46.7)	61.1 (51.4)	53.0 (46.7)	49.0 (44.4)	54.0 (47.3)	53.0 (46.7)	80.3 (63.7)	69.0 (56.2)	46.6 (43.1)	62.9 (52.4)	44.9 (42.1)	41.0 (39.8)	50.3 (47.2)	63.7 (52.9)	55.6 (48.2)	20.0 (26.6)	
Kagzi-Kalan	49.0 (44.4)	57.0 (49.0)	39.6 (39.0)	50.0 (45.0)	48.9 (40.4)	61.0 (51.4)	95.7 (78.1)	53.0 (46.7)	69.1 (56.2)	69.7 (58.1)	57.0 (49.0)	45.0 (42.1)	34.4 (35.9)	34.4 (35.9)	53.7 (47.7)	17.0 (24.4)	
Eureka	37.0 (37.5)	37.0 (37.5)	46.3 (42.9)	46.3 (42.9)	41.6 (40.2)	37.0 (37.5)	54.4 (47.5)	57.0 (49.0)	37.0 (37.5)	46.4 (42.9)	49.0 (44.4)	42.3 (40.6)	34.4 (35.9)	37.0 (37.5)	43.0 (40.9)	15.0 (24.4)	
Mean	46.3 (42.8)	51.7 (46.0)	46.3 (42.9)	48.4 (44.1)	48.1 (43.9)	50.3 (43.2)	76.8 (63.1)	59.7 (50.7)	51.0 (45.6)	59.5 (51.1)	50.3 (45.2)	42.7 (40.8)	39.6 (39.0)	44.2 (44.1)	44.3 (43.7)	17.3 (24.6)	

Values in parentheses are transformed values.

C. D. for cvs. at 5% level : (1.02)

" " " 1% " : (1.40)

C. D. for chem. at 5% level : (1.02)

" " " 1% " : (1.40)

C. D. for cvs. x chem. at 5% level : (1.77)

" " " " 1% " : (2.43)

C. D. for concn. at 5% level : (2.12)

" " " 1% " : (2.92)

C. D. for cvs. x chem. x concn. at 5% level : (6.35)

" " " " 1% " : (8.75)

TABLE 2
Effect of growth regulators on percent final survival of lemon cuttings without leaves

Cultivars	IBA (ppm)					NAA (ppm)					NAD (ppm)					Total mean	Water treated control
	1000	2000	3000	4000	Mean	1000	2000	3000	4000	Mean	1000	2000	3000	4000	Mean		
Baramasi	48.1 (43.9)	44.0 (41.6)	50.8 (45.4)	17.2 (24.5)	40.0 (38.9)	35.7 (36.7)	27.5 (31.6)	32.1 (34.5)	52.1 (46.2)	36.9 (37.2)	10.4 (18.8)	21.2 (27.4)	18.3 (25.3)	33.1 (35.1)	20.7 (26.7)	32.0 (34.4)	14.0 (21.9)
Kagzi-Kalan	29.4 (32.8)	16.0 (23.6)	18.7 (25.6)	40.1 (39.2)	26.0 (30.3)	29.4 (32.8)	30.4 (33.4)	63.3 (52.7)	19.8 (26.4)	35.7 (36.3)	10.4 (18.8)	10.6 (19.0)	21.9 (27.9)	6.5 (14.8)	12.4 (20.1)	24.5 (28.9)	5.0 (12.9)
Eureka	26.6 (31.0)	32.1 (34.5)	28.0 (31.9)	49.4 (44.6)	34.0 (35.5)	19.4 (26.1)	50.7 (45.4)	31.8 (34.3)	14.3 (22.2)	29.1 (32.0)	8.9 (17.4)	23.8 (29.2)	11.5 (19.8)	8.7 (17.8)	13.1 (20.9)	24.9 (29.5)	10.0 (18.4)
Mean	34.7 (35.9)	30.7 (33.2)	32.5 (34.3)	35.5 (36.1)	33.3 (34.9)	28.1 (31.9)	36.2 (36.8)	42.4 (40.5)	28.7 (31.6)	33.8 (35.2)	9.9 (18.3)	18.5 (25.2)	17.2 (24.3)	16.1 (23.6)	15.4 (29.8)	9.7 (18.2)	

Values in parentheses are transformed values.

C. D. for cvs. at 5% level : (2.59)

" " " 1% " : (3.56)

C. D. for cvs. X chem. at 5% level : NS

C. D. for concn. at 5% level : (2.79)

" " " 1% level : (3.84)

C. D. for cvs. X chem. X concn. at 5% level : (8.36)

" " " " at 1% " : (8.75)

ROOTING OF LEMON CUTTINGS

more effective than NAD in final survival. Application of NAA (3000 ppm) produced maximum (42.4%) number of plants, whereas it was minimum (9.9%) in NAD (1000 ppm).

The interactions among cultivars, chemicals and concentrations were also significant. Per cent final survival was highest (63.3%) with NAA at 3000 ppm and was lowest (6.5%) at 4000 ppm of NAD in Kagzi-Kalan cultivars.

IBA at 3000 ppm in Baramasi and 4000 ppm in Kagzi-Kalan and Eureka lemon and NAA at 4000, 3000 and 2000 ppm treated to Baramasi, Kagzi-Kalan and Eureka lemon cuttings, respectively had significantly higher final survival as compared to other concentrations of IBA and NAA in each cultivar. The response

of NAD treatment towards rooting and establishment was poor though 4000, 3000 and 2000 ppm concentrations were relatively more effective in Baramasi, Kagzi-Kalan and Eureka lemon, respectively than other concentrations.

It is apparent from the data that the per cent final survival in case of cuttings with leaves was higher as compared to cuttings without leaves in all the three cultivars. Chatterjee and Mukherjee (1980) also reported that in case of Jack fruit cuttings without leaves, the rooting percentage after 45 days was nil, whereas in case of cuttings with leaves treated with 5000 and 1000 ppm IBA, the rooting was 90 and 60 per cent, respectively. Similar observations were also reported by Ali *et al.* (1969) in tea cuttings.

REFERENCES

- Ali, M. M., Chakraborty, H. and Alam, A. F. M. 1969. Effect of leaf area on the strike and subsequent growth of tea cuttings. *Tea J. Bangla Desh* 7 (2) : 6-4.
- Chatterjee, B. K. and Mukherjee, S. K. 1980. A note on the effect of leafy and non-leafy cuttings on rooting of jackfruit (*Artocarpus heterophyllus* Lam.), *Prog. Hortic.* 11 : 49-51.
- Cooper, W. C. 1940. Rooting of citrus cuttings with systemic substances. *Fla. State Hortic. Soc. Proc.* 53 : 174-77.
- Hartman, H. T. and Hansen, C. J. 1958. Effect of season of collecting, IBA and pre-planting storage treatment on rooting in Mariana plum, peach and quince hard-wood cuttings. *Proc. Am. Soc. Hortic. Sci.* 71 : 57-66.
- Hitchcock, A. E. and Zimmerman, P. W. 1939. Comparative activity of root inducing substance and method of treating cuttings. *Contrib. Boyce Thompson Inst.* 10 : 461-80.
- Jawanda, J. S., Josan, J. S. and Singh, S. N. 1979. Propagation of *Prunus* species by cuttings. II. Effect of IBA and the type of cuttings on rooting in plum. *J. Res. Punjab agric. Univ.* 17 : 17-21.
- Rathore, S. N. S. 1973. Effect of plant growth regulators on the cuttings of Karna-Khatta. *Farm J.* 14 : 13-14.
- Singh, R. P. 1962. Studies into the effects of source plant regulator treatment and planting environment on citrus cuttings. II. The influence of indole butyric acid and maturity of wood on the performance of Karna-Khatta cuttings. *Indian J. Hortic.* 19 : 25-30.

EFFECT OF MOISTURE STRESS, SOWING METHODS AND NITROGEN LEVELS ON THE QUALITY AND OIL YIELD OF MUSTARD

G. M. KHAN* and S. K. AGARWAL

Department of Agronomy

Haryana Agricultural University, Hisar

(Received : March 10, 1983; Revised : July 2, 1984)

ABSTRACT

Experiments were conducted during rabi seasons of 1977-78 and 1978-79 to study quality and oil yield of mustard (*Brassica juncea* Coss.) as affected by three irrigation levels (no irrigation, ID/CPE=0.4 and ID/CPE=0.6); two sowing methods (conventional, and ridge and furrow) and four levels of nitrogen (0, 40, 80 and 120 kg/ha). The sowing methods and irrigation levels did not influence oil, protein, allylisothiocyanate content and iodine value. Oil yield increased significantly in ridge and furrow method in 1978-79. The application of irrigation based on ID/CPE=0.4 increased the oil yield significantly over no irrigation in both the years. Nitrogen application significantly decreased the oil content but the oil yield significantly increased with the successive increase of nitrogen upto 80 kg/ha. In both the years allylisothiocyanate content and iodine value were increased significantly with the successive application of nitrogen, however, protein content increased with the application of 80 kg N/ha over control in 1978-79.

Mustard (*Brassica juncea* Coss.) is one of the important oil seed crops of the north west region of country. The soils are generally sandy loam with poor water holding capacity (Singh and Vijay Kumar, 1979). Withholding of irrigation causes moisture stress which reduces oil yield (Singh and Moolani, 1969), however, no effect on oil content and quality has been noted due to irrigation (Wankhede *et al.*, 1970). Mustard sown in furrow and ridges gave higher yield (Batra *et al.*, 1976) and saved irrigation water over conventional flat system as well (Yadava and Bhola, 1979). Nitrogenous fertilizer increased oil yield and iodine value,

allylisothiocyanate (Bishnoi and Singh, 1979) and decreased the oil content and increased protein content (Yadava, 1975; Ganga Saran and De, 1979). The present investigation was, therefore, taken up to study the effect of irrigation, method of sowing and nitrogen application on chemical composition and oil yield of mustard.

MATERIAL AND METHODS

Mustard was planted during rabi seasons of 1977-78 and 1978-79 on 7th and 10th October, respectively. Two sowing methods (conventional, and ridge

*College of Agriculture, Wadura, Sopore, Kashmir.

and furrow), three irrigation levels (0, 0.4 and 0.6 WUF) and four nitrogen levels (0, 40, 80 and 120 kg/ha) were tested in split plot design with three replications, sowing methods and irrigation levels being in main plots and nitrogen levels in sub-plots. In conventional method sowing was done on flat beds while in ridge and furrow method it was done in furrows. Scheduling of irrigation was done on the basis of climatological approach. Irrigations each of 93 mm were applied on the basis of irrigation depth (ID) and commulative pan evaporation (CPE) values of 233 and 155 mm under ID/CPE ratio of 0.4 and 0.6 for entire season. One and two irrigations were applied under ID/CPE=0.4 and 0.6, respectively. However, one irrigation was given in ID/CPE=0.6 during 1978-79 due to 65.1 mm rain at second irrigation. The depth of irrigation water (ID) was calculated when the available soil moisture (ASM) was depleted to the extent of 60% from 120 cm soil profile. Doses of nitrogen alongwith basal dose of 25 kg P_2O_5 /ha was applied at sowing. The sources of nitrogen and phosphorus were urea (46% N) and single superphosphate (16% P_2O_5), respectively. The seed samples were collected after harvest for the estimation of oil, protein, allylisothiocyanate and iodine. Oil, protein and allylisothiocyanate were analysed by AOAC (1960) method and iodine value by Vij's method. Protein was calculated by multiplying nitrogen content with 6.25 and the oil yield was computed from the seed yield and oil percentage of the seed.

RESULTS AND DISCUSSION

The sowing methods did not show significant effect on oil, protein and

allylisothiocyanate (ATC) contents and iodine value (Tables 1 and 2). However, the oil yield increased significantly in ridge and furrow method compared with conventional method in 1978-79. This might be mainly due to higher seed yield and higher oil content, as the oil yield is a product of seed yield and oil content. Irrigation did not show significant effect on oil content which has also been noted by Wankhede *et al.* (1970) in toria and Yusuf (1973) in mustard. Irrigation had also no effect on protein and allylisothiocyanate content and iodine value during both years. Application of irrigation based on ID/CPE=0.4 increased the oil yield significantly over moisture stress treatment during both years and ID/CPE=0.6 over ID/CPE=0.4 in 1978-79. Increase in seed yield coupled with slight increase in oil content made this difference. Intensity (content) as well as capacity (yield) factors are positively correlated with the oil yield per unit area. The average increase in oil yield in ID/CPE=0.4 was 18.55% over moisture stress. Increase in oil yield with the increase in the level of irrigation over no irrigation has been recorded by Singh and Moolani (1969).

The progressive increase in nitrogen application significantly decreased the oil content and increased the oil yield per hectare (Table 1). Oil yield increased significantly upto 80 kg N/ha in both the years. Similar results were also observed by Jana (1963), Lahiri (1964) and Adamczewski and Musnicks (1967). Decrease in oil content with nitrogen application might be due to the utilization of carbohydrates in protein formation in the presence of nitrogen. Oil yield followed similar pattern as under

TABLE 1

Effect of sowing methods, irrigation and nitrogen levels on oil content and oil yield of mustard

Treatments	Oil content (%)		Oil yield (q/ha)	
	1977-78	1978-79	1977-78	1978-79
Sowing methods				
Conventional	36.27	38.05	3.62	5.05
Ridge and furrow	36.30	38.34	4.01	5.86
S. Em. $\pm$	0.13	0.21	0.13	0.10
C. D. at 5%	NS	NS	NS	0.31
Irrigation levels				
Moisture stress	36.21	37.64	3.31	4.72
ID/CPE=0.4	36.22	38.37	3.94	5.58
ID/CPE=0.6	36.64	38.57	4.20	6.08
S. Em. $\pm$	0.16	0.26	0.15	0.12
C. D. at 5%	NS	NS	0.47	0.38
Nitrogen levels (kg/ha)				
0	37.62	40.14	3.07	3.48
40	37.11	39.11	3.65	5.25
80	35.46	37.34	4.26	6.56
120	34.95	36.17	4.27	6.53
S. Em. $\pm$	0.35	0.31	0.12	0.19
C. D. at 5%	1.00	0.88	0.34	0.54

NS=Non-significant.

TABLE 2

Effect of sowing methods, irrigation and nitrogen levels on protein content, allyliso-thiocyanate content and iodine value of mustard

Treatments	Protein content (%)		Allyliso-thiocyanate (%)		Iodine value (No.)	
	1977-78	1978-79	1977-78	1978-79	1977-78	1978-79
Sowing methods						
Conventional	16.20	16.97	0.50	0.49	105.36	106.15
Ridge and furrow	16.57	17.15	0.49	0.48	104.53	106.10
S. Em. $\pm$	0.29	0.17	0.003	0.003	0.15	0.22
C. D. at 5%	NS	NS	NS	NS	NS	NS
Irrigation levels						
Moisture stress	16.32	16.62	0.49	0.49	105.02	106.64
ID/CPE=0.4	16.53	17.25	0.49	0.48	104.67	105.68
ID/CPE=0.6	16.33	17.25	0.50	0.48	105.15	106.06
S. Em. $\pm$	0.35	0.21	0.003	0.004	0.19	0.27
C. D. at 5%	NS	NS	NS	NS	NS	NS
Nitrogen levels (kg/ha)						
0	15.67	16.24	0.46	0.45	98.07	99.77
40	16.16	16.93	0.49	0.47	103.21	104.48
80	16.78	17.49	0.52	0.50	108.25	108.87
120	16.95	17.59	0.53	0.51	110.25	111.38
S. Em. $\pm$	0.36	0.23	0.003	0.003	0.24	0.30
C. D. at 5%	NS	0.66	0.010	0.010	0.68	0.86

NS=Non-significant

QUALITY PARAMETERS OF MUSTARD

irrigation. Application of nitrogen increased protein content in 1978-79, and allylisothiocyanate content and iodine value in both years (Table 2). This might be due to the fact that oil seeds contain very little carbohydrates, consequently a high negative correlation between nitrogen and protein content. Such observations were also noted by Arora and Bhatia (1970) and Dhindsa and Gupta

(1974). The increase in allylisothiocyanate content with increase in nitrogen may be because increase in nitrogen uptake caused increased sulphur uptake. These observations were also recorded by Arora and Bhatia (1970) and Bishnoi (1977). The increase in iodine value was also reported by Anderson *et al.* (1956), Singh (1968) and Bishnoi (1977).

REFERENCES

- Adamczewski, K. and Musnicks, C. 1967. The rate of nitrogen fertilizer under turnip rape (*Brassica oleifera*). *Pamięt. Pulawskis*. 25 : 51-57.
- Anderson, G., Olson, I. and Loof, B. 1956. Combine variety and nitrogen fertilization trials in winter rape. *Sver. Utsadesforen. Tidskr.* 66 : 39-54.
- AOAC, 1960. Official Methods of Analysis. Association of Official Agricultural Chemists, Washington.
- Arora, S. K. and Bhatia, I. S. 1970. Chemical composition of *Brassica juncea* as affected by nitrogen application. *Agrochemica* 14 : 198-201.
- Batra, P. C., Mehrotra, N., Katria, D. P., Oswal, M. C., Virmani, S. M. and Singh, K. 1976. Salient highlights of research conducted during the 5 years period 1971-76 by the Co-ordinated Dryland Agriculture Research Project, main centre, Hisar. Haryana Agricultural University, Hisar, p. 54.
- Bishnoi, K. C. 1977. Growth, yield and quality parameters of three raya (*Brassica juncea* (L.) Czern and Coss.) varieties and their moisture and nutrient use pattern in relation to sowing time and nitrogen levels. Ph. D. thesis, Haryana Agricultural University, Hisar.
- Bishnoi, K. C. and Singh, K. 1979. Oil yield and quality parameters of three raya (*Brassica juncea* (L.) Czern and Coss.) varieties as affected by sowing time and nitrogen. *Indian J. Agron.* 24 : 255-65.
- Dhindsa, S. K. and Gupta, S. K. 1974. Variability in chemical composition of raya (*Brassica juncea* Coss.). *Haryana agric. Univ. J. Res.* 4 : 192-95.
- Ganga Saran and De, R. 1979. Influence of seeding dates, varieties, rates and methods of nitrogen application on the seed yield and quality of rape-seed grown on rainfed land. *Indian J. agric. Sci.* 49 : 197-201.
- Jana, P. K. 1963. The effect of spacing and fertilization on the growth, yield and quality of raya (*Brassica juncea*). M. Sc. thesis, Indian Agricultural Research Institute, New Delhi.
- Lahiri, J. R. 1964. A study on the effect of nitrogen fertilization and time of sowing on growth, yield and quality of ray (*Brassica juncea*) varieties. M. Sc. thesis, Indian Agricultural Research Institute, New Delhi.
- Singh, G. B. 1968. Studies on the effect of irrigation and fertilizer levels on the nutrient uptake, water use, yield and quality of raya (*Brassica juncea* L.). Ph.D. thesis, Punjab Agricultural University, Ludhiana.
- Singh, G. B. and Moolani, M. K. 1969. Studies on the effect of fertilizers and irrigation levels on water use efficiency of ray (*Brassica juncea*). Proc. Symp. Soil and Water Management, I.C.A.R., Hisar, held on March 11-13, pp. 323.

KHAN AND AGARWAL

- Singh, K. P. and Vijay Kumar, 1979. Influence of irrigation on leaf water potential of wheat and barley at two dates of sowing. *Field Crop Res.* 2 : 117-24.
- Wankhede, N. P., Ahlawat, I. P. S. and Sahni, V. M. 1970. Effect of varying levels of irrigation, plant population and fertilizer on yield and quality of Indian rape (*Brassica campestris* L. var. toria Suthie & Full). *Indian J. agric. Sci.* 40 : 873-78.
- Yadava, B. D. 1975. Varietal response of raya (*Brassica juncea* (L.) Czern and Coss.) to row spacing and nitrogen. M. Sc. thesis, Haryana Agricultural University, Hisar.
- Yadava, T. P. and Bhoja, A. L. 1979. Research achievements for 1970-77. Oil Seed Section, Dept. of Plant Breeding, Haryana Agricultural University, Hisar, pp. 68.
- Yusuf, M. 1973. Effect of frequencies and timing of irrigation on growth, yield and quality of safflower, mustard and linseed. Ph. D. thesis, Indian Agricultural Research Institute, New Delhi.

RESPONSE OF PADDY TO NITROGEN SOURCES, THEIR APPLICATION TIME AND NITRIFICATION INHIBITORS

DALEL SINGH, R. S. ANTIL, VINOD KUMAR and MAHENDRA SINGH

Department of Soils

Haryana Agricultural University, Hisar

(Received : May 6, 1983; Revised : February 20, 1984)

ABSTRACT

Investigations to study the effect of different nitrogen sources, their time of application and nitrification inhibitors on yield and uptake of N in paddy, were undertaken during the years 1979-81. Efficiency of different N sources was in the order: urea=ammonium sulphate > urea > CAN. Grain yield and N uptake in grain and straw of paddy significantly increased with increasing N levels upto 120 kg N ha⁻¹. Sulphur-coated urea, neemcake-coated urea, pre-incubated urea with soil and urea treated with ST (2-sulfanilamidothiazole), were not found beneficial over best split of urea alone with respect to paddy yield. Only a slight beneficial effect of urea+AM (2 amino-4 chloro-6 methyl pyrimidine) was observed. Nitrogen application in three equal split doses, i.e., 1/3 at puddling+1/3 at 21 days+1/3 at 42 days or N applied at 1/3 at 7 days+1/3 at 21 days+1/3 at 42 days gave significantly higher grain yield as compared to N application at 14 or 21 days after transplanting or N applied in 2 split doses.

Paddy is grown mostly in medium-textured soils where alternate submergence and drying (field capacity moisture) occur generally during crop growth period in northern India. In these soils the leaching, denitrification and volatilization are expected to be high as compared to conventional submerged conditions where paddy is grown in heavy-textured soils (Meelu, 1980). Under best management conditions, efficiency of nitrogen in paddy is generally low. The efficiency could be increased using right type of fertilizer, split application at suitable time and using coated fertilizers and nitrification inhibitors (Rajale and Prasad, 1974; Meelu, 1980; Prasad *et al.*, 1981). Present investigations were, therefore, undertaken to study the effect of sources of nitrogen, its time of application and

possibility of use of nitrification inhibitors and coated fertilizers in upland paddy.

MATERIAL AND METHODS

Three field experiments were conducted at Rice Research Station, Kaul (Kurukshetra). In the first experiment, there were four sources of nitrogen, i.e., urea, urea, ammonium sulphate and CAN with four levels of nitrogen 0, 40, 80 and 120 kg ha⁻¹. The experiment was laid out in split plot design. In the second experiment there were nine treatments with three replications in a randomised block design. The treatments included (i) control, (ii) urea, (iii) urea+neemcake (20% by weight of urea), (iv) urea+ST (2-sulfanilamidothiazole, 0.3% by weight of urea), (v) urea+AM (2 amino-4 chloro-6 meth-

yl pyrimidine), (vi) urea+ tarcoal coating, (vii) urea pre-incubated with 1:6 urea and soil for 48 h, (viii) urea pre-incubated with 1 : 6 urea : FYM for 48 h, and (ix) sulphur-coated urea. Nitrogen in all treatments except control was applied @ 120 kg N ha⁻¹. The coating of neemcake was done as described by Sharma and Prasad (1980). For pre-incubating urea with soil or FYM, one part of urea was mixed with six parts of soil or FYM (moist) and kept in polythelene bags for 48 h (Anonymous, 1977). Third experiment was conducted to study the time of N application in a randomised block design. The six treatments included (i) 1/3 N at puddling+1/3 N at 21 days after transplanting (A.T.)+1/3 N at 42 days A.T., (ii) 1/3 N at 7 days A.T.+1/3 N at 21 days A.T.+1/3 N at 42 days A.T., (iii) 1/3 N at 14 days A.T.+1/3 N at 28 days A.T.+1/3 N at 42 days A.T., (iv) 1/2 N at 21 days A.T.+1/2 N at 42 days A.T., (v) 1/2 N at 21 days A.T.+1/4 N at 42 days A.T.+1/4 N at boot stage, (vi) 1/3 N at 21 days A.T.+1/3 N at 42 days A.T.+1/3 N at boot stage. Nitrogen was applied @ 120 kg N ha⁻¹ in all treatments through urea.

First experiment was conducted only for one year during 1980-81, and second and third experiments were conducted for two years at fixed location during 1980-82. The soil where first experiment was conducted was loam in texture with pH 8.1, EC 0.14 mmhos/cm at 25°C organic carbon 0.60%, and available N, P, K, 185, 26 and 188 kg ha⁻¹, respectively. The second and third experiments were conducted in the same field and the soil was loam in texture, with pH 8.05, EC 0.13 mmhos/cm at 25°C, organic carbon 0.69%, and available N, P, K, 179.60, 24 and 189 kg ha⁻¹, respectively.

The grain and straw samples were oven dried at 60°C, ground to pass 2 mm sieve and digested in diacid mixture of H₂SO₄ : HClO₄ (9 : 1). Nitrogen was determined colorimetrically by Lindner (1944) method.

RESULTS AND DISCUSSION

Nitrogen Sources and Levels

Data in Table 1 clearly show that the response of N was upto 120 kg N ha⁻¹. The per cent increase over control in grain yield due to application of 40, 80 and 120 kg N ha⁻¹ was 25.2, 62.2 and 106.6, respectively. Among N sources uran and ammonium sulphate gave significantly higher grain and straw yields over urea and CAN. Efficiency of different nitrogen sources was found in the following order : uran = ammonium sulphate > urea > CAN. Similar results were reported by Raghavulu and Sreeramamurthy (1975) and Meelu *et al.* (1981) who found CAN as inferior source to ammonium sulphate and urea.

Effect of different nitrogen sources on N concentration was not significant. However, increasing levels of nitrogen increased N content in straw. Grain contained more than two times nitrogen than straw. Uptake of N in grains and straw increased significantly with increasing levels of N and total uptake of N at 0 and 120 kg N ha⁻¹ was 48.52 and 119.78 kg ha⁻¹, respectively (Table 1). All sources of N gave significantly higher uptake of N as compared to CAN treatments. The apparent recovery of N was highest in uran (62.20%) and lowest in CAN (38.0%) treatments.

TABLE 1
Effect of levels and sources of N on yield and uptake of N in paddy

Treatments	Yield (t ha ⁻¹)		N concentration (%)		N uptake (kg ha ⁻¹)			Apparent recovery (%)
	Grain	Straw	Grain	Straw	Grain	Straw	Total	
N levels (kg ha ⁻¹)								
0	35.69	33.87	0.95	0.43	33.94	14.58	48.52	—
40	44.68	45.40	1.04	0.48	46.35	19.98	66.33	44.56
80	57.89	59.90	1.09	0.48	63.65	28.57	92.22	54.62
120	73.76	76.99	1.13	0.49	82.92	36.86	119.78	59.39
LSD (0.05)	1.70	2.35	NS	0.03	3.11	2.02	3.96	—
N sources								
Urea	53.56	53.56	1.04	0.45	57.42	23.99	81.41	53.26
Ammonium sulphate	55.10	58.03	1.04	0.46	57.69	27.06	84.75	57.00
Calcium ammonium nitrate (CAN)	48.01	46.49	1.06	0.47	51.49	22.18	73.67	38.00
Uran	55.18	58.09	1.07	0.43	60.24	26.76	87.00	62.20
LSD (0.05)	1.33	2.25	NS	NS	4.20	1.81	4.04	—

TABLE 2
Effect of different nitrification inhibitors and slow release fertilizers on yield of paddy

S. No.	Treatments	Yield ($q\ ha^{-1}$)				Total N uptake ($kg\ ha^{-1}$)	
		1980-81		1981-82		1980-81	1981-82
		Grain	Straw	Grain	Straw		
1.	Control	28.13	32.93	30.50	29.50	60.59	44.12
2.	N_{120} as plain urea (3 splits)	68.80	74.93	73.25	75.50	162.08	114.85
3.	N_{120} + Neemcake	67.06	95.73	72.92	78.00	181.79	114.51
4.	N_{120} + ST	70.00	90.26	74.50	80.00	182.40	129.73
5.	N_{120} + AM	73.86	94.53	77.81	81.50	195.71	151.66
6.	N_{120} + Tarcoal coating	70.13	99.73	74.67	77.00	204.95	152.12
7.	N_{120} + Pre-incubation with soil	66.40	73.33	70.75	71.50	141.68	118.32
8.	N_{120} + Pre-incubation with FYM	64.93	76.93	67.92	68.50	156.54	108.59
9.	N_{120} as sulphur coated urea	60.26	60.80	64.75	64.17	137.67	91.17
	LSD (0.05)	8.16	11.79	4.00	4.50	21.65	40.31

USE OF NITRIFICATION INHIBITORS IN PADDY

TABLE 3
Effect of time of application of nitrogen on yield of paddy

S. No.	Treatments	Yield (q ha ⁻¹)				Total N uptake (kg ha ⁻¹)	
		1980-81		1981-82		1980-81	1981-82
		Grain	Straw	Grain	Straw		
1.	1/3 N at P.D. + 1/3 N 21 days A.T. + 1/3 N 42 days A.T.	63.06	50.80	70.40	72.27	136.86	108.85
2.	1/3 N 7 days A.T. + 1/3 N 21 days A.T. + 1/3 N 42 days A.T.	63.33	64.80	69.60	70.13	135.62	119.94
3.	1/3 N 14 days A.T. + 1/3 N 28 days A.T. + 1/3 N 42 days A.T.	58.13	56.66	64.93	70.53	123.69	122.78
4.	1/2 N 21 days A.T. + 1/2 N 42 days A.T.	58.40	56.00	64.50	69.87	128.84	114.50
5.	1/2 N 21 days A.T. + 1/4 N 42 days A.T. + 1/4 N at B.S.	55.33	50.13	63.13	63.60	116.37	110.01
6.	1/3 N 21 days A.T. + 1/3 N 42 days A.T. + 1/3 N at B.S.	54.53	46.80	62.13	60.93	102.44	111.07
	LSD (0.05)	NS	NS	5.09	7.28	NS	NS

P.D.—Puddling, A.T.—After transplanting, and B.S.—Boot stage.

Nitrification Inhibitors and Coated Fertilizers

Except AM, none of the nitrification inhibitors and coated fertilizer was found beneficial in comparison to urea alone (Table 2). An average increase of 6.77% in grain yield was observed in urea+AM treatments as compared to urea alone. On the contrary there was no significant increase in grain yield due to application of ST and neemcake coating. A negative response was observed in case of urea pre-incubated with soil. Sulphur coated urea also gave an average reduction of 12.1% in grain yield over urea alone. Nitrogen uptake was highest in both years in urea+tarcoaf followed by urea+ST treatment and lowest in sulphur coated urea treatment on equal N basis. All the treatments where nitrogen was applied either with inhibitor or through coated fertilizers, gave significantly higher uptake of N than control in both the years. It, therefore, suggests that none of the nitrification inhibitors (except AM) or coated fertilizers tested above was beneficial to increase efficiency of added N in upland paddy in Haryana where higher temperature and wetting drying sequence prevails, rather than continuous submergence. The poor response in present case may, therefore, be due to high temperature which ranges frequently between 40 to 44°C, as a result of which there may be break-down of nitrification inhibitors and higher temperature may also have a quick dissolution effect on coated fertilizers. The results are suppor-

ted by findings of Meelu (1980) who found no beneficial effect of neemcake, sulphur coated urea and sulphathiazole treated urea in Punjab soils. The results, however, are in contradiction to those of Prasad *et al.* (1971), Well and Shockley (1975), Prasad (1979) and Sharma and Prasad (1980), probably because the agro-climatic conditions in their cases were different.

Time of Nitrogen Application

Effect of time of application of N on yield of paddy has been depicted in Table 3. Highest grain yield was recorded in both the years when N was applied, 1/3 at puddling+1/3 at 21 days A.T.+1/3 at 42 days A.T. or 1/3 at 7 days A.T.+1/3 at 21 days A.T.+1/3 at 42 days A.T. There was an average reduction of 7.8 and 12.6 per cent when N was applied at 1/3 at 14 days A.T.+1/3 at 21 days A.T.+1/3 at 42 days A.T. and 1/3 at 21 days A.T.+1/3 at 42 days A.T.+1/3 at boot stage, respectively, in comparison to 1/3 N at puddling+1/3 at 21 days+1/3 at 42 days A.T. Further delaying in first application of N upto 21 days even with splitting of N in two or three doses was not found beneficial. Total uptake of N was not affected by time of application (Table 3). Raghavulu and Sreeramamurthy (1975) found that the application of N in three split doses over two splits was beneficial. Meelu *et al.* (1981) reported that delaying of 1/3 N dose upto 7 days was even more beneficial over its application at transplanting.

REFERENCES

- Anonymous. 1977. Fertilizer urea—its efficient use. *Fert. News* 22 : 1-18.
- Lindner, R. C. 1944. Rapid analytical method for some of the more common inorganic constituents of plant tissue. *Plant Physiol.* 19 : 76-89.
- Meelu, O. P. 1980. Efficiency of nitrogen in Indian rice culture. *Fert. News* 25 : 27-30.
- Meelu, O. P., Sagar, S., Maskina, M. S., Rekhi, R. S. and Singh, H. N. 1981. Comparative efficiency of different sources and time of N application in rice and wheat. Proc. National Symposium on Crop Management to Meet the New Challenges, held at Haryana Agricultural University, Hisar. pp. 3-4.
- Prasad, R. 1979. Increasing fertilizer N efficiency with slow release fertilizers and nitrification inhibitors. *Fert. News* 24 : 25-32.
- Prasad, R., Rajale, G. B. and Lakhdive, B. A. 1971. Nitrification retarders and slow release nitrogen fertilizers. *Adv. Agron.* 23 : 337-83.
- Prasad, R., Sharma, S. N., Prasad, M. and Reddy, R. N. S. 1981. Efficient utilization of nitrogen in rice-wheat rotation. Proc. National Symposium on Crop Management to Meet the New Challenges, held at Haryana Agricultural University, Hisar, p. 2.
- Raghavulu, P. and Sreeramamurthy, V. 1975. Sources and time of application of nitrogen for lowland rice. *Indian J. Agron.* 20 : 167-68.
- Rajale, G. B. and Prasad, R. 1974. Relative efficiency of urea, nitrification inhibitors treated urea and slow release nitrogen fertilizers for rice. *J. agric. Sci.* 83 : 303-07.
- Sharma, S. N. and Prasad, R. 1980. Relative efficiency of urea, nitrification-inhibitor treated urea and sulphur coated urea for rice. *Indian J. Agron.* 25 : 403-09.
- Well, B. R. and Shockley, P. A. 1975. Conventional and controlled release N sources for rice. *Proc. Soil Sci. Soc. Am.* 99 : 549-55.

RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XV, No. 1, pp. 94—96 (March 1985)

NUTRIENT STATUS OF **BER** (*ZIZYPHUS MAURITIANA* L.) ORCHARDS IN MAHENDRAGARH DISTRICT OF HARYANA

R. YAMDAGNI, V. P. AHLAWAT and V. S. CHAUHAN
Department of Horticulture
Haryana Agricultural University, Hisar

(Received : January 22, 1983; Revised : August 9, 1983)

Information on tree nutrition in **ber** is lacking and no definite recommendation on fertilizer application can be made without the knowledge of nutrient status of **ber** trees as well as soil of the orchards. The present survey was conducted to assess the mineral nutrient status of both the soil and trees of 17 selected orchards representing Mahendragarh district in Haryana State. Ten to 15-year old orchards of **ber** cultivar Umran, in full bearing, were surveyed during the study. Six to seven-month old fully expanded leaves as suggested by Nijjar and Kumar (1979) were collected during January 1982 at random from 70 trees in an acre. Leaves were first washed in dilute HCl and then with distilled water and were oven dried. Acid digested samples were analysed for nitrogen (Jackson, 1962), phosphorus (Vandomolybdate method), potassium (Flame Photometer), and calcium and magnesium (Versenate method). Soil samples were analysed as per procedure described by Muhr *et al.* (1965).

The data regarding soil and leaf nutrient status of different orchards are given in Table 1. It was observed that pH of the soil varied from 7.5 to 9.1, and

electrical conductivity was lower than 1.0 mmhos/cm which indicated suitability of soil for **ber** cultivation. Organic carbon content varied from 0.21 to 0.35, which was in low range. The available phosphorus content of all the sample orchards was in deficient range. Since the farmers were not applying any chemical fertilizers, the low range of nutrients was obvious. The leaf analysis revealed that nitrogen content varied from 2.05 to 3.92 per cent. It was in low range in five orchards whereas in remaining orchards it was in medium range. The phosphorus content varied from 0.125 to 0.210 per cent which indicates slight deficient range. Similarly potassium was also in low range as it varied from 1.10 to 1.75 per cent. Magnesium content ranged from 0.85 to 1.64 per cent indicating that the trees were in optimum to high range. Calcium content varied from 1.17 to 3.26 which is in optimum range. The yield per tree varied from 50-75 kg. The low yield is attributed to the deficiency of major nutrients in soil as well as leaves. Thus, the data indicated that about 30% of orchards were in deficient range with regard to nitrogen content. The low content of nitrogen in foliage was due to the fact that soils were in

TABLE 1
Nutritional status of ber orchards in Mahendragarh district

S. No.	Location	Soil fertility status				Leaf mineral content (%)					Yield (kg/plant)
		pH	EC (1:2) mmhos/cm	Organic carbon (%)	P ₂ O ₅ (kg/ha)	N	P	K	Ca	Mg	
1.	Rewari	7.8	0.21	0.35	8	2.05	0.125	1.55	1.17	1.32	50
2.	"	7.9	0.25	0.32	8	2.47	0.150	1.65	1.52	1.59	58
3.	"	7.8	0.21	0.30	7	2.10	0.137	1.75	1.46	0.89	52
4.	"	7.5	0.22	0.35	8	2.75	0.150	1.40	2.02	0.85	70
5.	Mahendragarh	8.1	0.18	0.24	6	2.37	0.125	1.45	1.83	1.64	60
6.	"	8.0	0.16	0.21	5	2.37	0.200	1.50	1.91	1.14	72
7.	"	8.8	0.18	0.23	6	2.10	0.170	1.65	1.57	1.62	68
8.	"	8.1	0.15	0.25	6	2.50	0.193	1.25	3.26	1.25	70
9.	Narnaul	8.9	0.33	0.30	5	2.22	0.125	1.40	1.46	0.89	71
10.	"	9.0	0.33	0.30	5	2.30	0.125	1.75	1.57	1.62	68
11.	"	9.1	0.32	0.28	4	2.50	0.181	0.92	1.52	1.59	65
12.	"	8.9	0.33	0.28	5	3.55	0.200	1.50	1.83	1.64	70
13.	"	9.1	0.34	0.28	5	3.92	0.200	1.40	1.57	1.62	75
14.	"	9.1	0.33	0.29	4	2.50	0.137	1.10	2.02	0.85	70
15.	"	8.9	0.34	0.29	5	3.37	0.210	1.20	1.52	1.60	68
16.	"	8.9	0.33	0.30	5	2.95	0.131	1.25	2.02	0.85	70
17.	"	8.9	0.32	0.31	4	3.17	0.150	1.05	1.57	1.62	68
Mean		8.5	0.27	0.28	5.64	2.65	0.159	1.39	1.75	1.32	66.1

deficient range with respect to organic carbon. There seems to be no deficiency of potassium, calcium and magnesium. The yield per plant was less in all the orchards. The production of the trees can be increased manifold, if chemical fertilization is adopted. Yamdagni *et al.*

(1980) reported that application of 500 g N per tree gave the better yield response in Kaithli cultivar of ber. It is, therefore, advisable that ber growers in Mahendragarh district must apply fertilizer as per recommendation (Anon., 1981) to increase productivity of trees.

REFERENCES

- Anonymous. 1981. *Package and Practices for Rabi Crops*. Directorate of Publications, Haryana Agricultural University, Hisar.
- Jackson, M. L. 1962. *Soil Chemical Analysis*. Asia Publishing House, Bombay, India.
- Muhr, G. R., Datta, N. P., Sankarasubramany, H., Leley, V. K. and Donhue, R. L. 1965. Soil testing in India, USAID Mission, New Delhi.
- Nijjar, G. S. and Kumar, S. 1979. Follar sampling technique in ber. *Punjab hort. J.* 19: 40-45.
- Yamdagni, R., Kumar, R. and Jindal, P. C. 1980. Effect of graded doses of N on fruit set, fruit drop and yield of ber (*Zizyphus mauritiana* L.) cv. Kaithli. *Prog. Hort.* 12: 58.

RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XV, No.1, pp. 97—98 (March 1985)

OBSERVATIONS ON THE EXTENT OF DECLINE IN DIFFERENT CULTIVARS OF CITRUS

R. K. ARORA, V. P. AHLAWAT and R. YAMDAGNI

Department of Horticulture
Haryana Agricultural University, Hisar

(Received : May 13, 1983; Revised : March 19, 1984)

Citrus fruits are grown commercially in arid irrigated region of Haryana. The area under these fruits is on consistent increase. It has been observed that tree shows good growth and gives normal yield in the initial five to six years of planting but later on its growth slows down, with the result drying of shoots starts from apical portion and proceeds towards lower portion of shoots (Chadha *et al.*, 1970). The problem of die-back can partially be solved by planting various cultivars which have proven tolerance to it.

The extent of decline in various scion cultivars of citrus species under Hisar conditions was studied. The experimental material consisted of six cultivars of citrus, viz., Jaffa and Campbell Valencia cultivars of sweet orange; Pearl tangelo; Kinnow and Honey-mandarin hybrids and Dancy tangerine budded on Jatti Khatti. The planting was 15-year old. During 14th and 15th year of age, the extent of decline was determined by visualizing the condition of the trees. The per cent die-back in each plant was calculated by counting the number of branches dried. There were four replications and each replication had 10 trees as units. The percentage so obtained was converted into transformed values and data were analysed.

The data in Table 1 reveal that the extent of decline varied from 43.13 to 69.67 per cent in different cultivars of citrus. It was interesting to note that Campbell Valencia cultivar of sweet orange exhibited the lowest intensity (43.13%) of tree decline whereas, Honey mandarin had the highest (69.67%). Rest of the species of citrus were non-significant with each other in relation to decline.

In sweet orange cultivars, Campbell Valencia showed significantly lower intensity of decline as compared to Honey, whereas it was non-significant when Jaffa was compared. The low intensity of decline in Campbell Valencia may be due to its better compatibility with Jatti Khatti (*C. jambhiri* L.) rootstock as compared to other stionic combinations of sweet orange as the place of the union between the above stock and scion was more smooth than in other cases. This confirms the findings of Chauhan *et al.* (1980) who reported that Campbell Valencia scion was more prolific and vigorous on Jatti Khatti rootstock as compared to other stionic combinations of sweet orange.

In mandarin cultivars, i.e., Kinnow and Honey, the intensity of decline varied

TABLE 1
Per cent intensity of decline in various cultivars of citrus

	Cultivars					
	Campbell Valencia	Jaffa	Dancy	Pearl	Honey	Kinnow
Per cent intensity of decline	43.13 (41.03)	50.44 (45.23)	57.59 (49.37)	51.37 (45.74)	69.67 (56.84)	55.25 (47.98)
C. D. at 5% level of significance	(15.81)					
C. D. at 1% level of significance	(21.81)					

Figures in parentheses are angular transformed values.

from 55.25 to 69.67 per cent with lowest being in Kinnow. Dancy tangerine was of the medium (57.59) order in decline. Among mandarins, tangerine and tangelo, Pearl tangelo had the lowest (51.37%) intensity of decline as compared to Honey.

From the study it is clear that among the sweet orange cultivars Campbell Valencia has tolerance to decline and it is followed by Pearl tangelo.

REFERENCES

- Chadha, K. L., Randhawa, N. S., Bindra, O. S., Chohan, J. S. and Knorr, L. C. 1970. *Citrus Decline in India—Causes and Control*. Punjab Agricultural University, Ludhiana. pp. 97.
- Chauhan, K. S., Arora, R. K. and Gupta, O. P. 1980. Pre-bearing performance of stionic combinations of sweet orange. National Symposium on Tropical and Sub-Tropical Fruits held at Bangalore, Abstract, pp. 31.

RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XV, No. 1, p. 99 (March 1985)

A NEW RECORD OF OCCURRENCE OF *EPHESTIA CAUTELLA* (WLK) ON STORED COTTON SEED IN HARYANA

A. S. NANDAL, V. S. MALIK and ZILE SINGH*

Department of Entomology

Haryana Agricultural University, Hisar

(Received : July 6, 1983; Revised : December 24, 1983)

The almond moth, *Ephestia cautella* (Wlk) has so far been reported as a pest of powdery material produced due to damage by insect pests to grains in storage such as sorghum, maize, and rice, seed of groundnut and cashewnut, often causing considerable damage (Ayyar, 1940). Hargreaves (1948) while enlisting insect pests of cotton of the world, reported the occurrence of *E. cautella* on stored seed of cotton in Brazzel, Egypt, Nigeria, Portorico, Tanganyika and Uganda. There is, however, no report from India of the damage to cotton seed by this pest. During October 1982, cotton seed stored in gunny bags at Haryana Agricultural University, Hisar showed the infestation by larvae of *E. cautella*. Only those seeds which were broken during the process of ginning harboured the larvae. Most of the larvae

were observed to form webbings over their body.

Presence of larvae was recorded by examining 5 samples, each consisting of one kilogram of cotton seed at fortnightly intervals during the period from October to December. A sample of 5 kg seed showed the presence of 18 and 20, 11 and 9, and 4 and 2 larvae during the first and second fortnights of October, November and December, respectively. Further studies, however, are needed to determine the pest status of *E. cautella*.

ACKNOWLEDGEMENT

The authors are grateful to Dr. J. D. Bradley, Commonwealth Institute of Entomology, London for identification of moth.

REFERENCES

- Ayyar, T. V. R. 1940. *Hand-book of Economic Entomology for South India*. Superintendent Government Press, Madras, pp. 386.
- Hargreaves, H. 1948. *List of Recorded Cotton Insects of the World*. Commonwealth Institute of Entomology, 41 Queen Gate, London, pp. 49.

*Directorate of Project-cum-Plan Formulation.

RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XV, No. 1, pp. 100—101 (March 1985)

POWDERY MILDEW ON *CAPSICUM ANNUM* IN HARYANA

LUXMI CHAND SAINI and J. N. CHAND

Department of Plant Pathology
Haryana Agricultural University, Hisar

(Received : August 1, 1983; Revised : March 1, 1984)

A severe and widespread attack of powdery mildew on chilli (*Capsicum annum* L.) was observed during winter season of 1981-82 in Ambala district of Haryana. Disease symptoms were recorded as white floury patches on the lower surface of the leaves. Upper surface became chlorotic, later turning black. In severe cases, patches coalesced covering large area of the lamina. Lower leaves showed more infection as compared to the upper leaves. Heavily infected plants bore less number of fruits and of inferior quality as compared to the less infected plants. Defoliation was also marked as a sign of severe infection. Disease severity was recorded as high as 67.3% on the basis of number of leaves infected.

Microscopic studies of the infected leaves revealed that the fungal mycelium was septate, hyaline, intercellular and remfying between the mesophyll cells. The conidiophores arose from the mycelium and came out singly or in clusters through the stomata. They were elongate ($113.85 \times 7.59 \mu\text{m}$ in diameter), septate, usually branched, swollen, hyaline and bore only single conidium at the apex (Fig. 1). The conidia were single celled, hyaline, cylindrical or

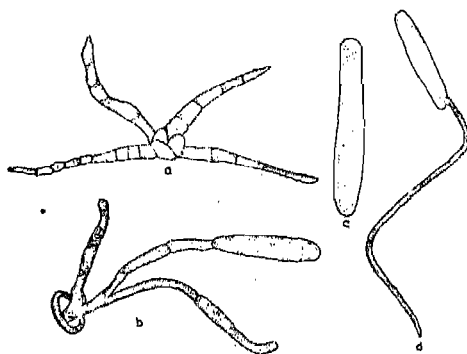


Fig. 1. Branched conidiophore (a), conidiophore with conidium (b), conidium (c) and germinated conidium with long germ tube (d).

irregularly shaped and measured $63.75\text{--}69.40 \times 15.18\text{--}21.1 \mu\text{m}$ in diameter. The conidium germinated by means of a long germ tube which arose from one end. The morphological characters of the fungus agreed with those of *Leveillula taurica* (Lev.) Arn.

Earlier Salmon (1906), Butler (1918) and Schweizer (1928) reported that *Oidiopsis taurica* inspite of other hosts can attack *Capsicum annum*. Sawada (1933), Orleux and Felix (1963) and Natour *et al.* (1971) reported *Leveillula taurica* causing powdery mildew on *Capsicum annum*.

POWDERY MILDEW ON CHILLI

REFERENCES

- Butler, E. J. 1918. *Fungi and Disease in Plants*. Periodical Experts, Delhi, pp. 271.
- Natour, R. M., El-Behadli, A. H. and Majeed, M. G. 1971. Occurrence of *Leveillula taurica* in Iraq. *Plant Dis. Rep.* **55** : 192.
- Orieux, L. and Felix, S. 1963. Notes on a fungal disease of *Capsicum pepper* in Mauritius. *Rev. Agric. Sucr. Maurica.* **42** : 134-36.
- Salmon, E. S. 1906. On *Oidiopsis taurica*—an endophytic member of the Erysiphaceae. *Ann. Bot. Lond.* **20** : 187-200.
- Sawada, K. 1933. Descriptive catalogue of the Formosan Fungi. Part IV. *Rep. Dep. Agric. Formosa.* **67** : 117.
- Schweizer, J. 1928. On the Erysiphaceae (mildew fungi) of Java. *Arch. Rubber Nederl. Indie.* **12** : 323-42.

NATURE AND EXTENT OF DAMAGE OF *HELIOTHIS ARMIGERA* (HUBNER) IN SEED CROP OF ONION

R. K. KASHYAP and M. L. PANDITA

Department of Vegetable Crops

Haryana Agricultural University, Hisar

(Received : August 12, 1983; Revised : February 20, 1984)

Heliothis armigera (Hubner) (Lepidoptera : Noctuidae) is a polyphagous pest and has been found damaging a number of crops including vegetables.

During May 1982, a number of onion (*Allium cepa* L.) umbels of variety Hisar-2 were found withering at Vegetable Research Farm, Haryana Agricultural University, Hisar. Holes (apparently made by the insect) were observed in the stem as well as at the base of these withered umbels. During 1982-83, studies were initiated to know the identity of the insect responsible for this damage, its nature and extent of damage on seed crop of onion.

The newly hatched larva was found feeding on the stem by making scratches on it. These scratches were clearly visible when the crop reached at the maturity stage. The larva moved upwards while feeding on stem tissues and this type of feeding continued upto second larval instar. After this, the larva made a circular hole in the stem and entered inside it. The larva, thereafter, fed on stem tissues internally and as a result of this, third, fourth and fifth instar larva were able to hide completely. It is because of

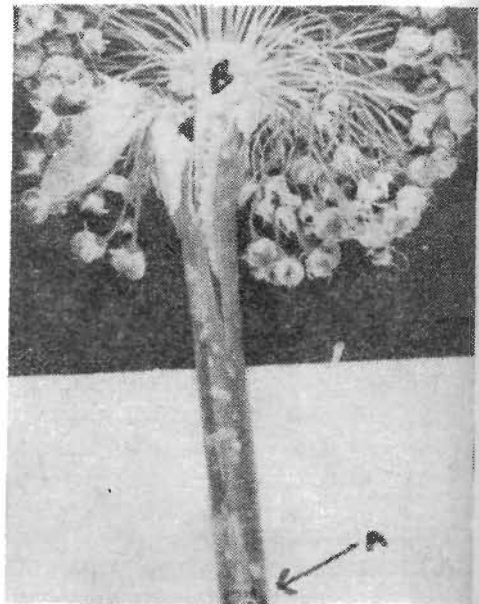


Fig. 1. Entrance hole of the larva in the stem (a); and full grown caterpillar feeding on the base of umbel from inside the stem (b).

this reason that the detection of the pest becomes difficult. While feeding on the internal tissue, the larva moves upward and ultimately reaches at the base of the umbel and starts feeding on it (Fig. 1). Due to this damage, all the flowers in an umbel dried up, resulting in the complete loss of seeds. It was also observed that if the damage to the base of umbel was

DAMAGE IN SEED CROP OF ONION

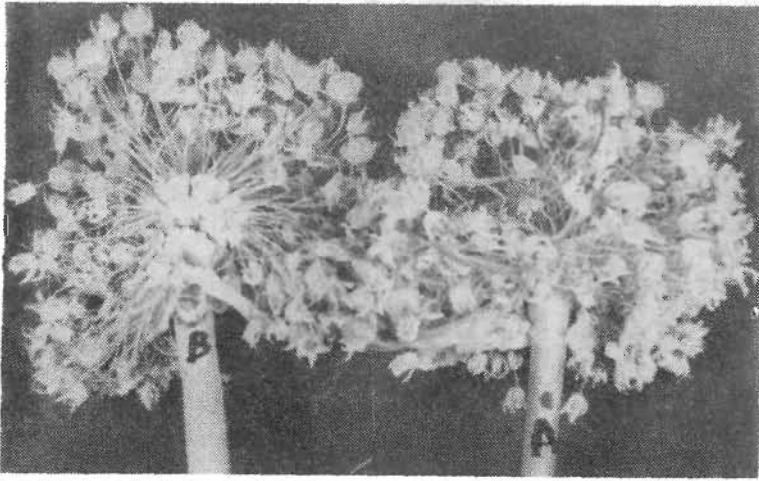


Fig. 2. Entrance hole of the larva in the stem (a); and circular hole at the base of umbel for the exit of fifth instar larva (b).

in the early stages of flowering, the umbel dried up completely, whereas if the damage was after the seed initiation, the seeds never ripened. The full grown fifth instar larva comes out of the umbel by making a circular hole at the base of the umbel (Fig. 2) and enters the soil for pupation. In few cases, it was also observed that those larvae which failed to enter the stem, reached the umbel directly and fed on the flowers. Two hundred random onion stems from one acre were examined and this revealed an infestation of 14% on stem basis. The damaged stems were found to harbour one larva in each stem. These insects were reared in the laboratory on onion umbels and

were identified to be tomato fruit borer, *Heliothis armigera* (Hubner).

Among vegetable crops, this is a serious pest of tomato (Singh and Chahal, 1978; Kashyap *et al.*, 1982; Kashyap, 1983), potato (Chandla and Rizvi, 1977), *Dolichos lablab* and peas (Singh and Singh, 1975). Occurrence of this insect on onion (Sharma and Chaudhary, 1982) has earlier been reported. It is evident from the present studies that this insect can assume the status of a major pest in seed crop of onion. Therefore, suitable control measures need to be worked out for its control on seed crop of onion.

REFERENCES

- Chandla, V. K. and Rizvi, S. M. A. 1977. Chemical control of *Heliothis armigera* Hb. (Noctuidae : Lepidoptera) on potato. *Pesticides* 11 (9) : 60-61.
- Kashyap, R. K. 1983. Studies on resistance behaviour of tomato genotypes against fruit borer, *Heliothis armigera* (Hubner). Ph. D. thesis, Haryana Agricultural University, Hisar.

KASHYAP AND PANDITA

- Kashyap, R. K., Bhutani, R. D. and Kalloo. 1982. Relative susceptibility and variability studies against fruit borer (*Heliothis armigera* Hubner) in tomato (*Lycopersicon esculentum* Mill.). *Punjab hortic. J.* **12** : 190-93.
- Sharma, S. K. and Chaudhary, J. P. 1982. Studies on nature of damage and identity of population of *Heliothis armigera* (Hubner) under different growth stages of gram crop. *Indian J. agric. Res.* **16** : 95-98.
- Singh, D. and Chahal, B. S. 1978. Control of tomato fruit borer (*Heliothis armigera* Hubner) in Punjab. *Haryana J. hortic. Sci.* **7** : 182-86.
- Singh, H. and Singh, G. 1975. Biological studies on *Heliothis armigera* (Hubner) in the Punjab. *Indian J. Entomol.* **37** : 154-64.

VOCATIONAL INTERESTS OF FINAL YEAR HIGH SCHOOL GIRLS

SAROJ KASHYAP and K. KUMAR
Department of Extension Education
Haryana Agricultural University, Hisar

(Received : January 8, 1983; Revised : August 4, 1983)

ABSTRACT

Study on vocational interests of girls, measured by using Chatterjee's Non-Language Preference Record, and conducted on 100 final year high school girls from two schools in Hisar, revealed that girls were more interested in literary and medical professions followed by scientific, agricultural and technical vocations. The interest patterns of rural and urban girls, however, significantly differed but both the groups had first two vocational interests in literary and medical areas.

The girls of today are the women of tomorrow. Marriage and home-making, as a full-time career for most of the women, has restricted their entry to the public services. But a significant shift of women towards employment can be visualised now-a-days. Gadgil (1964) described the trend in detail. Women are now generally employed in public services—education, social, medical and health services. The total number of women employees in our country was 13.4 lakhs (Anonymous, 1966) and it rose to 20.53 lakhs in September, 1972 (Anonymous, 1972). The curve of employment of women has been rising. Therefore, career planning for girls is as important as it is for boys.

Adolescence is the right stage for proper vocational planning. The actual transition from the childhood to the adulthood takes place during this period. It is the period in which the girls make efforts to adjust themselves suitably in life and

work. Normally, it is the period when they make decisions having far reaching influences on the rest of their lives. Soon after completing high school, one is confronted with the problem of choosing her vocation.

Choosing vocation, according to Super (1957) is a process rather than an event. The right choice of the vocation at this stage will determine as to what extent the girls will prove useful in public service satisfying the society and to what extent they will love and enjoy the vocation they take. These conditions are likely to be satisfied only if one's vocation is compatible with one's interests. The choice of an educational career or vocational field of training is, therefore, not a simple but critical problem. Thus, the studies on vocational and personal interests of girls become very important and need to be conducted in different socio-cultural conditions existing in different parts of the country or even in different parts of a state.

METHODOLOGY

A number of rural high schools were surveyed but it was difficult to find any girl student in tenth class. In the locality of Hisar, only one rural school (Govt. Girls High School, Barwala) was found to have a good number of girl students in this class. The urban variant which was purposively selected, was Senior Model High School, Hisar. There were about 70 and 60 girls in these two rural and urban schools, respectively. Fifty students were selected randomly from each school.

There are four broad methods of measuring interests—expression, manifestation, tests and inventory. In expression, the respondents directly express their interests. Interests measured in this way are not highly reliable and may not be stable. In manifestation, the behaviour of the person is to be observed to draw conclusion about his interests. This is very cumbersome and time consuming process of measuring interests. In tests, also behaviourable manifestations are observed under standardised conditions.

Inventory, where a person has to select one out of a number of alternative activities or pictures, has been found to be very reliable method of measuring interest. Inventorised interests are found to be reliable and stable. It was, therefore, decided to select a suitable inventory for the measurement of vocational interests in literary, agricultural and medical occupations.

Kuder's Preference Record is the most widely used interest inventory for the measurement of interests, but this was not considered good under Indian conditions. Hence, a non-language or pictorial inventory was considered better than a verbal inventory (Chatterjee, 1962). Chatterjee's Non-Language Preference Record (CNPR), which has been developed on the lines of Kuder's Preference Record was, therefore, selected. It simultaneously measured interests in literary, agriculture, medical, scientific, technical, sports, outdoor work, crafts, household work and fine arts.

Interest scores in the following six vocational fields were calculated from the answer sheets.

1. Agriculture Interest in growing plants, careing for animals and using agricultural tools and machines.
2. Crafts Interest in working with one's own hands for making and fixing things. This is related to both mechanical and fine art interests, but it requires less scientific interest and knowledge than mechanical work does, and less artistic interest or ability than fine-arts activities. It is primarily interest in hand work and skill.
3. Literary work Interest in reading, studying and teaching anything to do with language and books.
4. Medical Interest in being a doctor, nurse or hospital worker of some sort.

VOCATIONAL INTERESTS OF GIRLS

5. Scientific Interest in physics, chemistry, laboratory work and astronomy including both studying and teaching science.
6. Technical Interest in using and repairing mechanical and electrical equipments (e. g., motor cars, radio, etc.), working in factories and scientific laboratories.

RESULTS AND DISCUSSION

Data in Table 1 reveal the interest scores which the girls obtained in the six vocational areas. As the maximum possible interest scores which a person could get on the CNPR differed from vocation to vocation, the obtained interest scores were converted into percentages of the maximum possible scores and were called the standard mean scores. This made inter-vocational comparisons of the score possible.

Out of the six vocational areas, literary was found to attract the greatest attention of the girls. The standard mean score in literary was 49.658—the highest of all the scores. The interest of girls in this vocation can be easily understood. Teaching is a gainful employment and a noble job. To get a job of a teacher is also comparatively easier

as a large number of new schools have come up. Moreover, a teacher has ample time in the form of holidays, vacations and leisure hours to look after household work and/or to pursue further studies. Thus, it seems natural for the final year high school girls to be very much interested in literary and teaching pursuits. This is one vocational area in which a lady can work, make a substantial earning and be also with her husband.

The next area in which the girls were interested was medical. Girls in Haryana have high occupational aspirations. It is no wonder why most of them would like to be doctor. Though literary profession got higher score than the medical, it seems to be more a result of pragmatism than a real preference for literary profession to medical profession.

TABLE 1

Vocational interest score of final year high school rural and urban girls

Areas of vocational interest	Maximum possible score	Raw interest score of the whole group (n=100)	Mean standard interest score		
			Whole group (n=100)	Urban group (n=50)	Rural group (n=50)
Literary	73	36.25	49.658	49.562	49.753
Medical	91	41.01	45.066	48.527	41.604
Agriculture	80	26.49	33.113	28.90	37.325
Scientific	90	37.78	41.978	47.022	36.933
Technical	78	24.93	31.962	29.154	28.359
Crafts	76	16.71	21.987	20.237	23.737

The next area was scientific, followed by agriculture. It may be mentioned here that women perform a lot of agricultural operations in Haryana and they have also been found to have decision making roles in farming matters. Fifty per cent of the girls selected in the sample were from a rural school. Thus, agriculture being perceived as a vocational area appears to be natural. Interest in agriculture was followed by interest in technical professions and crafts work.

Comparison of Interest of Rural and Urban Girls

The standard mean interest scores in the vocational areas for both the urban and rural girls is given in Table 1. Both the groups gave first preference to literary profession and second to medical. The two groups' interest pattern seemed to differ in respect of agriculture, scientific, technical and crafts.

In order to find out whether the overall vocational pattern of the rural and urban girls differ from each other, Spearman's rank order correlation/co-efficient was calculated. This was 0.170 and was non-significant at 5% level of probability. This indicates that the rural and urban girls had, on the whole, different vocational interest patterns.

The difference was in the field of agriculture. The urban group ranked it 5th, whereas the rural group gave it 3rd preference. Scientific vocations were

given third preference by the urban group and fourth by the rural one. Technical professions ranked fourth in case of urban and fifth in case of rural girls. In craft work, the rural and urban groups did not differ; and both the groups ranked it sixth in order of their preference.

It may be mentioned here that the school going girls are not likely to favour their employment in villages itself in rural arts and crafts work. Whereas the general tendency on the part of planners seems to attach importance to this area as part-time and full-time employment to rural women. It might be good for those who have not gone upto high school level. For those who have gone upto high school level, craft work is certainly not going to be a vocational area of interest.

Whenever any youth development programme is organised in a village for boys or girls, there is a tendency to give emphasis on the rural vocational training. The findings show that this type of programme is not likely to attract girls completing high school. They have interests in professions like medical, technical and literary. Thus, this intelligent section of rural girls is likely to get alienated from rural girls programme. It might, therefore, be necessary to include in youth development programmes something for the rural girls who have aspirations for vocations which are considered urban.

REFERENCES

Anonymous. 1966. *The Employment Review*. Director General of Employment and Training, New Delhi.

Anonymous. 1972. *The Employment Review*. Director General of Employment and Training, New Delhi.

VOCATIONAL INTERESTS OF GIRLS

Chatterjee, S. 1962. *Chatterjee's Non-Language Preference Record*. Mansayan Press, Netaji Subhash Marg, Pahar Gang, Delhi.

Super, D. E. 1957. *The Psychology of Careers*. Harper and Row Publishers Incorporated, New York.

Gadgil, D. R. 1964. Women the working force in India. Cited from : *The Changing Occupation Pattern* by J. S. Gulati, NCERT, p. 19.

PLANNING SMALL FARMS UNDER VARYING CAPITAL

P. K. SARDANA and B. S. PANGHAL

Department of Agricultural Economics

Haryana Agricultural University, Hisar

(Received : February 16, 1983; Revised : March 27, 1984)

ABSTRACT

The small farmers of India have not been able to take much advantage of improved technology due to inadequacy of resources with them. Out of these scarce resources, capital is the most crucial one. Findings of the study reveal that if adequate working capital is made available to small farmers, they have the potential for increasing their incomes and employment on farm even at existing level of technology.

Introduction of improved technology in agriculture has increased the possibilities of enhancing/improving productivity and income on the farms. Further, the continuously rising prices of farm products during the last few years have offered incentives to the farmers for increasing their farm products through the use of scientific methods of cultivation. The increase in farm productivity involves a manifold increase in capital requirements due to increased use of modern farm inputs. The majority of Indian farmers are too poor to adopt the improved agricultural farm practices due to their meagre and inadequate resources. This problem is more serious on small farms. It is, therefore, essential to study the production possibilities with varying levels of capital input on the small farms. The objectives of the present study were :

- (i) To find out optimum cropping pattern for the small farms under varying capital requirements with existing and improved levels of technology.

- (ii) To study the prospects of increasing the income on small farms with existing and improved technology.

MATERIAL AND METHODS

Bhiwani district having adequate infrastructure for marketing of milk and milk products (milk plant) was purposively selected for the present study. Stratified sampling was used for selection of sample for the study. A block-wise list of small and marginal farmers, who had received dairy loan during the year 1979-80 was obtained from Small Farmer's Development Agency (SFDA). Ten per cent of total number of farmers receiving dairy loan from each block was selected. In this way 30 farmers from Dadri-I, 17 from Dadri-II, 5 each from Tosham and Badhra, 10 from Bawani Khera, 2 from Loharu and 28 from Bhiwani and thus making total of 97 farmers out of total 971 were selected for the study.

PLANNING FARMS UNDER VARYING CAPITAL

The cross-section data with regard to input-output details and their prices, resource availability and other restrictions were collected with the help of a pre-structured schedule.

Variable capital programming technique was used for developing optimum plans at the existing and improved levels (I and II)* of technology. The pre-determined data include the technical input-output coefficient (a_{ij} 's), returns over variable cost (C_j), real activities (X_j) and resource supplies (b_i). The problem is :

$$\text{Maximize } Z = \sum_{j=1}^n c_j x_j$$

Subject to

$$\sum_{j=1}^n a_{ij} x_j = \text{Variable capital}$$

$$\sum_{j=1}^n a_{ij} x_j \leq \text{Kharif irrigated land}$$

$$\sum_{j=1}^n a_{ij} x_j \leq \text{Kharif unirrigated land}$$

$$\sum_{j=1}^n a_{ij} x_j \leq \text{Rabi irrigated land}$$

$$\sum_{j=1}^n a_{ij} x_j \leq \text{Rabi unirrigated land}$$

$$\sum_{j=1}^n a_{ij} x_j \leq \text{Cotton land}$$

$$a_{ij} \geq 0 \text{ and } b_i \geq 0$$

labour restriction was not included in the model.

Real activities included in the model are wheat desi, wheat mexican, gram desi, gram kabuli, cotton, bajra desi, bajra hybrid and guar. The livestock activity being fixed at level of one buffalo was excluded in the final analysis, because SFDA provided loan for only one buffalo and the farmers were not in a position to purchase any more out of their own resources. On sample farms, on an average, an area of 0.19 ha was put under jowar fodder crop to meet the fodder requirement of buffalo. Therefore, 0.19 ha of land was subtracted out of the total kharif land.

ECONOMIC FRAME WORK OF THE PROBLEM

Fig. 1 illustrates how a farmer whose main objective is to maximize profit could decide about the amount of capital use. Suppose capital is an input to be

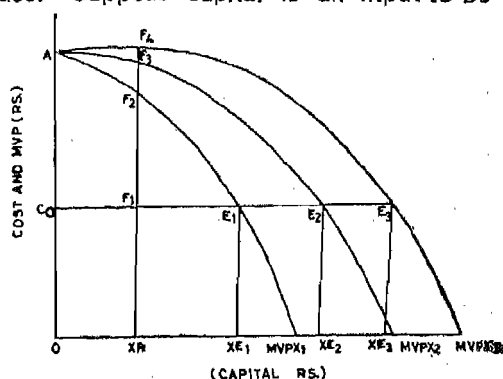


Fig. 1. Effect of change in capital use at existing and improved technology.

Since the availability of family labour was quite adequate on small farms,

*The improved level of technologies-I and II refer to 50 and 60 per cent, respectively of the recommendations given in 'Package of Practices' published by Directorate of Extension Education, HAU, Hisar, which have reached on the farm of the progressive farmers in the study area.

used in a production system MVP curve represents the marginal value products of capital at the existing technology. If the cost of money, including interest rate, is at the level C_0 and he has unconstrained access to credit to borrow the input (capital), the producer would maximize his returns above the costs, if capital is used at level XE . At this level of input use, the returns above variable cost are represented by the area enclosed by $C_0 AE$, ($OAE, XE, -OC_0 E_1 X E_1$). Such a view of optimization is not sufficient, however, if access to capital is restrained due to limited availability of credit so that he is able to spend capital upto XR . The effect of this is reduction in net earnings to the amount represented by the area enclosed by $F_1 F_2 C_1$.

Because of the introduction of new technology the MVP curve would shift towards right ($MVPX_2$). If the per unit cost of money remains unchanged and he has unconstrained access to credit to buy this input, the producer would maximize his return, above the cost by borrowing the money upto XE_2 . The effect of this is an increase in net earnings to the amount represented by the area enclosed by $E_1 AE_2$. If access to the capital is restrained at a previous level DR because of credit facilities not expanding at all after technological change, the net income of the farmer would increase only by the amount represented by the area enclosed by $F_2 AF_3$.

RESULTS AND DISCUSSION

Optimum Farm Plans with Existing Technology

The results obtained by the programming are given in Fig. 2. First plan

represents the trivial 'optimum' plan where the farmers have zero capital and produce zero income. It is evident from the figure that the working capital requirement for the optimum farm plans at existing level of technology was about Rs. 1166, generating an income of about Rs. 4869 as compared to the existing plan at the existing level of technology and resource use (Appendix I) yielding a net return of Rs. 3133 requiring Rs. 1056 as capital. However, the net income was raised on reallocating the existing resources, showing sub-optimal use of capital under existing resource use pattern. Crops coming in the most profitable plan were wheat mexican, gram kabuli, cotton, **bajra** hybrid and **guar**.

The marginal productivity of capital, the total income and level of real activities corresponding to Rs. 0.00, 22.80, 59.65, 518.63, 611.03, 673.47, 932.11 and 1166.31 are depicted in Fig. 2. The income and level of real activities corresponding to Rs. 22.80 of capital shown by the line aa' was Rs. 527.40 and the level of P_3 (**guar**) was 0.30 ha. Similarly, the lines bb' , cc' , dd' , ee' , ff' and gg' correspond to approximate plans for Rs. 59.65, 518.63, 611.03, 673.47, 932.11 and 1166.31 of capital, respectively, and the income was Rs. 1108.96, 3819.38, 4123.58, 4272.96, 4794.48 and 4868.85, respectively. The straight lines drawn between the points corresponding to the successive plans of continuous solutions provide the optimum programmes for intermediate capital levels, at which the optimum combination of activities happened to change. Having inserted the appropriate lines in the figure, there is no difficulty in finding the optimum plan for any level of capital supply.

PLANNING FARMS UNDER VARYING CAPITAL

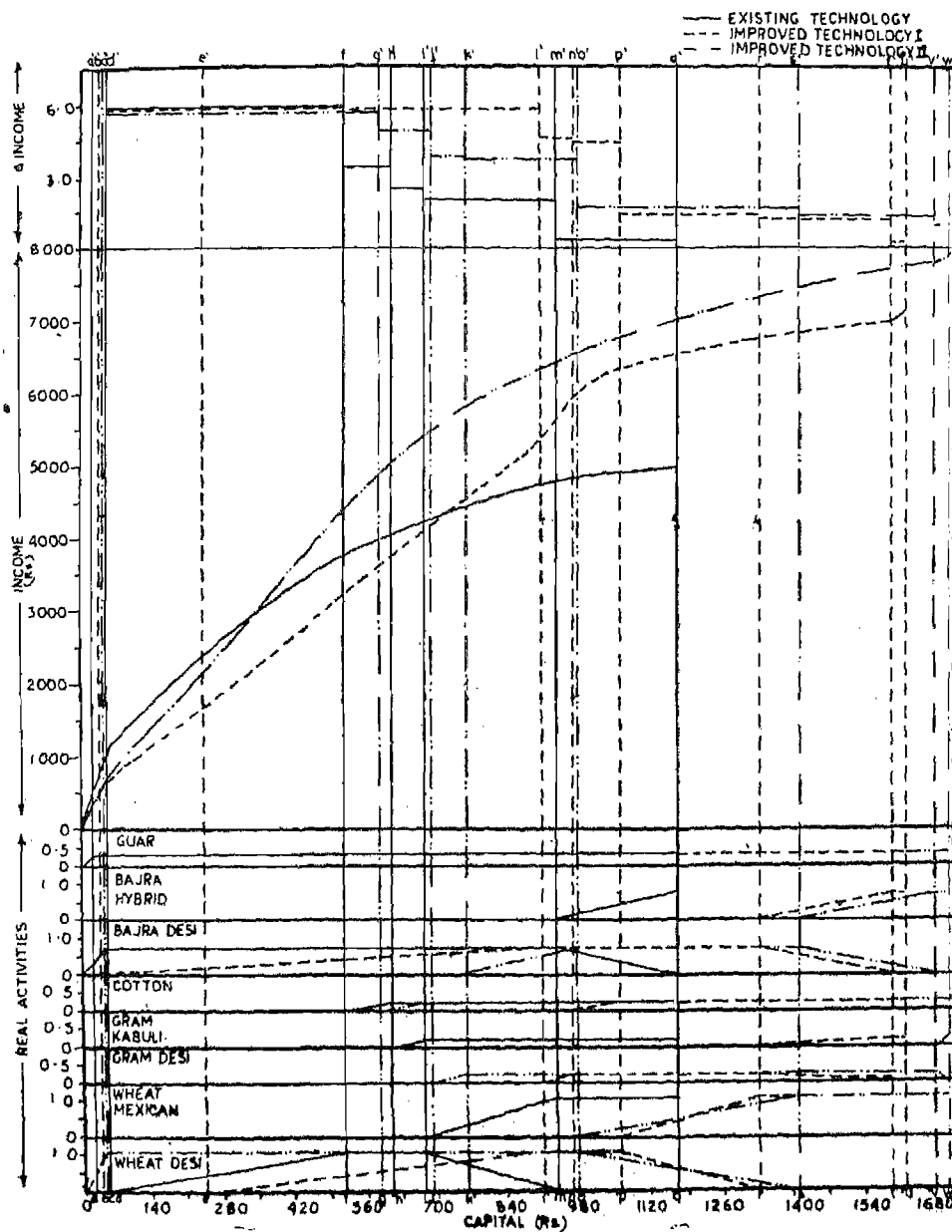


Fig. 2. Plans at existing and improved levels of technology.

Optimum Farm Plans with Improved Technologies

The optimum farm plans with improved technologies—I and II are depicted in Fig. 2. As evident from figure, working capital requirement for an optimum at improved technology-I for generating an income of Rs. 7087.83 was Rs. 1613.13. The income from 0.00 to Rs. 1613.13 capital was between 0.00 to Rs. 7087.83. The above findings show sufficient scope to increase income on small farms through adoption of improved technologies with marginal increase in working capital.

Fig. 2 also enables to follow easily the successive steps of the continuous solution. The total income and level of real activities are represented by dotted line. The figure also shows all the critical plans at which investment opportunity changes as the availability of capital increases at different levels of technology. The slope of the line indicates change in income with a per unit change in investment.

Marginal Value Products

A linear programming problem has a dual solution. The development of

optimum farm plans and marginal value productivity of resources were used as restraints.

The MVP of rabi irrigated and un-irrigated land were Rs. 1067 and 3049 at existing level of technology and these were increased to Rs. 2053 and 4400 at improved level of technology showing thereby increase of 92.41 and 44.30 per cent, whereas at improved level of technology-II increase of 139.92 and 55.46 per cent was observed. For kharif unirrigated and irrigated lands, increase in MVP by 19.97 and 68.84 per cent was observed at improved level of technology-I and 92.03 and 78.29 per cent at improved level of technology-II over the existing technology. For cotton land MVP was increased from Rs. 1520 at existing level to Rs. 2109 at improved level of technology-I (88.75%) and Rs. 2710 (78.29%) at improved level of technology-II.

ACKNOWLEDGEMENTS

The authors acknowledge the help rendered by Dr. K. N. Rai, Assistant Scientist, Department of Agricultural Economics, Haryana Agricultural University, Hisar and the staff of S.F.D.A., Bhiwani.

APPENDIX I

Existing plan

Particulars	Area (ha)	Net returns per hectare (Rs.)	Net returns (Rs.)
Wheat desi	0.075	2557	191.78
Wheat mexican	0.30	3049	914.70
Gram desi	0.69	252	173.88
Gram kabuli	0.14	1067	149.38
Bajra desi	0.05	868	43.40
Bajra hybrid	0.41	979	401.39
Cotton	0.60	1521	912.60
Guar	0.06	1758	105.48
Jowar	0.25	961	240.25
Total	—	—	3132.86

FACTORS INFLUENCING FARM MODERNIZATION IN HARYANA

B. S. BANGARWA*, RAJ SINGH and R. S. KADIAN*

Department of Sociology .

Haryana Agricultural University, Hisar

(Received : February 17, 1983; Revised : October 3, 1983)

ABSTRACT

Technological development is pre-requisite for attaining more output in agriculture but without its diffusion and adoption the desired results cannot be attained. As the situation prevails, the production of technology is much faster compared with its diffusion. The study conducted in different agro-climatic regions of Haryana revealed that respondents belonging to upper caste, educated and with larger size of land holding adopted the new farm technology in larger quantum.

The region now comprising Haryana was comparatively less developed within the erstwhile State of Punjab. The State was deficit in food grains and had a very poor industrial growth. It lacked elementary infrastructures for overall development. Moreover, area under irrigation was 40% of the total cropped area and farmers were mainly growing *desi* varieties and followed more or less the ageold cropping pattern. However, since Haryana's inception in November, 1966 the use of high-yielding variety seeds of cereal crops, fertilizers, and plant protection measures increased considerably. The progress of mechanisation of agricultural operations also registered phenomenal changes. As a result of these developments, the production of paddy, wheat, sugarcane, total kharif cereals, total food grains and all crops increased by 211, 68, 39, 70, 45 and 44 per cent, respectively in 1977-78, over the base period of 1966-67 (Statistical Abstracts

of Haryana 1978-79 and 1979-80). Taking the same base period again, the indices of area under crops, net area sown, cropping intensity, yield, productivity and agricultural production in 1977-78 increased to 117, 107, 109, 112, 136 and 144 per cent, respectively.

The social scientists also attempted to understand the process of farm modernization in terms of socio-economic and cultural variables like caste, education, size of land holding, etc. Reddy and Reddy (1972) and Madalia and Rajwadi (1976) found that the size of farm was positively related to the adoption of farm practices. Muthiah *et al.* (1978) concluded that the different farm size groups adopted recommended practices irrespective of their size. Kahlon (1981) indicated that socio-cultural factors are inhibiting adoption of improved technology. Agro-Economic Research Centre (1981) reported that Harijan farm households

*Department of Agricultural Economics.

appeared to have used less fertilizers as compared to households belonging to upper castes. The level of farmers' educational attainments appeared to have no influence on fertilizer use. Sushama *et al.* (1981) found that farm size, income and socio-economic status had positive and significant relationship with adoption. Waghmare and Pandit (1982) observed socio-cultural constraints in the adoption of high yielding varieties. To understand the role of these variables in modernizing agriculture in Haryana, the present study was undertaken so that the process of farm modernization could be accelerated to maintain the present growth rate in agricultural production.

METHODOLOGY

The study was conducted in rural Haryana. To ensure representation of different agro-climatic regions, the State was divided into three zones. Zone I—consisting of Ambala, Kurukshetra, Karnal and Sonapat districts, has more assured irrigation and fertile land. In contrast to this zone, areas comprising Bhiwani, Mahendragarh, Gurgaon and Faridabad having relatively less irrigation facilities and sandy soils could be characterised as dry farming (Zone II). In between these two zones lies the Zone III comprising Sirsa, Hisar, Jind and Rohtak districts. To represent the three broad agro-climatic regions of the State, Bawal, Jind and Karnal tehsils were selected purposively from Mahendragarh, Jind and Karnal districts, respectively. From each tehsil, one cluster of four contiguous villages was selected. A list of farmers in ascending order of their holding sizes was prepared for each cluster of four selected

villages. These farmers were categorised into small, medium and large farm size groups. For determining the range of holding falling into small, medium and large farm groups, the farmers from the top of the list accounting for one-third of the total cultivated area of the sample villages were termed as small farmers. Farmers from the middle of the list sharing next one-third of the total area were termed as medium farmers, and the farmers from the bottom of the list accounting for the remaining one-third of the area were termed as large farmers. Hence, in Mahendragarh district, farmers with the size of operational holding below 1.6 ha, 1.6 to 3.2 ha and above 3.2 ha were categorised into small, medium and large farm groups, respectively. However, in case of Jind and Karnal districts, the size of operational holding of the small, medium and large farm groups was found to be below 2.4 ha; 2.4 to 4.8 ha and above 4.8 ha, respectively. From each cluster, 60 farmers i.e. 20 each from the small, medium and large farm size groups were selected randomly. In this way 180 farmers were selected as respondents for the present study. The number of farmers of various size groups selected from the sample villages was in probability proportional to the number of farmers in each size group. These respondents were interviewed with the help of a structured schedule for collecting primary data in the year 1979-80. Data, thus, collected were converted into percentages for drawing inferences.

RESULTS AND DISCUSSION

For understanding the process of farm modernization in terms of socio-economic

FARM MODERNIZATION

and cultural variables, the relationships between caste, education and farm size and new farm technology such as tubewells, tractor, thresher, improved seeds, fertilizers and plant protection chemicals were studied (Table 1).

An appraisal of data reveals that new farm technology has percolated to farmers representing all caste groups, literacy status and different farm size groups. The proportion of its adoption among respondents representing different socio-cultural background was uneven. It shows that the farmers are eager to adopt technology which is culturally compatible, economical and easy to practise. Data

in Table 1 reveal that the application of fertilizers and use of improved seeds were acceptable to most respondents representing different caste groups. Similarly, the economic feasibility and profitability of tubewells and threshers found ready acceptance among most respondents representing upper and backward castes. The use of plant protection chemicals and the purchase of tractors is a complex technology and did not find general acceptance among upper and backward castes and particularly among scheduled castes. The poor acceptability of modern farm technology among scheduled caste respondents may also be attributed to their smaller size in the

TABLE 1

Relationship between selected variables and the elements of farm modernization

Selected variables	Elements of farm modernization					
	Tubewell	Tractor	Thresher	Improved seeds	Fertilizers	Chemicals
Caste groups						
Upper (165)	121 (73.33)	35 (21.21)	66 (40.00)	94 (56.96)	131 (79.39)	26 (15.75)
Backward (10)	7 (70)	2 (20)	6 (60)	3 (30)	9 (90)	3 (30)
Scheduled (5)	—	—	—	1 (20)	2 (40)	—
Education						
Illiterate (84)	50 (78.12)	8 (12.50)	26 (40.62)	33 (51.56)	53 (82.81)	7 (7.81)
Literate (116)	78 (67.24)	29 (25)	46 (39.65)	65 (56.03)	89 (76.72)	22 (18.96)
Farm size						
Small (60)	26 (43.33)	1 (1.66)	14 (23.33)	24 (40.00)	37 (61.66)	3 (5.00)
Medium (60)	49 (81.66)	7 (11.66)	20 (33.33)	35 (58.33)	50 (83.33)	11 (18.33)
Large (60)	53 (88.33)	29 (48.33)	38 (63.33)	39 (65)	55 (91.66)	15 (25)

Figures in parentheses are percentages.

sample, non-agricultural background and poor socio-economic status in the society. Agro-Economic Research Centre (1981) also noticed variation among different caste groups in the adoption of improved farm technology.

Literacy level of respondents was related to selected elements of new farm technology. Illiterate respondents were ahead of their literate counter-parts in the adoption of fertilizers, installation of tubewells, and purchase of threshers, whereas the literate respondents were ahead of illiterates in the adoption of improved seeds, purchase of tractors and in the use of plant protection chemicals. Thus, literacy level was not playing any prominent role in the adoption of new farm technology. The findings of Agro-Economic Research Centre (1981) also reveal that the level of farmers' educational attainments had no influence on fertilizer use.

The relationship between farm size and the adoption of selected elements of

farm modernization revealed that farm size plays determinant role in the adoption of new farm technology. As the farm size increased from small to large, the extent of adoption of all the selected aspects of farm modernization increased accordingly. Technology such as tractors and use of plant protection chemicals found poor acceptance among respondents representing small farm size group probably due to complexity and economic incompatibility to their status, whereas technology which was profitable, compatible and useful to their farm size found moderate to good acceptance. It may be concluded that the extent of adoption of farm practices by farmers representing scheduled castes and backward classes was not encouraging. Hence, extension/development agents must pay adequate attention to these categories. Extension agents must also spend adequate time and energy in order to educate the illiterate farmers about complex but profitable farm practices.

REFERENCES

- Agro-Economic Research Centre. 1981. Factors affecting fertilizer use in the hill region of Uttar Pradesh. *Agricultural Situation in India* 36 : 279-82.
- Kahlon Jr., A. S. 1981. Factors affecting adoption of improved animal-drawn implements in India. *Agricultural Situation in India* 36 : 259-61.
- Madalia, V. K. and Rajwadi, R. V. 1976. Adoption of agricultural innovations. *Kurukshetra* 24 : 14-15.
- Muthiah, M., Perumal, G. and Somasundaram, S. 1978. Influence of peripatetic training programme on the adoption of recommended farm practices. *Indian J. Ext. Educ.* 14 : 62-64.
- Reddy, K. J. and Reddy, G. B. 1972. Adoption of improved agricultural practices in Andhra Pradesh. *Indian J. Ext. Educ.* 8 : 17-20.
- Statistical Abstracts of Haryana 1978-79 and 1979-80. Department of Statistics, Government of Haryana.
- Sushama, N. P. K., Menon, A. G. G. and Bhaskaran, C. 1981. Adoption behaviour of selected tribes of Kerala. *Indian J. Ext. Educ.* 17 : 71-76.
- Waghmare, S. K. and Pandit, V. K. 1982. Adoption of wheat technology by tribal farmers of Madhya Pradesh. *Indian J. Ext. Educ.* 18 : 95-98.

DROP-OUTS AMONG SCHEDULED CASTES IN HARYANA

J. K. KHAIRWAL and RAJ SINGH

Department of Sociology

Haryana Agricultural University, Hisar

(Received : March 23, 1983; Revised : March 28, 1984)

ABSTRACT

The findings of the study conducted in two villages in Hisar district of Haryana State indicated high rate of drop-outs among scheduled castes. The proportion of drop-outs was high at the primary level followed by middle and high standard in the sampled villages. Long absence, non-payment of dues, refusal to study and failure were mentioned the reasons for their drop-outs in school records. However, according to respondents poverty followed by poor in studies and employment opportunity were main causes for their drop-outs.

The beginning of the process of modernization in India sometime in the middle of Nineteenth Century, shook the age old social structure to its very foundation. The conservative traditions started dwindling. The reform movements brought some consciousness for ameliorating lot of Harijans. Educating them came to be considered as a means of raising their status both social and economic. Efforts were initiated to create opportunities for their education and employment. As a result of all these efforts, our countrymen are growing more and more education conscious and this consciousness is also reflected among the backward sections of the country. However, the success throughout this period has been partial, as is evident from the scheduled castes literacy percentage during 1981 which has been estimated to about 25.88% of total population of the scheduled castes in the state of Haryana, whereas literacy level of Haryana as a whole is around 36 per cent.

Choudhary (1974) and Khan (1980) found maximum drop-out proportion at primary standard. Karlekar (1975) reported that considerable drop-outs from educational institutions were due to economic pressure. Their involvement in household activities for the augmentation of family income does not allow to devote more time for study. Brahne (1975-76) found that drop-outs among scheduled castes were due to hard economic conditions. Punalekar and Singh (1975) reported the poverty and economic hardship as the main causes of drop-outs including related factors such as distance, location, behaviour of teachers, behaviour of school mates, domestic exigencies, individual deficiency and cultural factors such as belief and value. Mehta (1976) reported that proportion of drop-outs was much higher in the rural as compared to urban areas. Lack of synchronization between the timings of vacation of examination and peak agricultural seasons also leads to drop-

outs at very early ages. Chitnis and Aikara (1977) reported factors like failure, employment, and parents poor economic condition for drop-outs. Pimpley (1978) observed that the urban children had a higher rate of drop-outs. An analysis of above studies indicates that only sporadic attempts have been made to understand the problem of drop-outs among scheduled castes. Therefore, in the present study an attempt was made to understand the problem of drop-outs among scheduled castes from various angles.

METHODOLOGY

The study was conducted in Hisar district of Haryana State. Two villages viz., Satrod Khas and Ladwa were selected for gathering information, the former being urbanized and the latter being less urbanized village and located at the respective distance of 10 and above 10 km from the district headquarter. Both the villages were having schools since independence and high schools were in existence for more than a decade. Two categories of scheduled castes students were selected for gathering the primary data, one, those appeared in 8th standard examination and are studying between 8th and 10th classes. Second the contemporary of these school going students who had to discontinue their studies before appearing in the middle standard examination. In all 30 students from Satrod Khas—15 school going and 15 drop-outs, and 32 from Ladwa—16 school going and an equal number of drop-outs were included in the sample making a total of 62 respondents. All these respondents were interviewed personally with the help of a structured interview schedule in the year 1981-82. The data

thus collected were converted into percentages for drawing inferences.

RESULTS AND DISCUSSION

Before discussing the problem of drop-outs it is worthwhile to know the education trend among scheduled castes at different periods in the sampled villages.

A perusal of Table 1 reveals that the enrolment of students belonging to scheduled castes increased progressively among all groups since the establishment of schools in both the villages. The drop-outs percentage was as high as 83 in village Satrod Khas upto 1950 which came down to 60 in the next decade, i. e., 1951-60. But, during 1961-70 it increased to 64% and during 1971-80 it swelled as high as 86% particularly in an urbanized village like Satrod Khas which is definitely a cause of concern for educational planners. However, the drop-outs trends in Ladwa village was found to be different from Satrod Khas but the per cent of drop-outs was very high and ranged between 84-100. Analysis of drop-outs at sub-castes level reveals minor variations. The percentage of drop-outs among chamars was lower compared with other sub-caste groups indicating their progressiveness towards education.

To have clear knowledge of the drop-outs problem, it is worthwhile to find out drop-outs proportion in different classes. Analysis of data presented in Table 2 reveals that drop-outs at primary level were 89, 83, 55 and 49 per cent, respectively during forties of the Twentieth Century, 1951-60, 1961-70 and 1971-80, whereas the drop-outs percentage in middle and

DROP-OUTS AMONG SCHEDULED CASTES

TABLE 1
Education of scheduled castes as per sub-caste groups

Period	Sub-caste groups							
	Chamar		Dhanak		Balmiki		Total	
	A	D (%)	A	D (%)	A	D (%)	A	D (%)
Satrod Khas								
Upto 1950	39	28 (72)	38	35 (92)	3	3 (100)	80	66 (83)
1951-60	32	17 (53)	31	20 (65)	7	5 (71)	70	42 (60)
1961-70	125	82 (66)	87	56 (64)	10	5 (50)	222	143 (64)
1971-80	226	187 (83)	124	112 (90)	19	18 (95)	369	317 (86)
Ladwa								
1951-60	7	7 (100)	1	1 (100)	—	—	8	8 (100)
1961-70	113	96 (85)	6	5 (83)	7	6 (86)	126	107 (85)
1971-80	174	140 (80)	28	25 (89)	33	33 (100)	235	198 (84)

A=Admitted D=Drop-outs

TABLE 2
Drop-outs among scheduled castes as per different classes

Period	Primary	Middle	High	Total
Satrod Khas				
Upto 1950	59 (89)	7 (11)	—	66
1951-60	35 (83)	7 (17)	—	42
1961-70	78 (55)	39 (27)	26 (18)	143
1971-80	154 (49)	102 (32)	61 (19)	317
Ladwa				
1951-60	5 (63)	—	3 (38)	8
1961-70	69 (64)	25 (23)	13 (12)	107
1971-80	121 (61)	51 (26)	26 (13)	198

Figures in parentheses are percentages.

high classes was very small in the formative days of the establishment of school which increased marginally in subsequent years. It may be concluded that drop-outs at primary level is decreasing, whereas at middle and high classes it is increasing even in urbanized villages. A more or less similar trend was noticed in

Ladwa village. Pimpley (1978) also observed high drop-outs among scheduled castes in urban areas. Choudhary (1974), Karlekar (1975) and Punalekar and Singh (1975) reported high drop-outs among scheduled castes in primary and middle classes.

TABLE 3

Reasons for drop-outs as per school records

Period	Long absence	Non-payment of dues	Refusal to study	Failure	Total
Satrod Khas					
Upto 1950	55 (83)	1 (2)	10 (15)	—	66
1951-60	40 (95)	—	—	2 (5)	42
1961-70	120 (84)	21 (16)	—	2 (1)	143
1971-80	240 (76)	64 (20)	—	13 (4)	317
Ladwa					
1951-60	6 (75)	—	2 (25)	—	8
1961-70	98 (92)	7 (7)	2 (2)	—	107
1971-80	180 (91)	18 (9)	—	—	198

Figures in parentheses are percentages.

To have clear view of the casualties for drop-outs, school records as well as respondents views were taken into account.

An appraisal of Table 3 reveals that long absence is largely responsible for drop-outs among scheduled castes in both the sampled villages, followed by non-payment of dues, refusal to study and failure in examination. Jaiswal and Jha (1970-71), Joshi (1979) and Goyal (1981) also reported similar reasons for drop-outs. In the urbanized village the problem of absence is decreasing, whereas in the non-urbanized village it is increasing. This variation may be attributed to location of the schools from district headquarters. The school located near urban centre could be supervised efficiently compared with the one located far away, hence influenced teacher's performance and interest. It may be inferred that lack of concern both on the part of teachers as well as parents had resulted

into long absence which had resulted in drop-outs.

The respondents who had to discontinue their studies were also asked to elaborate important reasons for their drop-outs. A perusal of Table 4 reveals that poverty was reported as a major factor for drop-outs followed by poor in studies. It is obvious that poverty continues to be an important factor for drop-outs among scheduled castes. Jaiswal and Jha (1970-71), Karlekar (1975),

TABLE 4

Reasons for drop-outs

Reasons	Satrod Khas	Ladwa
Poverty	60	81
Poor in studies	20	19
Joined service	13	—
Illness	7	—
Total	100	100

Figures are percentages.

DROP-OUTS AMONG SCHEDULED CASTES

Chitnis and Aikara (1977) and Goyal (1981) reported economic hardship as obstacle for drop-outs and poor performance in studies.

The data indicate that the extent of drop-outs was quite substantial in both the sampled villages among scheduled castes which is really a very [serious setback to programmes of educational upliftment of scheduled castes. This situation may be attributed to deteriorating economic conditions of these people and lack

of concern on the part of teachers to provide adequate motivation and generate necessary interest among scheduled castes students. Moreover, most parents of these students are equally unaware of the importance of education. They seldom persuade them to go to school regularly and acquire good education and rather employ them in wage earning activities. Hence, it is imperative to evaluate the policy of education of scheduled castes and give it a new direction for better results.

REFERENCES

- Brahne, S. 1975-76. Scheduled castes and scheduled tribes. *Yojna* 19 : 97-99.
- Chitnis, S. and Aikara, J. 1977. The scheduled castes and college education—A study of drop-outs and the situation of the scheduled castes students of Bombay. *ICSSR Res. Abstr. Quart.* 6 : 11-22.
- Choudhary, N. D. 1974. School leaving and stagnation among scheduled castes. *Shiksha Vivechan* 3 : 179-97.
- Goyal, B. R. 1981. *Educating Harijans*. The Academic Press, Gurgaon.
- Jaiswal, N. K. and Jha, P. P. 1970-71. Sociological study of scheduled castes. *Kurukshetra* 18 : 9.
- Joshi, S. D. 1979. Educational problems of scheduled castes and scheduled tribes of Baroda district. Ph.D. thesis, M. S. University of Baroda, Baroda.
- Karlekar, M. 1975. Higher education and the scheduled castes. *J. Higher Educ.* 1 : 179-87.
- Khan, M. A. 1980. *Scheduled Castes and their Status in India*. Uppal Publishing House, New Delhi.
- Mehta, P. 1976. Socio-Psychological Interventions for Universalizing Education—A Case for Radical Social Transformation and Non-formal Education. National Labour Institute, New Delhi.
- Pimpley, P. N. 1978. Problems of non-attendance of school of the children of scheduled castes in Haryana. Research project submitted to ICSSR, New Delhi.
- Punalekar, S. P. and Singh, K. K. 1975. School drop-outs among Harijan children. *ICSSR Res. Abstr. Quart.* 4 : 124-41.

DECLARATION

FORM IV

(See Rule 8)

<i>Place of publication</i>	... Haryana Agricultural University, Hisar
<i>Periodicity of publication</i>	... Quarterly (March, June, September & December)
<i>Printer's name</i>	... Dr. J. N. Chand
<i>Whether citizen of India ?</i>	... Yes
<i>Address</i>	... Director of Publications Haryana Agricultural University, Hisar
<i>Publisher's name</i>	... Dr. J. N. Chand
<i>Whether citizen of India ?</i>	... Yes
<i>Address</i>	... Director of Publications Haryana Agricultural University, Hisar
<i>Editor's name</i>	... Dr. R. P. Bansal
<i>Whether citizen of India ?</i>	... Yes
<i>Address</i>	... Editor (Research) Haryana Agricultural University, Hisar
<i>Names and addresses of individuals who own the newspaper and partners or shareholders holding more than one per cent of the total capital.</i>	... Haryana Agricultural University, Hisar

I, Dr. J. N. Chand, hereby declare that the particulars given above are true to the best of my knowledge and belief.

Sd/-
Dr. J. N. Chand

CALCIUM, PHOSPHORUS, MANGANESE AND ZINC RETENTION IN BROILERS GIVEN MAIZE AND SORGHUM BASED DIETS WITH DIFFERENT ENERGY AND PROTEIN LEVELS

V. P. SAXENA

Department of Animal Nutrition
Haryana Agricultural University, Hisar

(Received : June 16, 1982; Revised : September 3, 1984)

ABSTRACT

An experiment was designed in $4 \times 2 \times 2$ factorial arrangement to test 16 diets of four dietary protein combinations (20—17%, P₁; 22—19%, P₂; 24—21%, P₃ and 26—23%, P₄) with two sets of ME/P ratios (130 : 1 — 155 : 1, E₁; and 145 : 1—170 : 1, E₂) and two grains (maize and sorghum). Feeding trials were continued for 10 weeks on 1020 day-old commercial broilers. Balance trials for calcium, phosphorus, manganese and zinc were conducted at 5th and 9th week of growth for the starting and finishing period.

The retention of calcium, phosphorus, manganese and zinc remained unaffected due to different dietary grains within the first 6 weeks of broiler growth. Generally all the high energy diets had better calcium and manganese retention, while retention of phosphorus and zinc remained unaltered. As regards the finishing period, better ($P < 0.01$) retention of minerals was observed with maize-based diets. Lower retention was exhibited from diets carrying the lesser overall concentrations of protein and energy viz., from P₁ and P₂ (E₁ and E₂) diets only.

Leach and Norris (1958) reported that increasing the energy content of a chick diet appeared to increase the need for potassium. Again, Edwards *et al.* (1960) showed a higher calcium requirement when large amount of tallow, as the main supplier of energy, was included in poultry ration. On the other hand, Lillie *et al.* (1964) reported that dietary energy content had no effect on calcium and phosphorus utilization in agreement with earlier reports by Fisher *et al.* (1953), Pepper *et al.* (1955) and Vendepopuliere *et al.* (1961), while Peeler

et al. (1960) reported the superiority of high energy diets for better mineral retentions.

The present study was conducted to know the comparative efficiency of maize and sorghum based broiler diets at various energy and protein levels with respect to retention of calcium, phosphorus, manganese and zinc.

MATERIAL AND METHODS

Day-old broilers were distributed into 32 groups containing 31 to 32 chicks in

each, on the basis of their weights. The chicks had been vaccinated against Ranikhet disease. The average weight of chicks in each group was 50 g. Sixteen dietary treatments (Saxena and Pradhan, 1978) were randomly assigned to these groups so that each treatment was assigned to two replicate groups. Sixteen diets were formulated using 4 combinations of protein levels (20, 22, 24 and 26 per cent protein during starting phase followed by 17, 19, 21 and 23 per cent protein in finishing phase, the respective double combinations being denoted as P_1 , P_2 , P_3 and P_4), two sets of metabolizable energy: protein ratios (130:1—155:1, E_1 and 145:1—170:1, E_2) and two grains (maize and sorghum) in $4 \times 2 \times 2$ factorial design. The diets were fed during starting (0-6 weeks) and finishing (6-10 weeks) periods of broilers. The first level or ratio in each combination or set, respectively, was used during starting period while the second was used in finishing period.

The chicks were reared under electrically heated wooden floor brooders on fresh and dry saw dust upto 4 weeks of their starting period. The analysed dietary values of calcium, phosphorus, manganese and zinc, as presented in Table 1 satisfied well over ISI (1967)/NRC (1971) specifications. The tannin content of grain sorghum used for feed formulation was estimated according to Burns (1971).

Metabolic trials for balance of calcium, phosphorus, manganese and zinc were conducted at the fifth week during starting and ninth week during the finishing period in battery brooders and

grower batteries, respectively, on 10 randomly selected birds from each treatment. During metabolic trial, the feed was offered in the morning and feed residue was recorded next morning before offering more feed. Samples of both feeds and feed residues were collected and preserved for chemical analyses. The droppings were collected every morning, weighed, put in plastic bags and preserved in deep freeze. At the end of week the droppings were pooled replicate-wise. A representative sample was put in plastic bag and was preserved for chemical analysis. The feed, the residue and the droppings were analysed for calcium and phosphorus using the method of Talapatra *et al.* (1940). The samples meant for manganese and zinc estimation were digested by following the method of Lindsay and Norvell (1968) in diacid mixture of nitric acid (distilled) and perchloric acid (AR grade) in the ratio of 5:1. The trace minerals were analysed by using an atomic absorption spectrophotometer (Model Varian Techlon AA 120). The data were analysed as per Snedecor and Cochran (1967) using the method of analysis of variance.

RESULTS AND DISCUSSION

The tannin content of grain sorghum used for feed formulation was estimated to be 0.55 per cent. The percentage retentions of dietary intake of calcium, phosphorus, manganese, and zinc have been presented in Tables 2 and 3 for the starting and finishing growth periods of the broilers, respectively.

The minerals retention remained unaffected due to different grains in the

STUDY OF BROILERS

TABLE 1
Dietary contents of calcium, phosphorus, manganese and zinc for starter and finisher periods of broiler growth

Growth period	Mineral	Grain	P ₁		P ₂		P ₃		P ₄	
			E ₁	E ₂	E ₁	E ₂	E ₁	E ₂	E ₁	E ₂
Starting (0-6 weeks)	Calcium (%)	Maize Sorghum	1.73	1.68	1.73	1.70	1.73	1.68	1.69	1.63
			1.72	1.68	1.72	1.68	1.73	1.68	1.69	1.63
	Phosphorus (%)	Maize Sorghum	0.99	0.99	0.96	0.95	0.91	0.91	0.90	0.89
			1.00	0.99	0.96	0.95	0.91	0.91	0.90	0.90
	Manganese (ppm)	Maize Sorghum	125.36	123.64	119.85	118.50	112.50	110.25	107.06	104.95
			126.59	124.96	121.05	119.19	113.50	111.44	108.38	106.22
	Zinc (ppm)	Maize Sorghum	99.42	99.42	95.42	95.42	89.82	89.82	87.39	87.39
			100.61	100.61	96.61	96.61	91.00	91.00	88.51	88.48
Finishing (6-10 weeks)	Calcium (%)	Maize Sorghum	1.72	1.68	1.72	1.67	1.70	1.66	1.66	1.62
			1.71	1.68	1.70	1.66	1.70	1.65	1.67	1.65
	Phosphorus (%)	Maize Sorghum	1.04	1.03	1.00	0.99	0.95	0.94	0.91	0.91
			1.04	1.04	1.00	1.00	0.95	0.95	0.92	0.91
	Manganese (ppm)	Maize Sorghum	133.07	131.67	124.08	122.52	117.60	115.83	111.10	109.59
			134.33	132.92	127.42	125.84	118.81	117.03	112.30	110.81
	Zinc (ppm)	Maize Sorghum	100.92	100.92	96.73	96.73	91.02	91.02	90.13	90.01
			102.11	102.11	97.92	97.92	92.21	92.21	91.32	91.06

P₁=20—17%, P₂=22—19%, P₃=24—21%, P₄=26—23% CP from starting-finishing period.

E₁=130 : 1—155 : 1, E₂=145 : 1—170 : 1, ME/CP ratio from starting-finishing period.

TABLE 2
Treatment means for % minerals retention for broiler starting growth period (0-6 weeks)

Mineral	Grain	P ₁		P ₂		P ₃		P ₄		Average (grains)
		E ₁	E ₂	E ₁	E ₂	E ₁	E ₂	E ₁	E ₂	
Calcium	Maize	50.53	52.80	49.53	53.35	50.75	48.17	50.13	51.84	50.89
	Sorghum	49.52	54.46	52.12	51.99	52.17	50.70	52.36	50.89	51.77
	Av.	50.02 ^c	53.63 ^a	50.82 ^{bc}	52.67 ^{ab}	51.46 ^{abc}	49.43 ^c	41.24 ^{abde}	51.36 ^{abc}	
Phosphorus	Maize	48.43	49.46	48.22	50.26	49.40	47.72	48.95	48.63	48.88
	Sorghum	47.67	50.43	49.58	49.38	50.15	49.08	50.14	49.01	49.43
	Av.	48.05	49.94	48.90	49.82	49.77	48.40	49.54	48.82	
Manganese	Maize	56.62	57.58	56.54	58.62	58.16	56.33	58.04	58.95	57.60
	Sorghum	55.66	59.18	48.12	57.93	58.96	57.86	59.32	58.19	58.15
	Av.	56.14 ^b	58.38 ^a	57.33 ^{ab}	58.27 ^a	58.56 ^a	57.09 ^{ab}	58.63 ^a	58.57 ^a	
Zinc	Maize	41.39	42.42	41.28	43.22	42.52	40.86	42.23	42.80	42.09
	Sorghum	40.60	43.29	42.52	42.22	43.15	42.08	43.27	42.17	42.41
	Av.	40.99	42.85	41.90	42.72	42.83	41.47	42.75	42.48	

Means with the same superscripts do not differ significantly ($P < 0.05$) for a grain in a period. Each figure represents the average of ten observations.
 $P = 20\%$, $P_2 = 22\%$, $P_3 = 24\%$, $P_4 = 26\%$ CP.
 $E_1 = 130 : 1$, $E_2 = 145 : 1$, ME/CP ratio.

SAXENA

STUDY OF BROILERS

TABLE 3
Treatment means for % minerals retention for broiler finishing growth period (6-10 weeks)

Mineral	Grain	P ₁		P ₂		P ₃		P ₄		Average (grains)
		E ₁	E ₂	E ₁	E ₂	E ₁	E ₂	E ₁	E ₂	
Calcium	Maize	51.00 ^c	54.12 ^{ab}	52.91 ^{bc}	55.27 ^a	55.24 ^a	54.86 ^{ab}	53.96 ^{ab}	55.23 ^a	54.07 ^{**}
	Sorghum	48.96 ^d	51.28 ^c	49.28 ^d	54.04 ^b	52.32 ^{bc}	56.10 ^a	52.54 ^{bc}	53.96 ^b	52.29
	Av.	49.93	52.69	51.10	54.65	53.78	55.48	53.25	54.59	
Phosphorus	Maize	48.12 ^d	49.87 ^{bc}	49.87 ^c	50.86 ^{ab}	51.31 ^a	50.71 ^{abc}	50.75 ^{abc}	51.27 ^a	50.31 ^{**}
	Sorghum	46.75 ^d	48.01 ^c	47.40 ^{cd}	49.99 ^b	49.68 ^b	51.57 ^a	49.93 ^b	50.71 ^{ab}	49.25
	Av.	47.43	48.94	48.52	50.42	50.49	51.14	50.34	50.99	
Manganese	Maize	56.07 ^c	58.33 ^b	58.39 ^b	59.74 ^{ab}	60.44 ^a	59.78 ^{ab}	59.74 ^a	60.69 ^a	59.17 ^{**}
	Sorghum	54.18 ^e	55.96 ^d	55.22 ^{de}	58.66 ^{bc}	58.34 ^c	60.85 ^a	58.93 ^{bc}	59.90 ^{ab}	57.75
	Av.	55.12	57.14	56.80	59.20	59.39	60.32	59.43	60.29	
Zinc	Maize	41.44 ^c	43.06 ^b	42.95 ^b	44.02 ^{ab}	44.51 ^a	43.97 ^{ab}	43.81 ^{ab}	44.35 ^a	43.51 ^{**}
	Sorghum	39.97 ^d	41.22 ^c	40.64 ^{cd}	43.18 ^b	42.95 ^b	44.79 ^a	43.00 ^b	43.70 ^{ab}	42.43
	Av.	40.70	42.14	41.80	43.60	43.73	44.38	43.40	44.02	

**Significantly different at P<0.01 level.

Means with the same superscripts do not differ significantly (P<0.05) for a grain in a period.

Each figure represents the average of ten observations.

P₁=17%, P₂=19%, P₃=21%, P₄=23% CP

E₁=155 : 1, E₂=170 : 1, ME/CP ratio.

starting period. During the finishing period, however, better minerals retention was observed on maize based diets.

Calcium

Starting period. It is evident from the results (Table 2) that three of diets carrying higher overall concentrations of protein and energy i.e., P_3E_1 , P_4E_1 and P_4E_2 , resulted in concentration values which fell in groups of superior responses on one side and also in those of inferior responses on the other side. Thus, no specific trend was observed for calcium retention which remained unaffected due to different grains. However, when pooled averages for both the grains were evaluated together, it was revealed that different energy-protein levels had significant effect on calcium retention.

Finishing period. The P_2E_2 , P_3E_1 , P_4E_2 , P_3E_2 , P_1E_2 and P_4E_1 maize diets provided higher retentions. Among sorghum-based diets, P_3E_2 exclusively provided the maximum response. However, the lowest retentions were observed with P_1E_1 and P_2E_1 maize or sorghum diets.

Many of the high-protein high-energy diets (e. g., P_3E_1 , P_4E_2 , P_3E_2 and P_4E_1 maize-based; P_3E_2 sorghum-based) resulted in best retentions. However, the low-energy maize or sorghum diets with lower protein levels (P_1 or P_2) gave the lowest retention values. In this line, it was reported by Peeler *et al.* (1960) that high and low energy diets (1605 vs. 1265 Kcal ME/lb) produced 0.54 and 0.38 per cent bone ash, respectively. On the other hand, Edwards *et al.* (1960) noticed a higher calcium requirement when as principal supplements of energy,

large amounts of tallow were included in rations. They interpreted that the type of fat had an effect on calcium utilization, whereas in the present study vegetable oil (sesame oil) was used.

Phosphorus

Starting period. Again, the various protein or energy levels did not significantly alter the mean retention values for phosphorus relative to maize or sorghum diets which provided the pooled averages of 48.88 and 49.33 per cent, respectively.

Finishing period. During finishing phase, maximum retention of phosphorus was obtained with P_3E_1 , P_4E_2 , P_2E_2 , P_1E_1 and P_3E_2 maize based diets and P_3E_2 and P_4E_2 sorghum based diets. However, the maize diet P_1E_1 and sorghum diets P_2E_1 and P_1E_1 gave the lowest retention values.

In general, the diets having lower amounts of protein and energy (i.e., P_1E_1 and P_2E_1) provided the lowest retentions irrespective of grains. On the other hand, Lillie *et al.* (1964) observed that calcium or phosphorus utilization remained unaffected by the energy content of a ration as also reported by Fisher *et al.* (1953), Pepper *et al.* (1955) and Vandepopuliere *et al.* (1961).

Manganese

Starting period. Considering the pooled averages for the two grains, the P_4E_1 , P_4E_2 , P_3E_1 , P_1E_2 , P_2E_2 and P_3E_2 diets resulted in maximum retention of manganese. However, minimum manganese retention was obtained with P_1E_1 diet. The lower levels of protein (P_2 or E_1) at

STUDY OF BROILERS

a lower plane of energy (E_1) provided the lower values of manganese retention.

Finishing period. Superior and similar values emerged from P_4E_2 , P_3E_1 , P_4E_1 , P_3E_2 and P_2E_2 maize diets while the lowest retention was obtained on P_1E_1 diet. Highest retention was only recorded with the sorghum mashes P_3E_2 and P_4E_2 , the lowest responses being reflected from the P_2E_1 or P_1E_2 diet.

It was apparent that higher retentions followed on the high energy high protein diets such as P_4E_2 , P_3E_2 , P_3E_1 , etc. while the lower energy coupled with low protein (i.e., P_1E_1 , P_1E_2 or P_2E_1) concentrations often projected the lower values.

Zinc

Starting period. As in case of

phosphorus, the retention of zinc also remained unaffected due to energy protein ratios or grains.

Finishing period. Amongst the maize diets, best responses were recorded from P_3E_1 , P_4E_2 , P_2E_2 , P_3E_2 and P_4E_1 diet. The lowest value emerged from P_1E_1 diet. As regards the sorghum mashes, the P_2E_2 and P_4E_2 ranked equally superior to all other diets, whereas the lowest retention occurred either on P_2E_1 or P_1E_1 diet.

Low-energy low-protein combinations (e.g., P_1E_1 , P_2E_1 , etc.) provided lower retentions as also generally evident in case of other minerals studied. Again, a trend of higher retention emerged from the high-energy high-protein diets such as P_4E_2 , P_3E_2 , P_3E_1 , etc.

REFERENCES

- Burns, R. E. 1971. Method for estimation of tannin in grain sorghum. *Agron. J.* **63** : 151-52.
- Edwards, H. M. (Jr.), Dunahoo, W. S., Carmon, J. L. and Fuller, H. L. 1960. Effect of protein, energy and fat content of the ration on calcium utilization. *Poult. Sci.* **39** : 1389.
- Fisher, H., Singen, E. P. and Matherson, L. D. 1953. The influence of feed efficiency on the phosphorus requirement for growth and bone calcification in the chick. *Poult. Sci.* **32** : 749.
- ISI. 1967. *Indian Standard Specification of Broiler Feeds*. Indian Standard Institution, Manak Bhavan, 9 Bahadurshah Zafar Marg, New Delhi-1.
- Leach, R. M. and Norris, L. C. 1958. The effect of protein and energy on the potassium requirement of the chick. *Poult. Sci.* **37** : 1220.
- Lillie, R. J., Iwining, P. F. and Denton, C. A. 1964. Calcium and phosphorus requirements of broilers as influenced by energy, sex and strain. *Poult. Sci.* **43** : 1126.
- Lindsay, W. L. and Norvell, W. A. 1968. A new DPTA-TEA soil test for zinc and iron. *Agron. Abstr.* **61** : 84.
- NRC. 1971. *Nutrient Requirements of Domestic Animals. 1. Nutrient Requirements of Poultry*. National Research Council, National Academy of Sciences, Washington, D. C. 20418, USA.
- Peeler, H. T., Nelson, T. S. and Storer, N. 1960. The effect of energy on phosphorus requirement of the chick. *Poult. Sci.* **39** : 1282-83.
- Pepper, W. F., Slinger, S. J. and Motzok, I. 1955. Effect of animal fat on the calcium and phosphorus requirements of chick. *Poult. Sci.* **34** : 1216.

SAXENA

- Saxena, V. P. and Pradhan, K. 1978. Carcass composition of broilers on maize and sorghum diets at various levels of energy and protein in summer months. *Haryana agric. Univ. J. Res.* **8** : 282-90.
- Snedecor, G. W. and Cochran, W. G. 1967. *Statistical Methods*. The Iowa State University Press, Ames, Iowa.
- Talapatra, S. K., Ray, S. C. and Sen, K. C. 1940. The analysis of mineral constituents in biological materials. *Indian J. vet. Sci. Anim. Husb.* **10** : 243.
- Vandepopuliere, J. M., Ammerman, C. B. and Harms, R. H. 1961. The relationship of calcium phosphorus ratios to the utilization of plant and inorganic phosphorus by the chick. *Poult. Sci.* **40** : 951.

RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XV, No. 2, pp. 133—137 (June 1985)

AN APPRAISAL OF EDIBLE AND NON-EDIBLE ORGANS OF NALI AND ITS CROSSBRED LAMBS

K. S. SANGWAN and SHRI RAM

Department of Animal Breeding

Haryana Agricultural University, Hisar

(Received : January 19, 1984; Revised : October 29, 1984)

Liver, kidneys and testicles are rich source of animal protein in human diet. Most of the people have special liking for these internal organs due to their nutritive value, flavour, tenderness and juiciness. Hence, these organs are sold at a premium price in comparison to muscles and bones. Similarly, the non-edible organs like pluck, skin, hooves and head of the lamb also fetch a considerable price and is thus, an additional source of income to the farmer. Both edible and non-edible organs on an average fetch Rs. 15 per head, thus accounting for about 15% of the total income from slaughtered lamb. Therefore, these organs play a vital role in terms of economical aspect of the farmer. The genetic constitution of the lamb is likely to affect the quality and quantity of these organs. Similarly, the non-genetic factors may also influence these traits.

Contradictory reports have come out from a few studies conducted in India and abroad on these traits (Everitt and Jury, 1966; Epstein and Herz, 1968; Arnold *et al.*, 1969; Chaudhary and Chopra, 1980). It was, therefore, decided to undertake this investigation with an aim to study the effects of

various genetic and non-genetic factors on these traits.

The data on 185 Nali and its different crossbred male lambs at six months of age were collected over a period of six years (1977-82) from the Department of Animal Breeding, Haryana Agricultural University, Hisar. These lambs were raised on green fodder and roughages *ad lib.* and were fed individually with 250 g concentrate mixture daily just after weaning at 90 days upto slaughter. The lambs were slaughtered at 6 months of age and various edible and non-edible organs were removed manually and weighed. The percentage of edible organs was calculated as per cent of the dressed carcass weight.

The data were classified according to genetic groups. Since the data were spread from 1977-82, the six years were grouped into three periods each consisted of two consecutive years to reduce the matrix size. Each period was further sub-divided into two seasons according to the frequency of lambing. The data on per cent edible organs were subjected to Arc-sin transformation for analysis of variance.

TABLE 1
Least-squares analysis of variance for various edible and non-edible organs of male lambs

Source	Edible organs					Non-edible organs				
	d. f.	Liver (kg)	Kidney & testicles (kg)	Total edible organs (kg)	% edible organs	d. f.	Pluck (kg)	Skin (kg)	Hooves (kg)	Head (kg)
Genetic group	5	0.011	0.003	0.013	1.153	5	0.041**	0.080	0.007	0.033
Period	2	0.012	0.009**	0.035**	7.440**	2	0.145**	0.875**	0.210**	1.328**
Season	1	0.065**	0.013**	0.135**	0.159	1	0.184**	1.560**	0.164**	0.991**
Error	176	0.004	0.002	0.007	0.911	169	0.014	0.142	0.009	0.063

**Significant at 5% level.

STUDY OF LAMB ORGANS

TABLE 2

Least-squares means along with their standard errors for various edible and non-edible organs of male lambs (kg)

Particulars	Edible organs				Non-edible organs			
	Liver	Kidney & testicles	Total edible organs	% edible organs on dressed wt.	Pluck	Skin	Hooves	Head
Genetic group								
MN	0.307 ^a ±0.009 (54)	0.129±0.006 (54)	0.436±0.012 (54)	5.716±0.133 (54)	0.565 ^a ±0.017 (49)	1.668±0.054 (49)	0.511±0.014 (49)	1.398±0.036 (49)
CN	0.266±0.009 (58)	0.139±0.005 (58)	0.404±0.011 (58)	5.539±0.126 (58)	0.485 ^c ±0.016 (66)	1.554±0.051 (66)	0.484±0.013 (66)	1.347±0.034 (66)
MC	0.260±0.028 (6)	0.104±0.018 (6)	0.364±0.037 (6)	5.481±0.414 (6)	0.581 ^a ±0.051 (6)	1.563±0.164 (6)	0.540±0.041 (6)	1.335±0.109 (6)
CM	0.266±0.028 (6)	0.136±0.017 (6)	0.402±0.036 (6)	5.959±0.409 (6)	0.482 ^c ±0.050 (6)	1.592±0.162 (6)	0.484±0.041 (6)	1.262±0.107 (6)
NCM	0.267±0.022 (9)	0.120±0.014 (9)	0.386±0.029 (9)	5.558±0.330 (9)	0.513 ^b ±0.040 (9)	1.613±0.130 (9)	0.494±0.033 (9)	1.323±0.086 (9)
Nali	0.278±0.010 (42)	0.116±0.006 (42)	0.394±0.013 (42)	5.982±0.149 (42)	0.512 ^a ±0.018 (42)	1.637±0.059 (42)	0.504±0.015 (42)	1.335±0.039 (42)
Periods								
P ₁	0.258±0.012 (60)	0.109 ^b ±0.008 (60)	0.367 ^b ±0.016 (60)	6.148 ^a ±0.179 (60)	0.470 ^b ±0.022 (60)	1.456±0.071 (60)	0.431±0.018 (60)	1.145 ^a ±0.047 (60)
P ₂	0.272±0.012 (77)	0.132 ^a ±0.007 (77)	0.404 ^a ±0.015 (77)	5.505 ^b ±0.171 (77)	0.570 ^a ±0.021 (70)	1.692 ^a ±0.069 (70)	0.547 ^a ±0.017 (70)	1.422 ^b ±0.045 (70)
P ₃	0.292±0.010 (48)	0.131 ^a ±0.006 (48)	0.423 ^a ±0.013 (48)	5.465 ^b ±0.150 (48)	0.519 ^b ±0.018 (48)	1.665 ^a ±0.059 (48)	0.531 ^a ±0.015 (48)	1.433 ^a ±0.039 (48)
Seasons								
Summer	0.253 ^b ±0.009 (121)	0.115 ^b ±0.005 (121)	0.367 ^b ±0.011 (121)	5.672±0.127 (121)	0.486 ^b ±0.016 (116)	1.497 ^a ±0.051 (116)	0.468 ^b ±0.013 (116)	1.249 ^b ±0.034 (116)
Autumn	0.295 ^a ±0.011 (64)	0.133 ^a ±0.007 (64)	0.429 ^a ±0.015 (64)	5.739±0.164 (64)	0.559 ^a ±0.020 (62)	1.712 ^a ±0.066 (62)	0.537 ^a ±0.016 (62)	1.418 ^a ±0.043 (62)

Figures within parentheses denote the number of observations.
Means with different superscripts differ significantly ($P \leq 0.05$).

The data thus obtained were analysed using least squares procedure of Harvey (1966) and the mathematical model used was :

$$Y_{ijkl} = \mu + P_i + S_j + g_k + I_{ijkl} \text{ where}$$

Y_{ijkl} = is the l th observation on the lambs belonging to k th genetic group, j th season and i th period

μ = is the overall population mean

P_i , S_j and g_k = are the effects of i th period, j th season and k th genetic group, respectively and expressed as deviations from the μ .

I_{ijkl} = is the error term associated with each observation with mean zero and variance σ^2 .

Least-squares analysis of variance for edible and non-edible organs is presented in Table 1 and their means in Table 2.

Perusal of Table 1 reveals that genetic group differences did not exist for all the edible organs included in the study suggesting that development of these organs is independent of genetic effects. These traits are influenced significantly by the environmental factors such as periods and seasons. The period influenced all the edible organs except liver, and season had its significant effects on all these traits except in case of per cent edible organs. The lambs born in autumn

season were superior in edible organs. Hence, while studying these traits, due consideration should be given to environmental factors and the feeding and managerial conditions should be improved as far as possible such that these effects are minimised. Arnold *et al.* (1969) found that the weight of internal organs differed among different breeds. Chaudhary and Chopra (1980) also observed that liver and kidney weights were affected by genetic groups.

The pluck weight was affected significantly by the genetic groups, whereas period and season had statistically significant effect on all the non-edible organs included in the study (Table 2). Spring born lambs had lighter pluck, skin, hooves and head which were in desirable direction. CN and CM genetic groups were found to be the least in pluck weight followed by NCM and Nali, MM and MC (Table 2). Arnold *et al.* (1969) and Chaudhary and Chopra (1980) reported significant genetic group difference on internal organs.

ACKNOWLEDGEMENT

The authors are highly indebted to the Head, Department of Animal Breeding for facilities and cooperation extended during this study. Computer facilities extended by the IARI, New Delhi, are also thankfully acknowledged.

REFERENCES

- Arnold, G. W., Gharaybeh, H. R., Dudzinski, M. L., Mc Manus, R. W. and Axelsen, A. 1969. Body composition of young sheep. II. Effect of stocking rate on body composition of Dorset Horn cross lambs. *J. agric. Sci.* **72**: 77-80.

STUDY OF LAMB ORGANS

- Chaudhary, S. S. and Chopra, S. C. 1980. Note on factors affecting dressing percentage and weight of mutton fry in four breeds of Indian sheep. *Indian J. anim. Sci.* 50: 893-95.
- Epstein, H. and Herz, A. 1968. The body composition of three month old Rambouillet lambs of different live weight. *J. agric. Sci.* 70: 29-32.
- Everitt, G. C. and Jury, K. E. 1966. Effects of sex and gonadectomy on the growth and development of Southdown X Romney cross lambs. Part I. Effect on live weight. *J. agric. Sci.* 66: 1-14.
- Harvey, W. R. 1966. Least-squares analysis of data with unequal sub-class numbers. *Agric. Res. Sci.* 20-28 U.S.D.A.

EFFECT OF PHYSICAL EXERCISE ON PERIPHERAL CORTISOL LEVELS IN BUFFALO CALVES

S. P. AGARWAL, V. K. AGARWAL and P. K. DWARAKNATH

Department of Veterinary Physiology
Haryana Agricultural University, Hisar

(Received : May 8, 1984; Revised : September 12, 1984)

Physical exercise demands immediate cardiovascular and metabolic adjustments for supply of oxygen and energy to the working muscles. This is brought about by a variety of mechanisms involving biochemical, neural and hormonal interactions. Among various factors, adrenal corticoids and medullary hormones are most important modulators of physical stress. Hormonal changes in exercised individuals have been studied in different species of animals (Hartley *et al.*, 1972; Aakvaag *et al.*, 1978; Tacker *et al.*, 1978; Dybdal *et al.*, 1980; Persson *et al.*, 1980) but similar information on buffaloes is meagre (Agarwal *et al.*, 1983, 1985). The response of cortisol to exercise in buffaloes is not known. Therefore, an effort was made to monitor cortisol levels in male buffalo calves after subjecting them to physical exercise.

Male buffalo calves of 2 to 3 years of age maintained at the experimental sheds were classified into three groups viz., entire, castrated and vasectomised with four animals in each group. The animals were castrated and vasectomised at an age of 6 months to 1 year. The animals were exercised by pulling a stone

roller of 100 kg weight on a 'Kachcha' ground at a speed of 3 km/h for three hours continuously. Blood samples were collected before start of exercise, after the end of exercise and after 2, 6, 10 and 20 h of rest. Serum was separated and stored at -15°C . Sera were analysed for cortisol using RIA technique without chromatographic separation (Ruder *et al.*, 1972). The tritium labelled cortisol and the cortisol antibody were obtained from New England Nuclear, Boston, Mass, U.S.A. The unlabelled cortisol for standards and other chemicals were procured from M/s Sigma Chemicals Co., U.S.A. The assays were critically evaluated for their validity. The cross reactivity of antiserum is shown in Table 1. The sensitivity of the assay was 100 pg/tube. The assays were tested for parallelism with serially diluted serum samples and a correlation coefficient of 0.98 was found between serum dilution rate and the concentration of hormone estimated. The mean extraction and final recovery were found to be 94.7 and 92.2 per cent, respectively. The intra-assay and interassay coefficient of variation were 6.3 and 13.0 per cent, respectively. The data were statistically analysed

EXERCISE EFFECT ON CORTISOL LEVELS IN BUFFALO

TABLE 1

Cross reactivity of cortisol antiserum against other steroid hormones

Steroid	% cross reaction at 50% displacement
Corticosterone	42.8
11-Deoxycortisol	16.0
17- α Progesterone	9.2
Progesterone	6.3
Cortisone	4.6
Deoxycorticosterone	4.1
Aldosterone	1.4
Testosterone	1.2
Androstenedione	<1.0

in a two way classification by analysis of variance as suggested by Snedecor and Cochran (1968).

The cortisol levels in male buffalo calves before and after exercise are presented in Table 2. The initial levels of serum cortisol varied between 1.3 to 4.3 ng/ml in different groups of animals. There was a three to five fold increase in serum cortisol levels after exercise with peak levels ranging from 7 to 11 ng/ml. The levels started falling within two hours after rest and continued to fall for 10 h after the end of exercise when the concentration was almost one third to

that of the basal (pre-exercise) levels. Normal levels were attained after 20 h of rest except for castrated animals in which the low levels persisted. The statistical analysis revealed significant differences ($P < 0.01$) between pre- and post exercise stages but the group differences were not significant.

Higher levels of cortisol after exercise are in agreement with other studies in cattle (Arave *et al.*, 1978), horses (Dybdal *et al.*, 1980), pigs (Spencer, 1980) and men (Kindermann *et al.*, 1982; Kuoppasalmi *et al.*, 1980). The continuous fall of cortisol for 10 h after the end of exercise could be due to arrest of the secretion of ACTH from the pituitary by the higher cortisol levels circulating during exercise, because cortisol has been shown to be a potent inhibitor of ACTH release. Moreover, metabolic clearance rate of cortisol might have also been altered after exercise as Few (1974) observed that the half-life of cortisol in men under heavy work load was 31.5 min, against 74.5 min for the resting group. The results support the existence of an effective adrenocortical mechanism in buffaloes to combat the stress of physical exercise.

TABLE 2

Changes in cortisol levels (ng/ml) after exercise in buffalo calves

Group	Before exercise	After exercise	After rest				Overall
			2 h	6 h	10 h	20 h	
Entire	1.29 ± 0.37	7.17* ± 2.20	3.21 ± 1.45	1.84 ± 0.91	0.34* ± 0.03	1.27 ± 0.27	2.52 ± 0.63
Vasectomised	3.60 ± 1.07	9.75* ± 1.56	4.22 ± 0.97	1.88* ± 0.53	1.02* ± 0.63	4.80 ± 1.36	4.21 ± 0.70
Castrated	4.32 ± 1.83	11.12* ± 1.71	6.11 ± 0.25	2.72 ± 0.94	0.91* ± 0.20	1.80* ± 0.19	4.50 ± 0.88

*Significantly different ($P < 0.05$) from basal levels within the group.

REFERENCES

- Aakvaag, A., Sand, T., Opstad, P. K. and Fonnum, F. 1978. Hormonal changes in young men during prolonged physical strain. *Eur. J. appl. Physiol.* **39** : 283-91.
- Agarwal, S. P., Agarwal, V. K., Singh, N. and Dwaraknath, P. K. 1983. Effect of physical stress on blood serum levels of thyroid hormones in entire, vasectomised and castrated male buffaloes. *Trop. Vet. anim. Sci. Res.* **1** : 57-58.
- Agarwal, S. P., Agarwal, V. K., Singh, N. and Dwaraknath, P. K. 1985. Effect of stress of exercise on serum testosterone in buffalo males. *Indian J. dairy Sci.* **38** : 1-3.
- Arave, C. W., Walters, J. L. and Lamb, R. C. 1978. Effect of exercise on glucocorticoids and other cellular components of blood. *J. dairy Sci.* **61** : 1567-72.
- Dybdal, N. O., Gribble, D., Madigan, J. E. and Stabenfeldt, G. H. 1980. Alterations in plasma corticosteroids, insulin and selected metabolites in horses used in endurance rides. *Equine vet. J.* **12** : 137-40.
- Few, J. D. 1974. Effect of exercise on the secretion and metabolism of cortisol in man. *J. Endocrinol.* **62** : 341-53.
- Hartley, L. H., Mason, J. W., Hogan, R. P., Jones, L. G., Kotehen, T. A., Mougey, E. H., Wherry, F. E., Pennington, L. L. and Ricketts, P. T. 1972. Multiple hormonal responses to graded exercise in relation to physical training. *J. appl. Physiol.* **33** : 602-06.
- Kindermann, W., Schnabel, A., Schmitt, W. M., Biro, G., Cassens, J. and Weber, F. 1982. Catecholamines, growth hormone, cortisol, insulin and sex hormones in anaerobic and aerobic exercise. *Eur. J. appl. Physiol.* **49** : 389-99.
- Kuoppasalmi, K., Naveri, H., Harkonen, M. and Adlercreutz, H. 1980. Plasma cortisol, androstenedion, testosterone and luteinizing hormone in running exercise of different intensities. *Scand. J. Clin. Lab. Invest.* **40** : 403-09.
- Persson, S. G. B., Larsson, M. and Lindholm, A. 1980. Effect of training on adrenocortical function and red cell volume in trotters. *Zentralbl. fuer Veterinaermed.* **27** (A): 261-68.
- Ruder, H. J., Guy, R. L. and Lipsett, M. B. 1972. A radioimmunoassay for cortisol in plasma and urine. *J. Clin. Endocrinol. Metab.* **35** : 219-24.
- Snedecor, G. W. and Cochran, W. G. 1968. *Statistical Methods*. Oxford and I. B. H. Publishing Co., Bombay.
- Spencer, G. S. G. 1980. Relationship between plasma somatomedin activity and levels of cortisol and free fatty acids following stress in pigs. *J. Endocrinol.* **84** : 109-14.
- Tackor, M. M., Leach, C. S., Owen, C. A. and Rummel, J. A. 1978. Levels of cortisol, corticosterone, cortisone and 11-deoxycortisol in the plasma of stressed and unstressed subjects. *J. Endocrinol.* **76** : 165-66.

EFFECT OF ARTIFICIAL AGING ON THE LEVELS OF PROTEASE, LIPASE, RIBONUCLEASE, TOTAL LIPID AND FREE FATTY ACIDS FROM SOYBEAN SEEDS DIFFERING IN STORAGE POTENTIAL

A. S. RAO and D. S. WAGLE

Department of Chemistry & Biochemistry

Haryana Agricultural University, Hisar

(Received : October 4, 1983; Revised : May 23, 1984)

ABSTRACT

Seeds of four soybean cultivars differing in ambient storage potential were subjected to accelerated aging for different periods (0, 2, 4, 6 and 8 days) and tested for germinability, activities of protease, ribonuclease, lipase and total lipid and free fatty acids. Aging resulted in an increase in protease and lipase and a decrease in ribonuclease activities. Free fatty acid content increased substantially throughout the aging period. The magnitude of these changes was less in seeds of Kalitur to which it may owe its greater resistance to aging.

Amongst the several changes, thought to be responsible for seed deterioration, alterations in enzyme activities remain an important cause (Woodstock, 1972; Rao and Wagle, 1983; Roberts and Ellis, 1983). A meaningful approach of assessing the significance of enzymatic changes during seed deterioration, is to compare these changes during deterioration in cultivars having different storage potential. Accordingly, the present investigations were carried out on four soybean cultivars viz., Bragg, Hardee, Kalitur and T-49, differing in storage potential (Verma and Gupta, 1975).

MATERIAL AND METHODS

Aging of the seeds, scoring of germination percentage and enzyme extraction were carried out as stated previously (Rao and Wagle, 1980). Protease was assayed

colorimetrically at 410 nm using the substrate α -N-benzoyl-DL-arginine p-nitroanilide hydrochloride (BAPNA HCl) according to Kakade *et al.* (1974). One unit was defined as the amount of enzyme that caused increase in absorbance equal to 0.1 per 30 min incubation. Lipase activity was determined by the colorimetric estimation of 2-naphthol liberated from the substrate 2-naphthyl laurate (Seligman and Kramer, 1963). A unit of enzyme was taken as the amount of enzyme required to liberate one microgram of 2-naphthol on 1 h incubation. Using yeast RNA as substrate, the method of Wilson (1967) was followed for the assay of ribonuclease (RNase). One unit was defined as the amount of enzyme which caused change in absorbance of 0.1 at 260 nm, per 30 min incubation. Total lipid was extracted according to Huber and Newman (1975) and determined

gravimetrically. Titrimetric method of Rao *et al.* (1972) was employed for determining free fatty acids in the lipid extract and expressed as oleic acid equivalents.

All the above experiments were carried out in two replicates.

RESULTS AND DISCUSSION

Germinability

Germinability started declining after 4 days of aging in the varieties Bragg, Hardee and T-49, which progressively decreased with increase in aging period (Fig. 1). By 8 days of aging, the seeds of Bragg and Hardee were completely non-germinable, while the seeds of T-49 maintained only 25% germinability. In Kalitur aging had little or no adverse effect on germinability. Even after 8 days of aging 89% germination was observed.

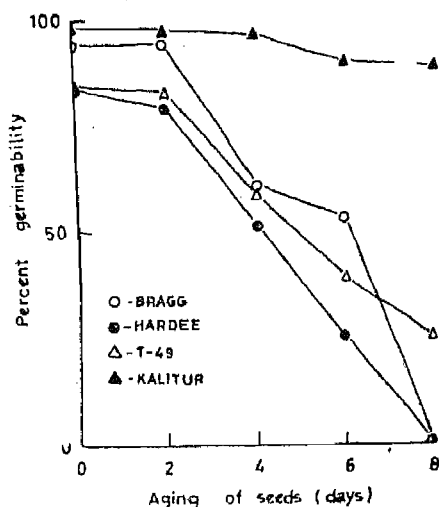


Fig. 1. Effect of accelerated aging of soybean seeds on germinability.

Protease Activity

Effect of aging on proteolytic activity (Fig. 2 and Table 1) was more pronounced in axis as compared to the cotyledons. In axis of all the cultivars proteolytic activity increased after 4 days of aging and continued to increase with further increase in duration of aging. The magnitude of increase was minimum in case of Kalitur. Axis protease activity was negatively and significantly correlated with germinability in Bragg and Kalitur ($P \leq 0.05$) and Hardee and T-49 ($P \leq 0.01$). Protease activity in cotyledons was negatively and significantly correlated with germinability at $P \leq 0.01$ in Bragg, Hardee and Kalitur and at $P \leq 0.5$ in T-49.

Increase in proteolytic activity has important implications in germinability.

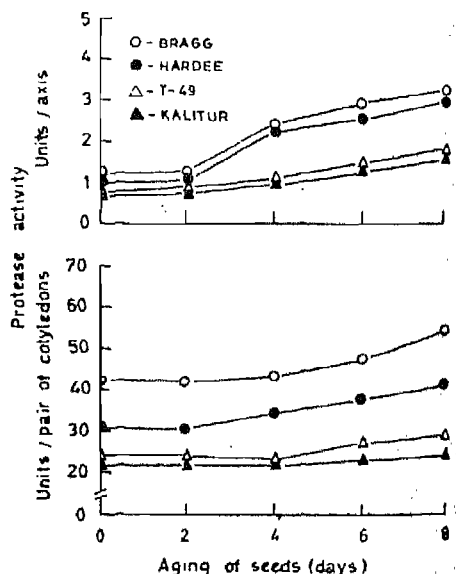


Fig. 2. Effect of accelerated aging of soybean seeds on protease activity.

ENZYMES IN AGED SEEDS

TABLE 1

Effect of accelerated aging of soybean seeds on protease activity

Variety	Units/mg soluble protein (specific activity)				
	Aging of seeds (days)				
	0	2	4	6	8
Axis					
Bragg	1.28	1.32	2.28	2.81	3.00
Hardee	1.02	1.06	2.17	2.45	2.97
Kalitur	0.96	0.97	1.21	1.50	1.95
T-49	0.78	0.75	1.01	1.38	1.70
Cotyledon					
Bragg	1.76	1.82	1.78	2.10	2.19
Hardee	1.62	1.66	1.80	2.03	2.26
Kalitur	1.50	1.42	1.52	1.70	1.57
T-49	1.33	1.26	1.29	1.43	1.50

First, enhanced proteolytic activity might be responsible for increased accumulation of amino acids which in turn may result in increased leaching of amino acids from aged seeds (Ching and Schoolcraft, 1968; Ching, 1972; Rao, 1980). Secondly, proteolytic activity may degrade enzymes and other non-enzymatic proteins necessary for germination and growth. The decrease in the activity of ribonuclease may be ascribed to increased proteolytic activity. In sorghum seeds, proteinase activity was found to increase throughout 48 days of accelerated aging by Perl *et al.* (1978). Thirdly, protease can also bring about the activation of some enzymes from bound or zymogen form to free active form. The increased beta-amylase (Rao and Wagle, 1980) and proteolytic activity might be due to such activation of zymogen form by proteolysis (Kruger, 1979). As against the above findings, Luczynska (1973) observed no change in the activity of protease in aged soybean seeds.

Ribonuclease Activity

Aging the seeds for 2 or 4 days had little or no effect on axis ribonuclease activity (Fig. 3 and Table 2). But there was an appreciable loss in the activity of the enzyme with extended periods of aging, the magnitude of loss being less in Kalitur. A similar pattern was obtained in cotyledons, with the difference that ribonuclease activity was not affected in Kalitur even after 6 days of aging. A positive and significant correlation was observed for axis RNase activity and germinability at $P \leq 0.01$ in all the varieties except Kalitur where the correlation was significant at $P \leq 0.05$. RNase activity in cotyledons was also positively and significantly correlated with germinability in Bragg and T-49 ($P \leq 0.05$) and Hardee ($P \leq 0.01$) while it was non-significant for Kalitur. The decreased RNase activity in cotyledons as a result of aging may decrease the mobilisation of reserve RNA which is essential during germina-

tion and early seedling growth. In axis, a low RNase activity may lead to a low nucleic acid turnover during germination.

Lipase Activity, Total Lipid and Free Fatty Acids

Aging caused a substantial increase in lipase activity (Fig. 4 and Table 3)

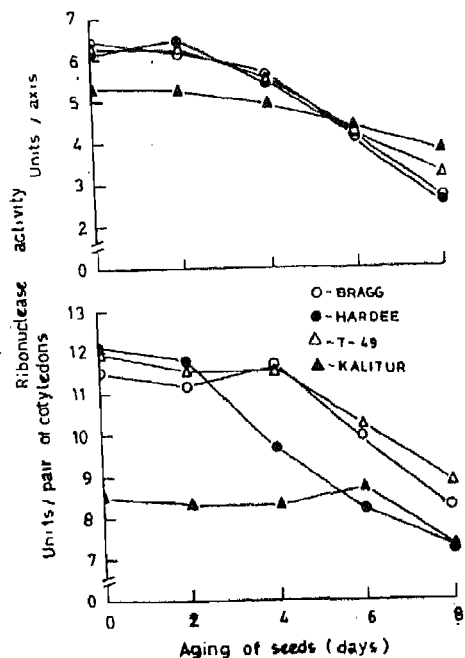


Fig. 3. Effect of accelerated aging of soybean seeds on ribonuclease activity.

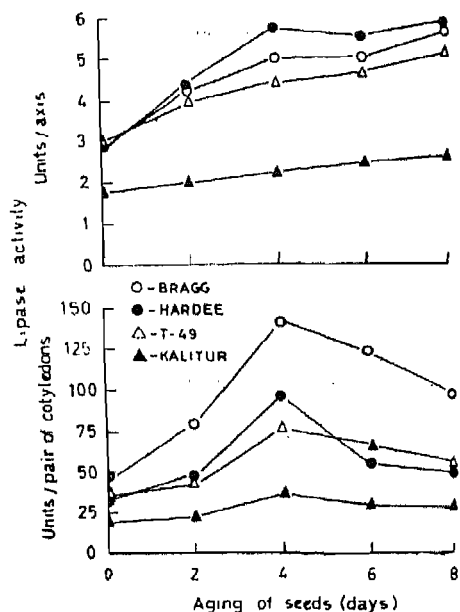


Fig. 4. Effect of accelerated aging of soybean seeds on lipase activity.

TABLE 2
Effect of accelerated aging of soybean seeds on ribonuclease activity

Variety	Units/mg soluble protein (specific activity)				
	Aging of seeds (days)				
	0	2	4	6	8
Axis					
Bragg	6.29	6.14	5.37	4.13	2.47
Hardee	6.17	6.45	5.43	3.99	2.61
Kalitur	6.63	6.64	6.26	6.42	4.73
T-49	5.97	5.75	5.42	3.94	2.91
Cotyledon					
Bragg	0.47	0.48	0.47	0.43	0.33
Hardee	0.62	0.63	0.53	0.43	0.39
Kalitur	0.58	0.55	0.58	0.65	0.47
T-49	0.65	0.59	0.64	0.53	0.45

ENZYMES IN AGED SEEDS

TABLE 3
Effect of accelerated aging of soybean seeds on lipase activity

Variety	Units/mg soluble protein (specific activity) Aging of seeds (days)				
	0	2	4	6	8
Axis					
Bragg	2.88	4.19	4.76	4.93	5.33
Hardee	2.77	4.40	5.69	5.38	5.93
Kalitur	2.21	2.51	2.81	3.00	3.28
T-49	2.83	3.65	4.26	4.36	4.78
Cotyledon					
Bragg	1.91	3.42	5.79	5.38	3.85
Hardee	1.70	2.54	4.94	2.95	2.62
Kalitur	1.28	1.46	2.58	2.22	1.78
T-49	1.84	2.20	4.24	3.44	2.75

TABLE 4
Effect of accelerated aging of soybean seeds on total lipid and free fatty acids

Variety	Free fatty acids (μ g/organ)					Total lipid (mg/organ)				
	Aging of seeds (days)					Aging of seeds (days)				
	0	2	4	6	8	0	2	4	6	8
Axis										
Bragg	1.1	1.3	1.3	1.6	1.9	0.46	0.42	0.44	0.42	0.44
		(+18)	(+18)	(+45)	(+73)					
Hardee	0.9	1.1	1.9	1.9	1.9	0.42	0.44	0.42	0.42	0.38
		(+22)	(+111)	(+111)	(+111)					
Kalitur	0.8	0.8	0.9	1.1	1.1	0.34	0.38	0.36	0.34	0.38
		(0)	(+13)	(+38)	(+38)					
T-49	1.1	1.3	1.6	1.6	1.8	0.50	0.48	0.50	0.48	0.50
		(+18)	(+45)	(+45)	(+64)					
Cotyledon										
Bragg	100	138	154	265	352	31	32	31	32	33
		(+38)	(+54)	(+163)	(+252)					
Hardee	62	87	141	158	203	19	19	20	20	18
		(+40)	(+127)	(+155)	(+227)					
Kalitur	51	56	84	93	110	16	16	17	16	17
		(+10)	(+65)	(+82)	(+116)					
T-49	68	79	127	158	172	18	19	17	19	19
		(+16)	(+87)	(+132)	(+153)					

Figures in parentheses indicate per cent deviation from control.

TABLE 5

Effect of accelerated aging of soybean seeds on total lipid and free fatty acids

Variety	Free fatty acids (mg/g dry wt.)					Total lipid (mg/g dry wt.)				
	Aging of seeds (days)									
	0	2	4	6	8	0	2	4	6	8
Axis										
Bragg	0.32	0.39	0.38	0.47	0.56	131	123	125	127	129
Hardee	0.29	0.36	0.61	0.61	0.61	135	141	135	135	122
Kalitur	0.34	0.31	0.39	0.50	0.50	154	158	156	154	172
T-49	0.31	0.38	0.43	0.44	0.52	138	137	138	137	147
Cotyledon										
Bragg	0.79	1.08	1.19	2.07	2.82	246	254	244	253	264
Hardee	0.64	0.90	1.50	1.61	2.14	196	202	214	201	195
Kalitur	0.74	0.83	1.30	1.38	1.65	238	233	256	245	257
T-49	0.82	0.96	1.54	1.91	2.11	217	228	206	227	233

accompanied by increase in free fatty acids (Tables 4 and 5) in both axis and cotyledons of all the varieties, the magnitude of increase being less in Kalitur. In axis, lipase activity increased throughout the aging period but in cotyledons, activity increased upto 4 days and then decreased, though total activity remained high in aged seeds. Though lipase activity increased in cotyledons it had non-significant correlation with germinability. However, axis lipase activity was negatively and significantly correlated with germinability at $P \leq 0.05$ in Bragg, Kalitur and T-49. Free fatty acids increased throughout the aging period in both axis and cotyledons. However, this

was not reflected in any appreciable difference in total lipid content (Tables 4 and 5). Increased content of free fatty acids during adverse storage conditions has hitherto been observed in soybean (Agarwal and Siddiqui, 1973; Verma and Gupta, 1975) and rice (Agarwal, 1977) which may lead to greater fatty acid oxidation and free radical formation which may damage several cellular components particularly of membranes (Harman and Mattick, 1976).

ACKNOWLEDGEMENT

One of the authors (ASR) thanks CSIR, New Delhi, for financial assistance.

REFERENCES

- Agarwal, P. K. 1977. Germination, fatty acidity and leaching of sugars from five cultivars of paddy (*Oryza sativa*) seeds during storage. *Seed Sci. Technol.* 5 : 489-98.
- Agarwal, P. K. and Siddiqui, M. N. 1973. Influence of storage temperature and seed moisture on germination, free fatty acid content and leaching of sugars from soybean seeds during storage. *Seed Res.* 1 : 75-82.

ENZYMES IN AGED SEEDS

- Ching, T. M. 1972. Aging stresses on physiological and biochemical activities of crimson clover (*Trifolium incarnatum* L. var. Dixie) seeds. *Crop Sci.* **12** : 415-18.
- Ching, T. M. and Schoolcraft, I. 1968. Physiological and chemical differences in aged seeds. *Crop Sci.* **8** : 408-09.
- Harman, G. E. and Mattick, L. R. 1976. Association of lipid oxidation with seed aging and death. *Nature* **260** : 323-24.
- Huber, D. J. and Newman, D. W. 1975. Relationships between lipid changes and plastid ultrastructural changes in senescing and regreening soybean cotyledons. *J. exp. Bot.* **27** : 490-511.
- Kakade, M. L., Rackis, J. J. and Puski, G. 1974. Determination of trypsin inhibitor activity of soy products. A collaborative analysis of an improved procedure. *Cereal Chem.* **51** : 376-82.
- Kruger, J. E. 1979. Modification of wheat beta-amylase by proteolytic enzymes. *Cereal Chem.* **56** : 298-302.
- Luczynska, J. 1973. Activity of some enzymes from soybean seeds aging at various air humidities. *Bull. Acad. Pol. Ser. Sci. Biol.* **21** : 155-69.
- Perl, M., Luria, I. and Gelmond, N. 1978. Biochemical changes in sorghum seeds affected by accelerated aging. *J. exp. Bot.* **29** : 497-509.
- Rao, A. S. 1980. Biochemical aspects of seed deterioration in soybean. Ph.D. thesis, Haryana Agricultural University, Hisar.
- Rao, A. S. and Wagle, D. S. 1980. Beta-amylase activity in artificially aged soybean seeds. *Biol. Plant.* **23** : 24-27.
- Rao, A. S. and Wagle, D. S. 1983. Effect of accelerated aging of soybean seeds on isocitrate lyase and malate synthetase activities. *Seed Res.* **11** : 82-86.
- Rao, B. P., Rao, S. D. T. and Reddy, B. R. 1972. Rapid method for determination of free fatty acid content in fatty oils. *J. Am. Oil Chem. Soc.* **49** : 338-39.
- Roberts, E. H. and Ellis, R. H. 1983. Physiological, as ultrastructural and metabolic aspects of seed viability. In: *The Physiology and Biochemistry of Seed Development*, pp. 465-85, Khan, A. A. (ed.). Elsevier Bio-medical Press, Amsterdam.
- Seligman, A. M. and Kramer, S. P. 1963. Lipase. In: *Methods of Enzymatic Analysis*, pp. 776-78, Bergmeyer, H. U. (ed.). Academic Press, New York.
- Verma, R. S. and Gupta, P. C. 1975. Storage behaviour of soybean varieties vastly differing in seed size. *Seed Res.* **3** : 30-44.
- Wilson, C. M. 1967. Purification of a corn ribonuclease. *J. Biol. Chem.* **242** : 2260-63.
- Woodstock, L. W. 1972. Biochemical tests for seed vigour. *Proc. Int. Seed Test Assoc.* **34** : 253-64.

UREIDES AND ENZYMES OF THEIR METABOLISM IN NODULES OF MUNGBEAN AS INFLUENCED BY PLANT GENOTYPE AND RHIZOBIAL STRAIN

D. SINGH, A. S. RAO, H. S. NAINAWATEE and R. SINGH

Department of Chemistry & Biochemistry

Haryana Agricultural University, Hisar

(Received : October 6, 1983; Revised : February 18, 1984)

ABSTRACT

The levels of uricase, allantoinase, allantoin and allantoic acid were monitored at different stages of growth and development of mung in three different symbiotic associations. A significant ureide metabolism in mungbean nodules was observed.

In addition to amino acids/amides, ureides, chiefly allantoin and allantoic acid form another major organic nitrogenous solute exported to the shoot from the nodulated root system. The enzymes uricase and allantoinase which are responsible for the formation of allantoin and allantoic acid, respectively, have been demonstrated in high levels in nodule fractions as compared to the other plant parts in soybean (Tajima and Yamamoto, 1975; Tajima *et al.*, 1977) and cowpea (Herridge *et al.*, 1978; Atkins *et al.*, 1980; Schubert *et al.*, 1981). Accordingly, the present investigation was undertaken to assess the significance of ureide metabolism by following the levels of uricase, allantoinase, allantoin and allantoic acid, at different stages of growth and development. The effects of plant genotype and the rhizobial strain on the levels of the above parameters were also studied.

MATERIAL AND METHODS

Seeds of two cultivars of mungbean (*Vigna radiata* (L.) Wilczek) K851 and T44, high and low yielding, respectively, were procured from the Department of Plant Breeding of this University.

Strains, S24 (slow growing and Hup⁺) and R3S (fast growing and Hup⁻) were provided by the Department of Microbiology of this University.

After surface sterilisation of seeds with ethanol K851 seeds were inoculated with both the strains while that of T44 with S24 only. Treated seeds were sown in sterile Leonard Jar assemblies (Dahiya and Khurana, 1981.) The crop was raised in the screenhouse during kharif season using N-free nutrient medium (Sloger, 1969).

UREIDE METABOLISM IN MUNGBEAN NODULES

Samples were collected at 15, 25, 35, 45, 55 and 65 days of sowing corresponding to the stages, early vegetative, late vegetative, early flowering, early pod filling, active pod filling and maturity, respectively.

Extraction for Ureides

Ethanol extract prepared according to Antoniow and Sprent (1978) with some modifications, was used for the estimation of ureides. Nodules (1 g) were crushed gently in 5 ml distilled water and centrifuged at 4000 xg for 15 min. The supernatant obtained was treated with five volumes of 80% ethanol and kept at 4-8°C for 4 days with occasional shakings. The precipitate formed was removed by centrifugation at 4000 xg for 15 min and the supernatant was referred to as 80% ethanol extract and was used for the estimation of ureides according to Trijbels and Vogels (1966).

Enzyme Extraction and Assays

The root system was washed free of sand and detached nodules were homogenised in chilled mortar using 2 volumes of cold 0.1 M phosphate buffer (pH 7.6) containing 2% polyvinyl pyrrolidone, 1% β -mercaptoethanol and 10 mM dithiothreitol according to the method of Boland *et al.* (1978). The homogenate was centrifuged at 10,000 xg for 30 min at 0-4°C. The supernatant obtained (nodule cytosol fraction) was used for assaying all enzymes.

Uricase was assayed according to Tajima and Yamamoto (1975). The enzymatic oxidation of uric acid was

followed spectrophotometrically by recording the decrease in absorbance at 292 nm at 30°C.

Allantoinase was also assayed as per the procedure of Tajima and Yamamoto (1975).

Unit of activity for the enzymes has been defined as the μ mol of product formed per hour per plant nodules. All the above experiments were carried out in two replicates.

RESULTS AND DISCUSSION

Uricase exhibited a similar pattern in all the symbiotic associations (Fig. 1). Its activity increased till early flowering and then decreased at early pod filling, which remained more or less unchanged at active pod filling stage. At all the stages, except at the vegetative stage, K851-R3S had higher uricase activity as compared to K851-S24 and T44-S24 symbiotic associations. K851-S24 symbiotic association had the lowest activity at flowering and pod filling stages. Similar differences due to plant genotype and rhizobial strain were not found for allantoin levels (Fig. 2). Except at early flowering, genotypes did not differ in their allantoin levels. Thus, there seems to be no clear cut relation in the effect of genotype and rhizobial strain on uricase and allantoin levels indicating that allantoin production is also governed by factors other than uricase levels. Till early flowering, nodulation with S24 resulted in a greater allantoin production in K851. The activities of glutamine synthetase and asparagine synthetase also showed similar strain differences (Singh, 1982). This raises the possibility

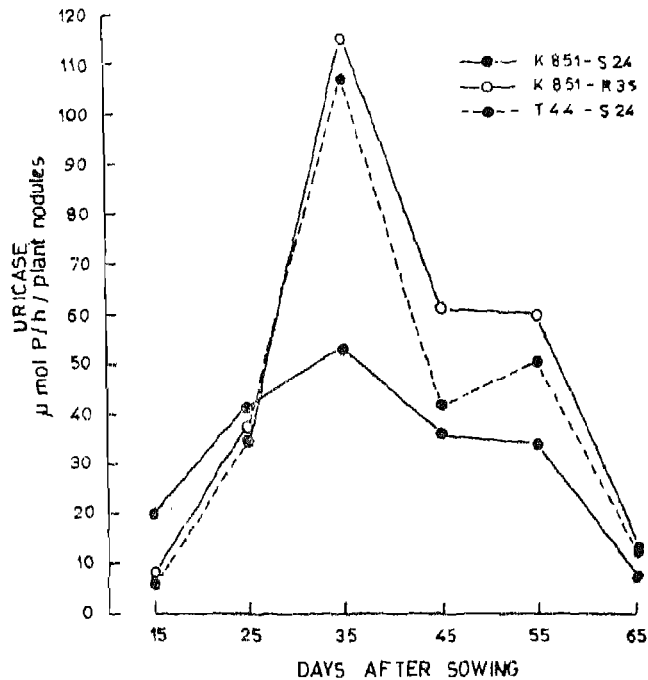


Fig. 1. Uricase activity in nodules of K851-S24, K851-R3S and T44-S24 symbioses.

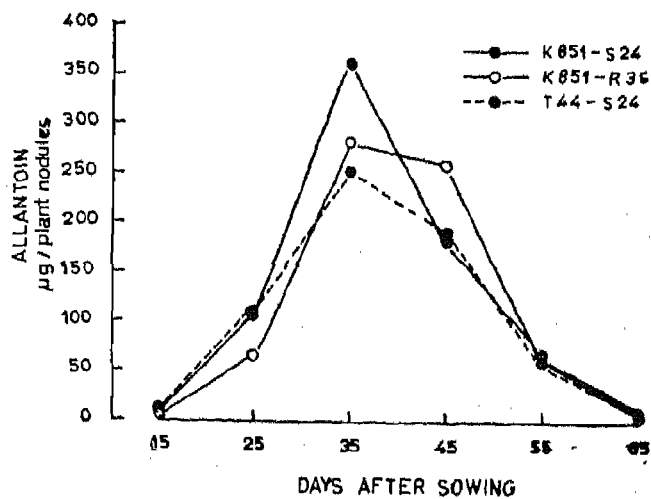


Fig. 2. Allantoin content in nodules of K851-S24, K851-R3S and T44-S24 symbioses.

UREIDE METABOLISM IN MUNGBEAN NODULES

that the allantoin levels are also affected by the production of glutamine and asparagine which can be used for its biosynthesis.

Allantoinase activity (Fig. 3) differed from uricase pattern in that, nodules from S24 symbiosed K851 plants showed higher allantoinase activity through-

out as compared to plants nodulated with R3S. This is also reflected in the allantoinic acid levels which were in general, more in K851-S24 nodules (Fig. 4). K851-S24 symbiotic association also showed higher levels of allantoinase and allantoinic acid than T44-S24 association at early flowering and early pod filling stages.

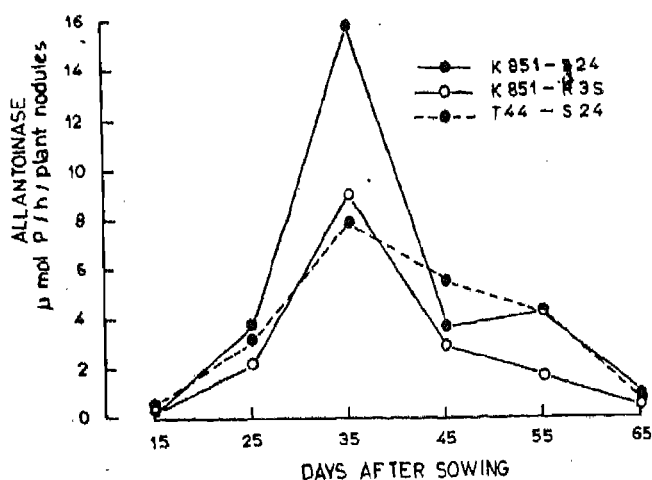


Fig. 3. Allantoinase activity in nodules of K851-S24, K851-R3S and T44-S24 symbioses.

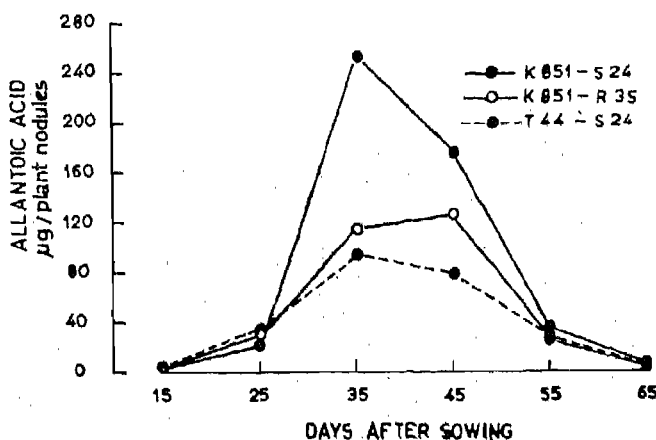


Fig. 4. Allantoinic acid content in nodules of K851-S24, K851-R3S and T44-S24 symbioses.

Both the enzymes and ureide content declined drastically from active pod filling stage to maturity indicating rapid nodule senescence during this period.

From these results, it is clear that significant ureide metabolism occurs in mungbean nodules. However, the demonstration of higher levels of glutamine synthetase, asparagine synthetase, and aspartate aminotransferase and amino acids (Singh, 1982) suggests that ammonia is initially assimilated into

amides, which may then serve as N-substrate for a purine based synthesis of ureides as demonstrated in soybean nodules (Matsumoto *et al.*, 1977a, b; Fujihara and Yamaguchi, 1978).

ACKNOWLEDGEMENT

Thanks are due to Dr. K. R. Dadarwal Microbiologist, for providing *Rhizobium* cultures and CSIR New Delhi, for financial assistance.

REFERENCES

- Antoniw, L. D. and Sprent, J. I. 1978. Primary metabolites of *Phaseolus vulgaris* nodules. *Phytochemistry* **17** : 675-78.
- Atkins, C. A., Rainbird, R. M. and Pate, J. S. 1980. Evidence for a purine pathway of ureide synthesis in N₂ fixing nodules of cowpea. *Z. Pflanzenphysiol.* **97** : 249-60.
- Boland, M. J., Fordyce, A. M. and Greenwood, R. M. 1978. Enzymes of nitrogen metabolism in legume nodules : A comparative study. *Aust. J. Plant Physiol.* **5** : 553-59.
- Dahiya, J. S. and Khurana, A. L. 1981. Chillum jar, a better technique for screening of rhizobia under summer conditions. *Plant Soil* **63** : 299-302.
- Fujihara, S. and Yamaguchi, M. 1978. Effects of allopurinol (G-hydropyrazol (3, 4-d) pyrimidine) on the metabolism of allantoin in soybean plants. *Plant Physiol.* **62** : 134-38.
- Herridge, D. F., Atkins, C. A., Pate, J. S. and Rainbird, R. M. 1978. Allantoin and allantoic acid in the nitrogen economy of the cowpea (*Vigna unguiculata*). *Plant Physiol.* **62** : 495-98.
- Matsumoto, T., Yatazawa, M. and Yamamoto, Y. 1977a. Distribution and change in the contents of allantoin and allantoic acid in developing nodulating and non-nodulating soybean plants. *Plant Cell Physiol.* **18** : 353-59.
- Matsumoto, T., Yatazawa, M. and Yamamoto, Y. 1977b. Incorporation of ¹⁵N into allantoin in nodulated soybean plants supplied with ¹⁵N₂. *Plant Cell Physiol.* **18** : 459-62.
- Schubert, K. R., Deshone, G. M., Blayes, D. A. and Hanks, J. F. 1981. Nitrogen assimilation and partitioning in soybean. The biosynthesis of ureides and amides. In: *Current Perspectives in Nitrogen Fixation*, p. 331, Gibson, A. H. and Newton, W. E. (eds.). Australian Academy of Science, Canberra.
- Singh, D. 1982. Nodule metabolism in relation to symbiotic nitrogen fixation in mungbean (*Vigna radiata* (L.) Wilczek). Ph. D. thesis, Haryana Agricultural University, Hisar.
- Sloger, C. 1969. Symbiotic effectiveness and N₂ fixation in nodulated soybean. *Plant Physiol.* **44** : 1666-68.
- Tajima, S. and Yamamoto, Y. 1975. Enzymes of purine catabolism in soybean plants. *Plant Cell Physiol.* **16** : 271-82.
- Tajima, S., Yatazawa, M. and Yamamoto, Y. 1977. Allantoin production and its utilisation in relation to nodule formation in soybeans. *Soil Sci. Plant Nut.* **23** : 225-35.
- Trijbels, F. and Vogels, G. D. 1966. Degradation of allantoin by *Pseudomonas acidovorans*. *Biochem. Biophys. Acta* **113** : 292-301.

CYTOGENETIC EFFECTS OF FOOD ADDITIVES IN BARLEY.

1. FOOD DYES

HARI OM MEHRA and P. K. SAREEN

Department of Genetics

Haryana Agricultural University, Hisar

(Received : May 3, 1982; Revised : August 24, 1984)

Among the various direct food additives, food dyes comprise by far the largest single category. These chemicals in addition to being toxic may bring about cellular and subcellular changes in the consumers and so four very commonly used food dyes viz., tartrazine (FD and C No. 5), amaranth (FD and C No. 2), azorubine (C. I. Food Red 3) and yellowish orange were screened for their cytogenetic effects.

Barley (*Hordeum vulgare*) cv. C 164 was used as test system. The roots of germinated seeds were dipped in aqueous solution of each dye for 10 h, fixed in acetic-alcohol (1 : 3) for 2 h and squashed in modified carbol fuchsin (Miller *et al.*, 1971). The frequency of anaphase bridges was calculated on the basis of the cells at anaphase, that of fragments and metaphase laggards on the basis of metaphase cells and the mitotic index as the percentage of dividing cells. To study the effect on germination and root length, 100 seeds were soaked in different concentrations of each dye for 10 h, washed with water, allowed to germinate and data were recorded after 24, 48 and 72 h.

All the food dyes tested were found to interact with the barley system. The cytological abnormalities observed in the present study are presented in Fig. 1.

Tartrazine

It was not clastogenic but was mitodepressive, the effect being dose related (Table 1). Seed germination was delayed and the effect on root length was prominent after 72 h of the treatment with 2% tartrazine (Tables 2 and 3). The stunted root growth can be attributed to the decrease in mitotic index. There is no report regarding its toxicological or physiological effects except some cases where this dye produced asthma and allergy.

Amaranth

Amaranth was mitodepressive but ineffective in inducing chromosomal breaks (Table 1). It induced somatic pairing which led to crossing over as indicated by the presence of pseudobridges formed as a result of unterminated 'chiasma like structures'. These bridges never appeared at telophase because of terminalization of these structures. The pseudobridges were un-

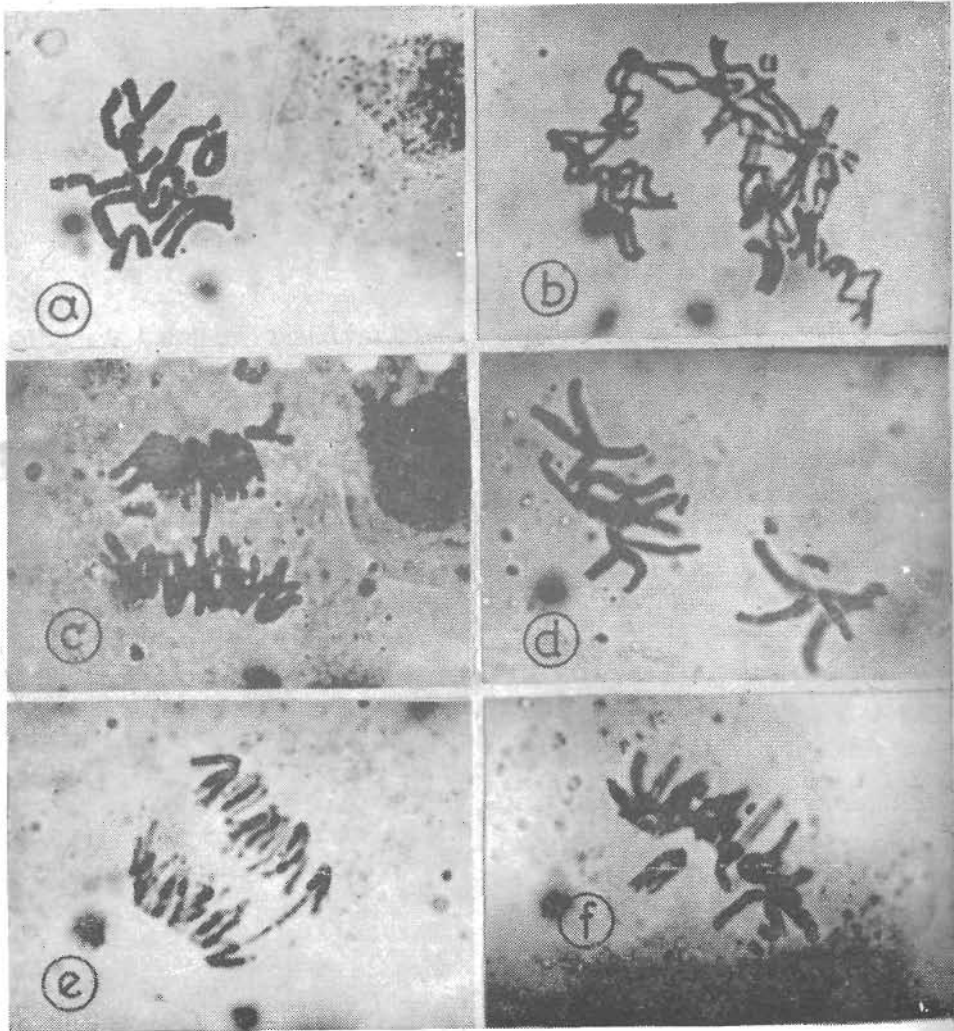


Fig. 1. Somatic cells of *Hordeum vulgare* showing various abnormalities as a result of action of food dyes. (a) Prophase showing somatic pairing of chromosomes; (b) prophase showing sister chromatid cross over configuration; (c) a pseudo-bridge at anaphase; (d) chromosome fragments at metaphase; (e) an anaphase bridge; (f) a metaphase laggard.

CYTOGENETIC EFFECTS OF FOOD ADDITIVES

TABLE 1

Clastogenic and mitodepressive effects of food dyes in barley

Dyes	Total cells	Concentration (% w/v)	Mitotic index	Cells with chromosomal aberrations (%)		
				Anaphase bridges	Fragments	Total Clastoant cells
Tartrazine	750	0	5.62	0	0	0.61
		0.25	5.29	0	0	0
		0.50	5.16	0	0	0
		1.00	3.40	0	0	0
		1.50	1.52	0	0	0
		2.00	1.43	0	0	0
Amaranth	610	0	5.66	0	0	0
		0.25	4.12	0	0	0
		0.50	3.77	0	0	0
		1.00	3.65	1.61	0	1.61
		1.50	3.85	4.44	0	4.44
		2.00	1.99	4.88	0	4.88
Azorubine	653	0	5.69	0	0	0
		0.25	4.79	0	0	0
		0.50	3.50	0	2.44	2.44
		1.00	2.00	0	2.17	2.17
		1.50	1.62	2.38	6.06	8.44
		2.00	1.44	2.85	8.93	11.78
Yellowish orange	692	0	4.86	0	0	0
		0.25	4.91	0	0	0
		0.50	4.31	2.44	3.85	6.29
		1.00	4.65	2.86	8.69	11.55
		1.50	4.35	4.88	10.52	15.40
		2.00	4.58	6.67	11.11	18.44*

*Metaphase laggards were also observed in 0.66% of the cells in this treatment. Rest of the treatments did not produce any metaphase laggards.

accompanied by fragments. Somatic pairing and bridges were observed only in the cells from roots treated with 1% or more of the dye indicating that amaranth is clastogenic at high concentrations. The seed germination data suggest that

24 h treatment was toxic at high concentrations only (Tables 2 and 3). On the basis of genetic studies amaranth has been declared relatively safe (Arnold *et al.*, 1976).

TABLE 2

Effect of food dyes on seed germination in barley (mean of three replicates after transforming the data by angular transformation)

Time after treatment (h)	Food dyes	Dose (% w/v)						C. D.
		0	0.25	0.5	1.0	1.5	2.0	
24	Tartrazine	60.9	59.7	60.6	57.1	53.7*	53.9*	5.6
	Amaranth	72.2	68.6	70.9	64.5*	64.1*	57.1*	7.8
	Azorubine	69.4	69.2	67.4	65.3	66.1	65.1	10.1
	Yellowish orange	69.2	62.0	64.3	59.7*	56.8*	60.7*	5.9
48	Tartrazine	65.2	64.1	61.5	62.6	59.7*	60.2	5.2
	Amaranth	72.9	73.6	73.6	69.1	67.1	61.7*	6.4
	Azorubine	77.2	77.2	70.1	68.8	69.7	69.9	13.0
	Yellowish orange	70.0	64.6	64.3	65.0	65.9	64.1	8.1
72	Tartrazine	65.4	62.7	61.7	63.1	61.1	63.3	5.4
	Amaranth	79.1	74.5	73.6	65.9*	71.1*	67.7*	7.3
	Azorubine	77.2	74.4	70.1	71.1	75.1	72.1	11.2
	Yellowish orange	70.5	67.5	69.3	64.4*	66.1	65.8	5.6

*Significant at 5% level.

TABLE 3

Effect of food dyes on root length (mm) in barley (mean of three replicates)

Time after treatment (h)	Food dyes	Dose (% w/v)						C. D.
		0	0.25	0.5	1.0	1.5	2.0	
24	Tartrazine	15.6	14.1	12.3	12.9	10.6	10.1	9.8
	Amaranth	7.8	7.5	8.3	7.1	6.9	4.7	5.1
	Azorubine	7.3	12.5	11.2	16.2	13.3	13.2	6.6
	Yellowish orange	6.7	4.9	5.9	5.6	5.0	6.2	3.2
48	Tartrazine	31.4	29.5	28.7	29.3	30.5	26.1	8.8
	Amaranth	31.1	30.6	30.6	28.4	26.0	24.9	6.7
	Azorubine	19.6	28.5*	30.8*	37.6*	35.0*	37.9*	7.0
	Yellowish orange	23.1	21.6	20.8	20.1	16.6	19.3	4.9
72	Tartrazine	51.5	51.3	48.5	46.2	46.7	42.1*	6.2
	Amaranth	46.9	45.6	46.5	43.1	44.5	43.1	13.5
	Azorubine	30.5	38.7	45.1	54.6*	53.9*	59.2*	16.1
	Yellowish orange	51.9	53.1	45.5	47.8	47.1	48.3	8.3

*Significant at 5% level.

CYTOGENETIC EFFECTS OF FOOD ADDITIVES

Azorubine and Yellowish Orange

These were found to be clastogenic (Table 1). Azorubine induced chromosomal breaks at higher concentrations (1.5 and 2.0 per cent) while yellowish orange was effective even at low concentrations. The anaphase bridges included both pseudo and breakage fusion type. However, no telophase bridges could be detected. Somatic chromosomal pairing was also observed. Yellowish orange at 2% induced metaphase laggards. The reduction in mitotic index was marginal at all concentrations (Table 1). It delayed seed germination. However, only 1.5% of the dye affected root growth upto the initial 48 h and it was as good as the control later on. Mitotic index and root growth increased in 0.25% Azorubine, but declined at higher concentrations. Thus, like radiations (Nuttal

et al., 1968), it stimulates cell division at low doses but at high doses physiological disturbances result in a reduction in cell division. However, the dye was not toxic (Table 2). Azorubine has been reported to be non-mutagenic but toxic in case of yeast (Brown *et al.*, 1978). However, no report is available on yellowish orange.

From the present investigation, it appears that the four food dyes are not completely safe. Amaranth, azorubine and yellowish orange are genotoxic and can have genetic dangers of varying magnitudes. Mitodepressive / mitogenic effects as observed in this study can lead to stunted or unscheduled growth. However, before making any conclusion, these are to be tested extensively in other test systems including mammals.

REFERENCES

- Arnold, D. W., Kennedy, G. L., Keplinger, M. L. and Calandra, J. C. 1976. Failure of FD and C Red No. 2 to produce dominant lethal effects in mouse. *Food Cosmet. Toxicol.* **14** : 163-65.
- Brown, J. P., Roehm, G. W. and Brown, R. J. 1978. Mutagenicity testing of certified food colours and related Azo, Xanthene and Triphenyl methane dyes with the *Salmonella*/microsome system. *Mutat. Res.* **56** : 248-71.
- Miller, R. A., Gamborg, O. L., Keller, W. A. and Kao, K. N. 1971. Fusion and division of nuclei in multinucleated soybean protoplasts. *Can. J. Genet. Cytol.* **13** : 347-53.
- Nuttal, V. W., Lyall, L. H., Less, D. H. and Hamilton, H. A. 1968. Response of garden crop plants to low dose gamma irradiation of seeds. *Can. J. Plant Sci.* **48** : 409.

GRAIN GROWTH OF WHEAT AS INFLUENCED BY TIME OF SOWING AND NITROGEN FERTILIZATION

S. D. DHIMAN, D. P. SINGH and H. C. Sharma

Department of Agronomy

Haryana Agricultural University, Hisar

(Received : February 25, 1983; Revised : June 8, 1984)

ABSTRACT

Field experiments were conducted to evaluate the effects of time of sowing and nitrogen nutrition on air-temperature and development of flag leaf area and their influence on the pattern of grain growth in a triple gene dwarf *aestivum* wheat (cv. WH-296). An increase in air temperature from heading to maturity increased the rate of grain growth in a wheat spike. But the higher rate of grain growth at higher atmospheric temperatures could not compensate for the shorter duration of grain filling in attaining the maximum final grain weight in wheat spikes. The flag leaf area and biomass were related to the grain growth of wheat spike. Grain growth rate of 0.35 ± 0.01 g spike⁻¹ week⁻¹ over 7 weeks period seems to be optimum for attaining final maximum weight in a spike of mother shoot of dwarf wheat. This rate of grain growth was attained at around 18°C mean air temperature and 25 cm² flag leaf area mother-shoot⁻¹ over 7 weeks duration with the application of 120 kg N ha⁻¹ in the November sown dwarf wheat.

The genetic traits find full expression only when environmental conditions— atmospheric and chemical are present in optimal form. Photosynthesis of ears, and flag leaves during grain filling period has been recognized as a major contributor to grain yield in the cereals (Allison and Watson, 1966; Thorne, 1966; Evans *et al.*, 1975). A reduction in photosynthesis rate and/or that of photosynthetic surface should lead to a reduction in yield. Fischer and Kohn (1966) showed that the yield of field grown wheat was inversely correlated with the rate of leaf senescence after anthesis. The close relationship between flag leaf area, its duration and grain yield has also been observed under different atmospheric and

chemical environments (Wicke *et al.*, 1972; Wattal and Asana, 1976; Dhiman *et al.*, 1980). Also process of grain growth has been reported to be strongly influenced by temperature (Evans, 1975; Gallagher *et al.*, 1975). The number of grains in wheat is normally determined by the time of anthesis, whereas grain growth takes place after anthesis (Duncan, 1975; Gallagher *et al.*, 1975). Thus, the flag leaf area, its duration and prevailing ambient air temperatures during reproductive phase of growth seem to play a dominating role in influencing the grain yield of wheat. Under field conditions, it is possible to create different photosynthetic surfaces and temperature regimes by varying the time of sowing

GRAIN GROWTH IN WHEAT

and nitrogen application to study their influence on grain growth of Indian wheat, which is not yet adequately understood. The present study was, therefore, directed to discuss the effects of time of sowing and nitrogen levels on photosynthetic surfaces and air temperatures and their influence on grain growth of a triple gene dwarf wheat under field situations.

MATERIAL AND METHODS

Wheat (*Triticum aestivum* L. cv. WH-296) was tested for grain growth from heading to maturity during winter season 1978-79 at the Research Farm of Haryana Agricultural University, Hisar. Three different temperatures were attained by sowing wheat on 22nd October (D_1), 13th November (D_2), and 23rd December (D_3) 1978 in one experiment. Three different photosynthetic surfaces were created by applying 40, 120 and 200 kg N ha⁻¹ in another experiment sown on November 23, 1978. The soil of experimental plot was sandy loam in texture with organic carbon 0.27%, available phosphorus 18 kg ha⁻¹, available potash 408 kg ha⁻¹ and pH 7.9. The other cultural practices including irrigation schedules (4-6 irrigations depending upon crop duration) were followed as per recommendations. A total of 83 mm rainfall was received during the crop season. The main shoots of uniform vigour and phenology were tagged in a 10 m long plot from among 7 central rows of wheat spaced 23 cm apart. Five main shoots were removed at weekly intervals just above the ground level from each plot randomly for measuring the flag leaf area and spike growth. The area of flag leaf was measured by

area meter (LI 3000, Lincoln Nebraska, USA).

After measuring the leaf area, the grain and other plant components were dried separately in an oven at 65°C till constant weight. The correlation coefficients and regression functions were calculated as described by Crow and Crow (1969).

RESULTS AND DISCUSSION

The grain growth of wheat was affected by ambient air temperature prevailed during the grain filling stage of wheat under different dates of sowing (Fig. 1). In general, a delay in sowing reduced the duration of grain filling in wheat. The wheat ear took about nine, seven and five weeks of time to attain full grain growth under October 22, November 13 and December 23 sowings, respectively. The rates of leaf senescence also increased with delayed sowing. However, the final grain weight was recorded maximum under November 13 sowing (D_2), followed by October 22 (D_1), and minimum in December 23 (D_3) sowing. But the rate of grain growth increased with delay in sowing. The values of about 0.40 g, 0.34 g and 0.21 g week⁻¹ spike⁻¹ were recorded under D_3 , D_2 and D_1 treatments, respectively. Temperature seems to play a greater role in influencing the grain growth of wheat. The ambient air temperature was elevated due to increase in the duration and intensity of radiation with delay in sowing (Fig. 1, Singh *et al.*, 1980). Evans (1975) and Gallagher *et al.* (1975) also reported that a rise in temperature increased the rate of grain growth, but shortened the duration, and the mean weight per grain remained

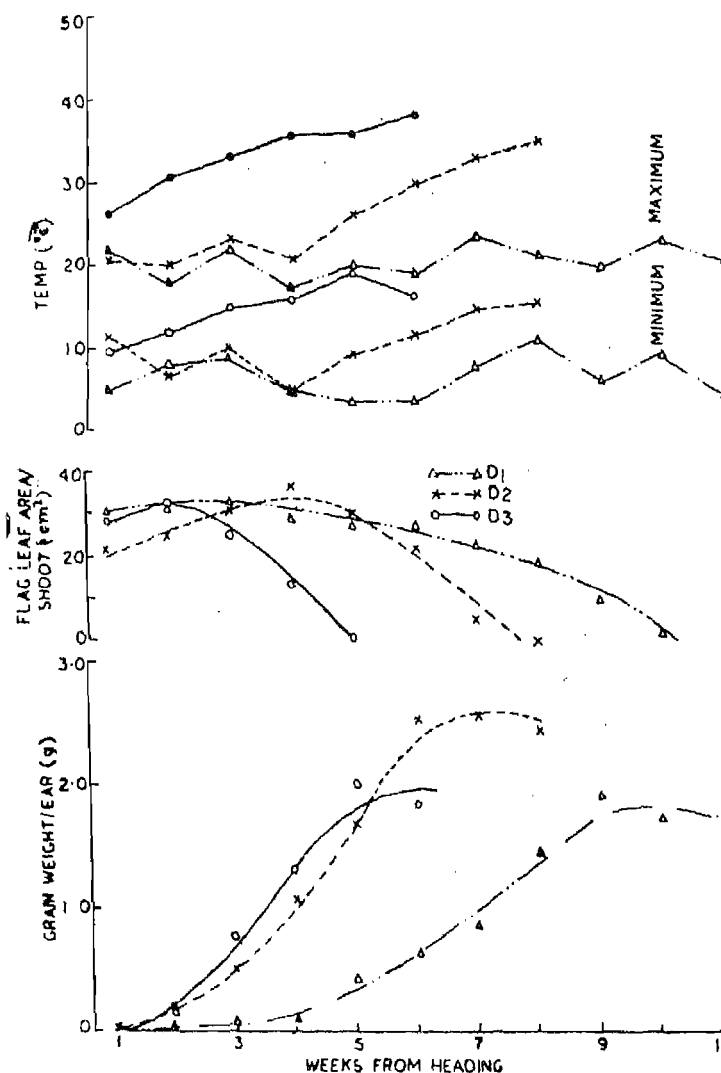


Fig. 1. Effect of dates of sowing on air temperature, flag leaf area and grain growth in a wheat spike. Each point in the figure for flag leaf area and grain weight per spike is a mean of five mother shoots harvested at weekly intervals from the ear emergence onwards.

constant. However, at exceptionally high temperatures ($>30^{\circ}\text{C}$), the increase in the rate of grain growth failed to compensate for the shorter duration, resulting in a decrease in mean grain

weight (Thorne and Ford, 1971; Spieritz, 1974). Our observations also confirmed the above results to some extent as number of grains per ear was fairly constant both in tall (Singh and Singh,

GRAIN GROWTH IN WHEAT

1973) and dwarf (Sumboli and Sharma, 1974) wheat under different dates of sowing. However, there is some optimum temperature for attaining a moderately optimum flag leaf area over certain period to supply required amount of assimilates to the developing grains. The mean values of day and night temperature equal to 17.7°C and flag leaf area equal to 24.9 cm^2 over a 7 weeks period seem to be quite suitable for attaining a maximum growth of grains in a spike of triple gene dwarf wheat.

The effects of nitrogen nutrition on flag leaf area and grain growth have been shown in Fig. 2. The flag leaf area increased with the increase in the doses of nitrogen application. At lower level of 40 kg N ha^{-1} , it showed almost a linear decline with the plant age, while at higher doses of 120 and 200 kg N

ha^{-1} , the flag leaf area increased from heading to about two weeks, and started senescing thereafter till maturity. The grain growth pattern did not follow the course of flag leaf area development during initial stages of grain filling, but later the final grain weight was related to the flag leaf area duration. The mean values of flag leaf area maintained during grain filling period of 7 weeks duration at mean air temperature of 18.3°C in treatments with 40, 120 and 200 kg N ha^{-1} were 15.0, 24.7 and $28.4\text{ cm}^2\text{ shoot}^{-1}\text{ week}^{-1}$, respectively. The corresponding mean values for grain growth were 0.31, 0.36 and $0.38\text{ g spike}^{-1}\text{ week}^{-1}$, respectively. An increase in the nitrogen application not only maintained a higher vegetative growth, but also increased the filled grain percentage and individual grain weight (Helmes, 1973; Tanaka, 1977).

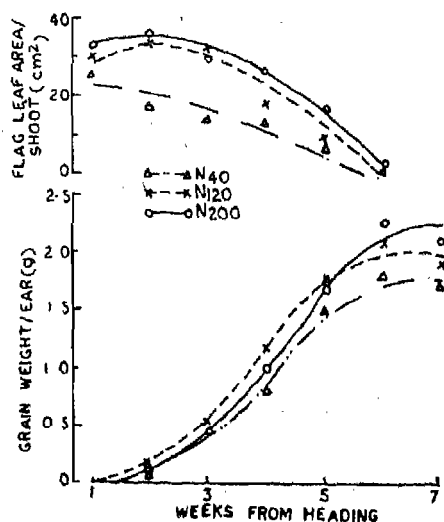


Fig. 2. Effect of nitrogen levels on flag leaf area and grain growth in a wheat spike. The measurements were carried out on five mother shoots as in Fig. 1.

The biomass production has also shown a positive relation to grain yield per spike under various environmental conditions (Figs. 3 and 4). Similar results have also been reported by Thornley (1979). It is interesting to note that the wheat sown very early or late in the season produced lesser amount of biomass and grain yield, but the vegetative system was more efficient in translocating the photosynthates to the developing grains in the spike under delayed sowing. However, the major limitation under these situations would be the lesser biomass production per se, which can only be increased by developing wheat genotypes with higher rate of biomass production under very early or late sown conditions.

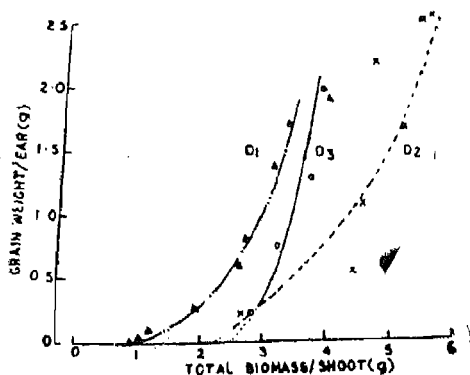


Fig. 3. Relation of shoot dry weight to grain weight of wheat spike under three dates of sowing of wheat. The mean grain weight per spike from Fig. 1 and the mean dry weight of respective mother shoots have been used for curve fitting.

$$D_1 \text{ (22 October): } Y = 0.028 X^{2.17} \\ (r=0.960)$$

$$D_2 \text{ (13 November): } Y = 0.0058 X^{2.41} \\ (r=0.862)$$

$$D_3 \text{ (23 December): } Y = 0.00014 X^{6.87} \\ (r=0.914)$$

The results of two experiments carried out on a November sown triple gene dwarf wheat were in quite agreement with regard to the duration of grain filling and rate of grain growth in the spikes of mother shoots. The prevalence

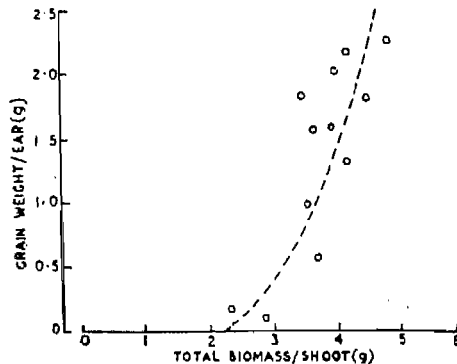


Fig. 4. Relation of shoot dry weight to grain weight of wheat spike. The mean grain weight per spike from Fig. 2 and the mean dry weight of respective mother shoots have been used for curve fitting.

$$Y = 0.00128 X^{5.04} \\ (r=0.972)$$

of around 18°C mean air temperature over 7 weeks period of grain filling with a flag leaf area of about 25 cm² mother shoot⁻¹ seems quite ideal to maintain the grain growth rate of 0.35±0.01 g spike⁻¹ for attaining the highest final grain weight in the spikes of dwarf wheats. This rate of grain growth can be attained by applying 120 kg N ha⁻¹ to a November sown irrigated dwarf wheat under North Indian conditions.

REFERENCES

- Allison, J. C. S. and Watson, D. J. 1966. The production and distribution of dry matter in maize after flowering. *Ann. Bot. (NS)* 30: 365-81.
- Crow, A. and Crow, A. 1969. *Mathematics for Biologist*. Academic Press, London—New York.
- Dhiman, S. D., Sharma, H. C. and Singh, R. P. 1980. Association between flag leaf area and grain yield in wheat. *Indian J. plant Physiol.* 23: 282-87.
- Duncan, W. G. 1975. Maize. In: *Crop Physiology—Some Case Histories*, pp. 23-50, Evans, L. T. (ed.). Cambridge University Press, Cambridge.
- Evans, L. T. 1975 (ed.). *Crop Physiology—Some Case Histories*. Cambridge University Press, Cambridge. pp. 327-55.

GRAIN GROWTH IN WHEAT

- Evans, L. T., Wardlaw, J. F. and Fischer, R. A. 1975. Wheat. In : *Crop Physiology—Some Case Histories*, pp. 101-50, Evans, L. T. (ed.). Cambridge University Press, Cambridge.
- Fischer, R. A. and Kohn, G. D. 1966. The relationship of grain to vegetative growth and post flowering leaf area in the wheat crop under conditions of limited soil moisture. *Aust. J. agric. Res.* 17 : 281-95.
- Gallagher, J. N., Biscoe, P. V. and Scott, R. K. 1975. Barley and its environment. V. Stability of grain weight. *J. appl. Ecol.* 12 : 319-36.
- Helmes, D. P. 1973. Influence on development of semi-dwarf and standard height wheat cultivars in different photo-period and nitrogen treatments. *Can. J. Bot.* 51 : 41-56.
- Singh, D. P. and Singh, R. R. 1973. Effect of time of sowing and varieties on the growth and yield of wheat. *Balwant Vidyapeeth J. agric. Sci. Res.* 15 : 1-7.
- Singh, D. P., Singh, P., Singh, P. and Singh, M. 1980. Effect of sowing time and irrigation on growth, yield and water use efficiency of lentil. Proc. 3rd Afro-Asian Conference, ICID, Delhi, India, Oct. 23-29. pp. 139-46.
- ✓ Spieritz, J. H. J. 1974. Grain growth and distribution of dry matter in the wheat plant as influenced by temperature, light, energy and size. *Neth. J. agric. Sci.* 22 : 207-20.
- Sumboli, G. L. and Sharma, S. P. 1974. Effect of dates of sowing on growth and yield of dwarf wheat varieties. *Indian J. Agron.* 19 : 171-75.
- Tanaka, A. 1977. Nutrient requirement of field crops during growth. In : *Physiological Aspects of Crop Nutrition*, pp. 75-100, Gupta, U. S. (ed.). Atama Ram and Sons, Delhi.
- Thorne, G. N. 1966. Physiological aspects of grain yield in cereals. In : *Growth of Cereals and Grasses*, pp. 88-105, Miltthorpe, F. L. and Ivins, J. D. (eds.). Dutterworth, London.
- Thorne, G. N. and Ford, M. A. 1971. Sink capacity of wheat ears. Rep. Rothamsted Exp. Stn., part 1. pp. 94-95.
- ✓ Thornley, J. H. M. 1979. Wheat grain growth-anthesis to maturity. *Aust. J. plant Physiol.* 6 : 187-94.
- Wattal, P. N. and Asana, R. L. 1976. Physiological analysis of the yield of tall and semi-dwarf cultivars of wheat. *Indian J. plant Physiol.* 19 : 184-89.
- Wicke, H. J., Stock, H. G. and Singh, D. P. 1972. Studies on the effect of sprinkler irrigation on the yield formation of cereal crops. *Acker-Pflanzenbau-Bodenkunde* 17 : 573-84.

EFFECT OF GROWTH REGULATORS ON FRUIT-SET, FINAL RETENTION AND FRUIT QUALITY IN SWEET LIME (*CITRUS LIMETIOIDES* TANAKA.)

R. K. ARORA and R. YAMDAGNI

Department of Horticulture

Haryana Agricultural University, Hisar

(Received : March 30, 1983; Revised : October 25, 1983)

ABSTRACT

Total number of flowers, hermaphrodite flowers and final fruit retention were maximum with cycocel (1000 ppm), ethrel (450 ppm) and silver nitrate (600 ppm). NAA (150 ppm) increased the total number of flowers but was not effective in increasing the hermaphrodite flowers and final fruit retention. Ethrel (600 ppm) and NAA (100 ppm) resulted in significant increase in T.S.S. content of fruit. Acidity was increased by silver nitrate.

The main cause of shy bearing in some of the clones in sweet lime is the production of large number of male flowers rather than the usual hermaphrodite flowers. It seems that plant hormones are responsible for the production of different types of flowers. Osborn (1965) reported that plant growth substances are involved in each of the steps of the reproductive growth. Many research workers have used ethrel at various concentrations for the induction of flower buds in different fruit crops (Wee and Rao, 1977; Balakrishnan *et al.*, 1979). Similarly, Monselise *et al.* (1966) reported induction of flower buds as a result of cycocel sprays on Eureka lemon. Unfruitfulness and shy bearing in Eureka lemon was overcome by spraying growth regulators (Nir *et al.*, 1972).

The present investigation was undertaken with an objective to study the

effect of growth regulators on flowering, fruiting and fruit quality in sweet lime.

MATERIAL AND METHODS

The studies were conducted during 1978 to 1980. The sweet lime trees of Local cultivar of similar vigour and age were selected and fertilized uniformly. Four chemicals viz., cycocel (500, 750, 1000 and 1250 ppm), silver nitrate (150, 300, 450 and 600 ppm), ethrel (150, 300, 450 and 600 ppm) and NAA (50, 100, 150 and 200 ppm) were used for spray on the trees. These treatments were replicated three times keeping one tree as a unit in each treatment. There was one control, on which only water was sprayed. In all fiftytwo trees were sprayed. Four litres of chemical solution per tree was sprayed. First spray was given in the month of November and the second in January well before the initiation and differentiation of floral

buds. The experiment was in factorial randomized block design.

Total Number of Flowers per Shoot

Total number of flowers was recorded in the randomly tagged four branches of thumb thickness in all the four directions of the tree. Daily counting of the opened flowers on each shoot was done in the morning by marking a black dot on the petal with the help of a black pen. Out of the total flowers, hermaphrodite flowers were counted and subtracted from the total flowers to get the number of male flowers opened. Counting was started from first of March and continued till first of April.

Fruit-set

As soon as the petals started shedding and ovary started developing a week after bloom, the number of such developed fruits on the tagged branches was recorded, and thus the percentage of fruit-set was calculated on the basis of total as well as hermaphrodite flowers.

Final Fruit Retention

Matured and harvestable fruits were counted on each tagged shoot. Percentage was calculated on the basis of set fruits and total number of hermaphrodite flowers.

Physico-Chemical Characters

Standard conventional methods were used while recording data on these aspects. Chemical analysis of fruits was done as per methods in AOAC (1960).

RESULTS AND DISCUSSION

Total Hermaphrodite and Male Flowers per Shoot

The data in Table 1 reveal that the number of flowers increased with all the concentrations of NAA, cycocel, ethrel and silver nitrate over control. However, within each treatment, only 1000 ppm of cycocel, 300 ppm ethrel, 150 and 600 ppm of silver nitrate and 150 ppm of NAA gave significant results. Monselise *et al.* (1966) and Nir *et al.* (1972) also observed an increase in flowering in Eureka lemon by spraying cycocel at 1000 and 4000 ppm. Similar increase in flowering by silver nitrate application in determinate Cucumber has been reported by Kalloo and Franken (1978) and Atsmon and Tabba' (1979).

Growth regulators with the exception of cycocel (500 ppm) and NAA (200 ppm) produced significantly higher percentage of hermaphrodite flowers as compared to control wherein no hermaphrodite flower was observed. Male flowers decreased with all concentrations of silver nitrate, ethrel and cycocel. However, lowest concentrations of ethrel, cycocel and all concentrations of NAA did not show any effect. Within each treatment the increase in hermaphrodite flowers was significant with cycocel (1000 ppm), ethrel (300 ppm) and silver nitrate (600 ppm). This increase in total and hermaphrodite flowers by cycocel might be due to its retarding effect on vegetative growth and increased rate of translocation of conserved metabolites and hormones to the site of floral bud differentiation. Similar observations were also reported by Rudakov (1979).

TABLE 1

Effect of different chemicals on flowering, fruit setting and final fruit retention

Treatments (ppm)	Average number of flowers per shoot	Per cent hermaphrodite flowers	Per cent male flowers	Per cent fruit set (on the basis of total flowers)	Per cent fruit set in hermaphrodite flowers	Per cent fruit retention (on the basis of fruit set)	Per cent final fruit retention in hermaphrodite flowers
Control	5.3	0	100.0	0	0	0	0
Cycocel							
500	26.6	0	100.0	0	0	0	0
750	38.3	24.8	75.2	12.82	49.4	35.02	14.2
1000	140.6	31.9	58.1	14.06	43.9	13.94	6.2
1250	72.0	30.3	69.7	16.77	54.5	10.00	5.3
Ethrel							
150	58.6	5.7	94.3	4.81	28.0	6.75	2.7
300	109.3	23.5	76.5	19.22	75.8	6.58	4.8
450	86.5	16.1	83.9	6.75	42.9	28.59	29.6
600	55.8	15.3	84.7	8.62	78.7	0	0
AgNO ₃							
150	165.0	22.6	77.4	4.51	21.1	22.68	8.5
300	98.6	17.8	82.2	2.90	16.9	26.32	24.5
450	110.7	17.2	82.8	3.77	24.0	20.85	6.1
600	136.1	26.4	73.6	7.73	29.2	31.68	10.3
NAA							
50	23.0	2.4	97.6	2.90	20.8	19.00	18.7
100	17.1	5.0	95.0	1.30	10.0	29.10	7.7
150	44.7	0.3	99.7	0	0	0	0
200	20.0	0	100	0	0	0	0
C. D. at 5%	30.54	9.83	10.54	8.19	19.29	10.16	5.95

GROWTH REGULATORS ON SWEET LIME

TABLE 2
Effect of different chemicals on physico-chemical quality of fruits

Treatments (ppm)	Weight of fruit (g)	Size of fruit (cm)		Rind thickness (cm)	Per cent juice	Per cent T.S.S.	Per cent acidity in terms of citric acid	Ascorbic acid content (mg/100 ml juice)
		Length	Breadth					
Control	—	—	—	—	—	—	—	—
Cycocel	—	—	—	—	—	—	—	—
500	—	—	—	—	—	—	—	—
750	140.7	6.75	6.23	0.29	45.00	7.20	0.0896	54.00
1000	143.0	6.92	6.27	0.29	53.90	6.90	0.0725	39.90
1250	164.0	8.74	6.48	0.32	42.10	6.80	0.0682	54.70
Ethrel	—	—	—	—	—	—	—	—
150	150.7	6.91	6.38	0.31	41.63	7.20	0.0680	57.30
300	117.7	5.96	5.87	0.29	44.23	7.20	0.0792	46.60
450	136.9	6.64	6.28	0.27	46.85	7.20	0.0725	58.70
600	118.7	5.90	5.90	0.19	44.93	7.80	0.0698	51.03
AgNO ₃	—	—	—	—	—	—	—	—
150	140.3	6.39	6.42	0.22	47.13	6.80	0.2688	50.50
300	120.3	6.15	6.01	0.24	45.60	7.50	0.2560	55.70
450	96.0	5.51	5.62	0.20	47.03	7.10	0.2474	59.10
600	135.7	6.42	6.33	0.30	41.16	7.00	0.2133	51.70
NAA	—	—	—	—	—	—	—	—
50	121.0	6.53	5.91	0.23	46.80	7.40	0.0768	53.40
100	154.0	6.99	6.40	0.33	42.00	7.60	0.0640	59.10
150	—	—	—	—	—	—	—	—
200	—	—	—	—	—	—	—	—
C. D. at 5%	25.51	0.55	0.36	0.02	1.71	0.59	0.0280	4.50

Ethrel is known to induce flowering in annual and perennial crops and increase in flowering by ethrel in the present studies is in agreement with the findings of Chako *et al.* (1972) in mango and Lord *et al.* (1974, 1975) in apple.

Fruit-set

No fruit-set was observed in control trees (Table 1). Growth regulators with the exception of cycocel (500 ppm) and NAA (150 and 200 ppm) significantly increased the per cent fruit-set. Ethrel (300 ppm) gave significantly the highest fruit-set followed by cycocel (1250 ppm) as compared to the other growth regulator treatments. Fruit set on the basis of hermaphrodite flowers was also significantly higher with ethrel (300 and 600 ppm) over other treatments. This increase in fruit-set by cycocel and ethrel was related to the increased production of hermaphrodite flowers. Bairamova *et al.* (1976) and Blinovskii *et al.* (1980) also obtained higher fruit-set in apple with cycocel application.

Final Fruit Retention

It is apparent from the data that the final retention was significantly higher with cycocel (750 ppm), ethrel (450 ppm) and silver nitrate (600 ppm). However, cycocel (1000 ppm) gave the highest final fruit retention as compared to its other concentrations. This increase in final fruit retention is directly related with the increase in total number of flowers, per cent hermaphrodite flowers and initial fruit-set. Since ethrel application contributed to the regulation of flowering and stimulated enzyme system, the retention of fruit was improved. These results are in conformity with those

of Buban *et al.* (1977) who reported increased yield in apple, Monselise *et al.* (1966) in lemon, Rudakov (1979) and Blinovskii *et al.* (1980) in apple by the application of cycocel.

Physico-Chemical Characters

It is apparent from the data in Table 2 that the fruit weight and size (length and breadth) increased significantly with cycocel (1250 ppm), ethrel (150 and 450 ppm) and silver nitrate (150 ppm). The increase in weight and size of fruits was related to the number of fruits finally retained. Bairamova *et al.* (1976) reported increase in bunch size in Agadi grapes by application of cycocel before flowering. Similarly increase in pineapple fruit size by ethrel application was obtained by Balakrishanan *et al.* (1979). Rind thickness was significantly reduced by ethrel (600 ppm) followed by silver nitrate (450 ppm).

Highest juice content was obtained with cycocel (100 ppm) followed by silver nitrate (450 ppm), ethrel (450 ppm) and NAA (50 ppm) as compared to other treatments.

The increase in total soluble solids was significant with ethrel (600 ppm) and NAA (100 ppm), whereas acid content was lower with NAA (100 ppm) and cycocel (1250 ppm) relative to other treatments. Acidity was three times more and significantly higher in all the concentrations of silver nitrate as compared to other treatments.

Silver nitrate (450 ppm) and NAA (100 ppm) followed by ethrel (450 and 150 ppm) resulted in significantly higher ascorbic acid content as compared to other treatments.

GROWTH REGULATORS ON SWEET LIME

REFERENCES

- AOAC. 1960. Official and tentative methods of analysis. Association of Official Agricultural Chemists, Washington.
- Atsmon, D. A. Lang and Tabbak, C. 1979. Comparative effects of gibberellin, silver nitrate and amino ethoxy vinyl glycine on sexual tendency and ethylene evolution in cucumber plants (*Cucumis sativus*). *Plant Cell Physiol.* 20 : 1547-55.
- Bairamova, D. B., Mekhtizade, R. H. and Alijev, I. A. 1976. The growth and productivity of grape vines treated with CCC. *Referativnyi Zhurnal.* 5.55. 993. (*Hort. Abstr.* 47 : 11310).
- Balakrishnan, S., Arvindakshan and Nair, N. K. 1979. Efficacy of certain regulators in inducing flowering in pineapple (*Ananas comosus*). *Agric. Res. J. Kerala* 16 : 125-28. (*Hort. Abstr.* 50 : 3789).
- Blinovskii, I. K., Agafonov, N. V. and Rabei, L. A. 1980. Characteristics of apple tree growth and cropping in intensive orchards in relation to the application of Chlormequat. *Timiryazevskoi Sel's Kokhozyaistvennoi Akademii* No. 2. (*Hort. Abstr.* 50 : 6032).
- Buban, T., Schmidt, S. and Katztuss, M. 1977. Chemical treatment for increasing apple yield. *Kertgazdasag* 9 (1) : 1-12 (*Hort. Abstr.* 47 : 11155).
- Chako, E. K., Kohli, R. K. and Randhawa, G. S. 1972. Studies on the effect of ethrel on mango. I. Flower induction in off year in Langra trees. *Indian J. Hortic.* 29 (2) : 1-4.
- Kalloo and Franken, Sabine. 1978. Chemical induction of staminate flowers in four determinate gynocious lines of Pickling cucumber. *Gartenbauwissenschaft* 43 (6) : 9 : 280-82.
- Lord, W. J., Greene, D. W., Cromack, L. G. and Morin, R. J. 1974. Further studies on the use of ethephon (ethrel) to initiate flower bud development. *Proc. Massachusetts Fruit Growers Assoc.* 80 : 75-78. (*Hort. Abstr.* 46 : 5408).
- Lord, W. J., Greene, D. W. and Damon, R. A. Jr. 1975. Evaluation of fruit abscission and flower bud promotion capabilities of ethephon and SADH on apple. *J. Am. Soc. Hortic. Sci.* 100 : 259-61.
- Monselesse, S. P., Goren, R. and Halevy, A. H. 1966. Effect of B-9, Cycocel and Benzo-thiazole oxyacetate on flower bud induction of lemon trees. *Proc. Am. Soc. Hortic. Sci.* 89 : 195-200.
- Nir, I., Goren, R. and Leshem, B. 1972. Effect of water stress, GA and CCC on flower differentiation in Eureka lemon trees. *J. Am. Soc. Hortic. Sci.* 97 : 774-81.
- Osborn, D. J. 1965. Interaction of hormonal substances in the growth and development of plants. *J. Sci. Food Agric.* 16 : 1-3.
- Rudakov, Yu I. 1979. The effect of Tur (Chlormequat) on growth and cropping of Palmette apple trees. *Nauch. Trudy Tashkent.* 79 : 9-13 (*Hort. Abstr.* 50 : 3111).
- Wee, Y. C. and Rao, A. N. 1977. Flowering response of Singapore spanish Pineapple to monthly application of acetylene and NAA. *Malays. agric. J.* 51 : 154-66. (*Hort. Abstr.* 50 : 3791).

WATER TABLE DECLINE AND QUALITY TREND IN THE VICINITY OF LOWER GHAGGAR BASIN

JOGINDER SINGH and RANVIR KUMAR

U. N. D. P. Centre of Soil and Water Management

Haryana Agricultural University, Hisar

(Received : April 19, 1983; Revised : February 9, 1984)

ABSTRACT

Water table decline and quality variation trend were observed at Haryana Agricultural University Farm, Sirsa and adjoining areas by installing 43 observation wells at a grid of 125 m × 160 m from 1979 through 1982. The water table over the entire area was observed to be falling at an average rate of 49.50 cm per year. Approximately 33% of the area under less than 8 m water table depth shifted towards deeper depth during the period. The groundwater quality was generally good. Nearly 53% of the area was overlain with electrical conductivity ranging between 1000-2000 μ mhos/cm. The pumping at the farm needed to be controlled in view of the declining trend.

During the last two decades, major portion of Ghaggar basin, of which study area forms a part, having marginal groundwater quality and comprising north-west portion of Haryana State has been transformed from dryland agriculture to irrigated farming. This transformation was made possible with the introduction of Bhakra canal system in the early sixties. It has brought about changes in the watershed conditions of the semi-arid tract; the one extremely important and likely to create far reaching effects on the tracts ecology and life of its inhabitants is the changing groundwater regime (Singh, 1981). The groundwater modelling studies have been undertaken at a few locations in Haryana State. An attempt has been made to suggest ways and means to check rise of water table in saline groundwater areas—Haryana Agricultural University Farm, Govt. Farm Hansi by using groundwater

modelling approach (Singh and Kumar, 1982; Singh *et al.*, 1984). The present study was conducted at the farm of Haryana Agricultural University with an area of 166 hectare to observe the dynamic behaviour of water table. The study area being in the vicinity of Ghaggar river gets lot of recharge which has resulted in the large scale pumping and decline in water table.

METHODOLOGY

The water table data were recorded once in a month by installing 43 observation wells at a grid of 125 m × 160 m. Groundwater maps, viz. water table decline, isobath and groundwater contour maps for different periods were drawn to study the changes in water table. The area under different water table depth ranges was estimated by planimeter. Water table decline map for the period

WATER TABLE DECLINE STUDY

June 1979 to June 1982 was used to estimate the area under different amplitude ranges and subsequently to determine the net discharge during the period. Iso-conductivity maps were drawn during different months and area under different E. C. ranges was determined.

RESULTS AND DISCUSSION

Groundwater Movement

Groundwater contour map of October 1982 clearly indicates that sub-surface flow is occurring from north-west to south-west direction of the farm (Fig. 1). The hydraulic gradient ranges from 4 to 5 m per kilometer.

Variation of Per cent Area under Different Water Table Depth Ranges

Isobath or depth to water table maps were drawn for pre-and post-monsoon periods (June and October) from June 1979 through October 1982. From these maps, the per cent of total area mapped under various water table depth ranges was measured and has been given in Table 1. The general water table depth varied from 5 to 12 m during June 1979 and 7 to 14 m in October 1982. During June 1979 only 8.74% of the area was under more than 10 m water table depth which increased to 19.23% during October 1979. The per cent area under this water table depth (>10 m) range

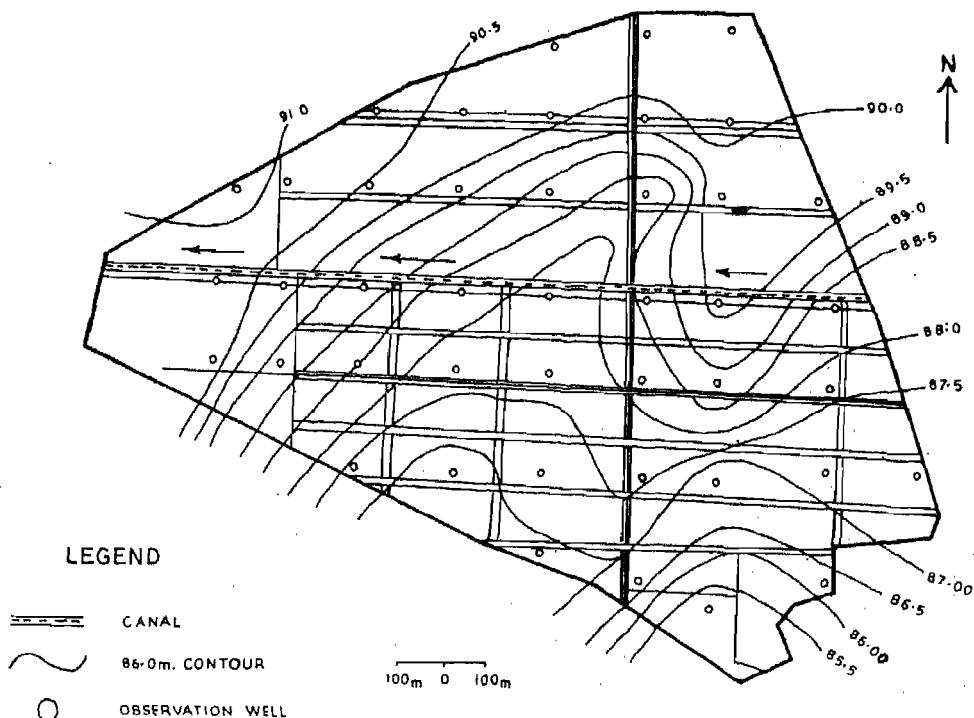


Fig. 1. Water table contour map of H. A. U. farm Sirsa (October 1982).

TABLE 1

Variation of per cent area under different water table depth ranges

Period	Water table depth range (m)						
	<6	6-7	7-8	8-9	9-10	10-11	11-12
June 1979	8.20	6.56	32.24	28.96	15.30	6.01	2.73
October 1979	9.89	7.69	18.13	21.98	23.08	11.54	7.69
June 1980	7.37	9.52	10.58	26.46	20.13	11.65	14.29
October 1980	6.88	6.88	11.11	24.33	22.22	14.29	14.29
June 1981	0.54	10.75	9.14	19.35	21.34	20.97	10.92
October 1981	—	12.83	10.70	18.72	17.10	21.39	10.70
June 1982	—	12.02	10.38	10.93	23.41	23.50	9.84
October 1982	—	—	13.83	5.32	25.00	21.28	14.36

increased to 25.94 and 28.58 during June and October 1980, respectively. More and more area continued shifting under deeper water table depth ranges and by the end of October 1982, the area under more than 10 m depth increased to 55.85 per cent. Therefore, during a short period of three years, the area under deeper water table range (>10 m) increased approximately by three fold. Similarly, per cent area under less than 7 m water table depth reduced from 17.58 to zero during the same period (Anonymous, 1982).

Groundwater Balance

Various components of groundwater balance equation were estimated for the period from June 1980 to May 1981. The generalised equation of water balance is given below (Anonymous, 1982) :

$$I - ET - q_o + q_{in} - q_p + R = \mu \Delta h$$

Where I = Total inflow into the area (canal + tubewell water) 'cm'

ET = Evapotranspiration 'cm'

q_o = Sub-surface outflow 'cm'

q_{in} = Sub-surface inflow 'cm'

q_p = Total pumpage 'cm'

R = Rainfall 'cm'

μ = Specific yield '—'

Δh = Change in water level 'cm' during the balance period

The area is supplied irrigation water through a minor of Sirsa major distributory and four tubewells have been installed at the farm. One tubewell is used for supplying drinking water. During the period total inlet of water in the area works out to be 78.75 cm both from canal and tubewells. The water from one of the tubewells used for public health has been excluded for estimating the inlet in the area while included for estimating the pumpage. The total pumpage amounts to 28.14 cm. The evapotranspiration is estimated based on the experiments conducted at the University Farm and equals 78.93 cm. Similarly sub-surface inflow and outflow were determined by drawing flow net and found to be 22.03 and 31.47 cm. Change in storage was estimated from water

WATER TABLE DCLINE STUDY

table fluctuation and came to be -6.43 cm (decline). Rainfall during the study period was observed to be 32 cm. The net change in storage from water balance equation is -5.76 cm while that from water table decline is -6.43 cm. There is close proximity between two estimations. From different components it is clear that groundwater pumpage from the farm and the surrounding areas is mainly responsible for water table decline (contributing 70%) as compared to 30% being contributed by sub-surface flow. The additional pumpage in the boundary area of the farm is inducing more sub-

surface outflow from the area than inflow to the area.

Per cent area under Different Water Table Decline Amplitude and Discharge

The per cent area under different water table decline amplitude was estimated from June 1979 through June 1982 (Fig. 2) by plotting the equal fall in water table. The changes in groundwater storage were estimated by using following relationship (Brown *et al.*, 1972) :

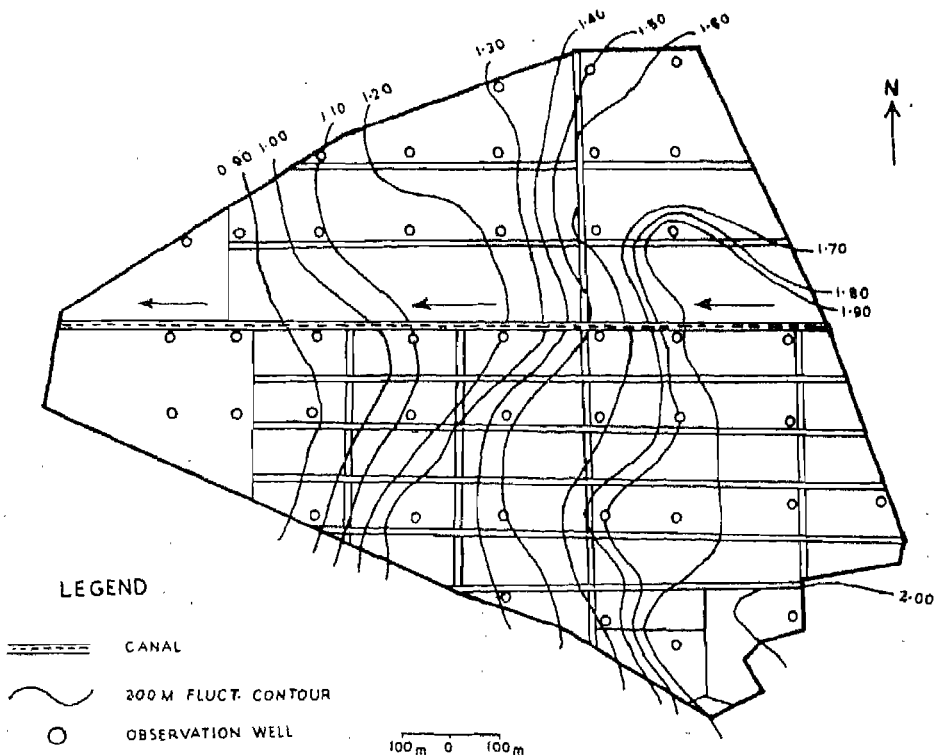


Fig. 2. Water table decline map of H. A. U. Farm Sirsa (June 1979—June 1982).

$q = \mu \cdot \Delta H \cdot A$
 where q = Discharge
 μ = Specific yield of the aquifer formation
 ΔH = Change in water table
 A = Area corresponding to change ' ΔH '

The value of ' μ ' was taken to be 15% based on pumping tests conducted at different sites by HSMITC and C.G.W.B. (Personal Communication). Contour interval was kept minimum (0.1 m) to

give weightage to area under different classes of water table decline. The per cent area under different water table decline amplitude is given in Table 2. The discharge for the period worked out to be 3694 ha-cm which in turn resulted an approximate decline in water table at a rate of 49.45 cm per year. It is exceptionally a high rate of decline in water table and if the pumpage is not restricted or other remedial measures followed, it would require the installation of submersible/turbine pumps in tubewells.

TABLE 2
Per cent area under different water table decline amplitude

Period	Water table decline amplitude (m)							Amount of discharge (ha-cm)	Total fall (cm)
	<0.9	0.9-1.1	1.1-1.3	1.3-1.5	1.5-1.7	1.7-1.9	1.9-2.1		
June 1979- June 1982	14.82	10.64	15.96	9.57	21.28	7.98	19.68	3694	148.35

TABLE 3
Per cent area under different E. C. ranges

Period	Electrical conductivity range (mmhos/cm)				
	<2	2-3	3-4	4-5	>5
August 1979	65.05	15.59	2.15	4.84	12.37
September 1979	64.09	11.60	6.08	4.97	13.26
October 1979	63.80	14.94	6.32	5.17	9.77
November 1979	60.45	14.12	7.34	4.52	13.57
December 1979	60.00	14.86	8.57	5.71	10.86
February 1980	63.58	12.72	9.25	5.20	9.25
June 1980	63.50	20.50	12.00	2.50	1.50
October 1980	60.00	25.00	13.00	2.00	—
October 1981	61.00	20.50	15.00	3.50	—
October 1982	60.50	23.50	12.50	3.50	—

WATER TABLE DECLINE STUDY

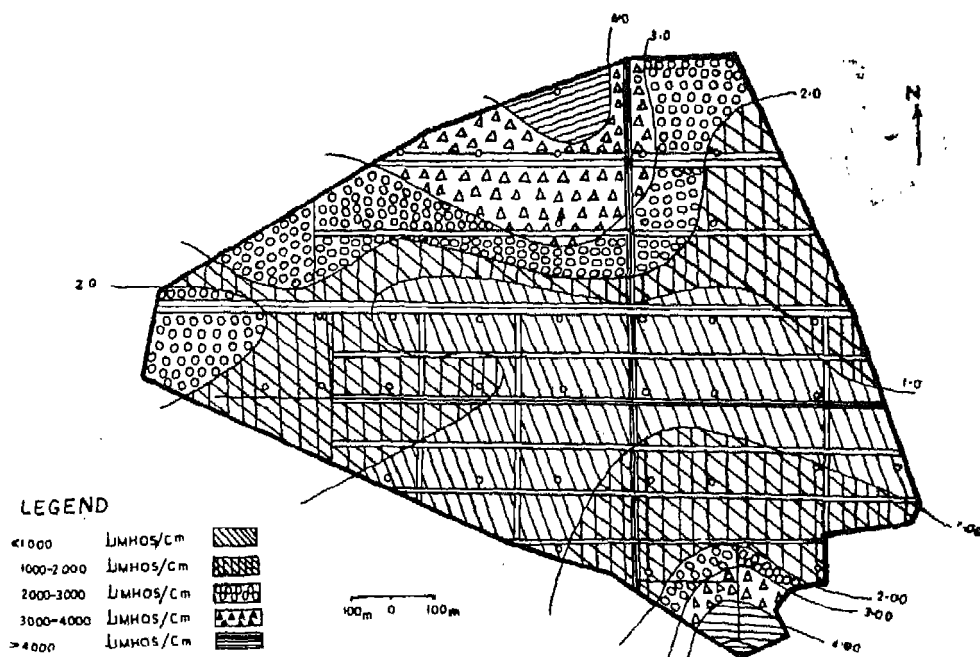


Fig. 3. Isoconductivity map of H. A. U. Farm Sirsa (October 1982).

Groundwater Quality

Water samples were collected during every two months from observation wells and detailed chemical analysis was carried out. Iso-conductivity maps were drawn by plotting Iso E. C. lines and per cent area under different E. C. ranges determined for different periods. The area under different E. C. ranges was estimated and has been given in Table 3.

Iso-conductivity map for the month October 1982 is shown in Fig. 3. As is seen from Table 3, most of the area is under good quality range (less than 2 mmhos/cm). The area under this range varied from 12 to 25 per cent during the period of observation. With the decline in water table, there is minor readjustment among different classes of E. C. but on an overall the quality has not deteriorated to large extent.

REFERENCES

Anonymous, 1982. Annual progress report of "Study of nderground Water Quality and Water Table Fluctuation". Department of Agricultural Engineering, Haryana Agricultural University, Hisar.	Brown, R. H., Konoplyantsev, A. A., Ineson, J. and Kovalevsky, V. S. 1972. Ground Water Studies—An International Guide of Research and Practice. UNESCO, Paris.

SINGH AND KUMAR

- Singh, Joginder, 1981. A multiple regression model for prediction of average water table depth in part of lower Ghaggar basin. Proceedings International Conference on Agricultural Engineering and Agro-Industries, Asian Institute of Technology, Bangkok, Paper No. 225.
- Singh, Joginder and Kumar, R. 1982. Groundwater simulation model for shallow water table aquifer; IAHS, Publication No. 136; Improvement of Methods of Long Term Prediction and Variation in Groundwater Resources, pp. 233-40.
- Singh, R., Sandhi, S. K., Singh, J. and Kumar, R. 1984. A groundwater model for simulating the rise of water table under irrigated conditions. *J. Hydrol. (Amst.)* (in press).

EFFECT OF THINNING ON FRUIT-DROP, RIPENING, FRUIT QUALITY AND YIELD IN BEAUTY SEEDLESS GRAPES

V. S. CHAUHAN*

Department of Horticulture

Haryana Agricultural University, Hisar

(Received : May 16, 1983; Revised : October, 19 1983)

ABSTRACT

Cluster+berry thinning treatments were most effective in reducing the berry drop, shot berries, enhancing ripening and improving fruit quality. Total yield per vine was decreased by crop regulatory treatments. Cluster thinned to 24 per vine+berry thinning was an ideal treatment for optimum yield and quality.

Beauty Seedless is one of the early cultivars recommended for commercial cultivation in North India. It is well known for its high yield and wide adaptability to different systems of training. Experience of the past 5 years has, however, shown that inspite of many strong points in favour of this cultivar, its cultivation on commercial scale is confronted with several pressing problems such as berry drop, presence of shot berries, uneven ripening and hence lower fruit quality.

MATERIAL AND METHODS

Ten year old Beauty Seedless grapevines growing at the Experimental Vineyard of Haryana Agricultural University, Hisar, were used. The vines were planted at 3×3 m distance, kniffin trained (double wire) and spur pruned. Experiment consisted of five crop regulation treatments, i. e., no thinning, cluster thinned to 16 and 24 with and without berry thinning. Thinnings were done

after the berries had set and technique described by Singh *et al.* (1980) was followed. Each treatment consisted of a single vine and was replicated four times in randomised block design.

Observations were recorded on berry drop, ripening, bunch, berry and crop weight, shot berries colour intensity, juice, total soluble solids and acidity. Berry drop was recorded by counting the berries of two tagged clusters from each vine at berry set and then at harvest. Ripening was judged when berries developed uniform colour and showed TSS/acid ratio of about 20. Bunch and berry weight were recorded by taking 10 bunches and 100 berries, respectively, from each treatment. Normal and shot berries (size less than 4 mm in diameter) were separated from five clusters at harvest and counted for calculating the percentage of shot berries. Colour intensity was measured by using the method of Kliever (1970). Total soluble solids were determined by hand

*Present address : Krishi Gyan Kendra, Bhiwani.

refractometer. Total acidity was determined by titrating the juice against 0.1% NaOH using phenolphthalein as an indicator and expressed as tartaric acid in gram per 100 ml of juice.

RESULTS AND DISCUSSION

Berry Drop

Crop regulation treatments reduced berry drop significantly over control. Clusters thinned to 16 per vine+berry thinning had the lowest percentage of berry drop than all other treatments (Table 1). Reduced competition for nutrients and growth substances particularly auxin in remaining berries of berry thinning treatment may be the possible reason for inhibition of berry drop.

Ripening

Crop regulation treatments advanced ripening over control. Cluster+berry thinning treatments were more effective

in advancing the ripening than cluster thinning treatments alone (Table 1). Mechanical stimuli such as division of grape cluster stimulates ethylene production (Singh and Weaver, 1979) and ethylene is well known as a ripening hormone (Pratt and Goeschl, 1969). Hence, possibility may seem that berry thinning (removal of parts of the cluster) induced ethylene production in remaining parts of the cluster which enhanced ripening. Another possibility may be the better distribution of nutrients in remaining parts of the cluster which advanced ripening in these treatments.

Bunch, Berry and Crop Weight

Crop regulation treatments did not affect the average bunch weight significantly. Though berry number was reduced in berry thinning treatments yet bunch weight was not reduced. This has been due to reduced number of shot berries and increased berry weight in cluster+berry thinning treatments. In

TABLE 1

Effect of crop regulation treatments on berry drop, ripening, yield components and shot berry of Beauty Seedless grapes

Treatments	Berry drop (%)	Enhanced ripening (days)	Bunch weight (g)	Berry weight (%)	Yield/vine (kg)	Shot berry (%)
No thinning (control)	36.13 ^a	—	398.27	1.35 ^c	11.94 ^a	36.62 ^a
Cluster thinned to 16 per vine	15.18 ^c	3	397.75	1.44 ^b	6.36 ^c	27.41 ^b
Cluster thinned to 24 per vine	19.15 ^{bc}	2	400.30	1.42 ^b	9.60 ^b	25.27 ^{bc}
Cluster thinned to 16 per vine+berry thinning	10.15 ^a	7	400.85	1.30 ^a	6.46 ^a	20.78 ^c
Cluster thinned to 24 per vine+berry thinning	15.97 ^c	6	399.65	1.47 ^{ab}	9.59 ^b	23.15 ^{bc}
C. D. at 5%	4.63		NS	0.06	0.40	4.49

Data with different superscripts within the column are significantly different at 5% level.

EFFECT OF THINNING IN BEAUTY SEEDLESS

general, crop weight per vine was reduced by crop regulation treatments. Similarly reduction in total yield per vine was observed by cluster (Singh and Chundawat, 1978) and berry (Sharples *et al.*, 1961) thinning.

Shot Berry

It is apparent from the data in Table 1 that clusters thinned to 16 per vine + berry thinned bunches had the lowest percentage of shot berries. However, it did not differ significantly with cluster thinned to 24 per vine + berry thinning. The occurrence of shot berries in Beauty Seedless cultivar is mostly near the apex of the cluster, hence, apex removal in berry thinning treatments was mainly responsible for reducing the number of shot berries in a bunch. Reduction in number of shot berries would account for bunch quality since they detract from eye appeal.

Quality Components

Data recorded on quality components are presented in Table 2.

Cluster + berry thinning treatments had greater colour development in berries. Under these treatments, berries were most attractive, uniform and deep coloured. Induced ethylene production by berry thinning as explained earlier may be one of the reasons for enhancing the uniform colour development since anthocyanin synthesis by ethylene has been reported in fruit tissues (Howell *et al.*, 1976).

Crop regulation treatments increased the percentage of juice in berries significantly. Of all the treatments, berry thinning with lower level of cluster gave the maximum percentage of juice. In general, increased berry size in crop regulation treatments may be the possible reason for higher percentage of juice. Previous information on this aspect of thinning is lacking.

The maximum percentage of total soluble solids of the juice was obtained with cluster thinned to 16 per vine + berry thinning. However, difference with

TABLE 2
Effect of crop regulation treatments on quality components of Beauty Seedless grapes

Treatments	Colour absorbance (C. D. at 530 nm)	Juice (%)	T. S. S. (%)	Acidity (%)	TSS/acid ratio
No thinning (control)	0.48 ^d	63.77 ^c	15.62 ^d	1.19 ^a	13.21 ^e
Cluster thinned to 16 per vine	0.74 ^b	68.15 ^{ab}	18.00 ^{bc}	0.32 ^e	22.00 ^e
Cluster thinned to 24 per vine	0.70 ^c	67.75 ^b	17.07 ^c	0.37 ^b	19.57 ^d
Cluster thinned to 16 per vine + berry thinning	0.77 ^a	70.15 ^a	20.87 ^a	0.69 ^d	30.10 ^a
Cluster thinned to 24 per vine + berry thinning	0.75 ^{ab}	67.57 ^b	19.00 ^b	0.69 ^d	27.35 ^b
C. D. at 5% level	0.03	2.20	1.19	0.04	0.67

Data with different superscripts within the column are significantly different at 5% level.

cluster thinned to 24 per vine+berry thinning was not significant. The possible reason for such increase in total soluble solids may be the better nutrition in remaining parts of the cluster due to combined effects of cluster and berry thinning. The findings of Kondrya and Bukatar (1973) also support the contention that cluster and berry thinning increased total soluble solids of the juice.

Crop regulation treatments reduced the percentage of acidity significantly over control. Cluster+berry thinning treatments had significantly lower per-

centage of acidity than cluster thinning treatments. Similarly, Kondrya (1975) obtained lower percentage of total acidity in table grapes by thinning.

TSS/acid ratio was significantly affected by the crop regulation treatments. Cluster thinned to 16 per vine+berry thinning gave the highest ratio followed by cluster thinned to 24 per vine+berry thinning. The increase in ratio was due to both, increase in total soluble solids and decrease in total acidity. The findings of Sarowa and Bakshi (1972) in Perlette grapes also support the contention that thinning increased TSS/acid ratio.

REFERENCES

- Howell, G. S., Stergios, B. G., Stackhouse, S. S. and Bittenbender, H. C. 1976. Ethephon as a mechanical harvesting aid for High Bush blue berry. *J. Am. Soc. hortic. Sci.* 101: 111-15.
- Kliewer, W. M. 1970. Effect of temperature and light intensity on colouration of *Vitis vinifera* L. grape. *J. Am. Soc. hortic. Sci.* 95: 693-97.
- Kondrya, S. M. 1975. Thinning of bunches in table grape vine cultivars. *Agrotehnika vinograda Kishineu Moldavian SSR. Kartya Moldovenyaski* 1: 108-48.
- Kondrya, S. M. and Bukatar. 1973. Grape thinning in theov. Zhemchug Saba. *Vinodel. Vinograd. SSSR* 2: 19-20.
- Pratt, H. K. and Goeschl, J. D. 1969. Physiological roles of ethylene in plant. *Ann. Rev. plant Physiol.* 20: 541-84.
- Sarowa, P. S. and Bakshi, J. C. 1972. Fruit crop and quality regulation in Perlette variety of vinifera grapes. IV. Effect of pruning, bunch thinning, girdling, sevin and gibberellic acid treatments. *Punjab hortic. J.* 12: 68-77.
- Sharples, G. C., Kuykendall, J. R., True, L. F. and Tate, H. F. 1961. Improvement of market quality of cardinal grape by inflorescence apex removal. *Proc. Am. Soc. hortic. Sci.* 77: 315-21.
- Singh, I. S. and Chundawat, B. S. 1978. Effect of crop level and leaf area on growth and quality of Beauty Seedless grape. Paper Presented at Intern. Symp. on Arid Zone Research held at Jodhpur.
- Singh, I. S., Jindal, P. C. and Yamdagni, R. 1980. Techniques for improving yield and quality of grapes. *Haryana Farm.* 9: 10-11.
- Singh, I. S. and Weaver, R. J. 1979. Standardization of sampling time and technique for measurement ethylene in grapes. *Haryana J. hortic. Sci.* 8: 45-46.

PRODUCTIVITY AND WATER-USE OF PEARL MILLET IN DRYLAND AS AFFECTED BY CROP GEOMETRY

B. P. SINGH

Dry Farming Research Centre
Haryana Agricultural University, Bawal

(Received : May 28, 1983; Revised : January 5, 1984)

ABSTRACT

Pearl millet production increased appreciably with the adoption of row spacing of 60 cm. The increase was 8.7 and 5.7 per cent over 45 and 75 cm row spacings, respectively. Highest seed yield was obtained with 1 lac plants per ha followed by 1.25 lacs and the lowest with 1.5 lacs plants/ha. Planting of pearl millet at 60 cm apart in rows with 1.0 to 1.25 lacs plants/ha appeared to be the better proposition for higher yields in dryland with limited moisture supply conditions. Planting of pearl millet at 60 cm rows apart and 1 lac plants per ha exhibited higher water-use efficiency during 1981 and 1982, whereas it was more at 45 cm rows apart and 1.25 lacs plants/ha in 1983 due to good rains received during crop growth. Planting at 45 cm rows apart with 1.25 lacs plants/ha gave maximum seed yield of 30.58 q/ha when stress was comparatively less in 1981. During 1982, due to severe stress the treatment at 45 cm with 1 lac plants/ha gave the maximum seed yield of 19.03 q/ha, whereas the differences were neutralized with good rains in 1982 in dryland on aridisols.

In dryland areas, the crops suffer due to limited availability of soil moisture during its reproductive phase. Stabilization of pearl millet production in dryland conditions in different years is possible by maintaining an optimum plant population by tailoring with variable row spacing and number of plants per hectare. This will also have profound influence on soil profile moisture depletion and its storage during different stages of the growth.

Present experiment was laid out with the aim of stabilizing production of pearl millet in dry land with efficient utilization of soil moisture at optimum row spacing and plant population.

MATERIAL AND METHODS

The field experiments were conducted for three consecutive years of *kharif* 1981, 1982 and 1983 at the Dry Farming Research Centre, Bawal. The treatments consisted of three row spacings (45, 60 and 75 cm) and three plant populations (1, 1.25 and 1.5 lacs plants per ha). Thus, nine treatment combinations were kept. Each treatment was replicated four times in randomized block design. The soil of the experimental field was loamy sand in texture, low in available nitrogen (190 to 282 kg N/ha), medium in available phosphorus (18 to 20 kg P_2O_5 /ha) and high in potassium (540 to 560 kg K_2O /ha). The

pH of the experimental field was 8.2 during all the years.

The crop was sown on 5th, 19th and 15th July, in 1981, 1982 and 1983, respectively. Recommended dose of phosphorus and half of the nitrogen were applied at the time of sowing and remaining half was applied at the knee high stage of the pearl millet. A higher seed-rate of hybrid pearl millet 'BJ 104', i.e., 6 kg/ha was used to get large number of seedlings to facilitate the maintaining of desired plant population in each treatment. The thinning of the crop was done at 15 days crop's growth stage to maintain the exact plant population as per treatment allocated to different row spacings. The crop was harvested on maturity in the last week of September in each year. The

years 1981, 1982 and 1983, respectively represented the normal, sub-normal and good year in respect of the rains received during crop seasons (Table 1). Excessive rains in 1983 increased the crop growth vigorously and the crop was affected by ergot and downy mildew diseases and the yield potential could not be realized. Consumptive use of water of different treatments was calculated from the data of moisture depletion from soil profile and the rainfall received during the crop season.

RESULTS AND DISCUSSION

Effect of Row Spacing

During 1981 and 1982, pearl millet grown at varying row spacings produced significant variation in seed yield (Table 2).

TABLE 1

Total precipitation, weekly rainfall, number of rainy days, effective rainfall days (in parentheses) and rainfall periods during kharif 1981, 1982 and 1983

Periods	Meteorological week	Rainfall (mm)			No. of rainy days		
		1981	1982	1983	1981	1982	1983
2 July- 8 July	27	8.8	—	33.4	1	—	2(1)
9 July-15 July	28	47.8	11.7	11.6	1(1)	2(1)	2
16 July-22 July	29	52.0	21.5	83.0	3(3)	4(2)	3(3)
23 July-29 July	30	135.4	16.4	129.8	4(4)	2(1)	6(6)
30 July- 5 Aug.	31	23.4	39.4	35.6	3(2)	2(2)	4(1)
6 Aug.-12 Aug.	32	16.0	22.8	1.8	1(1)	1(1)	—
13 Aug.-19 Aug.	33	15.2	24.8	99.2	1(1)	1(1)	5(3)
20 Aug.-26 Aug.	34	—	20.8	96.8	—	1(1)	4(3)
27 Aug.- 2 Sep.	35	—	—	50.8	—	—	3(1)
3 Sep.- 9 Sep.	36	—	4.6	31.8	—	—	3(1)
10 Sep.-16 Sep.	37	—	—	3.2	—	—	1
17 Sep.-23 Sep.	38	—	5.2	2.5	—	1	2
24 Sep.-30 Sep.	39	—	7.2	—	—	1	—
Total		298.6	169.4	579.5	14(12)	16(9)	35(19)

DRYLAND PEARL MILLET WITH CROP GEOMETRY

TABLE 2

Effect of crop geometry on the seed and stover yield of pearl millet

Treatments	Seed yield (q/ha)				Stover yield (q/ha)			
	1981	1982	1983	Mean	1981	1982	1983	Mean
Effect of row spacing (cm)								
45	26.56	14.43	20.13	20.37	57.07	30.15	78.92	53.71
60	29.51	16.49	20.42	22.14	49.17	29.04	68.82	49.01
75	28.31	14.69	19.91	20.94	47.51	28.61	62.60	46.24
S. Em $\pm$	1.07	0.75	0.98	0.99	1.97	1.45	4.66	3.00
C. D. at 5%	2.22	1.55	NS	NS	4.08	NS	9.60	6.18
Effect of plant population (lacs/ha)								
1.0	29.31	17.37	18.74	21.81	45.87	27.77	67.53	47.06
1.25	29.23	15.21	20.87	21.77	47.57	29.78	72.89	50.08
1.50	25.84	12.94	20.39	19.72	56.35	31.19	70.00	52.51
S. Em $\pm$	1.07	0.75	0.98	0.99	1.97	1.45	4.66	3.00
C. D. at 5%	2.22	1.55	2.02	2.04	4.08	3.01	NS	NS

NS—non-significant.

However, there was no significant difference in 1983 as well as for the mean seed yield. A row spacing of 60 cm apart increased the mean seed yield by 8.7 and 5.7 per cent, respectively over closer (45 cm) and wider (75 cm) row spacings. Low yield during 1982 may be attributed to dry spells coinciding with grand-growth and grain development stages (Table 1). During 1981 crop season, the total rainfall was 298.6 mm, while during 1982 it was 169.4 mm which was not well distributed during both the years. There were 26 days dry spells each year in August 1981 and 1982. Similarly, there was no rainfall after August 14 in 1981 and after a dry spell of 34 days in August and September only 17.0 mm rainfall was received in three showers in 1982, having no efficacy on water content in soil. Rainfall pattern data (Table 1) clearly indicate the extent of water deficit during crop cycle at grand-growth and grain development stages,

which resulted in significant reduction in grain and stover yield. The reduction was more during 1982 as compared to the preceding year 1981. This may also be attributed to the less number of days having effective showers (9 days) in 1982 against 12 days in 1981. During 1983, there were 35 rainy days with 19 effective shower days, which enhanced the vegetative growth of the crop and also attracted diseases. The favourable rains gave large stover yield, though the potential seed yield due to diseases and excessive vegetative growth could not be realized.

Effect of Plant Population

A plant population of 1.5 lacs plants per ha reduced the seed yield significantly when compared to lower plant populations of 1.0 and 1.25 lacs (Table 2). Large plant population of 1.5 lacs gave 10.6 and 10.5 per cent lesser seed yield than

the 1.0 and 1.25 lacs of plants/ha, respectively. Similar results have been obtained by Bhardwaj *et al.* (1971), Reddy and Reddy (1978), Nirwal and Upadhyay (1979) and Singh (1983). The lack of response of hybrid pearl millet to higher plant population of 1.5 lacs plants/ha could be attributed to higher competition among plants for light, nutrients, moisture and space, which resulted in poor development of individual plant and hence lower yield per plant. There was manifesting effect of large plant population on stover yield of pearl millet. It increased each year with the increase in number of plants/ha. Similar results have been reported by Singh (1983) on aridisols.

Interaction of Row Spacing and Plant Population

Interaction of row spacing $\times$ plant population was found to be significant on seed yield during 1981 and 1982 (Table 3). The best treatment combination was 1.25 lacs plant population at 45 cm row spacing followed by 1.50 lacs plants per ha

TABLE 3
Interaction of row spacing and plant population on the seed yield (q/ha) of pearl millet

Plant population (lacs/ha)	Row spacing (cm)		
	45	60	75
1981			
1.0	27.96	28.67	23.04
1.25	30.58	30.06	27.90
1.50	29.40	28.95	26.57
S. Em $\pm$	1.33		
C. D. at 5%	2.75		
1982			
1.0	16.15	19.03	16.92
1.25	14.58	16.15	14.89
1.50	12.55	14.30	11.96
S. Em $\pm$	1.29		
C. D. at 5%	2.68		

during 1981. These results can be explained in the light of the fact that crop sown at wider row spacing with large plant population resulted in starvation and lowest seed yield.

TABLE 4
Effect of crop geometry on the consumptive use and water-use efficiency of pearl millet

Treatments	Consumptive use (cm)			Water-use efficiency (kg/cm/ha)		
	1981	1982	1983	1981	1982	1983
Row spacing (cm)						
45	40.26	21.12	42.00	66.1	67.9	47.6
60	41.00	21.03	43.33	71.9	78.4	47.7
75	41.47	19.98	42.67	68.2	73.2	40.7
Plant population (lacs/ha)						
1.0	40.22	20.60	41.00	72.6	84.3	45.7
1.25	40.96	20.83	42.67	71.5	73.2	48.9
1.50	41.59	20.70	44.33	62.0	51.3	40.16

DYRLAND PEARL MILLET WITH CROP GEOMETRY

Water-use

The values of consumptive use obtained in 1981 at wider row spacing were higher than obtained at closer row spacing of 45 cm (Table 4). During 1982 the maximum consumptive use was recorded at closer row spacing due to stress. In 1983, there was not much difference in consumptive use, however it was more at 60 cm row spacing. Among the plant population treatments, large plant population of 1.5 lacs plants/ha recorded the maximum consumptive use during 1981 and 1983 and 1.25 lacs plants/ha in 1982.

A row spacing of 60 cm recorded the maximum values of water-use efficiency

of 71.9, 78.4 and 47.7 kg/cm/ha during 1981, 1982 and 1983, respectively. The water-use efficiency values decreased with the increasing plant population of pearl millet. When seed yield and water-use are to be considered, the higher seed yield obtained at low plant population could be attributed to efficient utilization of available soil moisture, through more absorption of net radiation by plants (Yao and Shaw, 1964).

ACKNOWLEDGEMENT

The author is grateful to the Director of Research, Haryana Agricultural University, Hisar, for providing the facilities.

REFERENCES

- Bhardwaj, R. B. L., Singh, A. and Gautam, R. S. 1971. Studies on the inter-relation of plant population and nitrogen levels with HB₁. *Indian J. Agron.* 16 : 50-53.
- Nirwal, B. G. and Upadhyay, U. C. 1979. Growth and yield of hybrid pearl millet HB₁ as influenced by inter and intra row spacings and varying levels of nitrogen. *Indian J. Agron.* 24 : 17-20.
- Reddy, M. R. and Reddy, B. V. R. 1978. Response of HB-4 and D-174 bajra to different levels of nitrogen and row spacings. *Indian J. Agron.* 23 : 385-86.
- Singh, B. P. 1983. Productivity of transplanted pearl millet under dryland. *Trans. Indt. & Ueds.* 8 : 89-92.
- Yao, A. Y. M. and Shaw, R. H. 1964. Effect of plant population and planting pattern of corn on the distribution of net radiations. *Agron. J.* 56 : 165-69.

EFFECT OF SEEDING TIME, SEED-RATE AND ROW SPACING ON SEED YIELD AND WATER-USE EFFICIENCY OF DRYLAND GRAM IN SOUTH-WEST HARYANA

B. P. SINGH, H. C. SHARMA* and B. P. CHUGH

Dry Farming Research Centre
Haryana Agricultural University, Bawal

(Received : May 28, 1983; Revised : April 3, 1984)

ABSTRACT

Seeding time brought significant variations in seed yield. Gram seeded on October 20 gave 100 and 170 kg more seed yield per ha over the crop seeded on October 10 and 30, respectively. There was no difference in seed used @ 35-45 kg/ha in 3 years, however, a seed-rate of 45 kg/ha gave 10.9 and 6.9 per cent more yield over 25 and 35 kg/ha, respectively. Row spacing of 30 cm gave 8 and 5.1 per cent higher seed yield over 60 and 45 cm, respectively. Maximum consumptive use was calculated in the crop sown on 20th October and at wider row spacing. Crop seeded on 10th October recorded the highest value of 5.3 to 10.4 kg-mm/ha of water-use efficiency. A row spacing of 30 cm gave each year large W.U.E., varying from 4.7 to 13.28 kg-mm/ha.

Among pulses, gram (*Cicer arietinum* L.) is the most important crop in terms of area and production in Haryana, occupying 90% area and 92% of production of total pulses grown in the state. In the south-west Haryana, gram occupies 40 to 45% of the total cropped area during rabi season, of which 85% is rainfed. The more area in gram is due to the practice of deciding fields to seed on the basis of soil moisture at seeding time. Gram gets a choice over small seeded ones (which have poor emergence capability to come out from deep placement) due to its good emergence from the deep seeding in moist zone in dryland areas. Thus, for fetching high yields and better moisture utilization, optimum seeding time, seed-rate and row placements may influence the productivity of

gram as well as the water-use and its water-use efficiency. However, the information on seeding time with plant distribution (seed-rate and row spacings) is lacking under dryland conditions of south-western Haryana.

MATERIAL AND METHODS

The experiment was conducted during the rabi 1975-76 to 1978-79 at Dry Farming Research Centre, Bawal. The treatment comprised all combinations of three seeding dates (10th, 20th and 30th October), three seed-rates (25, 35 and 45 kg/ha) and three row spacings (30, 45 and 60 cm). The experiment was laid out in split plot design keeping the combinations of seeding time and seed-rates in main plots and row spacing in

*Department of Agronomy, HAU, Hisar

sub-plots. There were four replications each year and the net plot size was $3.60 \times 7.0 \text{ m}^2$. The experiment was planted with C214 cultivar of gram each year in kharif fallow where moisture was conserved. There was $150 \pm 8 \text{ mm}$ moisture in 1 m soil profile at the first planting date, whereas at the last planting it was $130 \pm 5 \text{ mm}$ during all the four years of investigation.

The soil of the experimental field was loamy sand with 7.8 pH and 0.20 mmhos/cm conductivity. It had low nitrogen, medium phosphorus and higher potassium content. The bulk density of the soil was 1.45 g cm^{-3} and its $-1/3 \text{ bar}$ and -15 bar percentages of water content were 15.4 and 3.6, respectively. The weather during all the four seasons was typical of semi-arid seasonally dry conditions of south-western part of Haryana. The soil samples upto a depth of 100 cm were taken periodically for moisture determination by gravimetric method. Consumptive use of water or water use of different treatments was calculated from the data of moisture depletion from the soil profile and rainfall received as follows :

$$\text{Consumptive use : } \frac{(MS - MH) \times Bd \times Di}{100} + R$$

(c. u.) i=1

(Where MS—moisture at sowing; MH—moisture at harvesting; Bd—bulk density at ith layer; D—depth of the layer and R—rainfall received).

The rainfall data (meteorological week-wise) for the crop seasons are given in Table 1.

RESULTS AND DISCUSSION

Seed yields during 1975-76 and 1978-79 were quite good due to rainfall received during fruiting stage during both years and at pre-flowering during 1978-79. During 1976-77 rainfall received in meteorological week 4 (January 22 to 28) coinciding with flowering of gram and afterwards long dry spell of 65 days affected the gram production adversely (Tables 1 and 2). In 1977-78, the crop was damaged by the hail storms in meteorological week 9, thus low seed yield could be recorded. The effects of seeding time, seed-rates and row spacings on the seed yield of gram, consumptive use and its water-use efficiency have been discussed below :

Effect of Seeding Time

Sowing date affected the seed yield of gram in three out of four years (Table 2). Good yields during 1975-76 and 1978-79 were recorded due to timely winter rains; low yield during 1976-77 was the result of dry winter; and hail storms decreased the yield considerably in 1977-78 (Tables 1 and 2). In 1978-79, the good and well distributed rains narrowed down the effect of seeding time. Gram seeded on October 20, gave 100 and 170 kg seed yield per hectare (with 7.8 and 13.4 per cent) more over the crop seeded on October 10 and 30, respectively. Faroda and Singh (1982) also reported from Hisar the mid October as an optimum sowing time for gram. In south-western part of Haryana, in early October desiccating hot winds take toll of emerging seedlings and delay sowing due to sudden change of the season in late part of October and desiccating hot winds at

TABLE 1

Rainfall (mm) and rainydays (in parentheses) during different crop seasons

Rainfall periods	Meteo- rologi- cal week	1975-76	1976-77	1977-78	1978-79
15 Oct.—21 Oct.	42	—	—	—	—
22 Oct.—28 Oct.	43	4.3(1)	—	—	—
26 Nov.—2 Dec.	48	—	—	—	3.1(1)
8 Jan.—14 Jan.	2	—	—	—	3.8(2)
15 Jan.—21 Jan.	3	—	—	—	16.2(3)
22 Jan.—28 Jan.	4	—	21.5(4)	—	—
29 Jan.—4 Feb.	5	—	—	—	5.2(1)
5 Feb.—11 Feb.	6	—	—	—	1.1(1)
12 Feb.—18 Feb.	7	32.0(2)	—	25.4(3)	20.5(1)
19 Feb.—25 Feb.	8	4.0(1)	—	—	14.3(2)
26 Feb.—4 Mar.	9	—	—	41.0(1)	2.4(2)
5 Mar.—11 Mar.	10	—	—	4.2(1)	16.4(1)
12 Mar.—18 Mar.	11	—	—	13.3(1)	—
19 Mar.—25 Mar.	12	2.4(1)	—	—	—
26 Mar.—1 Apr.	13	—	—	1.1(1)	—
2 Apr.—8 Apr.	14	—	18.5(2)	2.1(2)	3.0(1)
Total		42.7(5)	40.8(4)	87.1(9)	86.4(14)

TABLE 2

Effect of seeding time, seed-rate and row spacing on the seed yield (q/ha) of gram in dryland

Treatments	1975-76	1976-77	1977-78	1978-79	Mean
Seeding time					
10 Oct.	18.50	9.52	6.89	18.33	13.31
20 Oct.	19.33	11.47	8.27	18.22	14.31
30 Oct.	18.29	9.94	4.73	17.54	12.62
C. D. at 5%	NS	0.99	0.40	0.55	—
Seed-rate (kg/ha)					
25	18.39	9.00	5.88	17.64	12.72
35	18.67	10.93	6.56	18.25	13.60
45	18.64	10.88	8.55	18.20	14.11
C. D. at 5%	NS	0.99	0.40	0.55	—
Row spacing (cm)					
30	19.02	10.66	7.53	18.86	13.99
45	18.60	10.01	6.90	18.91	13.60
60	18.53	10.36	6.58	16.31	12.94
C. D. at 5%	NS	NS	0.60	0.89	—

SEED TIME, SEED-RATE AND SPACINGS IN DRYLAND GRAM

fruiting of late gram crop affecting the production adversely. These findings are in conformity with those of Saxena and Yadav (1975), Panwar (1978), Faroda and Singh (1979) and Kulkarni (1979).

Effect of Seed-rate

Out of four years of investigation, the seed-rate @ 35 kg/ha gave significantly higher seed yield over 25 kg/ha during three years (Table 2). There was no difference in seed-rate 35-45 kg/ha during 3 years (1975-76, 1976-77 and 1978-79). Increasing of seed-rate from 25 kg/ha to 35 and 45 kg/ha increased the mean seed yield by 6.9 and 10.9 per cent, respectively. Faroda and Singh (1979) advocated for a seed-rate of 40 to 50 kg/ha for higher seed yield in gram grown in dryland areas.

Effect of Row Spacing

Data in Table 2 indicate that there was no difference in row spacing in 1975-76 and 1976-77 while during 1978-79, 45 and 30 cm spacings being at par were significantly superior to 60 cm spacing. During 1977-78, 30 cm row spacing came out to be the best. However, row spacing of 30 cm gave 8 and 5.1 per cent higher mean seed yield over 60 and 45 cm row spacings, respectively. The yield variations were governed by the soil moisture received during crop season (Table 1) where dryland gram showed high degree of adjustability to the available space and moisture. These results are in conformity with those of Saxena and Yadav (1975), and Faroda and Singh (1979).

TABLE 3

Effect of seeding time, seed-rate and row spacing on the consumptive use (mm/1 m soil profile) and water use-efficiency (kg/mm/ha) of gram in dryland

Treatments	1975-76		1976-77		1977-78		1978-79	
	C. U.	W. U. E.	C. U.	W. U. E.	C. U.	W. U. E.	C. U.	W. U. E.
Seeding time								
10 Oct.	150	12.33	137	6.06	164	4.20	177	10.35
20 Oct.	143	13.52	137	6.95	155	5.30	175	10.40
30 Oct.	142	12.88	133	6.51	152	3.10	172	10.19
Seed rate (kg/ha)								
25	147	12.51	138	6.52	157	3.70	175	10.08
35	143	13.06	134	7.41	157	4.10	175	10.40
45	145	12.96	135	7.10	157	5.40	175	10.40
Row spacing (cm)								
30	143	13.28	134	7.80	154	4.70	171	11.02
45	147	12.66	136	7.30	157	4.30	175	10.80
60	145	12.79	137	7.50	159	4.10	179	9.10

Consumptive Use and Water-use Efficiency

Consumptive use of the crop varied from 133 mm/1 m moisture in soil profile to 179 mm/1 m in four year's study (Table 3). Maximum consumptive use was recorded in crop seeded on 10th October, which decreased in subsequent seeding dates. Seed-rate variations failed to govern the consumptive use of gram but the same was increased with increasing row spacings.

Maximum water-use efficiency was recorded in a crop seeded on 20th October each year, with W. U. E. values of 5.30 to 10.40 kg -mm/ha. Higher W. U. E. values in first two years were with 35 kg/ha seed-rate while in last two years these were more with 45 kg/ha. During

all the four years of investigation, a row spacing of 30 cm resulted in highest W. U. E. values varying from 4.70 to 13.28 kg/mm/ha. The higher values of water-use efficiency were obtained where greater seed yield of gram was recorded which may be attributed to the efficient utilisation of moisture in those treatments during all the years of experimentation. Shaw and Burrows (1966) reported the similar findings. According to them relative water availability fluctuated due to weather conditions as well as due to soil moisture content.

ACKNOWLEDGEMENT

Authors are grateful to the Director of Research, Haryana Agricultural University, Hisar for providing the facilities.

REFERENCES

- Faroda, A. S. and Singh, R. C. 1979. Effect of planting date, seed-rate and spacing on chickpea. Paper presented at Bengal Gram Seminar held at the time of rabi Pulse Workshop, Sep., 1979, Haryana Agricultural University, Hisar.
- Faroda, A. S. and Singh, R. C. 1982. Effect of varieties, sowing dates and soil fertility on gram production under rainfed conditions. *Trans. Isdt. & Ucds.* 7(2) : 6-8.
- Kulkarni, K. R. 1979. Production technology for Bengal gram. Symp. on Pulse Improvement Project, Haryana Agricultural University, Hisar, Sep. 19-23, 1979.
- Panwar, K. S. 1978. All India Subject Matter Seminar, Pulse Production Technology, CSAUAT, Kanpur/Ministry of Agriculture, Dept. of Agric. U. P. Aug. 28-30, 1978.
- Saxena, M. C. and Yadav, I. S. 1975. Some agronomic considerations of pigeonpea and chickpea. *Proc. International Workshop on Grain Legumes*, ICRISAT, Hyderabad. pp. 31-61.
- Shaw, R. H. and Burrows, W. C. 1966. Water supply, water-use and water requirements. In : *Advances in Crop Production*, pp. 122-42, Pierre, W. H., Aldrich, S. A. and Martin, W. P. (eds.). Iowa State University, Ames, Iowa.

STUDIES ON THE SIGNIFICANCE OF DEW FALL AT HISAR REGION

S. K. AGARWAL and V. UMAMAHESWARA RAO

Department of Agricultural Meteorology
Haryana Agricultural University, Hisar

(Received : June 18, 1983; Revised : December 3, 1983)

ABSTRACT

Data on dew fall at Agricultural Meteorological Observatory, Haryana Agricultural University, Hisar, between 1970-80 at four heights (5, 25, 50 and 100 cm) above ground have been analysed. Dew occurrence is more on upper plates as compared to the lower plates. Monthly dew fall occurrence is considered at various heights. The maximum dew fall is usually deposited at a height of 100 cm. The year with maximum dew fall in 1976-77 is analysed in relation to rainfall. It is emphasized that continuous dew recordings in crops are useful for field studies concerned with the effect of weather conditions on plant growth and plant diseases.

The occurrence of dew is useful during the winter months in the northern region as it helps substantially in meeting the winter crop water requirements. Dew may benefit the internal water balance of the plants because transpiration is reduced during the morning hours when dew is still present on leaves. Secondly, dew forms a water film on the plant surface, which may facilitate the spread and germination of pathogen spores. Thus, dew can have beneficial and harmful effects on plants.

In periods of drought, some plants depend on dew for survival. Dew fall over India was illustrated cartographically by Raman *et al.* (1973) who found that in semi-arid and arid dry farming areas, dew deposition is too small to contribute significantly to the soil moisture.

The amount of dew deposition depends on structure, size and thermal properties of vegetative surfaces and micrometeorological factors such as temperature, humidity and wind velocity. Conditions favouring dew formation are clear skies, and atmosphere with low wind speed (10-12 km/h) and high humidity as a source for condensing water (Sharma, 1976).

METHODOLOGY

Data recorded at Agricultural Meteorological Observatory, Haryana Agricultural University, Hisar have been analysed. It is situated at the latitude 29°10'N, longitude 75°46'E and altitude of 215 m above sea level. Dew was recorded by Duvdevani dew gauges at four different heights above ground (5, 25, 50 and

100 cm) from 1970 through 1980. The Duvdevani dew gauge is a rectangular wooden block, coated with red paint which favours the retention of dew deposited on it. These blocks were exposed on a stand with specified heights at about sunset. The size, form and distribution of the dew deposited on the gauge were observed on the next morning. The dew deposited on the blocks was compared with a set of photographs of each dew type. These photographs bear the dew scales 1 to 8, each number bearing its equivalent in mm of dew in the range of 0 to 0.35 mm. The chief merits of the instrument are its simplicity and robustness. It suffers from the drawback that the relation between the amount of dew recorded and the amount actually deposited on natural surfaces is uncertain. Nevertheless in view of its simplicity and low cost, the instrument

is utilized by Indian Meteorological Department Observatories for the study of dew.

Mean monthly dew fall (mm) and mean monthly number of dew nights at the four heights from 1970-80 have been calculated. The average monthly rainfall for 1915-1980 and pan evaporation for 1968 to 1980 were also computed. The maximum dew fall, recorded during 1976-77, has been expressed as a percentage of normal and actual rainfall at Hisar.

RESULTS AND DISCUSSION

The monthly mean amount of moisture precipitated during the dew season of 1970-80 is shown in Fig. 1. The dew occurrence was more on upper plates as compared to the lower plates. It was

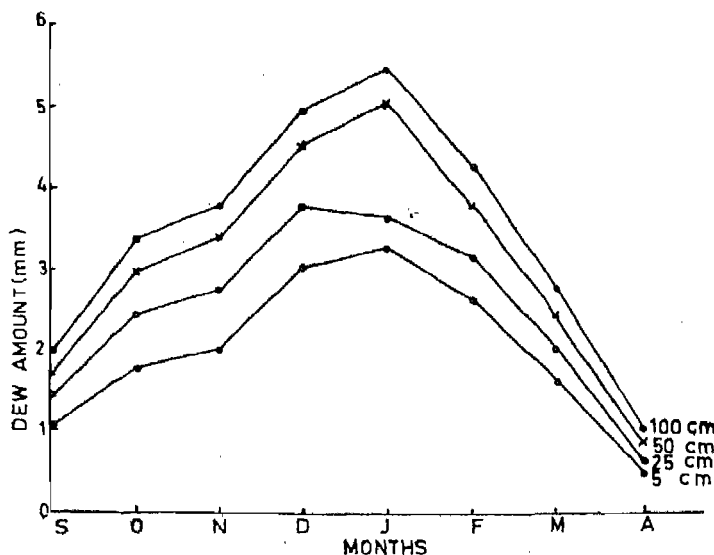


Fig. 1. Mean monthly dew occurrence at Hisar (1970-80).

DEW FALL AT HISAR

TABLE 1

Amount of dew expressed as percentage of normal and actual rainfall during the season

Months	Rainfall (mm)		Pan evaporation (mm) 1968-80	Dew amount (mm) 1976-77	Days with dew	$\frac{D \times 100}{D - R_1}$		Dew amount per night (mm)
	Actual (R_1) 1976-77	Normal (R_2) 1915-80				$D - R_1$	$D - R_2$	
Sep.	77.7	71.5	6.3	5.0	28	6.9	7.6	0.18
Oct.	0	12.9	5.7	6.1	31	100.0	89.7	0.20
Nov.	0	2.6	4.5	4.4	28	100.0	244.4	0.16
Dec.	0	7.1	2.4	4.0	29	100.0	129.0	0.14
Jan.	15.7	12.7	2.4	5.0	25	46.7	64.9	0.20
Feb.	0	10.7	3.4	5.9	28	100.0	122.9	0.21
Mar.	8.4	10.0	5.5	4.3	29	104.9	91.5	0.15
Apr.	25.8	5.2	9.8	0.9	12	3.6	20.9	0.08
Total	127.6	132.7	40.0	35.6	210	38.7	36.7	0.17

higher in December and January months, and lower in April. The total dew amount of 27.2 mm was received at 100 cm height. It provides moisture which helps in the early hours of sunshine. However, the dew amount is increased if the plates are exposed in a cropped field. In the wheat crop it was increased by 30 to 70 per cent at different stages of crop growth (Bishnoi, 1982). At 25 cm level, the maximum dew was observed during December, thereafter, it decreased during January. However, the dew fall amount was higher on all the other levels during January as compared to December.

Following the methods of Baier (1966) and Sharma (1976) the total dew fall during the months of September to April (1976-77) was compared with normal rainfall during the same period and calculated dew amount per night is shown in

Table 1. It can be seen that the monthly dew amounts varied from 0.9 to 6.1 mm. The number of nights per month fluctuated between 12 and 31. For the season as a whole (September to April) there were 210 days with dew and altogether 35.6 mm of dew was recorded. Table 1 presents the data on dew amount in comparison with rainfall contribution towards the plant growth. When the rainfall is less than dew amount, the major contribution in providing moisture to the plant is due to dew amount. The index values are around 100 per cent. However, as the rainfall increases contribution due to dew amount is relatively lesser as evident from the index values. So long the evaporation rates equal the normal rainfall, the contribution of dew may be taken as significant, but as the rainfall exceeds the evaporation rates the contribution of dew decreases.

REFERENCES

- Baier, W. 1966. Studies on dew formation under semi-arid conditions. *Agric. Meteorol.* **3** : 103-21.
- Bishnoi, O. P. 1982. The Agricultural Climate of the Hiser Area. Agri. Met. Publication-1.
- Raman, C. R. V., Venkataraman, S. and Krishnamurthy, V. 1973. Dew over India and its contribution to winter crop water balance. *Agric. Meteorol.* **11** : 17-35.
- Sharma, M. L. 1976. Contribution of dew in hydrologic balance of a semi-arid grass land. *Agric. Meteorol.* **17** : 321-31.

INFLUENCE OF IRRIGATION AND PHOSPHORUS FERTILIZATION ON ARHAR AND MOONG CROPS

B. S. MALIK, M. L. BATRA* and JAGDEV SINGH*

Department of Agronomy
Haryana Agricultural University, Hisar

(Received : July 5, 1983; Revised : May 25, 1984)

ABSTRACT

A 2-year study was carried out to compare the relative efficiency of arhar alone and intercropped with moong at three soil moisture regimes and three levels of phosphorus. During both years arhar intercropped with moong was better in terms of production potential, net economic returns as well as efficient utilization of water over the arhar in pure stands. No supplemental irrigation was necessary when the rainfall was sufficient, but one irrigation at 0.20 pan coefficient increased the pulse yield over no irrigation in the event of scanty rains. Application of phosphate at the rate of 40 kg P_2O_5 (17.4 kg P) per hectare is beneficial over the higher doses from the view point of greater production as also higher net returns.

With the evolution of short duration varieties of arhar (*Cajanus cajan* L.) and moong (*Phaseolus aureus* Roxb.) and as a result of the renewed fillip given to drive for increasing pulse production, the area under these pulses is expanding rapidly. Some research work has been carried out in regard to the production potential and relative economics of intercropping of arhar and moong but the literature concerning the effect of irrigation in relation to phosphorus on their companionship is very meagre. It was with a view to gather information on these aspects that the studies reported herein were initiated.

MATERIAL AND METHODS

A field trial was conducted at the Research Farm, Haryana Agricultural

University, Hisar, during kharif 1981 and 1982. The tract is characterized by the semi-arid climate.

The soil of the experimental site was sandy loam in texture, low in available N (189 kg/ha), medium in available phosphorus as P (11.9 kg/ha) and high in potash K_2O (337.5 kg/ha) and slightly alkaline in reaction (pH 8.1). The average values for field capacity, permanent wilting point and bulk density of the soil samples taken at 30 cm intervals to a depth of 120 cm were 19.25%, 7.25% and 1.50 g/cc, respectively.

Both years, the experiment was laid out in a split plot design with three replications keeping crops X irrigation in the main plots and phosphorus levels in the sub-plots. There were 18 treatments

*Department of Soils.

TABLE 1

Water expense and water-use efficiency in relation to irrigation
(mean of 1981-82)

Treatment	Profile water (cm)	Rainfall (cm)	Water added as irrigation (cm)	Total water expense (cm)	Grain yield (kg/ha)	Water-use efficiency (kg/ha-cm)
No irrigation	13.22	16.38	0.00	29.60	1781	60
IW/CPE=0.20	10.28	16.38	7.00	33.66	1940	57
IW/CPE=0.40	10.23	16.38	14.00	40.61	1979	48

comprising two crop stands viz., arhar alone (C_1) and arhar and moong in alternate rows (C_2); three soil moisture regimes viz., no post-sowing irrigation (I_0), 7 cm irrigation at IW/CPE value of 0.2 (I_1) and 7 cm irrigation at IW/CPE value of 0.4 (I_2); and three phosphorus levels viz., no phosphorus (P_0), 40 kg P_2O_5 /ha (P_1) and 80 kg P_2O_5 /ha (P_2), in terms of P it is 17.4 and 34.8 kg/ha, respectively.

Initially the crops (arhar variety UPAS-120 and moong variety Pusa Baisakhi) were sown on 19.6.81 in the first year and on 16.6.82 in the second year. But the subsequent early monsoon showers experienced in both years, caused water stagnation and adversely affected the germination. Re-sowing was, therefore, carried out on 31.7.1981 and 22.6.82 in the first and second year, respectively. The harvesting of moong was done on 17th October and 16th September in the first and second year, respectively and that of arhar on 27th November and 13th November in the first and second year. All plots received nitrogen at the rate of 20 kg/ha as basic dose through urea. The calculated amounts of phosphorus were drilled through granulated

single superphosphate at seeding. The water table fluctuated between 100 and 150 cm depth from soil surface. Number of irrigations given under I_1 and I_2 was one and two, respectively each year and depth of water applied per irrigation was 7 cm. Amount of precipitation received during the crop in the years 1981 and 1982 was 11.5 and 21.3 cm, respectively, whereas the evaporation (mean monthly) ranged from 2.6 to 6.3 mm in 1981 and 3.7 to 10.3 mm in 1982. It may be added here that the evaporation rate was relatively higher in the year 1982.

Water-use efficiency in respect of each irrigation regime has been calculated on the basis of profile moisture use upto 120 cm as determined by subtracting total moisture content at harvest from that at sowing, water added as irrigation plus the effective rainfall received during the growing period (total water expense). The water-use efficiency has been worked out by dividing the per hectare yield of arhar pure crop by total water expense. Energy equivalent is the edible portion of the material, and has been determined according to the method of Gopalan *et al.* (1970).

RESULTS AND DISCUSSION

Grain Yield

The 2-year grain yield data of arhar and moong under various treatments are reported in Table 2. The relatively lower crop yields during the year 1981 are primarily attributed to the late planting.

Effect of Crops

The data presented in Table 2 reveal that arhar yielded 2.25 and 11.36 per cent higher during 1981 and 1982, respectively, when it was grown pure as compared to its mixed stands with moong. The differences between the mean values were not significant in the first year as well as in the averaged effect of two years. Also, the two year mean total production for the treatment arhar alone was 19.67 q/ha as against 21.89 q/ha produced by arhar and moong together. Thus, the net increase in total production for the latter treatment over the former was of the order of 2.22 q/ha meaning thereby that intercropping of arhar and moong was consistently superior to the practice of growing arhar in pure stands. These findings are in line with the work of Saxena and Yadav (1973) and Singh and Singh (1980). This is also reflected in terms of energy equivalent ($Kcal \times 10^4$) as the total energy in C_1 (pure arhar) comes out to be 658.9, whereas in C_2 (intercropping) it is 737.9 (Table 2).

Effect of Irrigation

A reference to the relevant data for the year 1981 shows that the treatment receiving one irrigation at the IW/CPE value of 0.20 increased the yield of arhar

significantly over no supplemental irrigation. Accordingly irrigation at 0.40 irrigation ratio (two irrigations) did not increase the yield still further but the differences between the mean values missed significance by a narrow margin. Irrigation did not produce any significant effect on the per hectare yield of arhar during year 1982. As expected, the moong in no way, could be influenced by irrigation, since the differential irrigation treatments could be established only after this crop had been harvested. The difference in response to irrigation as evidenced during the two years could be attributed to the higher (213 mm) rainfall and its greater vitiating effect during 1982 as compared to 115 mm experienced during 1981.

Effect of Phosphorus

Phosphorus did increase the per hectare yield of both arhar and moong consistently but the effect was found significant only for moong. In the first year 80 kg P_2O_5 /ha was at par with the 40 kg/ha level, and produced significantly higher yield over the control. In the second year both the 40 and 80 kg/ha doses being mutually at par produced significantly higher pulse yield over the no P treatment.

The two year mean water use efficiency data along with profile water use and total water expense in respect of various irrigation treatments under comparison are averaged in Table 1.

The data show that water-use efficiency was the highest under the I_0 treatment which received no post-sowing irrigation and it showed a decreasing trend

TABLE 2
Grain yield, energy equivalent and relative economics of arhar and moong as influenced by different treatments

Treatments	Grain yield (q/ha)				Energy equivalent*			Gross income (Rs./ha)	Cost of cultivation (Rs./ha)	Net income (Rs./ha)
	1981		1982		Mean					
	Arhar	Moong	Arhar	Moong	Arhar	Moong	Moong			
Crop stand										
C ₁	16.32	—	23.03	—	19.67	—	658.9	5115	1745	3370
C ₂	15.96	3.38	20.68	3.76	18.32	3.57	613.7	6227	1995	4232
S. Em.	0.26	—	0.37	—	0.32	—	—	—	—	—
C. D. at 5%	N.S.	—	1.16	—	N.S.	—	—	—	—	—
Irrigation regimes										
I ₀	14.54	3.25	21.09	3.70	17.81	3.47	596.7	6053	1945	4108
I ₁	16.51	3.52	22.30	3.84	19.40	3.68	649.9	6553	1995	4558
I ₂	17.42	3.37	22.17	3.76	19.79	3.56	662.9	6605	2045	4560
S. Em.	0.32	0.17	0.45	0.32	0.32	0.25	—	—	—	—
C. D. at 5%	1.00	NS	NS	NS	NS	NS	—	—	—	—
Phosphorus levels										
P ₀	15.34	3.14	21.22	3.32	18.28	3.23	612.4	6077	1755	4322
P ₁	16.42	3.30	22.32	3.92	19.37	3.61	648.9	6516	1995	4521
P ₂	16.66	3.69	22.03	4.05	19.34	3.87	647.9	6615	2235	4380
S. Em.	0.46	0.15	0.54	0.19	0.48	0.17	—	—	—	—
C. D. at 5%	NS	0.45	NS	0.60	NS	0.52	—	—	—	—

*Energy equivalent is of the edible portion of material (Gopalan *et al.*, 1970).

INFLUENCE OF IRRIGATION AND PHOSPHORUS ON ARHAR AND MOONG

with the increased amount of water added as irrigation. This is because the increase in the irrigation frequently increased the water expense proportionately but did not cause a corresponding increase in the total yield, thus, following the well-known "Law of Diminishing Returns."

Production Economics

The data with regard to the two year mean gross income, cost of cultivation and net income in relation to different treatments are reported in Table 2. The results reveal that arhar in solid stands (C_1) yielded a net profit of Rs. 3370 per hectare, whereas intercropping of moong with arhar raised the mean net returns to Rs. 4232 per hectare. These results are allied with those of Singh and Singh (1980).

In regard to the effect of irrigation, it is evident that applying water at the 0.20 ratio (one irrigation) was as good as

irrigating the crop at 0.40 IW/CPE value (two irrigations) and produced an extra benefit to the tune of Rs. 450/ha as compared to the monetary returns realized from the no irrigation treatment. Thus, on the whole one irrigation was enough from the view point of production potential, efficient utilization of water as also the net economic returns. Phosphate at the rate of 40 kg P_2O_5 /ha resulted in extra mean benefit of Rs. 199 over no P treatment but further increase in the dose to 80 kg/ha produced a net loss of Rs. 141 as against 40 kg/ha.

ACKNOWLEDGEMENTS

The work reported was carried out under the I. C. A. R. Coordinated Project for Research on Water Management. The assistance is gratefully acknowledged. Thanks are also due to Professor M. C. Agarwal, Chief Scientist for his keen interest in the project.

REFERENCES

- Gopalan, C., Ramasastri, B. V. and Balasubramaniam, S. C. 1970. Nutritive value of Indian Foods. Indian Council of Medical Research, Delhi.
- Saxena, M. C. and Yadav, D. S. 1973. Field studies on parallel multiple cropping with short duration arhar. Proc. Symp. on Multiple Cropping, held at Haryana Agricultural University, Hisar from Oct. 7-8, 1972, pp. 232-38.
- Singh, R. K. and Singh, Mahatim. 1980. Intercropping of pigeonpea in Eastern Uttar Pradesh. *Indian J. Agron.* **25** : 581-85.

EFFECT OF LONG TERM APPLICATION OF FARM YARD MANURE AND NITROGEN. II. MINERAL P FRACTIONS

R. S. ANTIL, D. S. RUHAL and MAHENDRA SINGH

Department of Soils

Haryana Agricultural University, Hisar

(Received : July 20, 1983; Revised : April 3, 1984)

ABSTRACT

Soil samples from long term experiment in a fixed pearl millet-wheat rotation were analysed for Olsen's P and mineral P fractions. Olsen's P decreased from 13.0 to 7.62 kg/ha due to continuous cropping without FYM, but addition of FYM increased Olsen's P greatly. Al-P also increased due to FYM applications but Fe-P and Ca-P were not affected. The application of N with or without FYM decreased Olsen's P, Al-P and Fe-P but no trend was observed in case of Ca-P. Highest contents of Olsen's P and mineral P fractions were noted when FYM was applied in both the seasons and relative build up of P fractions was more when FYM was applied in monsoon than winter season. Most of the soil P was present in Ca-P form followed by Al-P $\geq$ Fe-P.

The knowledge of the various forms of P present in soil and the conditions under which these become available to plants is a pre-requisite in assessing the availability of P to the plants. The inorganic fractionation of soil phosphorus permits to understand the fate of applied and native nutrient under different soil and crop conditions. The distribution of various P fractions and their transformation under long-term cropping and manuring conditions were found to differ according to soil and crops (Chang and Jackson, 1958; Kanwar and Prihar, 1962). As knowledge on these aspects is sparse in soils of Haryana, an attempt was made to study the distribution of inorganic P fractions as affected by long term use of nitrogen and farm yard manure for 13 years in a fixed pearl millet-wheat rotation.

MATERIAL AND METHODS

A long-term field experiment was started in rabi (winter) 1967-68 at Haryana Agricultural University Farm, Hisar, with different levels of nitrogen and FYM under fixed pearl millet-wheat rotation. The experiment was laid out in a split plot design. The soil was sandy loam with pH 8.2, organic carbon 0.47 %, CaCO_3 1.12% and available N, P (Olsen's) and K 200, 13 and 498 kg/ha, respectively, determined by methods outlined by Jackson (1958). The treatments in the main plots included combinations of three modes of FYM application in kharif (monsoon season), in rabi (winter season) and both in kharif and rabi and three levels (15 (F_1), 30 (F_2) and 45 (F_3) tonnes/ha) of FYM in addition to one control (F_0).

MINERAL P FRACTIONS

During 1976-77 and 1977-78 the levels of FYM were reduced to 5, 7.5 and 10 tonnes/ha, respectively, but original levels were restored afterwards. Three levels of N (0, 60 and 120 kg/ha) were superimposed on each main plot. FYM was applied 3 weeks before sowing of the crops and mixed in the surface (0-15 cm) soil. Nitrogen was applied through urea in two splits, half at sowing and the remaining half at first irrigation.

The experiment consisted of four replications and gross plot size was 10×6 m. After completion of 13 years, soil samples from each plot were collected from 0-15 cm depth after the harvest of wheat crop (1980-81). Soil samples were air-dried, ground to pass through a 2 mm sieve and stored in polyethylene bags. Each soil sample was analysed

for available P (Olsen *et al.*, 1954) and soil inorganic P fractions (Peterson and Corey, 1966). The data obtained were subjected to statistical analysis.

RESULTS AND DISCUSSION

Olsen's P

The available P content decreased from 6.5 to 3.81 ppm due to continuous cropping without FYM, whereas it increased to 28.13 ppm with 45 tonnes of FYM/ha applied in both the seasons (Table 1) which was highest among all the treatments. This increase was attributed to mineralization of organic P of the FYM. Kanwar and Prihar (1962) and Schmid *et al.* (1977) also found increased available P content in soil due to long-term use of FYM. The cumulative and residual effect of FYM applica-

TABLE 1
Effect of modes of FYM and levels of FYM and nitrogen on Olsen's P (ppm) of soil

Treatments	FYM application				Mean (other than F ₀)
	F ₀	F ₁	F ₂	F ₃	
Modes of FYM application					
Winter + Monsoon	—	10.95	25.63	28.13	21.57
Winter	—	5.94	12.69	13.33	10.65
Monsoon	—	6.60	11.70	20.17	12.82
N (kg/ha) application					
0	4.20	8.86	20.10	21.67	16.88
60	4.50	8.33	16.80	20.27	15.13
120	2.72	6.27	13.13	19.67	13.02
Mean	3.81	7.82	16.68	20.54	—
C. D. at 5%					
1. Mode		1.24			
2. FYM		1.24			
3. Mode × FYM		2.15			
4. Control vs. others		1.60			
5. Nitrogen (control)		NS			
6. Nitrogen (other than control)		1.28			
7. Nitrogen × FYM		2.34			

tion indicated significant increase in P content over direct application suggesting slow mineralization of organic P derived from FYM. The application of N in absence as well as in presence of FYM decreased the available P content, presumably due to enhanced availability of P to crops and ultimately depleted soil available P. The extent of depletion was more in the absence of FYM. These results are in agreement with the earlier findings of Ruhel and Shukla (1979). Critical evaluation of the data indicated that although a considerable increase in available P occurred, a major portion of P applied through FYM during 13 years of experimentation (2575 kg P_2O_5 /ha) was not extractable in 0.5 M $NaHCO_3$ (pH 8.5) and/or utilized by the crops.

Al-P Content

The data presented in Table 2 indicate that increasing levels of FYM increased Al-P content of the soil from 19.13 to 41.26 ppm. The highest Al-P content (50.91 ppm) was noted when FYM was applied in both the seasons at the highest level and the cumulative mode of FYM application was found best, followed by direct application and residual effects. The difference between direct application and the residual effects was not significant, but proportionate increase in Al-P was slightly more when FYM was applied in winter in comparison to monsoon season.

With the application of nitrogenous fertilizers, Al-P decreased in presence as well as in absence of FYM. In the presence of N the utilization of other nutrients by better crop vigour increased, and the Al-P fraction might have contri-

buted to labile pool in the long run thereby showing a depletion. A significant interaction between $N \times FYM$ was also found.

Fe-P Content

The data on Fe-P (Table 3) in the soil samples under different treatment combinations suggested that the levels and modes of FYM application had no significant effect on the Fe-P content but the $mode \times FYM$ interaction was significant. Application of FYM in monsoon season contributed more towards the build up of Fe-P. Increase in Fe-P by FYM application has already been reported by Anjaneyulu and Omanwar (1979). With increasing levels of N, Fe-P content of soil decreased from 45.9 to 35.9 ppm in absence of FYM and from 41.1 to 31.52 ppm in presence of FYM which indicate that in presence of N more of Fe-P is either utilized by plants or transformed into other forms. The interaction between $N \times FYM$ was also significant.

Ca-P Content

The levels and modes of FYM application and levels of N application in presence as well as in absence of FYM and the interaction between $N \times FYM$ were non-significant on the build up of Ca-P in the soil (Table 4). On the whole, FYM application slightly decreased Ca-P in comparison to no FYM treatment indicating some solubilization/utilization of Ca-P through acidity produced during decomposition of organic matter. Harter (1969) also advocated that without sufficient organic matter which is needed to release CO_2 , Ca-P cannot be solubilized and this form of P may

MINERAL P FRACTIONS

TABLE 2

Effect of modes of FYM and levels of FYM and nitrogen on Al-P (ppm) of soil

Treatments	FYM application				Mean (other than F ₀)
	F ₀	F ₁	F ₂	F ₃	
Modes of FYM application					
Winter + Monsoon	—	34.11	39.75	50.91	41.59
Winter	—	29.24	29.59	38.21	32.35
Monsoon	—	24.41	34.33	34.70	31.15
N(kg/ha) application					
0	22.80	31.07	35.77	41.23	36.02
60	19.50	29.63	31.97	40.83	34.14
120	15.10	27.03	34.40	41.73	34.39
Mean	19.13	29.24	34.05	41.26	—
C. D. at 5%					
1. Mode		4.54			
2. FYM		4.54			
3. Mode × FYM		NS			
4. Control vs. others		5.87			
5. Nitrogen (control)		1.83			
6. Nitrogen (other than control)		0.58			
7. Nitrogen × FYM		1.06			

TABLE 3

Effect of modes of FYM and levels of FYM and nitrogen on Fe-P (ppm) of soil

Treatments	FYM application				Mean (other than F ₀)
	F ₀	F ₁	F ₂	F ₃	
Modes of FYM application					
Winter + Monsoon	—	43.18	35.48	27.75	35.47
Winter	—	30.76	25.05	40.94	32.25
Monsoon	—	35.78	38.23	36.62	36.88
N (kg/ha) application					
0	45.90	39.90	45.57	37.83	41.10
60	24.70	32.90	24.90	37.93	31.91
120	35.90	36.87	28.23	29.47	31.52
Mean	35.50	36.56	32.90	35.08	—
C. D. at 5%					
1. Mode		NS			
2. FYM		NS			
3. Mode × FYM		6.73			
4. Control vs. others		NS			
5. Nitrogen (control)		11.52			
6. Nitrogen (other than control)		3.64			
7. Nitrogen × FYM		6.64			

TABLE 4
Effect of modes of FYM and levels of FYM and nitrogen on Ca-P (ppm) of soil

Treatments	FYM application				
	F ₀	F ₁	F ₂	F ₃	Mean (other than F ₀)
Modes of FYM application					
Winter+Monsoon	—	242.2	227.6	229.4	233.1
Winter	—	211.5	220.6	221.6	217.9
Monsoon	—	194.0	254.5	236.2	228.2
N(kg/ha) application					
0	239.1	222.5	222.0	241.9	228.8
60	220.3	204.5	234.0	214.6	217.7
120	277.0	220.7	246.7	230.5	232.6
Mean	245.5	215.9	234.2	229.0	—
C. D. at 5%					
1. Mode		NS			
2. FYM		NS			
3. Mode × FYM		30.72			
4. Control vs. others		NS			
5. Nitrogen (control)		NS			
6. Nitrogen (other than control)		NS			
7. Nitrogen × FYM		NS			

not contribute much to the labile pool of soil P.

It is clear from the data presented in Tables 2-4 that in alkaline calcareous soils of this area Ca-P is the most dominant form followed by Al-P and Fe-P

which may be solubilized/transformed into comparatively more soluble forms by the regular use of organic manures. Similar observations have been reported by Deo and Ruhal (1972) and Ruhal and Deo (1979) for calcareous and high pH soils of Rajasthan.

REFERENCES

- Anjaneyulu, K. and Omanwar, P. K. 1979. Effect of long-term manuring in a fixed crop rotation on phosphorus fraction. *Bull. Indian Soc. Soil Sci.* 12 : 324-27.
- Chang, S. C. and Jackson, M. L. 1958. Soil phosphorus fractions in some representative soils. *J. Soil Sci.* 9 : 109-19.
- Deo, R. and Ruhal, D. S. 1972. Status and availability of phosphorus in calcareous soils of Rajasthan. *Indian J. agric. Sci.* 42 : 316-21.
- Harter, R. D. 1969. Phosphorus absorption sites in soils. *Proc. Soil Sci. Soc. Am.* 33 : 630-31.
- Jackson, M. L. 1958. *Soil Chemical Analysis*. Prentice Hall, Englewood Cliffs, N. J.
- Kanwar, J. S. and Prihar, S. S. 1962. Effect of continuous application of FYM and inorganic fertilizers on crop yields and properties of soil. *J. Indian Soc. Soil Sci.* 10 : 109-20.

MINERAL P FRACTIONS

- Olsen, S. R., Cole, C. V., Watanabe, F. S. and Dean, L. A. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U. S. Dept. Agric. Circ. 939, Washington.
- Peterson, G. W. and Corey, R. B. 1966. A modified Chang and Jackson procedure for routine fractionation of inorganic soil phosphates. *Proc. Soil Sci. Soc. Am.* **30** : 563-66.
- Ruhal, D. S. and Deo, R. 1979. Distribution of inorganic phosphorus fractions in Rajasthan soils. *Ann. Arid Zone* **18** : 56-61.
- Ruhal, D. S. and Shukla, U. C. 1979. Effect of continuous application of farm yard manure and nitrogen on organic carbon and available N, P and K content in soil. *Indian J. agric. Chem.* **12** : 11-18.
- Schmid, G., Rosopulo, A., Weight, H. and Borchert, A. 1977. Influence of intensive managed and fertilized rotation on yield, nutrient removal and balance, and environmental pollution. *Landwirtsch. Jahrb.* **54** : 458-79.

TOMATO FRUIT QUALITY DURING STORAGE AS INFLUENCED BY NITROGEN DOSES AND IRRIGATION INTENSITIES

D. K. BHATNAGAR, B. R. BATRA and M. L. PANDITA

Department of Vegetable Crops

Haryana Agricultural University, Hisar

(Received : July 19, 1983; Revised : February 22, 1984)

ABSTRACT

Application of different doses of nitrogen and irrigation intensities had significant impact on tomato fruit quality during storage. Quality fruits were produced under the treatment combination of nitrogen 120 kg/ha and irrigation intensity 0.8 ID/CPE. The fruits from this treatment could be stored for 10 and 20 days with good keeping quality at room and low temperature conditions, respectively. TSS and acid content increased, whereas ascorbic acid decreased with the subsequent increase in duration.

Keeping quality of tomato during storage is degraded owing to various physico-chemical changes and decay losses caused by several microbes (Chenulu and Thakur, 1968; Bhatnagar *et al.*, 1980). Quality of tomato fruits during storage can be enhanced and maintained through several means including cultural practices. According to Pandita and Bhatnagar (1981) increase in nitrogen levels and spacing resulted in the production of quality fruits. However, information pertaining to keeping quality lacks and needs due consideration. Hence, the investigation on the effect of various nitrogen doses and varying irrigation intensities on the keeping quality of tomato was carried out.

MATERIAL AND METHODS

The experiment was laid out in randomized block design, comprising three

levels of nitrogen ($N_1=40$, $N_2=80$ and $N_3=120$ kg/ha) and four levels of irrigation (ID/CPE $W_1=0.6$, $W_2=0.8$, $W_3=1.0$ and $W_4=1.2$). Twelve treatment combinations, thus, were replicated thrice.

Turning red tomato fruits of cv. HS-101 (February planted) were picked from all the treatments. The fruits were washed under running tap water and excess water was drained off. Fruits were packed in ventilated wooden boxes of 5 kg capacity, using paper cutting as cushioning material. Four packs of fruits with 4 kg per pack were kept at room ($26^\circ\pm 4^\circ\text{C}$) and low ($5^\circ\pm 1^\circ\text{C}$) temperatures.

Observations at room and low temperatures were recorded at an interval of two and four days, respectively. Keeping quality of the fruits was assessed on general appearance basis, subjected to a scale 0 through 5, where 0 score

STORAGE STUDIES IN TOMATO

was awarded to badly deteriorated fruits, 1—unacceptable, 2—acceptable, 3—fair, 4—good and 5—excellent (equivalent to freshly harvested firm fruits).

For determining inherent biochemical changes, samples of three healthy fruits from each box were taken. Estimations were made in triplicate for various constituents. Total soluble solids (TSS) were measured with the help of hand refractometer. Total titratable acidity and ascorbic acid content were determined by the methods of AOAC (1980).

RESULTS AND DISCUSSION

General Appearance

Scoring adopted for general appearance revealed fruit acceptability during storage (Table 1). Tomato fruits produced

under the treatment combinations W_1N_3 and W_2N_3 were quite acceptable when stored for 10 days under room storage conditions. However, fruits from the other treatment combinations could not be stored after 6 days. This might be due to excessive transpiration and respiration losses and rotting of the fruits in storage.

At low temperature, the fruits from the treatments W_2N_2 , W_2N_3 and W_3N_3 had reasonably good keeping quality upto 20 days as compared to other treatments. Low temperature also prolonged the shelf-life of the fruits almost double in comparison to those kept at room temperature due to slow rate of metabolic activities in the fruits. The results confirm the findings of Bhatnagar *et al.* (1980) on tomato storage.

TABLE 1

General appearance of tomato fruits as influenced by nitrogen doses and irrigation intensities during storage

Treatments	Room temperature					Low temperature				
	Days in storage									
	2	4	6	8	10	4	8	12	16	20
W_1N_1	5	4	3	1	0	5	5	4	1	0
W_1N_2	5	3	2	1	0	5	5	2	0	0
W_1N_3	5	5	4	3	2	5	5	2	1	0
W_2N_1	5	2	1	0	0	5	5	2	0	0
W_2N_2	5	5	2	1	0	5	5	3	2	2
W_2N_3	5	5	4	4	3	5	5	3	2	2
W_3N_1	5	3	2	1	0	5	5	4	3	1
W_3N_2	5	3	2	1	0	5	5	4	3	2
W_3N_3	5	3	2	1	0	5	5	4	2	2
W_4N_1	5	3	2	1	0	5	5	3	2	1
W_4N_2	5	3	2	1	0	5	5	3	2	1
W_4N_3	5	4	3	1	0	5	5	3	2	1

0=badly deteriorated, 1=unacceptable, 2=acceptable, 3=fair, 4=good, 5=excellent.

Total Soluble Solids

As clear from Table 2, TSS content of the fruits increased throughout the storage period at both the temperature conditions. During early period of storage, the increase in TSS was sharp. However, the fruits stored at low temperature could not reach the TSS value, attained by the fruits at room temperature. Bhatnagar and Singh (1982) also reported increased TSS content of muskmelon fruits during storage. Among various treatment combinations, W_1N_3 and W_2N_3 have the maximum TSS content in the fruits. The fruits from these treatments also retained the maximum TSS value in storage.

An increase in the nitrogen doses also resulted in increased TSS content of the fruits after harvest and the similar trend was further retained during storage. This might have resulted due to better vegetative growth and sugar assimilation with the subsequent increase in nitrogen content of the fruits (Pandita and Bhatnagar, 1981).

Ascorbic Acid Content

Ascorbic acid content of the fruits decreased with the increase in duration indicating more losses at room than low

temperature conditions (Table 3). Loss of ascorbic acid during storage has been referred to oxidation of ascorbic acid to dehydro-ascorbic acid (Gustafson and Cooke, 1956) which is accelerated at high temperature than low temperature.

Higher amount of ascorbic acid was recorded in the fruits produced under treatment combinations W_2N_3 and W_4N_3 as compared to others. Fruits from these treatments also retained maximum ascorbic acid content during storage under both the temperature conditions.

Total Titratable Acidity

Acid content of tomato fruits increased during storage (Table 4). Increase in acid content was slow at low temperature than at room temperature. The fruits produced under the treatments W_2N_3 and W_1N_3 were more acidic than those produced under other treatments. Increase in the nitrogen dose had supplementary effect on the acid content of the fruits, whereas it decreased with the increase in the frequency of irrigation.

ACKNOWLEDGEMENTS

Thanks are due to Dr. R Yamdagni, Prof. & Head, Department of Horticulture, for providing necessary facilities.

REFERENCES

- AOAC, 1980. Official Methods of Analysis. Association of Official Analytical Chemists, Washington, D. C.
- Bhatnagar, D. K. and Singh, G. P. 1982. Storage studies on different muskmelon cultivars. *Haryana agric. Univ. J. Res.* 12 : 456-61.
- Bhatnagar, D. K., Singh, G. P., Singh, J. P. and Singh, B. P. 1980. Studies on the storage behaviour of different tomato cultivars. *Haryana agric. Univ. J. Res.* 10 : 5-9.
- Chenulu, V. V. and Thakur, D. P. 1988. Survey for storage and market disease of certain fruits and vegetables in Delhi and control of soft-rot due to *Rhizopus* spp. *I.P.S. Bull.* No. 4 : 65-70.

STORAGE STUDIES IN TOMATO

TABLE 2
Total soluble solids (%) of tomato fruits as influenced by nitrogen doses and irrigation intensities during storage

Treatments	Room temperature						Low temperature						
	0	2	4	6	8	10	Days in storage		8	12	16	20	Mean upto 16 days
							Mean upto 8 days	4					
W ₁ N ₁	5.0	5.4	5.8	6.0	6.5	—	5.7	5.1	5.3	5.5	5.5	—	5.4
W ₁ N ₂	5.0	5.5	6.0	6.5	6.5	—	5.9	5.2	5.5	5.7	5.8	—	5.4
W ₁ N ₃	5.0	5.7	5.8	6.5	7.0	7.0	6.0	5.3	5.5	5.8	5.8	—	5.5
W ₂ N ₁	4.0	4.5	5.0	5.4	6.5	—	5.1	4.2	4.6	5.0	5.0	—	4.9
W ₂ N ₂	4.5	4.5	5.5	6.0	7.0	—	5.2	4.7	5.0	5.4	6.0	6.2	5.1
W ₂ N ₃	4.5	4.6	5.8	6.2	7.0	7.0	7.0	4.8	5.7	6.0	6.2	6.5	5.4
W ₃ N ₁	3.0	4.0	4.6	5.0	6.0	—	4.5	4.0	4.4	5.2	5.5	—	4.4
W ₃ N ₂	4.0	4.5	4.8	5.1	6.7	—	4.8	4.3	4.6	5.0	5.3	—	4.6
W ₃ N ₃	4.0	4.5	5.0	5.4	6.5	—	4.6	4.8	5.0	5.3	5.6	5.6	5.4
W ₄ N ₁	3.5	4.2	4.6	5.2	5.5	—	4.6	4.2	4.8	4.8	5.0	—	4.4
W ₄ N ₂	4.0	4.3	4.7	5.4	6.0	—	4.9	4.4	4.8	5.0	5.4	—	4.9
W ₄ N ₃	4.0	4.5	4.8	5.4	6.0	—	4.9	4.5	4.8	5.0	5.2	—	4.9
Mean	4.1	5.2	5.2	5.7	6.3			4.6	5.0	5.4	5.8		
C.D. at 5%	Storage period Treatment Storage period × treatment = 0.89						Storage period Treatment Storage period × treatment = 0.11						
	= 0.61 = 0.42						= 0.35 = 0.21						

TABLE 3
Ascorbic acid content (mg/100 g of edible parts) of tomato fruits as influenced by nitrogen doses and irrigation intensities during storage

Treatments	Room temperature						Low temperature							
	Storage period in days						Storage period in days							
	0	2	4	6	8	10	Mean upto 8 days	4	8	12	16	20	Mean upto 16 days	
W ₁ N ₁	18.0	14.6	12.8	8.5	4.7	—	11.7	17.0	15.0	12.7	10.8	—	13.9	
W ₂ N ₁	22.0	18.0	14.4	9.6	6.2	—	14.1	21.0	20.1	17.8	14.0	—	18.2	
W ₃ N ₁	26.0	21.4	19.2	12.8	8.3	5.2	17.5	25.1	23.5	21.2	16.0	—	21.5	
W ₄ N ₁	22.0	20.4	16.2	12.8	8.3	—	15.9	20.2	18.3	16.2	12.0	—	16.7	
W ₅ N ₁	26.5	22.8	18.8	12.6	8.3	—	17.8	24.6	22.0	16.2	14.0	10.2	14.2	
W ₆ N ₁	28.3	24.1	19.5	14.5	10.0	6.0	19.2	26.1	24.0	20.0	16.1	12.6	21.6	
W ₁ N ₂	22.0	18.2	10.4	7.4	3.2	—	12.0	20.0	18.6	17.2	15.1	—	17.7	
W ₂ N ₂	22.4	18.6	14.4	6.1	4.5	—	13.0	20.1	19.2	17.1	15.0	—	17.9	
W ₃ N ₂	24.5	19.5	16.2	9.5	5.3	—	15.0	22.6	20.4	19.0	16.0	14.2	19.5	
W ₄ N ₂	24.0	20.6	16.0	8.0	5.7	—	15.6	22.6	20.3	17.7	14.7	—	18.8	
W ₅ N ₂	28.0	22.2	18.1	11.0	7.7	—	17.4	26.0	25.1	22.8	19.1	—	23.3	
W ₆ N ₂	28.0	24.4	18.6	12.6	8.2	—	18.4	26.4	24.7	23.8	20.4	—	23.8	
Mean	24.2	20.40	16.1	10.5	5.9			22.6	20.9	18.5	15.3			
C. D. at 5%	Storage period Treatment = 1.62						Storage period Treatment = 1.41							
	Storage period × treatment = 1.81						Storage period × treatment = 2.01							
	Storage period × treatment = 0.67						Storage period × treatment = 1.21							

STORAGE STUDIES IN TOMATO

TABLE 4
Acid content (%) of tomato fruits as influenced by nitrogen doses and irrigation intensities during storage

Treatments	Room temperature							Low temperature						
	0	2	4	6	8	10	Mean upto 8 days	4	8	12	16	20	Mean upto 16 days	
W ₁ N ₁	0.20	0.26	0.29	0.34	0.40	—	0.22	0.21	0.23	0.26	0.26	—	0.24	
W ₁ N ₂	0.31	0.35	0.42	0.47	—	—	0.37	0.33	0.36	0.40	0.42	—	0.38	
W ₁ N ₃	0.40	0.46	0.48	0.48	.50	.50	0.46	0.48	0.43	0.45	0.45	—	0.44	
W ₂ N ₁	0.30	0.34	0.38	0.38	0.40	—	0.36	0.32	0.32	0.36	0.38	—	.35	
W ₂ N ₂	0.30	0.35	0.40	0.44	0.44	—	0.39	0.30	0.34	0.34	0.38	0.42	0.32	
W ₂ N ₃	0.40	0.42	0.46	0.48	0.52	0.52	0.46	0.40	0.43	0.45	0.47	0.48	0.44	
W ₃ N ₁	0.20	0.22	0.24	0.28	0.30	—	0.25	0.21	0.23	0.25	0.27	—	0.24	
W ₃ N ₂	0.22	0.26	0.28	0.30	0.34	—	0.28	0.22	0.24	0.25	0.27	—	0.25	
W ₃ N ₃	0.22	0.26	0.32	0.38	0.40	—	0.32	0.23	0.25	0.27	0.30	0.31	0.27	
W ₄ N ₁	0.18	0.20	0.23	0.27	0.30	—	0.24	0.18	0.20	0.23	0.28	—	0.23	
W ₄ N ₂	0.20	0.24	0.28	0.32	0.36	—	0.28	0.22	0.24	0.26	0.29	—	0.26	
W ₄ N ₃	0.20	0.26	0.30	0.34	0.38	—	0.30	0.22	0.24	0.27	0.30	—	0.26	
Mean	0.26	0.30	0.34	0.36	0.49			0.27	0.29	0.31	0.34			
C. D. at 5%	Storage period Treatment =0.12 =0.04 Storage period × treatment=0.22							Storage period Treatment =0.10 =0.01 Storage period × treatment=NS						

BHATNAGAR ET AL.

Gustafson, F. G. and Cooke, A. R. 1956. Oxidation of some ascorbic acid to dehydro-ascorbic acid at low temperature. *Science* **166** : 234.

Pandita, M. L. and Bhatnagar, D. K. 1981. Effect of nitrogen, phosphorus and spacing on fruit quality of tomato cultivar HS 102. *Haryana agric. Univ. J. Res.* **11** : 8-11.

RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XV, No. 2, pp. 213—215 (June 1985)

STUDIES ON *MELOIDOGYNE JAVANICA* (TREUB, 1885) CHITWOOD, 1949 INFECTING CHICKPEA IN HARYANA

D. C. GUPTA and D. S. DHANGAR
Department of Nematology
Haryana Agricultural University, Hisar

(Received : March 24, 1983; Revised : December 17, 1984)

Effect of various levels of *Meloidogyne javanica* (Treub, 1885) Chitwood, 1949 on growth parameters of chickpea has been reported by number of workers (Srivastava *et al.*, 1974; Reddy, 1975; Nath *et al.*, 1979; Dhangar and Gupta, 1983). But, information pertaining to its survey in Haryana, effect on yield and varietal reaction is lacking. Hence, in present investigation, studies on these aspects were undertaken.

A casual survey of chickpea was conducted in March, 1981 in the districts of Hisar, Bhiwani, Mohindergarh, Gurgaon and Rohtak. Plants showing stunted growth in patches were uprooted and intensity of root-knot infestation was recorded according to the gall index suggested by Johnson and Campbell (1980).

For seeing the effect of different types of soil on the yield of chickpea, three types of steam sterilized soil, i.e., sandy (S_1), loamy sand (S_2) and sandy loam (S_3) was used. There were two sets of pots filled with these soils. In the first set *Rhizobium* treated seeds (var. G. 130) and in the other, untreated seeds were sown in mid of October, 1980. Ten days after sowing, freshly hatched second

stage larvae of *M. javanica* were added around the roots of the plants in logarithmic series, i.e., 10, 100, 1000, 10000/plant. Hoagland's nutrient solution was applied once in fortnight for maintenance of the plants. After five months of inoculation, yield/pot was recorded.

For seeing the reaction of *M. javanica* on chickpea, seeds of all the varieties were sown in 10 cm earthen pots containing infested soil having initial population of 250 larvae/250 cc of soil. After 40 days of sowing the number of galls/plant was recorded and analysed statistically.

It has been observed that root-knot nematode was associated with chickpea in all districts surveyed except Rohtak. The intensity of root-knot was from very low (Hisar) to moderate (Bhiwani). However, the occurrence of root-knot nematode was 10% in Hisar and Mohindergarh, 19% in Bhiwani and 27% in Gurgaon. The low infestation of root-knot nematode observed in this survey might be due to low temperature prevailing during rabi season which is not favourable for nematode to infect, develop and reproduce (Kaushik and Bhatti, 1984).

TABLE 1

Effect of *M. javanica* on yield of chickpea in various types of soil with or without Rhizobium (mean of three replications)

Soil type		Yield/pot at different inoculum levels (g)					Mean	Componential equation
		0	10	100	1,000	10,000		
S ₁	T*	2.7	2.6	2.1	2.0	1.8	1.7	$Y=0.305 \times \bar{X} - 0.163$
	UT**	1.8	1.3	1.1	1.1	0.3		$Y=0.445 \times \bar{X} - 0.049$
S ₂	T	1.9	1.5	1.3	1.0	0.9	1.2	$Y=0.225 \times \bar{X} - 0.075$
	UT	1.8	1.4	1.3	0.7	0.1		$Y=0.705 \times \bar{X} - 0.370$
S ₃	T	8.1	7.5	6.4	6.4	5.1	6.2	$Y=0.930 \times \bar{X} - 0.051$
	UT	7.4	6.3	5.7	4.4	3.9		$Y=0.885 \times \bar{X} - 0.075$
Mean		3.9	3.4	3.0	2.7	2.0		

C. D. for inoculum density = 1.01

C. D. for soil = 0.78

C. D. for inoculum density $\times$ soil = 1.11

*T—Treated with Rhizobium.

**UT—Untreated.

TABLE 2

Reaction of various chickpea varieties/lines to *M. javanica* (mean of three replications)

Variety/line	No. of galls	Variety/line	No. of galls
H 35	87.0	H 722	137.0
H 136	134.6	H 764	79.6
H 168	60.0	H 780	97.0
H 201	83.0	H 73-9	37.6
H 241	38.0	H 73-24	90.0
H 339	111.0	H 73-26	80.6
H 369	35.0	H 73-27	69.0
H 467	30.0	H 363-2	52.5
H 519	18.0	H 373-2	47.0
H 529	111.0	H 628-3	23.0
H 550	96.0	HE 379	24.0
H 561A	46.0	C 235	16.0
H 573	38.0	C 130	60.0
H 662	30.0	Hima	49.0
H 716	113.0		

S. E. (d) = 7.08

C. D. at 5% = 14.16

C. D. at 1% = 18.83

MELOIDOGYNE JAVANICA INFECTING CHICKPEA

The soils in most of these districts were light textured and it could safely be assumed that this nematode may become a problem in future because of intensive cropping.

The data presented in Table 1 indicate that with the increase in the level of initial inoculum there was a corresponding reduction in yield. The inoculum levels of 1,000 and 10,000 larvae significantly reduced the yield of chickpea as compared to other levels of inoculum. The yield observed in sandy loam soil was more as compared to other two types of soils. Rhizobium treated plants gave higher yield than untreated plants.

Although infection was more in case of sandy loam soil but the yield was also significantly more as compared to other soil types which indicated that in sandy loam soil, the yield could be more because of better growth parameters (Dhangar and Gupta, 1983).

Out of 29 varieties tested for their reaction to *M. javanica* (Table 2) none showed resistant reaction. However, varieties, viz., C 235, HE 379, H 628-3, H 662 and H 457 showed less number of galls in comparison to other varieties.

REFERENCES

- Dhangar, D. S. and Gupta, D. C. 1983. Pathogenicity of *Meloidogyne javanica* to chickpea (*Cicer arietinum*) in relation to soil types, Rhizobium treatment, size of pots and time interval. *Indian J. Nematol.* 13 : 161-70.
- Johnson, A. W. and Campbell, G. M. 1980. Managing nematode population densities on tomato using crop rotation and a nematicide. *J. Nematol.* 12 : 6-19.
- Kaushik, H. D. and Bhatti, D. S. 1984. Biology of *Meloidogyne javanica* (Treub, 1885) Chitwood, 1949 on tomato under Haryana conditions. *Indian J. Nematol.* (in press).
- Nath, R. P., Banerjee, A. K., Haider, M. G. and Sinha, B. K. 1979. Studies on the nematodes of pulse crops in India. I. Pathogenicity of *M. incognita* on gram. *Indian Phytopathol.* 32 : 28-31.
- Reddy, D. D. R. 1975. Pathogenicity and control of root-knot nematodes (*Meloidogyne* spp.) infecting chickpea. *Mysore J. agric. Sci.* 9 : 434-39.
- Srivastava, A. K., Upadhyay, K. D. and Singh, G. 1974. Effect of root-knot nematode (*M. javanica*) on gram crop. *Indian J. Nematol.* 4 : 201-11.

RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XV, No. 2, pp. 216—217 (June 1985)

RELATIONSHIP BETWEEN FRUIT WEIGHT AND SEED CONTENT IN GRAPES

S. S. SHARMA, SUNEEL SHARMA and V. P. AHLAWAT
Department of Horticulture
Haryana Agricultural University, Hisar

(Received : May 17, 1983; Revised : December 10, 1984)

Fruit size in grapes is greatly influenced by the development of seeds and this may be the reason that seeded varieties have large sized berries as compared to seedless ones. Berry growth in grapes, is characterised by a distinct double sigmoid curve where two periods of rapid growth are separated by a period of slow growth. The rapid growth in the beginning is regulated by auxin and gibberellin hormones produced by the developing seeds (Coombe, 1960; Iwahori *et al.*, 1968). This obviously indicates that berry growth is directly influenced by the development of seeds. In this study, the relationships between the berry weight versus number of seeds per berry and the berry weight versus seed weight were examined using several seeded varieties of grapes.

Seven seeded grape varieties trained on double wire Kniffin system were selected for the experiment. The fruit samples for analysis were taken from ten clusters typical of each variety and from each cluster again ten berries were picked randomly and weighed. The seeds from each berry were removed manually, counted and wiped clean on a damp cloth. Then the seeds obtained from each berry were dried at room temperature for 48 h and weighed.

The data in Table 1 clearly indicate that out of seven varieties studied, maximum and minimum berry weight were recorded in Katta Kurghan and Khalili varieties, respectively. However, marked differences were observed in berry weight among various varieties. So far the number of seeds per berry is concerned, Early Muscat excelled over the others, whereas Bianshi Rai had the least. The seed content per berry differed significantly in various cultivars. A positive but non-significant correlation was observed when two characters viz. berry weight and number of seeds per berry were compared with each other. This suggests that seeds play a vital role in berry development of grapes. It is, therefore, essential to follow such management practices that ensure pollination, fertilization and better development of seeds particularly in those varieties where a high degree of association exists. The varieties showing lower degree of association, factors other than seed like nucellar tissue seem to contribute more towards fruit development. In case of berry weight versus seed weight also a significant positive correlation was observed. Olmo (1946) also reported that, in grapes, size of berry increases appreciably with the increase of seed length which clearly shows the importance of seed in berry

FRUIT WEIGHT AND SEED CONTENT IN GRAPES

TABLE 1

Relationship between weight of berry versus number and weight of seeds

Variety	Weight of 100 berries (g)	Number of seeds per 100 berries	Weight of 100 seeds (g)
Anab-e-Shahi	332.75	252.25	5.55
Banqai-Abyad	408.75	200.00	3.93
Champion	221.25	218.75	4.79
Early Muscat	313.75	268.75	4.54
Blanshi Rai	217.50	153.00	5.14
Katta Kurghan	606.00	200.75	10.02
Khalili	182.50	249.50	3.25
C. D. at 5%	38.30	7.19	0.12
C. D. at 1%	52.54	9.84	0.17
Correlation between berry weight and number of seeds (r)=0.212			
Regression between berry weight and number of seeds =0.180			
Correlation between berry weight and weight of seeds (r)=0.81			
Regression between berry weight and weight of seeds =0.11			

development. Hence, from the present studies, it can be inferred that varieties showing high degree of association between the attributes, berry size and number

of seeds per berry should be utilized as female parent in hybridization programme to develop bigger sized seedless varieties.

REFERENCES

- Coombe, B. G. 1960. Relationship of growth and development to changes in sugars, auxins and GA in fruits of seeded and seedless varieties of *V. vinifera* L. *Plant Physiol.* **35** : 241-50.
- Iwahori, S., Weaver, R. J. and Pool, R. M. 1968. Gibberellin like activity in berries of Seeded and Seedless Tokay grapes. *Plant Physiol.* **43** : 333-37.
- Olmo, H. P. 1946. Correlation between seed and berry development in some seeded varieties of *V. vinifera* L. *Proc. Am. Soc. hortlc. Sci.* **48** : 291-97.

RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XV, No. 2, pp. 218—220 (June 1985)

BIOEFFICACY AND ECONOMICS OF SYNTHETIC PYRETHROIDS IN COTTON UNDER HARYANA CONDITIONS

A. S. NANDAL, R. K. SAINI and ZILE SINGH

Department of Entomology

Haryana Agricultural University, Hisar

(Received : July 23, 1983; Revised : April 11, 1984)

There is a volume of information generated on the bioefficacy of the synthetic pyrethroids, viz., permethrin, cypermethrin, decamethrin and fenvalerate against a variety of insect pests, both in India and abroad. Their use appears to be encouraging in reducing the pest incidence and increasing the yield of crop (Lhoste and Piedallu, 1977; Murugesan *et al.*, 1979; Weaver *et al.*, 1979; Bhat and Patil, 1980; Manon and Surulivelu, 1980; Sukhija *et al.*, 1980).

Three synthetic pyrethroids viz., permethrin (0.1 kg a.i./ha), cypermethrin (0.08 kg a.i./ha) and decamethrin (0.02 kg a.i./ha) were tested for three years (1979 to 1981) to determine their effectiveness against pink bollworm of cotton. The results thus obtained were compared with those of carbaryl (1 kg a.i./ha). Experiments were conducted on the commercially grown cotton variety H-777. A randomised block design was adopted with three repeats in a plot of 100 sq. m. Each insecticide was sprayed 5 times at an interval of 10-12 days starting from first week of August.

All the three synthetic pyrethroids proved superior to carbaryl in reducing

the incidence of pink bollworm and increasing the yield and seed-cotton. Data presented in Table 1 indicate that the mean percentage of infested loculi of opened bolls by pink bollworm was 6.42, 3.29 and 2.60 per cent in plots treated with permethrin, cypermethrin and decamethrin, respectively, against 10.09% in plot treated with carbaryl.

But when the economics of the cost of application was taken into consideration, it did not prove encouraging. The data presented in Table 2 reveal that the increase in yield over carbaryl was 2.80, 3.25 and 3.6 q/ha in the plots treated with permethrin, cypermethrin and decamethrin, respectively. Based on the support price of seed-cotton @ Rs. 380/q as fixed by the Govt. of India for the year 1982-83 the gross profit gained over carbaryl in terms of yield increase worked out to be Rs. 1064.00, 1235.00 and 1371.80/ha in case of permethrin, cypermethrin and decamethrin, respectively. The net profit obtained from pyrethroid application over carbaryl, however, varied from Rs. 171.80 to 214.00/ha. This marginal increase can hardly be considered encouraging keeping in view the risk due to price fluctuations from year

TABLE 1
Effect of synthetic pyrethroid insecticides on incidence of pink bollworm and yield seed-cotton

S. No.	Insecticides	Dose (kg a.i./ha)	Mean percentage of infested loculi of opened bolls by pink bollworm			Yield of seed-cotton (q/ha)		
			1979	1980	1981	1979	1980	1981
			Average			Average		
1.	Carbaryl (Sevin 50 W. P.)	1.0	8.65	5.73	15.88	10.09	28.51	17.40
2.	Permethrin (Ambush 50 E. C.)	0.1	6.63	4.16	8.48	6.42	30.50	21.33
3.	Cypermethrin (Ripcord 10 E. C.)	0.08	4.17	2.34	3.17	3.29	31.77	20.63
4.	Decamethrin (Decis 2.5 E. C.)	0.02	2.93	2.79	2.07	2.60	32.65	20.53
								Average
								21.96
								24.76
								25.21
								23.23
								25.57

TABLE 2
Comparative cost of application of carbaryl and synthetic pyrethroid insecticides on cotton in Haryana

S. No.	Insecticides	Dose (kg a.i./ha)	Average yield of seed-cotton (q/ha) 1979 to 1981	Increase in yield over carbaryl	Gross profit over carbaryl in terms of yield increase per hectare	Cost of 5 applications of insecticides/ha (in rupees)	Increase in cost of application of pyrethroids over carbaryl	Net profit over carbaryl/ha
					1981-82	1982-83	1981-82	1982-83
1.	Carbaryl (Sevin 50 W. P.)	1.0	21.96	—	—	550.00	—	—
2.	Permethrin (Ambush 50 E. C.)	0.1	24.76	2.80	851.20	1064.00	850.00	1.20
3.	Cypermethrin (Ripcord 10 E. C.)	0.08	25.21	3.25	988.00	1235.00	1050.00	—62.00
4.	Decamethrin (Decis 2.5 E. C.)	0.02	25.57	3.61	1037.44	1371.80	1200.00	—102.56

Support price of seed-cotton as fixed by the Govt. of India=Rs. 304/q and Rs. 380/q for the years 1981-82 and 1982-83, respectively.

to year and even during the same season. This is also evident from the data that if sold at the support price of Rs. 304/q as fixed by the Govt. for the year 1981-82 it would lead to a loss rather than profit, as in case of cypermethrin and decamethrin.

The present studies, therefore, suggest that apart from the development of pest

resistance and appearance of secondary pests associated with the use of pyrethroids, their availability and higher costs will also be important limiting factors in recommending the use of synthetic pyrethroids on commercial scale on cotton in Haryana.

REFERENCES

- Bhat, M. V. and Patil, V. L. 1980. Role of cypermethrin in integrated pest management. Paper presented in All-India Seminar on Integrated Control of Pests on Irrigated Cotton held at Gunture, A. P. on 9-12 Feb., 1980.
- Lhoste, J. and Piedallu, C. 1977. Control of insects in cotton crops in Africa with some pyrethroids. *Pestic. Sci.* 8 : 254-57.
- Manon, T. V. and Surulivelu, T. 1980. Field evaluation of synthetic pyrethroids at two intervals of application in the control of cotton bollworm. Paper presented in All-India Seminar on Integrated Control of Pests on Irrigated Cotton held at Gunture, A. P. on 9-12 Feb., 1980.
- Murugesan, S., Parameswaran, S. and Balasubramaniam, M. 1979. Efficacy of five different synthetic pyrethroids in the control of bollworms and aphids on cotton. *Pesticides* 13 (10) : 15-17.
- Sukhija, H. S., Singh, J. and Butter, N. S. 1980. Efficacy of new insecticides against bollworms on cotton. *Pestology* 4 : 19-20.
- Weaver, J. S., All, J. N., Weaver, D. B. and Horuyuk, E. P. 1979. Influence of various insecticides on yield parameters of two cotton genotypes. *J. econ. Entomol.* 72 : 119-23.

RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XV, No. 2, pp. 221—222 (June 1985)

STUDIES ON CROSS POLLINATION AT VARIOUS DISTANCES IN RAPESEED AND MUSTARD

HARI SINGH, T. P. YADAVA and V. S. LATHER

Department of Plant Breeding

Haryana Agricultural University, Hissar

(Received : August 26, 1983; Revised : December 11, 1984)

For maintaining the genetic purity of the seed of *Brassica* species, [the contamination through outcrossing from other varieties of the same species or from other cross compatible species should be prevented. For this purpose, it is desirable to estimate the extent of outcrossing in particular species. Besides, the mode of pollination also determines the adequacy and effectiveness of various breeding techniques. In rapeseed and mustard such information is very scanty (Howard *et al.*, 1915). Present study was, therefore, conducted to gather information about the extent of outcrossing in rapeseed and mustard grown at various distances.

Varieties, BSH-1 and YSPB-24 from *Brassica campestris* L. and Prakash and RC 499 from *Brassica juncea* Coss. were chosen for the present study. Erect, thick and glaucous leaves habit of YSPB-24 and yellow petal colour of Prakash varieties were taken as the dominant marker characters as evidenced from their F_1 dominance for respective species. Spreading, thin and smooth leaves habit of BSH-1 and white petal colour in RC 499 were taken as recessive characters for respective species. These are distinguishable characters and can be easily identified and counted.

Five pots each of recessive parents, BSH-1 and RC 499 were placed at 5, 20, 50, 100, 150, 200 and 250 m distances from the varieties having dominant marker characters. Each variety for marker character had 20 pots placed at central place. Proper care of all these pots was taken from time to time and all other *Brassica* plants were removed from the vicinity of these distances. The seeds from all the distances for BSH-1 and RC 499 pots were harvested separately at maturity during 1979-80. These formed two sets each having 7 distances for BSH-1 (rapeseed) and RC-499 (Indian mustard) and were grown in split plot design with three replications during 1980-81. Species were taken in main plot and the spacings in sub-plots within the main plot. Each sub-plot had 5 rows each of 6 m length. Row to row and plant to plant distances within row were kept at 30 and 15 cm, respectively. Plants with erect and glaucous leaves of BSH-1 sub-plots and plants with yellow petal colour in RC 499 sub-plots were counted at flowering stage and the data were transformed by angular transformation. Statistical analysis of the data in split plot design was carried out as described by Panse and Sukhatme (1967).

Perusal of data in Table 1 revealed significant differences in per cent of cross pollination among the two species. In rapeseed it varied from 29.59 at 20 m to 15.56 at 250 m in BSH-1. There was high degree of cross pollination in rapeseed upto 150 m which declined at 200 and 250 m distances. In Indian mustard, cross pollination varied from 9.51 per cent at 5 m to 5.41 per cent at 100 m distance. However, there was no statistically significant difference in cross pollination above 5 m distances. The values of cross pollination in both the species must have been under estimated because the cross polli-

nation in BSH-1 and RC 499 was not taken into account.

The results reveal that cross pollination in these crops cannot be completely avoided because the flowers secrete nectar in abundance (Demianowicz, 1965) and the flowers are most attractive to bees which visit rape fields 3.5 to 4.0 km away from their hives neglecting fruit trees in favour of rapeseed (Hammer, 1952).

Exact minimum isolation distance cannot be worked out in these crops because of the factors mentioned above. From our study, 250 m for rapeseed (cross pollinated type) and 50 m for Indian mustard (self pollinated type) appeared adequate to maintain genotypes at considerably higher genetic purity although the chances of contamination from other genotypes cannot be completely ruled out. From breeding point of view considerably high degree of cross pollination at different distances which could be still higher in plants community, the population improvement methods like S_2 selection as suggested by Doggett and Eberhart (1968) and Doggett (1972) in sorghum could also be effectively practised over the conventional pedigree selection and mass selection followed for the improvement of rapeseed and mustard crops.

TABLE 1
Cross pollination (in percentage) at various distances in rapeseed and mustard

Distance (m)	Rapeseed var. BSH-1	Mustard var. RC 499
5	27.66	9.51
20	29.59	7.01
50	26.14	6.05
100	25.36	5.41
150	23.57	6.55
200	17.97	6.41
250	15.56	6.20
Average	23.69	6.88

C. D. at 5%

(i) between two sub-plot means at the same level of main plot = 3.76.

(ii) between two main plot means at the same level of sub-plot or different levels = 7.81.

C. V. (%) = 14.53.

REFERENCES

- Demianowicz, Z. 1965. Comparative investigation on nectar secretion, honey and seed yield of five Polish varieties of rape (*Brassica napus* var. Oleifera Metzger). Apimondia, XX Inst. Bee Keeping Jubilee Congress, Bucharest, August 26-31.
- Doggett, H. 1972. Recurrent selection in sorghum populations. *Heredity*. 28: 9-29.
- Doggett, H. and Eberhart, S. A. 1968. Recurrent selection in sorghum. *Crop Sci.* 8: 119-21.
- Hammer, O. 1952. Om rapsavlén, bierne of Froavlén. *Dansk Landbr.* 71: 67-69.
- Howard, A., Howard, G. L. C. and Khan, A. R. 1915. Flowering pollination and fertilization in Indian mustard. Mem. Dept. Agric. India (Botany series) 7: 213-37.
- Panse, V. G. and Sukhatme, P. V. 1967. *Statistical Methods for Agricultural Workers*. Indian Council of Agricultural Research, New Delhi.

EXTENT OF CHILD LABOUR AND ITS IMPACT ON THE HEIGHT AND WEIGHT OF CHILDREN IN RURAL HARYANA

JASBIR KAUR, M. NATH and S. N. LAHARIA*

Department of Child Development
Haryana Agricultural University, Hisar

(Received : August 12, 1983; Revised : September 22, 1984)

ABSTRACT

Study conducted in six villages of Jind and Sonapat districts of Haryana reveals that about 43% rural children were employed as labourer, mostly on daily paid basis in farming. Almost all the children of scheduled caste and 30% of the backward castes were working while those of dominant caste were nominal in number. The parents of most of the children were illiterate and were also working as labourers. It was observed that all the children were poor in health but the effect seemed to be more pronounced on the children of scheduled caste.

It is an obvious fact that the children form the foundation of a strong nation. A society, which fails to look after its children properly has to pay a heavy price in the long run. It is, therefore, essential that they should be given ample opportunity of learning and playing for their mental, physical and personality development, so that they become conscious and useful citizen of the nation. But it has been observed that a considerable number of children are working on different types of jobs, some of which are unorganised, unskilled, arduous and highly hazardous affecting their health and personality development adversely. Nambiar (1965) observed that child labour strikes at the very root of normal and healthy personality development of child labourers' physical, mental and

emotional make-up consequent upon working under strenuous conditions. According to an estimate of International Labour Organisation (Anonymous, 1979), about 52 million children, below the age of 15, were working in the world, mostly as unpaid labour. The national sample survey conducted by the Ministry of Labour had estimated that in India alone, the number of such children (5-14 years age group) would be about 17.3 million by the end of 1983 (Mazumdar, 1980).

Considering the seriousness of the problem, the Govt. of India adopted a policy on Child Development in 1974, which dealt with its various aspects. One of the objectives of this policy was that no child under 14 years of age should be engaged in any hazardous occupation.

*Joint Director (Extension), HAU, Hisar.

and undertake heavy work (Jain, 1979). But has it checked the problem? What is the present status, particularly in rural area? To answer these questions, a study was conducted to assess the extent of child labour at micro level and also its effect on their height and weight.

METHODOLOGY

The study was conducted in six randomly selected villages viz., Bahmniwala, Kheri-Sherkhan and Bhalang in block Kalayat (District Jind) and Bhanderi, Thaska and Gudda in block Kathura (District Sonapat). An exhaustive list of all the children from the six villages in the 6 to 15 years age group was prepared and their personal information such as age, sex, caste and parental occupation was collected. The number of working children in each village was also found out. Fifty working children per block on the basis of number of working children in the villages were

selected randomly in a proportionate manner (Table 1). To ensure the proper representation of children of each age group, the proportionate sampling was done on the basis of their age.

The data were collected by personal interview with the children and their parents. The height was measured with the help of a measuring tape graduated in centimeters while weight was taken with the help of portable weighing machine of 120 kg capacity. Effect on height and weight was seen by comparing the observed data with the standards recommended by Ghai *et al.* (1978).

RESULTS AND DISCUSSION

There were 1346 children (768 boys and 578 girls) in the age group of 6 to 15 years and about 43% of them were working as labourers. The proportion of boys was slightly higher than girls (Table 2). The data also revealed that

TABLE 1
Number of children selected from different villages

Name of the village	Total no. of children	Total no. of working children	Proportionate sample
Block Kalayat, District Jind			
Bahmniwala	245	161	25
Kheri-Sherkhan	391	124	20
Bhalang	155	30	5
Total	791	315	50
Block Kathura, District Sonapat			
Bhanderi	155	113	21
Thaska	288	103	20
Gudda	112	46	9
Total	555	262	50

IMPACT OF CHILD LABOUR

TABLE 2
Age-wise distribution of children

Age (years)	Total children				Working children							
	Boys		Girls		Total		Boys		Girls		Total	
	f	%	f	%	f	%	f	% (total)	f	% (total)	f	% (total)
6	70	9.1	38	6.6	108	8.0	32	9.6	11	4.5	43	7.4
7	75	9.8	62	10.7	137	10.2	24	7.2	28	11.5	52	9.0
8	81	10.5	67	11.6	148	11.0	41	12.3	26	10.6	67	11.6
9	77	10.0	62	10.7	139	10.3	34	10.2	17	7.0	51	8.8
10	103	13.3	74	12.8	177	13.1	50	15.0	31	12.7	81	14.0
11	55	7.2	40	6.9	95	7.1	21	6.3	22	9.0	43	7.4
12	116	15.1	63	10.9	179	13.3	51	15.3	28	11.5	79	13.7
13	56	7.3	50	8.5	106	7.9	14	4.2	25	10.2	39	6.7
14	58	7.5	51	8.8	109	8.1	28	8.4	30	12.3	58	10.0
15	77	10.0	71	12.3	148	11.0	38	11.4	26	10.6	64	11.1
Total	768	100.0	578	100.0	1346	100.0	333	100.0	244	100.0	577	100.0
												42.9

the number of working girls was more among the high age group than the lower ones. Among boys, the pattern was eccentric. The percentage of working children ranged between 31.1 to 53.2, which suggests that atleast one child out of every three children was working as labourer.

Caste-wise Distribution

On the basis of caste, the children were classified into four caste categories viz., dominant (Jat and Brahmins), backward, scheduled and miscellaneous. The data in Table 3 show that about 40% children belonged to dominant castes. It was because these villages were dominated by the people of dominant castes. The important revelation is that less than 2% children of dominant castes were working as labourer against all the children of scheduled caste and about 50% of the backward castes.

Educational Status of Children

On an average, one child out of every two used to go to school. There was no significant difference among the working and non-working children with respect to their general educational status (Table 4). The difference was sharp in case of girls, where only 28% working girls were going to schools against 42% of non-working girls.

Parents' Education, Occupation and Type of Family

The study revealed that the parents of 83% working children were illiterate. In case of remaining children, their parents were able to sign only. It shows that their educational status was very poor.

Most of them were also landless labourers. There were only 13 children, whose parents were either small or marginal farmers. About 16% of them were also from non-farming families (carpenter, blacksmith, washerman, etc.).

Data in Table 5 also show that about 80% working children were from joint families. Bigger family size seems to be an important factor forcing children to work as labourer.

Nature of Work Done by Children

It was observed that 34% children were working in agriculture as daily paid labour and 13% were employed by the landlords on contract basis. A sizeable number of boys was also working as herdmen (Table 6).

The percentage of girls working as daily paid labour was more than the boys, and most of them were working as domestic servants to look after household chores including cleaning of cattle sheds.

The data also show that about 50% of them were working for less than 6 h per day. More girls were working for longer period because most of them were employed as domestic servants. On the other hand, many boys, working with potters, blacksmiths etc., were employed only for a few hours per day.

Reasons for Working

To overcome the problem of child labour it is essential to know the reasons, which compel them to work as labourers. The investigation revealed that almost all the children were working due to poverty.

IMPACT OF CHILD LABOUR

TABLE 3
Caste-wise distribution of children

Caste	Total children				Working children							
	Boys		Girls		Total		Boys		Girls		Total	
	f	%	f	%	f	%	f	%	f	%	f	%
Dominant	309	40.2	214	37.0	523	38.8	4	1.2 (1.3)	5	2.0 (2.3)	9	1.6 (1.7)
Backward	171	22.3	142	24.6	313	23.3	95	28.5 (55.5)	65	26.6 (45.8)	160	27.7 (51.1)
Scheduled	234	30.5	174	30.1	408	30.4	234	70.3 (100)	174	71.3 (100)	408	70.7 (100)
Others	54	7.0	48	8.3	102	7.5	0	0 (0)	0	0 (0)	0	0 (0)
Total	768	100	578	100	1346	100	333	100 (43.3)	244	100 (42.2)	577	100 (42.9)

Figures in parentheses are the percentage of working children of that particular caste category.

TABLE 4
Educational status of children

Educational status	Total children				Working children							
	Boys		Girls		Boys		Girls					
	f	%	f	%	f	%	f	%				
School going	535	69.7	243	42.1	778	57.8	205	61.6	68	27.9	274	47.5
Non-school going	233	30.3	335	57.9	568	42.2	128	38.4	176	72.1	303	52.5
Total	768	100.0	578	100.0	1346	100.0	333	100.0	244	100.0	577	100.0

TABLE 5
Parental occupation and type of family of working children

	Boys	Girls	Total
Parental occupation			
Farming	4	9	13
Labour	37	35	72
Others	9	6	15
Total	50	50	100
Family type			
Nuclear	9	12	21
Joint	41	38	79
Total	50	50	100

TABLE 6
Nature of work done by the children and their working hours

	Boys	Girls	Total
Nature of work			
Farm labour as daily paid labour	11	23	34
Farm labour on contract basis	13	—	13
Grazing/Herdmen	15	4	19
Domestic servants	2	19	21
Working with potters/blacksmiths, etc.	9	2	11
Water carrier	—	2	2
Total	50	50	100
Working hours per day			
3-4	8	5	13
4-5	8	6	14
5-6	9	9	18
6-7	11	10	21
More than 7	14	20	34
Total	50	50	100

They had to work to support their families, due to one or the other reason, e. g., large family size (25), death of elder family member (7), etc. Similar observations were made in a pilot study conducted in Madras, Madurai and Coimbatore (Kulshrestha, 1978). In a seminar organised by National Institute of

Public Cooperation and Child Development, New Delhi (Anonymous, 1975) it was concluded that millions of families were below the poverty line and they had to deploy their children in the labour market in order to make out a bare subsistence.

IMPACT OF CHILD LABOUR

Effect on Height and Weight

The observed and expected height and weight of the children in different age groups have been shown in Figs. 1 and 2. The data reveal that the mean observed height and weight of all the children of all the age groups were less than the expected ones.

The effect on height seems to be more pronounced on boys as the mean difference between the observed and expected height is more (4.55 cm) among boys than the girls (3.65 cm). However, it is not statistically significant ($t=1.3$). Moreover, the difference was not uniform at all the age levels. Among boys, the difference was more acute from 9 to 11 years age, while among girls, it was more at the ages of 11, 12 and 13 years.

It is also seen that the gap in weight increases with the increase in age, both in boys and girls but it is more obvious among the children of higher age group. Contrary to height, the effect on weight was more among girls than boys, though the difference was not statistically significant ($t=1.8$). The study, thus, reveals that the health of almost all the working children was affected by the work.

Bhagliwal (1966) also reported that child labour stunted physical growth and interfered in their normal development. George (1964) also observed that child labour affected the health of small children.

Effect of Caste on Height and Weight

The data in Table 7 show that the mean difference of both height and weight is higher among the children of Harijan and backward castes than the sample mean difference. However, it is more among Harijan boys and girls than the backward castes children. In some other studies (Ramachandran *et al.*, 1968; Phadke *et al.*, 1971, Easwaran, 1972) also, it was observed that the children of lower socio-economic status were poor in health in comparison to children of higher socio-economic status.

On the basis of study, it can be concluded that the system of child labour is still prevalent to a considerable extent. The problem seems to be more acute among the persons of low socio-economic strata, particularly scheduled caste, as almost all the children belonging to that caste were working as labourer. It also affected the height and weight of boys and girls severely.

TABLE 7

Mean difference in height and weight of working children of Harijan and backward castes (in cm)

Aspect	Boys			Girls		
	Sample mean difference	Harijan	Backward	Sample mean difference	Harijan	Backward
Height	4.55	5.73	4.20	3.65	4.93	4.10
Weight	4.58	6.50	4.43	5.16	6.17	3.80

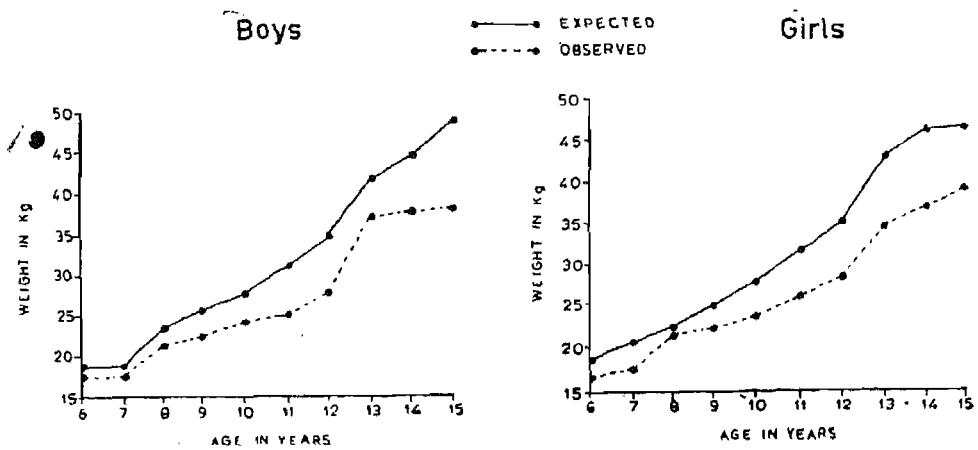


Fig. 1. Expected and observed weight of boys and girls.

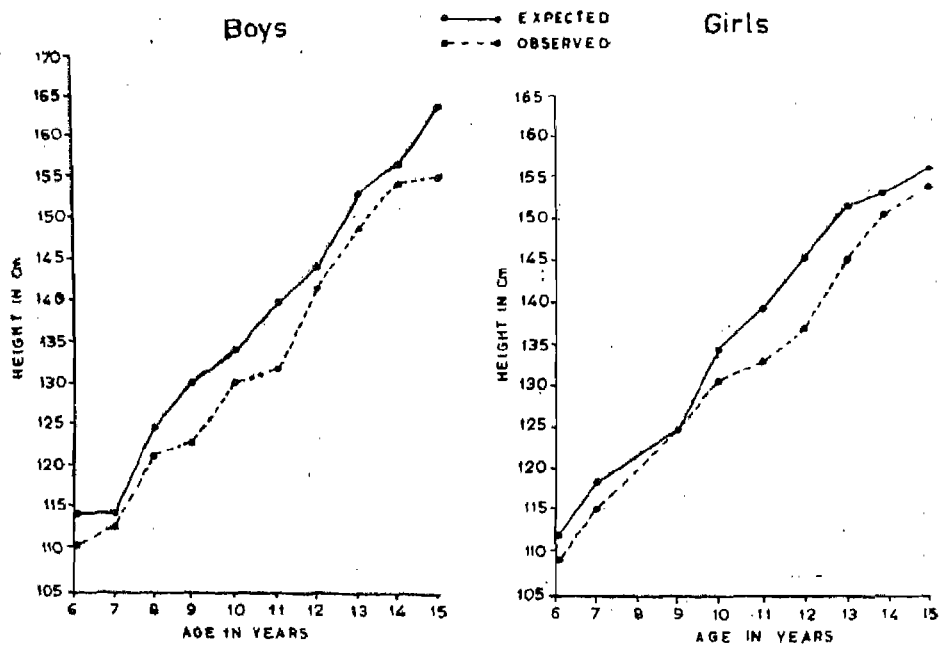


Fig. 2. Expected and observed height of boys and girls.

IMPACT OF CHILD LABOUR

REFERENCES

- Anonymous. 1975. Recommendation of Seminar on Employment of Children, organised by National Institute of Public Cooperation and Child Development, held at New Delhi on November 25-28. pp. 252-61.
- Anonymous. 1979. Child Labour in Asia—An ILO Survey. *Indian J. Public Administ.* 25 : 808-14.
- Bhagliwal, T. N. 1966. Child—A definition. *Social Welfare* 13 (9) : 4-6.
- Easwaran, P. P. 1972. Heights and weights of six to eight years old children in Coimbatore City. *Indian J. Nutr. Diet.* 9 : 135-44.
- George, C. M. 1964. Child labour—a feature. *Social Welfare* 11 (9) : 41-43.
- Ghai, O. P., Sāndhu, R. K., Ghai, A. R. and Verma, I. C. 1978. *Physical Growth and Behavioral Development of Indian Children*. All India Institute of Medical Sciences, New Delhi, pp. 9-12.
- Jain, S. N. 1979. Law and the child in India. *Indian J. Public Administ.* 25 : 613-24.
- Kulshrestha, J. C. 1978. *Child Labour in India*. Ashish Publishing House, New Delhi. pp. 13-18.
- Mazumdar, M. 1980. Caution—children at work. *Future* 1 (1) : 9-10.
- Nambiar, M. 1965. Human aspects of child labour. *Social Welfare* 12 (11) : 11-12.
- Phadke, M. V., Deodhar, N. S. and Kulkarni, H. D. 1971. Rural pre-school child—His growth and nutritional status. *Indian J. Medical Res.* 59 : 748-57.
- Ramachandran, K. U., Deshpande, V. A., Apte, S. V. and Shukla, N. N. 1968. *A Survey of School Children in Bombay City with Special Reference to their Physical Efficiency, Mental and Nutritional Status*. Asia Publishing House, Bombay. pp. 15-16.

A STUDY OF PHYSICALLY HANDICAPPED CHILDREN

SHANTI DEVI KHARANGAR and M. NATH

Department of Child Development
Haryana Agricultural University, Hisar

(Received : April 19, 1983; Revised : May 4, 1985)

Difficulties related to disability are not only experienced by the individual but also by other persons close to him. The family has to deal with the problems related to the disabled person such as need for care, disturbed social relationships and economic burden. For society as a whole there are many implications such as increased demand for care and economic support, loss of productivity, and the need for abolishing physical and social barriers (Balme, 1950-51). The problems faced by the individual, family and society are very often felt but very rarely quantified in economic terms.

In this study, an attempt has been made to document the prevalence and problems of the physically handicapped children and their families in Hisar city with the following objectives :

- (i) Nature and extent of disability in relation to some socio-economic factors, and
- (ii) parental attitudes.

The study was conducted in Hisar city of Haryana State during 1981-82. All the school going orthopaedically handicapped and deaf and dumb children, those who visited various hospitals

for treatment, and their parents were included as the universe for this study. During the survey only 9 deaf and 62 orthopaedically handicapped children were identified in the age group of 4 to 12½ years. All the 9 deaf and dumb children and at random 41 orthopaedically handicapped children were selected for the final study.

Three levels of disability extent among orthopaedically handicapped, were categorised with the help of a doctor.

Nature and Extent of Physical Disability in Relation to Economic Status and Educational Level of Parents

Majority of the deaf and dumb, and orthopaedically handicapped children were from middle and lower income groups (Table 1). Verma (1960-61) concluded that highest number of handicapped (63.8%) come from poor economic status. Majority of the parents of deaf and dumb and orthopaedically handicapped children were primary to high school educated. As evident from Table 1, 75.7, 17.0 and 7.3 per cent were moderately, mildly and severely disabled, respectively.

PHYSICALLY HANDICAPPED CHILDREN

TABLE 1

Nature and extent of physical disability in relation to economic and educational level of parents

	Nature of disability			Extent of disability			
	Deaf and dumb	Orthopaedically	Total	Severe	Moderate	Mild	Total
Income level							
High	0 (0)	7 (17)	7 (14)	1 (33.3)	5 (16.1)	1 (14.3)	7 (17)
Middle	6 (66.7)	9 (22)	15 (30)	0 (0)	8 (25.8)	1 (14.3)	9 (122)
Low	3 (33.3)	25 (61)	28 (56)	2 (66.6)	18 (58.1)	5 (71.4)	25 (61)
Total	9	41	50*	3 (7.3)	31 (75.7)	7 (17.0)	41**
Educational level							
Graduates/ Postgraduates	1 (5.6)	10 (12.5)	11 (11.2)	2 (33.3)	7 (11.7)	1 (7)	10 (12.5)
Primary to High School	11 (61.1)	36 (45.0)	47 (48.0)	2 (33.3)	27 (45.0)	7 (50)	36 (45.0)
Illiterate	6 (33.3)	34 (42.5)	40 (40.8)	2 (33.3)	26 (43.3)	6 (43)	34 (42.5)
Total	18	80	98	6	60	14	80

Figures in parentheses are percentages.

*n= 50 children

**n= 41 children

Attitude of Parents towards their Physically Handicapped Children

Majority of the parents sought immediate treatment for the children as soon as disability occurred (Table 2). Most of the parents rarely accompanied their handicapped children outside the home.

As many as 70% parents reported that most common form of teasing their disabled children subjected to was name calling. Majority of the parents were

of the view that they did not overprotect their physically handicapped children due to the limitation of the handicap. Major proportion of the parents was in favour of sending their physically handicapped children to the ordinary schools. Half of the parents reported that their physically handicapped children were more intelligent than their other normal children.

As far as behaviour of children was concerned, maximum parents never came

TABLE 2
Parental attitudes towards their physically handicapped children

S. No.	Parental attitudes	No. of parents	Total
(i)	Treatment sought		
	Immediately taken to hospital	66(67.3)	
	Child was taken to doctor after 2 or more than 2 years	20(20.5)	
	No treatment sought	12(12.2)	98
(ii)	Accompanying children outside the home		
	Always	26(26.5)	
	Rarely	56(57.2)	
	Never	16(16.3)	98
(iii)	Reaction to the teasing		
	Disabled were teased	69(70.4)	
	Disabled were not teased	29(29.6)	98
(iv)	Dealings with mistakes		
	Did not overprotect the handicapped	73(74.5)	
	Overprotected the handicapped	25(25.5)	98
(v)	Education of children		
	Special education for disabled	20(20.4)	
	Ordinary education for disabled	78(79.6)	98
(vi)	Intelligence of children		
	Like normal children	49(50.0)	
	More intelligent than normal	49(50.0)	98
(vii)	Behaviour of children		
	Normal	85(86.7)	
	Faced some problems	13(13.3)	98
(viii)	Liability of children		
	No liability	56(57.1)	
	Liability	42(42.9)	98
(ix)	Future aspirations		
	Higher education/training	70(71.5)	
	Nothing decided	28(28.5)	98

Figures in parentheses are percentages.

across any behaviour problem in their physically handicapped children. Majority of the parents did not feel their physically handicapped children as a liability to

them. Major proportion of the parents decided for the higher education and training of their physically handicapped children to make them self-reliant.

PHYSICALLY HANDICAPPED CHILDREN

REFERENCES

- Balme, Harold. 1950-51. Treatment and after-care of physically handicapped child. *Indian J. Social Work* 11 : 365-71.
- Verma, M. 1960-61. A socio-economic survey of 500 families of the physically handicapped in Kanpur. *Indian J. Social Work* 21 : 447-50.

COMPARATIVE PROFILE OF THE RURAL WOMEN KEY-COMMUNICATORS AND THEIR RECIPIENTS

DAMYANTI* and HIRA NAND

Department of Extension Education

Haryana Agricultural University, Hisar

(Received : June 27, 1983; Revised : September 22, 1984)

Women occupy a key position in every society, more so in paving the way for rural development. They are not only the custodians of the home but also equal partners in farming and decision-making on farming. The studies of Randhawa (1959), Puri (1971) and Kahlon (1975) support our this contention.

A study was conducted to identify the key-communicators among rural women with the specific purpose of locating among them the opinion-leaders and further analysing the profile of so identified key-communicators along with their respective recipients (opinion seekers) for the developmental communication. The scope of this paper is confined to the presentation of the comparative profile of the key-communicators and their recipients in getting the advice on issues related to domestic matters, education and health care of children, care of pregnant lady in the family, matters relating to marriages, preservation of home scale fruits and vegetables and elderly advice. The thrust has been to know if key-communicators had a profile identical to their recipients with

regard to personal, social and economic characteristics.

Since the sociometry technique was used in identification of the key-communicators, whole village approach was followed. Village Dhiranwas of Hisar II Block of Hisar district was purposively selected on the criterion of being a small sized village, wherein, each and every member of clientele system knew the other members of the system personally. The village had 156 households. The study was conducted among rural women. All the wives of heads of the families in the village who were actively associated with farming and home management constituted the respondent population. The total number of respondents were equal to total number of households in the village. However, only 146 respondents were interviewed. A well structured interview schedule, containing questions on different variables studied was used. The socio-economic status of the respondents was measured by using Socio-Economic Status Scale (Rural) developed by Trivedi (1963). The data were analysed and inferences were drawn on the basis of frequencies and percentages.

*Present address : Lecturer in Home Science, Govt. High School, Rewari.

RURAL WOMEN KEY-COMMUNICATORS

The sociometry technique, applied for the identification of key-communicators among rural women, revealed a cluster of 18 key-communicators for the criteria mentioned in the preceding paragraphs. Thus, the study deals with the comparative profile of these 18 key-communicators and their 146 recipients or opinion seekers.

The personal variables studied were age, family type and family size. Data in Table 1 reveal that, whereas, high majority of the recipients fell in the young (45.20%) or the middle (43.83%) age groups, their key-communicators belonged mainly to middle (55.55%) and old age (33.33%) groups. This trend is but natural. The older people are expected to be wiser on account of more experience to their credit. Culture of the Indian society also recognises older to be wiser over younger group.

As regards the family type and size, whereas majority of the key-communicators came from joint families (83.33%) and more than five members in the family (88.88%), the recipients were almost evenly divided as belonging to joint and nuclear families. However, only one-third of the recipients had a family size of up to five members.

The comparative social profile of the key-communicators and their recipients studied, included three social variables, viz. caste, socio-economic status and social participation. Both the key-communicators and their recipients belonged to Jat, Artisans and Scheduled caste. Apparently it appears that the different caste followers had their key-communicator within their own caste. Just possible,

a further probing, which has not been done for the present study, might reveal a slightly different trend. This assumption is based on the fact that as many as 34.90% scheduled caste opinion seekers shared only 22.22% of the key-communicators from their own caste and out of 4 artisan women 2 had been identified as the key-communicators revealing that the artisan key-communicators also had some followers from the other two caste groups.

A comparative profile of socio-economic status of key-communicators and their recipients revealed that, in most of the cases, the opinion seekers preferred a key-communicator of equal or higher socio-economic status to their own. Almost four fifths (77.77%) of the key-communicators coming from medium or high socio-economic status had less than two-thirds (68.49%) of the followers from medium or high socio-economic status. The findings of Mathai (1971) and Prem Lata (1982), that the opinion leaders had high socio-economic status and differed from their followers on this characteristic supported the findings of the present study.

As regards the social participation, the findings are as usually expected. The key-communicators had more social participation as compared to their followers. As many as 50% of the key-communicators were either members or office bearers of some village organisation, whereas only 19.73% of the recipients acquired this status. The findings of Mathai (1971) and Prem Lata (1982), that the opinion leaders had high social participation and differed from their followers on this characteristic supported the findings of the present study.

TABLE 1

Comparative personal, social and economic profile of rural women key-communicators and their recipients

S. No.	Variables	Key-communicators		Recipients	
		Frequency	%	Frequency	%
Personal variables					
X ₁	Age				
a.	Young	2	11.11	66	45.20
b.	Middle	10	55.55	64	43.83
c.	Old	6	33.33	16	10.96
X ₂	Family type				
a.	Nuclear	3	16.66	78	53.42
b.	Joint	15	83.33	68	46.57
X ₃	Family size				
a.	Upto 5	2	11.11	46	31.52
b.	Above 5	16	88.88	100	68.50
Social variables					
X ₄	Caste				
a.	Jat	12	66.66	91	62.22
b.	Artisan	2	11.11	4	2.73
c.	Scheduled caste	4	22.22	51	34.90
X ₅	Socio-economic status				
a.	High	8	44.44	45	30.82
b.	Medium	6	33.33	55	37.67
c.	Low	4	22.22	46	31.50
X ₆	Social participation				
a.	Office holder	5	27.77	5	3.30
b.	Member of one organisation	4	22.22	24	16.43
c.	No membership	9	50.00	117	80.43
Economic variables					
X ₇	Occupation				
a.	Labour	4	22.22	46	31.50
b.	Business	—	—	2	1.37
c.	Service	2	11.11	4	2.73
d.	Cultivation	12	66.66	94	64.38
X ₈	Land holding				
a.	Landless	6	33.33	52	35.61
b.	Upto 10 acres	4	22.22	29	19.86
c.	10-15 acres	2	11.11	13	8.90
d.	15-20 acres	—	—	19	13.01
e.	Above 20 acres	6	33.33	33	22.60

RURAL WOMEN KEY-COMMUNICATORS

Economic profile of the key-communicators and their recipients was studied with respect to occupation and size of land holding. Data in Table 1 reveal that majority of the key-communicators (66.66%) as also their followers (64.38%) belonged to farming occupation.

From the point of view of size of land holding, the key-communicators and their recipients appeared to have almost identical profile. Whether the trend is really identical or the choice pattern was different, could be established only by further in-depth probing.

REFERENCES

- Kahlon, P. 1975. Problems and progress of rural women in India. *Kurukshetra* 23 (8) : 24.
- Mathai, R. 1971. A study of communication pattern and key-communicators among rural women. Ph.D. thesis, Indian Agricultural Research Institute, New Delhi.
- Prem Lata. 1982. Action research on the flow of information regarding post-harvest technology through women key-communicators. M.Sc. thesis, Haryana Agricultural University, Hisar.
- Puri, S. 1971. Delineation of areas of decision-making by farm women. *Indian J. Ext. Educ.* 7 : 144-48.
- Randhawa, M. S. 1959. *Farmers of India*. Vol. 1. ICAR, New Delhi. pp. 120-24.
- Trivedi, G. 1963. Measurement and analysis of socio-economic status of rural families. Ph.D. thesis, Indian Agricultural Research Institute, New Delhi.

PHYSIOLOGICAL CHANGES DURING ELECTROANAESTHESIA

D. K. SHARMA* and HARIWIR SINGH

Department of Anaesthesiology

Postgraduate Institute of Medical Education and Research, Chandigarh

(Received: April 26, 1984; Revised: May 16, 1985)

ABSTRACT

Comparative studies on the physiological changes during electroanaesthesia in dogs, induced and maintained by several electroanaesthesia techniques have been conducted. Low frequency (500-1000 Hz) square waves, high frequency (10,000-40,000 Hz) square and sine bursts and combinations of low frequency square and high frequency sine bursts in interference pattern have been used to induce and maintain electroanaesthesia. Rise in mean arterial pressure, increase in heart rate, varying degrees of ECG changes and increase in respiratory rate and minute volume were recorded during electroanaesthesia. Changes in tidal volume were mild and insignificant. There was no evidence of respiratory depression. Physiological changes were transient and reversible after electroanaesthesia. The physiological changes were minimum when electroanaesthesia was induced and maintained with the combinations of low frequency square waves and high frequency sine bursts in interference pattern.

Various efforts have been made to study physiological changes during electroanaesthesia and the relationship between physical properties of the waveforms and their electroanaesthetic action (Van Harrevald *et al.*, 1942; Van Harrevald and Dandliker, 1945; Larson and Sances, 1968; Herin, 1968; Shimoji *et al.*, 1971). Andrew *et al.* (1973) studied cerebral blood flow and oxygen utilization under electroanaesthesia and did not find any evidence of cerebral hypoxia. Various other parameters have also been studied but uptill now not even a single waveform has been found to fulfill all the requirements of a good electroanaesthetic agent. This study has been conducted with an aim to find out most

suitable combination of electroanaesthesia waveforms producing minimum physiological alterations.

MATERIAL AND METHODS

Physiological studies under electroanaesthesia have been conducted by employing mono and biphasic forms of low frequency (500-1000 Hz) square waves (by using electronic stimulator-Techno) and high frequency square and sine bursts (10,000-40,000 Hz) (by using electroanaesthesia generator prototype designed and developed in technical collaboration of Biomedical Electronics Division of Central Scientific Instrument Organisation, Chandigarh) and a combination of low

*Present address: Department of Veterinary Clinics, Haryana Agricultural University, Hisar.

frequency square and high frequency sine bursts in interference pattern (by combining both the aforesaid electroanaesthesia generators together at the same time).

This study was conducted after performing 80 trials of electroanaesthesia using 20 dogs of either sex. The body weight varied between 10-20 kg. Ten trials were performed using each type of waveform viz., monophasic low frequency square waves (LUSq), biphasic low frequency square waves (LBSq), monophasic high frequency square bursts (UISqB), biphasic high frequency square bursts (BISqB), monophasic high frequency sine bursts (UISB), biphasic high frequency sine bursts (BISB), combination no. I (UISB+LBSq) and combination no. II (BISB+LUSq), in interference pattern.

The dogs were kept off feed overnight and were pre-medicated with 8-15 mg/kg of 2.5-5% solution of thiopentone sodium intravenous. This subanaesthetic dose was just sufficient to perform endotracheal intubation, put up electrodes and start electroanaesthesia. The effect of thiopentone was over within 5-10 min. Such premedication helped in proper uptake of the current by the target area (thalamus) and thus minimised induction discomfort. Needle electrodes (18 gauge needles fitted in banana electrodes) in fronto-occipital placement were used. Electroanaesthesia was induced by using crash induction descending current pattern technique (Smith *et al.*, 1967). An initial dose of 20-30 volts was given which was finally adjusted between 10-20 volts within 5-10 min. The pulse duration of low frequency square waves was from 2-5 msec and that of high frequency

square and sine bursts from 0.5-2.5 msec with a burst interphase of 5-11 msec.

Kymographic recording of mean arterial pressure (MAP) was done after cannulating femoral artery. Electrocardiogram in lead II was recorded after incorporating a filter in the circuit. Respiratory rate was also recorded. Tidal volume was measured by using Wright's respirometer and minute volume was calculated. Recordings were made before electroanaesthesia (E. A.), 15 min after E. A. current application, 45 min of current application and 5-10 min of termination of E. A. currents. These periods were, respectively, designated as control, induction, maintenance and recovery.

RESULTS AND DISCUSSION

Mean Arterial Pressure (MAP)

The results have been presented in Table 1. During induction a 14% rise in mean arterial pressure was observed where E. A. was induced with low frequency monophasic square waves. This rise in MAP is attributed to their potent E. A. action and subsequent sympathoadrenal and muscle activity (Lorenz *et al.*, 1966; Sharma and Singh, 1983). During maintenance it remained constant at 8.4% above the control value, while at recovery it was only 6% higher than the control value.

In the groups where biphasic forms of low frequency square waves were used to induce and maintain E. A. the rise was only by 13% during induction. In groups where mono and biphasic forms of high frequency square bursts were used rise in MAP was by 6.6 and 11 per cent, respectively, during induction.

PHYSIOLOGICAL CHANGES DURING ELECTROANAESTHESIA

TABLE 1
Changes in mean arterial pressure (mm of mercury) during electroanaesthesia by different waveforms (n=10).

S. No.	E.A. waveform	State of anaesthesia		After induction of anaesthesia		Recovery (after 5-10 min of termination of E.A.)
		Control	Induction (10 min)	30 min	60 min	
1.	Low frequency monophasic square waves (LUS _q)	135.0±5.29	154.0±5.69**	158.0±4.36**	146.0±3.71*	141.0±4.51*
2.	Low frequency biphasic square waves (LBS _q)	126.0±5.91	142.0±4.91**	146.0±5.99**	138.0±6.71*	131.0±1.81*
3.	Monophasic high frequency square bursts (UIS _q B)	128.0±5.25	136.5±6.00*	140.5±6.02**	135.5±6.18	129.5±4.27
4.	Biphasic high frequency square bursts (BIS _q B)	123.0±5.16	128.0±5.25	137.0±5.53**	129.5±5.12	125.0±5.00
5.	Monophasic high frequency sine bursts (UIS _q B)	126.0±5.39	141.5±6.48**	153.0±4.91**	134.0±7.24	127.5±6.60
6.	Biphasic high frequency sine bursts (BIS _q B)	135.0±6.20	149.0±5.14**	147.5±6.27**	145.5±5.68**	140.0±4.66
7.	Combination I (UISB+LBS _q)	128.5±7.25	140.0±6.48**	137.0±7.52**	135.0±8.08	129.0±7.60
8.	Combination II (BISB+LUS _q)	134.0±6.77	151.5±6.78**	154.5±5.98**	146.0±6.51**	142.5±7.42**

*Significant at 5% level **Significant at 1% level.

TABLE 2
Changes in heart rate, respiratory rate, tidal volume and minute volume during electroanaesthesia by different techniques (n=10)

S. No.	E.A. waveform	Anaesthetic state	Heart rate/min	Respiratory rate/ min	Tidal volume (ml/kg)	Minute volume (l/kg)
1.	LUS _q (Low frequency mono phasic square waves)	Control	186.3±7.08	13.5±1.47	11.4±1.0	0.146±0.017
		Induction	187.2±6.27	21.4±3.35	12.5±1.2	0.244±0.027*
		Maintenance	196.3±4.64	16.8±2.02	10.4±0.9	0.190±0.013
		Recovery	199.1±4.78*	16.7±1.95	11.3±1.5	0.161±0.013
2.	LBS _q (Low frequency biphasic square waves)	Control	174.8±9.21	15.8±1.91	12.5±0.9	0.200±0.035
		Induction	182.6±9.76	19.1±2.83	13.6±1.0	0.256±0.044
		Maintenance	186.7±10.52	22.3±3.49*	15.1±2.1	0.300±0.052*
		Recovery	184.8±10.43	21.2±3.03	13.8±1.1	0.280±0.035
3.	UIS _q B (Monophasic high frequency square bursts)	Control	179.0±7.53	21.8±3.06	7.8±0.71	0.160±0.028
		Induction	172.0±6.25	28.8±4.68	9.9±0.86*	0.260±0.039*
		Maintenance	180.6±9.79	34.0±5.74*	8.3±0.86	0.258±0.042*
		Recovery	182.7±8.75	30.5±5.44	8.2±0.82	0.220±0.034
4.	BIS _q B (Biphasic high frequency square bursts)	Control	174.4±3.94	16.8±1.84	10.8±1.05	0.163±0.019
		Induction	185.2±7.31	37.3±12.66	9.5±1.30	0.253±0.047*
		Maintenance	189.8±9.45	44.6±14.21	8.0±0.87*	0.250±0.053
		Recovery	176.4±9.23	43.9±14.22	8.4±0.97	0.260±0.052
5.	UISB (Monophasic high frequency sine bursts)	Control	174.6±6.40	14.9±2.48	10.2±1.10	0.140±0.023
		Induction	182.2±9.09	18.8±3.21*	10.9±1.28	0.186±0.025
		Maintenance	182.3±16.42	20.5±4.52*	12.1±1.25	0.247±0.065*
		Recovery	180.0±11.44	24.2±7.32	15.6±4.30	0.207±0.036*

PHYSIOLOGICAL CHANGES DURING ELECTROANAESTHESIA

6. BISB (Biphasic high frequency sine bursts)	Control	173.0±13.27	15.8±1.70	10.2±0.99	0.150±0.014
	Induction	191.4±10.56	19.0±1.90	10.30±1.09	0.166±0.021
	Maintenance	192.0±10.54	30.5±12.47	10.0±1.18	0.210±0.035
	Recovery	189.2±6.81	34.0±13.47	11.9±1.67	0.270±0.056**
7. Combination I (UISB+LBS _d)	Control	189.8±14.49	17.2±1.54	14.1±0.9	0.240±0.031
	Induction	191.0±10.83	16.3±1.79	18.1±3.8	0.260±0.023
	Maintenance	187.0±11.88	17.2±2.04	16.0±1.4	0.256±0.022
	Recovery	189.5±14.33	21.1±4.87	14.1±1.0	0.258±0.260
8. Combination II (BISB+LUS _d)	Control	175.3±9.78	18.7±3.13	14.0±1.10	0.240±0.031
	Induction	202.0±8.65*	20.7±5.75	15.6±1.50	0.270±0.038
	Maintenance	193.0±8.32*	21.5±5.70	13.3±0.97	0.250±0.030
	Recovery	205.5±8.46**	20.2±4.48	14.0±0.67	0.283±0.065

*Significant at 5% level

**Significant at 1% level.

In the groups where E. A. was induced by using mono and biphasic forms of high frequency sine bursts, rise in mean arterial pressure during induction was quite sharp, i.e., by 12.3 per cent. There was disturbed E. A. due to weak electroanaesthetic potency of these wave forms resulting in frequent electrode displacement and causing more convulsions consequent upon the distribution of the current to the subcortical structures than the target area (Lorenz *et al.*, 1966; Shimoji *et al.*, 1971).

In the groups where E.A. was induced and maintained by using the combinations of low frequency square waves and high frequency sine bursts in interference pattern the rise in MAP during induction was only by 8.5% indicating minimum induction discomfort and smooth onset of E. A.

Electrocardiographic Changes

In electrocardiogram there was rise in amplitude of P and T waves. Depression of S-T segment with and without inversion of T waves was also observed. There was occurrence of bigeminal, supra ventricular and nodal rhythm during E. A. The changes were recorded in various groups but the number and incidence of such changes were quite insignificant and differential effects of various electroanaesthesia waveforms used in this study could not be appreciated. The findings are in support of earlier studies (Shimoji *et al.*, 1971; Sances and Larson, 1975). Change in heart rate was quite variable during E. A. In most of the cases tachycardia was observed during induction and maintenance which is attributed to increased sympathoadrenal activity. Increased heart rate and ECG changes are

evident of sympathoadrenal activity during E. A. by the types of waveforms used.

Respiratory Rate, Tidal Volume and Minute Volume

The parameters are reported in Table 2. A significant rise in respiratory rate was observed during induction and maintenance of E. A. During induction of E. A. by low frequency monophasic square waves, it was by 58 per cent. In the group where biphasic low frequency square waves were used for induction of E. A., this rise in respiratory rate was only by 41 per cent. In the groups where E. A. was induced by monophasic high frequency sine bursts the rise in respiratory rate was by 26 per cent. In other groups rise in respiratory rate during induction of electroanaesthesia was insignificant. Panting was observed in 2 out of 25 cases where E. A. was induced and maintained by using biphasic forms of high frequency square bursts. Smith *et al.* (1976) mentioned that panting during electroanaesthesia is a mechanism to lower down the body temperature.

Changes in tidal volume were significant only in one group where monophasic high frequency square bursts were used to induce E. A. During maintenance a significant decrease in tidal volume was observed during E. A. by biphasic forms of high frequency square bursts. In other groups tidal volume remained unaffected during E. A.

With the rise in respiratory rate there was concurrent increase in minute volume. The rise in minute volume during induction of E. A. was significant in monophasic

PHYSIOLOGICAL CHANGES DURING ELECTROANAESTHESIA

low frequency square waves and biphasic high frequency square bursts groups. During maintenance the rise was significant in biphasic low frequency square waves and monophasic high frequency sine bursts groups. The findings are in support of Shimoji *et al.* (1971). There was no evidence of respiratory depression.

Changes in respiratory rate, tidal volume and minute volume were minimum in the groups where E. A. was induced and maintained by using aforesaid combinations of low frequency square waves

and high frequency sine bursts in interference pattern.

From the findings it is concluded that a good compromise and counterbalance existed between low frequency square waves and high frequency sine bursts in interference pattern resulting in potent and smooth electroanaesthesia. Based on this study, it is worthwhile to suggest to design a miniature synchronic output generator emitting low frequency square waves and high frequency sine bursts together at the same time.

REFERENCES

- Andrew, J. H., Lindquist, P. A. and Smith, R. H. 1973. Electroanaesthesia studies: Cerebral blood flow and oxygen utilisation during electroanaesthesia in rhesus. *Anaesth. Analg.* (Cleveland) **52** : 496.
- Herin, R. A. 1968. Electroanaesthesia in the dog. Comparative study of electric waveforms. *Am. J. vet. Res.* **29** : 601.
- Larson, S. J. and Sances, A. Jr. 1968. Physiological effects of electroanaesthesia. *Surgery* **64** : 281.
- Lorenz, R., Larson, S. J. and Sances, A. Jr. 1966. Analysis of rectangular and sinusoidal currents applied to model neuronal systems. Proc. Symp. Biomedical Engin. Milwaukee, Wisconsin, 1 : 81 (Cited from Smith *et al.*, 1967).
- Sances, A. Jr. and Larson, S. J. 1975. *Electroanaesthesia—Biomedical and Biophysical Studies*. Academic Press, New York, Sanfrancisco and London, pp. 21.
- Sharma, D. K. and Singh, H. 1983. Comparative evaluation of electroanaesthesia techniques. *Indian J. Anaesth.* **31** : 148-51.
- Shimoji, K., Higashi, H., Terasaki, H. and Morioka, T. 1971. Physiological changes associated with electroanaesthesia. *Anesth. Analg.* (Cleveland) **50** : 490.
- Smith, R. H., Tatsuno, J. and Zouhar, R. L. 1967. Electroanaesthesia—A review upto 1966. *Anesth. Analg.* (Cleveland) **46** : 109.
- Van Harrevald, A., Plesset, M. S. and Wiersma, C. A. 1942. Relation between physical properties of electric current and their electronarcotic action. *Am. J. Physiol.* **137** : 39.
- Van Harrevald, A. and Dandliker, W. B. 1945. Blood pressure changes during electronarcosis. *Proc. Soc. Exp. Biol. Med.* **60** : 391.

RELATIVE EFFICIENCY OF SELECTION ON PART AND ANNUAL RECORDS

B. S. CHHIKARA, R. S. MAAN and S. C. CHOPRA

Department of Animal Breeding
Haryana Agricultural University, Hisar

(Received : May 18, 1983; Revised : November 28, 1984)

ABSTRACT

The estimates of heritability of egg number and per cent production based on part records were computed from sire, dam and sire+dam components. The heritability estimated for part records through sire components of variance was higher than that based on residual annual records. There were positive genotypic and phenotypic correlations among part, residual and annual records. It was also observed that there were high correlations among part and annual records than part and residual records. Selection on part record was less efficient than selection on annual record per generation, but more efficient per unit of time. As the duration of part records increases, the efficiency of part record also increases. The age at first egg was reduced by 4 to 8 times more if selection is based on egg number than per cent production.

Since a breeder uses different selection criteria which have differential effect on generation interval, their efficiency should be compared per unit time rather than per generation. Similarly, Lerner (1958) had showed early part year egg production to be more efficient than full year egg production because generation interval is reduced to half. Bohren (1970) had made extensive review of literature and concluded that selection based on part records (on egg number or per cent production basis) is more efficient in increasing annual egg production than direct selection on annual records.

This study was taken up to evaluate the genetic and phenotypic parameters for different lengths of part, residual and annual egg production and to determine

the consequences of selection on different part records (on egg number or per cent production basis) to improve both annual egg number and per cent production. The relative effectiveness of selection on part period number of egg vs per cent production and their impact on age at first egg were also investigated.

MATERIAL AND METHODS

The data were collected from LH₁ strain of single comb White Leghorn breed maintained at the Experimental Poultry Farm of Haryana Agricultural University, Hisar. This strain is undergoing 6th selection for egg number using an index based on weighted combination of production of the individual, dam and sire family records.

SELECTION ON PART AND ANNUAL RECORDS

The data were collected on 1135 pullets which were progeny of 30 sires and 240 dams taken out in five hatches in weeks intervals. The data were corrected for hatch effects, using least squares constants (Harvey, 1966).

Various part records considered were egg production upto 240, 260, 280, 300 and 320 days of age. The egg production upto 480 days of age was taken as annual production. The residual period records were obtained by deducting part production from the total production.

Heritabilities were derived from sire, dam and sire+dam components (King and Henderson, 1954a, b). Standard errors of heritabilities were calculated according to Dickerson (1969). The genetic and phenotypic correlations between various traits were obtained from variance and covariance components (Becker, 1964). The standard errors were obtained for genetic and phenotypic correlations as per the formula suggested by Robertson (1959) and Goulden (1962), respectively. The relative

efficiencies due to selection on part periods compared to direct selection on annual production were obtained (for egg number and per cent production) by Searle (1965). Sampling errors of relative selection efficiencies were obtained as per formulae suggested by Searle (1965). The effectiveness of selection on number of eggs to a fixed age viz., selection on per cent production to a fixed age to improve different traits was obtained by using the formulae suggested by Bohren *et al.* (1970).

RESULTS AND DISCUSSION

Averages

The average performance of the pullets for the various production traits is given in Table 1.

Heritabilities

The heritability estimates estimated through different components both for egg number and per cent production in various part, residual and annual periods are given in Table 2.

TABLE 1
Average performance of a flock under selection

Body weight at 20 weeks	1220.4±3.63 g	
Body weight at 40 weeks	1880.9±4.42 g	
Average age at first egg	160.2±0.43 days	
Average egg weight	56.2±0.14 g	
	Number	Per cent
Egg production upto 240 days	58.4±0.22	70.3±0.18
Egg production upto 260 days	70.3±0.13	70.3±0.21
Egg production upto 280 days	85.4±0.29	70.1±0.18
Egg production upto 300 days	104.2±0.23	71.4±0.18
Egg production upto 320 days	113.7±0.34	70.1±0.20
Egg production upto 480 days	195.5±0.47	60.11±0.21

TABLE 2
Heritability estimates along with standard errors for various part, residual and annual records, and egg production

Period of estimate (days)	Egg number			Per cent production		
	S	D	S+D	S	D	S+D
Part						
240	0.45±0.08	0.20±0.10	0.34±0.05	0.30±0.09	0.28±0.04	0.26±0.08
260	0.46±0.09	0.20±0.08	0.32±0.04	0.30±0.09	0.32±0.04	0.30±0.07
280	0.44±0.09	0.22±0.09	0.34±0.06	0.34±0.06	0.32±0.05	0.33±0.06
300	0.39±0.08	0.31±0.10	0.33±0.05	0.35±0.07	0.36±0.07	0.33±0.08
320	0.36±0.09	0.35±0.09	0.32±0.10	0.30±0.06	0.37±0.08	0.34±0.06
Residual						
240	0.15±0.08	0.62±0.11	0.32±0.08	0.12±0.05	0.60±0.10	0.30±0.09
220	0.16±0.09	0.60±0.08	0.28±0.12	0.11±0.06	0.60±0.10	0.30±0.08
200	0.17±0.11	0.56±0.07	0.32±0.07	0.13±0.08	0.59±0.7	0.31±0.11
180	0.14±0.07	0.59±0.12	0.30±0.06	0.14±0.07	0.56±0.8	0.29±0.12
160	0.14±0.08	0.56±0.06	0.28±0.06	0.11±0.06	0.53±0.6	0.29±0.12
Annual						
480	0.12±0.07	0.63±0.10	0.38±0.4	0.09±0.04	0.64±0.12	0.38±0.07

SELECTION ON PART AND ANNUAL RECORDS

There was a tendency for sire component of variance to exceed the dam component of variance in early part for egg number, while the sire component decreased in magnitude, the dam component increased with the increase in the duration of the part periods. The sire and dam component estimates of heritability were approximately of the same order for per cent production in different part periods. It suggests that there was no evidence to give greater importance to one parent relative to the other in determining part period per cent production unlike egg number. The trait of egg number is greatly influenced by age at first egg. It may be possible that cumulative egg number contained a decreasing amount of variance due to age at sexual maturity as the part period became longer. The heritability estimate on sire component of variance basis, for age at sexual maturity was 0.487. The heritability from sire component for egg number may be high at the initial stages as long as variation due to age at first egg was effective, as it happened in this study. Flock (1975) made similar observations. The sire plus dam component estimate remained more or less the same for all traits and of same magnitude as that of annual production estimate derived from the same components.

The heritability estimates from sire component of annual production both for egg number and per cent production were very low when compared with the estimates derived from dam component, suggesting the importance of maternal and/or dominance effects in the inheritance of egg production to 72 weeks of age. This was consistent with the

low estimates of heritability observed from sire component for egg production to 72 weeks of age (King *et al.*, 1963; Van Vleck and Doolittle, 1964; Bohren *et al.*, 1970; Gowe *et al.*, 1973; Emsley *et al.*, 1977; Gowe, 1977). But Lerner and Cruden (1948), Sandhu and Dev (1972) and Flock (1977) reported higher estimates of heritability for annual production than obtained in this study. The estimates of residual period declined as the period became shorter when estimates were made from sire and dam components including sire plus dam components. The heritability estimates from sire component for residual periods were consistently smaller than the estimates from dam component. This may be due to the increased variability in persistency and viability during these residual periods, pointing towards the involvement of non-additive genes or maternal effects in the inheritance of residual period production. The heritability estimates from sire plus dam components for egg number and per cent production remained almost same in part, residual and annual periods. These estimates ranged between 0.26 to 0.34 and were in agreement with the reports of Lerner and Cruden (1948) and Flock (1975).

Correlations

The genetic and phenotypic correlations were positive and ranged from moderate to high as given in Table 3. This would point towards the benefit of selection on part period records and would bring about improvement in annual record not only due to improvement in part period, but also in the residual period. The genetic and phenotypic correlations

TABLE 3
Genetic and phenotypic correlations among part, residual and annual production records

Genetic correlation between		Egg number			Per cent production				
		S	D	S+D	ip	S	D	S+D	ip
Part	Residual								
240	240	0.04±0.31	0.84±0.04	0.46±0.10	0.19±0.01	0.95±0.14	0.86±0.12	0.52±0.10	0.30±0.01
260	220	0.13±0.21	0.89±0.07	0.41±0.11	0.22±0.04	>1	0.67±0.06	0.59±0.06	0.32±0.02
280	200	0.19±0.22	0.96±0.02	0.50±0.12	0.20±0.03	>1	0.74±0.08	0.67±0.15	0.35±0.05
300	180	0.25±0.08	0.88±0.05	0.57±0.08	0.25±0.02	>1	0.84±0.06	0.72±0.12	0.32±0.02
320	160	0.24±0.07	0.90±0.06	0.54±0.07	0.28±0.06	0.93±0.42	0.84±0.03	0.68±0.11	0.37±0.01
Part	Annual								
240	480	0.77±0.11	0.88±0.15	0.69±0.19	0.48±0.02	0.98±0.02	0.72±0.10	0.72±0.16	0.49±0.08
260	480	0.84±0.08	0.87±0.14	0.70±0.18	0.54±0.01	>1	0.69±0.06	0.72±0.14	0.52±0.12
280	480	0.84±0.05	0.92±0.02	0.77±0.16	0.60±0.02	>1	0.80±0.09	0.79±0.08	0.56±0.11
300	480	0.84±0.05	0.94±0.12	0.81±0.15	0.64±0.01	0.99±0.02	0.82±0.04	0.98±0.04	0.62±0.13
320	480	0.87±0.06	0.98±0.10	0.85±0.14	0.69±0.02	0.90±0.01	0.90±0.03	0.84±0.08	0.64±0.11
Number	Per cent	Part egg number X Annual per cent							
240	480	0.26±0.18	0.81±0.11	0.47±0.23	0.28±0.02	0.89±0.01	0.69±0.19	0.64±0.13	0.44±0.02
260	480	0.19±0.24	0.88±0.16	0.59±0.11	0.33±0.12	0.94±0.02	0.62±0.11	0.66±0.10	0.49±0.12
280	480	0.38±0.13	0.93±0.02	0.65±0.19	0.39±0.05	0.98±0.01	0.76±0.08	0.77±0.09	0.56±0.21
300	480	0.45±0.14	0.90±0.11	0.69±0.12	0.78±0.12	0.84±0.06	0.71±0.18	0.75±0.08	0.57±0.21
320	480	0.49±0.15	0.94±0.12	0.74±0.07	0.59±0.13	0.81±0.07	0.84±0.15	0.75±0.07	0.69±0.21

SELECTION ON PART AND ANNUAL RECORDS

between part and annual records were comparatively higher than the corresponding estimates between part and residual period both for egg number and per cent production. The estimates increased in magnitude with the increase in duration of part period. The findings of present study confirm the observations of Lerner and Cruden (1948), Van Vleck and Doolittle (1964) and Sandhu and Dev (1972). The genetic correlations obtained were comparable with the results of King (1961) and Clayton and Robertson (1966).

Relative Efficiency

Heritability estimates and genetic correlations estimated from sire and dam components were used for computing the relative efficiency (Table 4). Values of relative efficiencies estimated on per generation selection through early part record egg number were less efficient in increasing annual production both in terms of number of eggs and per cent

production than direct selection on the basis of annual egg number or annual per cent production. As the efficiency was measured per unit time, the efficiency exceeded in almost all instances except in a couple of cases involving part period egg number to improve annual per cent production. When selection was based on part period number of eggs, the relative efficiency of selection exceeded from 15 to 22 per cent to improve annual egg number and from 2 to 8 per cent to improve annual per cent production than the direct selection based on annual egg production. Selection on part period per cent production resulted in efficiency ranging from 15 to 29 per cent to improve annual egg number than direct selection based on annual per cent production. Part record production measured upto 280 days of age resulted in maximum efficiency per unit of time in 3 out of 4 possible combinations of selection examined.

TABLE 4
Relative efficiency of selection on part periods to improve annual production

Part period	Relative efficiencies			
	Annual egg number		Annual per cent production	
	Per generation	Per unit of time	Per generation	Per unit of time
Egg number				
240	0.589±0.120	1.153	0.469±0.218	0.828
260	0.652±0.170	1.170	0.499±0.113	0.849
280	0.715±0.101	1.201	0.601±0.109	1.004
300	0.765±0.142	1.216	0.650±0.109	1.021
320	0.816±0.143	1.228	0.719±0.109	1.098
Per cent production				
240	0.573±0.111	1.02	0.613±0.190	1.168
260	0.602±0.108	1.07	0.709±0.103	1.201
280	0.700±0.160	1.09	0.759±0.178	1.280
300	0.709±0.139	1.15	0.777±0.164	1.201
320	0.726±0.156	1.15	0.808±0.134	1.201

Most of the review of literature on genetic parameters estimates of the populations (Sandhu and Dev, 1972; Gowe, 1974; Flock, 1975) along with this study lend support to the conclusion that selection on partial records would be more efficient in increasing annual egg production than direct selection on annual egg records. The sampling errors of relative selection efficiency appeared to be little high and was in agreement with the observation of Searle (1965).

Selection on Per cent Production Versus Number of Eggs

From the parameter estimates different comparisons were made to study the effectiveness of the part period number of eggs and part period per cent production as criterion of selection as given in Table 5. The effectiveness of selection on part period number of eggs exceeded per cent production by 6.8 to 10.3 to improve annual egg number and was less effective by 28 to 10 per cent

to improve annual per cent production. Selection for egg number, therefore, may be viewed as an index selection involving per cent production and age at maturity. This probably is the reason for selection on per cent production to be more efficient than selection based on egg number. As evident from data, the part period egg number was less effective (6 to 30 per cent) than the part period per cent production to improve residual egg number. These results are in agreement to the findings of Bohren *et al.* (1970), Poggenpoel (1974) and Gowe (1977). Selection on part period number of eggs was 4.14 to 8.36 times more effective in decreasing age at first egg than selection on part period per cent production. The effectiveness was maximum in the early part periods and decreased with increase in the duration of part period as evident from column 4. Possibly the genetic variability of age at sexual maturity which was maximum in the early part periods might have some influence on the effectiveness in the early part periods.

TABLE 5

Comparison of the effectiveness of selection on part period number of eggs versus part period per cent production

Part/period	Δ GAP	Δ GA'P	Δ GRP	Δ GZP	Δ GRP	Δ GRP'	Δ GPW
	Δ GAP'	Δ GA'P'	Δ GRP'	Δ GZP'	Δ GZP	Δ GZP'	Δ GP'W
240	1.059	0.711	0.700	7.64	0.39	4.98	0.529
260	1.067	0.746	0.734	6.81	0.54	4.57	0.632
280	1.041	0.781	0.802	6.01	0.64	4.24	0.697
300	1.081	0.849	0.901	4.14	0.74	3.90	0.721
320	1.118	0.912	0.927	3.81	0.89	3.98	0.781

Δ GAP—Response in annual egg number from selection on part period egg number;

Δ GAP'—Response in normal egg number from selection on part period per cent production;

A—Annual egg number; R—Residual production; P—Part period egg number;

A'—Per cent annual production; P'—Part period per cent production;

Z—Sexual maturity; W—Average egg weight.

SELECTION ON PART AND ANNUAL RECORDS

The relative and absolute effectiveness of each criterion on residual egg number and age at maturity are given in Table 5. The part period egg number increased the residual period egg number by about 40 to 90 per cent as much as it would decrease age at sexual maturity. On other side, the part period per cent

production increased the residual period egg number 4 to 5 times than it would decrease age at maturity. Although selection on the basis of egg number and on per cent production reduced egg weight, the reduction due to selection on egg number was only 58 to 77 per cent of per cent production.

REFERENCES

- Becker, W. A. 1964. *Manual of Procedures in Quantitative Genetics*. Washington State University, U.S.A.
- Bohren, B. B. 1970. Genetic gain in annual egg production from selection on early part records. *World's Poult. Sci. J.* **26** : 647-57.
- Bohren, B. B., Kinney, T. B., Wilson, S. P. and Lowe, P. C. 1970. Genetic gain in annual egg production from selection on part period record per cent production in chicken. *Genetic Austine Tex* **65** : 655-67.
- Clayton, G. A. and Robertson, A. 1966. Genetics of changes in economic traits during the laying fear. *Br. Poult. Sci.* **7** : 142-51.
- Dickerson, G. E. 1969. *Techniques for Research in Quantitative Animal Genetics*. American Society of Animal Sciences, New York.
- Emsley, A., Dickerson, G. E. and Kashyap, T. S. 1977. Genetic parameters in progeny test selection for field performance of strain cross layers. *Poult. Sci.* **56** (1) : 121-46.
- Flock, D. K. 1977. Genetic analysis of part period egg production in a population of White Leghorns under long term RRS. *Sounderdruck aus Zeitschrift fur Tierzuchtung und Zuchtungsbiologie Bd.* **94** : 84-103.
- Goulden, C. H. 1962. *Methods of Statistical Analysis*. John Willey and Sons Inc., New York.
- Gowe, R. S. 1974. Selection for high egg production in domestic fowl. Proceedings of 23rd National Poultry Breeders Round Table Conference, Kansas city.
- Gowe, R. S. 1977. Multiple trait selection in egg stocks. 1. Performance of sex linked lines derived from three base populations. 2. Changes in genetic parameters over time in the sex selected strains. Proceedings of 26th National Poultry Breeders Round Table Conference, Kansas city.
- Gowe, R. S., Lentz, W. E. and Strain, J. H. 1973. Long term selection for egg production in several strains of White Leghorns. Performance of selected and control strains including genetic parameters of two control strains. 4th European Poultry Conference, London. pp. 225-45.
- Harvey, W. R. 1966. Least squares analysis of data with unequal subclass members. U. S. Department of Agriculture, Agriculture Research Service, 20 : 8.
- King, S. C. 1961. Inheritance of economic traits in the Regional Cornell control population. *Poult. Sci.* **40** : 975-86.
- King, S. C. and Henderson, C. R. 1954a. Variance components analysis of heritability studies. *Poult. Sci.* **33** : 147-54.
- King, S. C. and Henderson, C. R. 1954b. Heritability studies of egg production in the domestic fowl. *Poult. Sci.* **33** : 155-59.
- King, S. C., Van Vleck, R. D. and Doolittle, D. P. 1963. Genetic stability of the cornell random-bred control populations of White Leghorn control over several generations. *Poult. Sci.* **42** : 113-23.
- Lerner, I. M. 1958. *The Genetic Basis of Selection*. John Willey and Sons, Inc., New York.

CHHIKARA ET AL.

- Lerner, I. M. and Cruden, D. M. 1948. Heritability of accumulative monthly and annual egg production. *Poult. Sci.* 27 : 67-68.
- Poggenpoel, G. D. 1974. Responses with selection on part year egg production. Proceedings and Abstracts, 15th World Poultry Cong. and Expos. 149-51.
- Robertson, A. 1959. The sampling variance of the genetic correlation coefficients. *Biometrics* 15 : 469-85.
- Sandhu, J. S. and Dev, D. S. 1972. Efficiency of selection based on part year egg production. *Indian Poultry Gazette*. 56 (3) : 83-90.
- Searle, S. R. 1965. The value of indirect selection. 1. Mass selection. *Biometrics* 21 : 682-707.
- Van Vleck, R. D. and Doolittle, D. P. 1964. Genetic parameters of monthly egg production in Cornell controls. *Poult. Sci.* 43 : 560-67.

RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XV, No. 3, pp. 257—259 (September 1985)

UTILIZATION OF AGRO-INDUSTRIAL BYPRODUCTS BY LIVESTOCK AND POULTRY. VI. NUTRITIVE VALUE OF GRAM (*CICER ARIETINUM*) CHUNI FOR CATTLE

V. K. PALIWAL, S. S. KHIRWAR* and K. R. YADAV

Department of Animal Nutrition

Haryana Agricultural University, Hisar

(Received : April 12, 1984; Revised : September 15, 1984)

Gram (*Cicer arietinum*) is a major leguminous crop grown extensively under rainfed conditions. Gram chuni is the byproduct obtained during separation of cotyledons of gram seed for preparation of dal. Chuni consists of husk, embryo and variable quantities of broken cotyledons. The production of gram chuni varies from 15 to 20 per cent of total gram processed. Although gram chuni is being used as a concentrate in animal feeding since long, its chemical composition and nutritive value have been reported to vary with the place of production and the processing technique (Banerjee, 1978; Jain *et al.*, 1980). Present experiment was, therefore, conducted to assess the nutritive value of gram chuni available in Haryana for cattle.

Eight adult crossbred bullocks of approximately similar body weight (average 230 kg) were distributed in two comparable groups of four animals each after deworming. The animals under control group (Group I) were fed on an average 4.65 kg berseem (*Trifolium*

alexandrinum) hay to provide 127 Kcal ME/kg $W^{0.75}$ as calculated on the basis of NRC (1978). Animals under the experimental group (Group II) were provided 1.85 kg gram chuni to meet out 50% of the energy requirement, while rest of the energy needs were fulfilled with the help of 2.325 kg berseem hay. Animals under group II were offered weighed quantity of gram chuni which was consumed within a short period. Pre-weighed quantities of berseem hay were then offered to animals under both the groups. All the experimental animals had free access to trace mineralized salt bricks and water. After a preliminary feeding period of 10 days a digestion trial of seven days duration was conducted. The representative samples of berseem hay, gram chuni, faeces and feed residues were analysed for proximate principles by the methods of AOAC (1970).

Chemical analyses of gram chuni, offered during the trial period, revealed that it contained 19.85% crude protein, 3.11% ether extract, 28.26% crude fibre,

*Present address : Directorate of Research.

TABLE 1

Digestibility coefficients of proximate principles in the rations and gram chuni

Proximate principle	Berseem hay	Berseem hay + gram chuni	Gram chuni (by difference)
Dry matter	65.41±0.95*	65.67±0.16	66.01±0.33
Organic matter	69.69±1.53	69.95±0.38	70.25±0.80
Crude protein	66.17±1.99	67.29±0.56	68.67±1.19
Ether extract	60.61±4.99	83.18±2.15	90.09±2.71
Crude fibre	58.76±1.88	58.90±0.09	59.07±0.21
Nitrogen free extract	78.36±2.83	77.66±0.62	76.86±1.34
Total carbohydrates	70.72±1.99	70.32±0.41	69.86±0.92

*Figures are average of four observations.

43.54% nitrogen-free-extractives and 5.24% ash on dry matter basis. The corresponding figures for berseem hay were 17.83, 0.80, 26.26, 41.11 and 14.00 per cent, respectively. The average daily dry matter intake/100 kg body weight in group I was 1.88 kg while the value for group II was 1.66 kg. These figures indicate that the animals were consuming the required amount of nutrients, i. e., approximately 127 Kcal ME and 2.2 g C. P./kg $W^{0.75}$ as per recommendation of NRC (1978).

The replacement of hay with gram chuni resulted in increased ether extract digestibility while the digestibility of other nutrients remained practically same (Table 1). This might be due to higher ether-extract contained in gram chuni. The digestibility of various proximate principles in gram chuni was calculated by difference method and the figures are presented in Table 1. Unusually higher digestibility of ether extract was observed in case of gram chuni which indicated

that the components of ether extract contained in gram chuni were highly digestible. This may also be due to higher ether extract contained in chuni (3.11 per cent) in comparison to berseem hay (0.80 per cent).

On the basis of these digestibility coefficients, the gram chuni was found to contain 13.61% digestible crude protein (DCP) and 70.07% total digestible nutrients (TDN) on dry matter basis. The DCP and TDN contents were comparable to the figures 13.61 and 87.5 per cent, respectively, reported earlier by Banerjee (1978). Jain *et al.* (1980) reported that gram chuni contained 10.57% DCP and 59.65% TDN. These values were lower than the figures obtained under the present experiment. This reflects the differences in the chemical composition of feed material used in the trial. It may be inferred from the results obtained that gram chuni can serve as a valuable energy supplement for cattle.

GRAM CHUNI FOR CATTLE

REFERENCES

- AOAC. 1970. *Official Methods of Analysis*. Association of Official Agricultural Chemists, Washington, DC.
- Banerjee, G. C. 1978. *Animal Nutrition*. Oxford and IBH Publishing Co., Calcutta.
- Jain, V. K., Jayal, M. M. and Pathak, N. N. 1980. *Feeding of Dal chunies for economic animal production*. *Dairy Guide* 2 (10): 13-15.
- NRC. 1978. Nutrient Requirement of Domestic Animals No. 3. Nutrient Requirements of Dairy Cattle. National Academy of Sciences—National Research Council, Washington, DC.

EFFECT OF ACCELERATED AGING OF SOYBEAN SEEDS OF DIFFERENTIAL STORAGE POTENTIAL ON PHOSPHO- AND GLYCOLIPIDS

A. S. RAO and D. S. WAGLE

Department of Chemistry & Biochemistry
Haryana Agricultural University, Hisar

(Received : October 4, 1983; Revised : January 2, 1985)

ABSTRACT

Phospho- and glycolipids, the major lipid constituents of membranes, have been quantified in seeds and seedlings of four varieties of soybean after subjecting the seeds to accelerated aging treatment. Aging did not alter the lipid levels in seeds but appeared to cause a considerable reduction in the level of phospho- and glycolipids in seedlings which may affect the biogenesis of sub-cellular organelles during germination.

The rapid deterioration of stored seeds, particularly soybean, is a serious problem in tropical and subtropical countries, wherein high temperature and humidity greatly accelerate the aging phenomenon. Membrane damage is thought to be one of the major factors responsible for seed deterioration (Villiers, 1973; Roberts and Ellis, 1982). Accordingly, the present investigations have been undertaken to know the biochemical basis of membrane damage by quantifying phospho- and glycolipids, the major lipid constituents of membranes, in seeds of four varieties of soybean viz., Bragg, Hardee, Kalitur and T-49, differing in their ambient storage potential (Verma and Gupta, 1975), subjected to accelerated aging. Phospho- and glycolipids were also quantified in seedlings raised from aged seeds.

MATERIAL AND METHODS

Seeds were subjected to accelerated aging as described earlier (Rao and

Wagle, 1980). The method of Huber and Newman (1975) was employed for the extraction of lipids. Twentyfive axes and 10 cotyledons at 0 day after germination and 10 axes and 10 cotyledons at 5 days after germination were taken for the extraction of lipids. Two independent extractions were carried out. The quantity of phospholipids in the lipid sample was determined by estimating the lipid phosphorus according to Broekhuyse (1968). Galactolipids were estimated by determining the amount of hexose present in the lipid extract. For this galactolipids were hydrolysed (Joseph, 1954) and free hexose was measured (Trevelyan and Harrison, 1952). Results have been interpreted on organ basis i. e. per axis or per pair of cotyledons and also as a proportion of dry weight. Dry weight of the seeds was determined by keeping the samples at 105°C for 6 h, while at seedling stage samples were dried at 70°C for 48 h. Seeds of Bragg and Hardee completely lost their germinability after 8 days of

SEED AGING AND LIPIDS

aging (Rao and Wagle, 1980). Hence, at seedling stage, comparison among the varieties was possible only upto 6 days of aging.

RESULTS AND DISCUSSION

Aging did not appear to affect appreciably the dry weight and level of phospho- and glycolipids either in axis or in cotyledons of any variety (Tables 1—3). In contrast to these findings, a drastic reduction in the level of phospholipids has been reported in seeds of cucumber (Koostra and Harrington, 1969), corn

(Sedenko, 1975) and a slight reduction in the axis phospholipids of soybean (Priestley and Leopold, 1979) as a result of aging. On the other hand, Chapman and Robertson (1977) encountered a doubling of phospholipid content within 10 days of storage which they suggested arose from the onset of seed germination under conditions of high humidity. However, the present results on phospholipids seem to be in agreement with Maguire *et al.* (1973). They did not observe any change in the level of phospholipids in bleached pea seeds, which had lost germinability and showed increased leakage

TABLE 1
Effect of accelerated aging of soybean seeds on dry weight at 0 and 5 days after germination

Days after germination	0					5			
	mg/organ					Aging of seeds (days)			
Variety	0	2	4	6	8	0	2	4	6
Axis									
Bragg	3.5	3.4	3.5	3.3	3.4	31.2	29.8 (-4)	16.5 (-47)	7.7 (-75)
Hardee	3.1	3.1	3.1	3.1	3.1	17.9	13.2 (-26)	6.8 (-62)	6.6 (-63)
Kalitur	2.2	2.4	2.3	2.2	2.2	23.0	23.5 (+2)	17.0 (-26)	13.9 (-39)
T-49	3.6	3.5	3.6	3.5	3.4	21.9	22.2 (+1)	16.7 (-24)	6.3 (-71)
Cotyledon									
Bragg	128	127	129	128	125	92	92 (0)	109 (+18)	119 (+29)
Hardee	96	96	93	98	95	73	76 (+3)	91 (+25)	94 (+29)
Kalitur	69	68	65	67	67	32	33 (+3)	44 (+38)	49 (+53)
T-49	82	82	82	83	82	57	59 (+2)	65 (+13)	79 (+38)

Figures in parentheses indicate per cent deviation from control.

TABLE 2

Effect of accelerated aging of soybean seeds on glycolipids at 0 and 5 days after germination

Days after germination	0					5			
	#g Lipid galactose/organ Aging of seeds (days)								
Variety	0	2	4	6	8	0	2	4	6
Axis									
Bragg	18	17	19	17	17	54	51 (-6)	44 (-19)	28 (-48)
Hardee	15	16	15	16	14	35	35 (0)	22 (-37)	22 (-37)
Kalitur	13	13	12	13	12	37	34 (-8)	30 (-19)	28 (-24)
T-49	15	17	17	16	15	51	51 (0)	46 (-10)	25 (-51)
Cotyledon									
Bragg	131	132	136	126	128	198	174 (-12)	157 (-21)	143 (-28)
Hardee	141	144	150	146	134	192	185 (-4)	152 (-21)	167 (-18)
Kalitur	81	82	81	84	87	113	103 (-9)	94 (-17)	92 (-19)
T-49	96	99	101	100	99	151	163 (-18)	114 (-25)	124 (-18)

Figures in parentheses indicate per cent deviation from control.

of sugars. In view of the above conflicting findings it appears that membrane damage if any during aging may not be definitely related to quantitative variations in lipid constituents.

Considerable effects of aging on dry weight and on the level of phospho- and glycolipids were, however, evident in the seedlings (5 days after germination) raised from aged seeds (Tables 1-3). Aging caused a decrease in the level of glycolipids per organ (Table 2) in both axis and cotyledons, the decrease being less in Kalitur. However, 2 days aging

had little or no effect on the glycolipid amount expressed either per organ or as a proportion of dry weight (Tables 1 and 2). The level of glycolipids per unit dry weight decreased in cotyledons of the seedlings raised from seeds aged for 4 or more days. In the seedlings of all the varieties, axis glycolipids in relation to dry weight increased as a result of aging.

In the seeds, a similar trend as that of glycolipids was observed for phospholipids (Table 3). Even at seedling stage, on organ basis, aging did not bring about any appreciable changes in the level of

SEED AGING AND LIPIDS

TABLE 3

Effect of accelerated aging of soybean seeds on phospholipids at 0 and 5 days after germination

Days after germination Variety	0					5			
	Aging of seeds (days)								
	0	2	4	6	8	0	2	4	6
Axis									
Bragg	5.4	5.4	5.5	5.4	5.5	17.3	16.4 (-5)	12.0 (-31)	7.6 (-56)
Hardee	4.8	4.4	4.9	4.9	4.9	8.9	8.0 (-10)	6.7 (-25)	6.4 (-28)
Kalitur	4.8	4.9	4.8	4.8	4.6	10.1	9.5 (-6)	8.5 (-16)	8.6 (-15)
T-49	5.5	5.6	5.4	5.4	5.4	9.5	9.5 (0)	8.3 (-13)	6.0 (-37)
Cotyledon									
Bragg	99	98	100	103	106	96	93 (-3)	107 (+11)	107 (+11)
Hardee	65	62	67	64	65	60	61 (+2)	67 (+12)	62 (+3)
Kalitur	60	57	61	60	62	55	56 (+2)	61 (+11)	58 (+5)
T-49	76	74	76	75	75	70	70 (0)	66 (-6)	73 (+4)

Figures in parentheses indicate per cent deviation from control.

phospholipids in cotyledons. However, when expressed on dry weight basis (Tables 1 and 3) phospholipid content remained either similar or decreased depending on the variety and aging treatment. Increase in the aging period beyond 4 days was reflected in a decrease in the phospholipid content per axis. In Hardee, the quantity of phospholipid was decreased in axis even in seedlings grown from 2-day aged seeds. An increasing trend was observed in the axis when phospholipids were expressed on dry weight basis (Tables 1 and 3).

Biogenesis of subcellular organelles both in axis and cotyledons is a major event during seed germination (Mayer and Poljakoff-Mayber, 1980) and requires a continuous supply of phospho- and glycolipids. From the above results, it appears that there could be a depressed biogenesis of subcellular organelles in seedlings raised from aged seeds due to a lowering in the levels of phospho- and glycolipids particularly the latter. Lowered levels of glyoxysomal enzymes, isocitrate lyase and malate synthetase in seedlings raised from aged seeds (Rao and Wagle,

1983) also hints at a reduction in the biogenesis of subcellular organelles.

ACKNOWLEDGEMENT

Senior author is thankful to CSIR, New Delhi, for financial assistance.

REFERENCES

- Broekhuysse, R. M. 1968. Phospholipids in tissues of the eye. Isolation, characterization and quantitative analysis by two dimensional thin layer chromatography of diacyl and vinyl ether phospholipids. *Biochim. Biophys. Acta* 15 : 307-15.
- Chapman, G. W. and Robertson, J. A. 1977. Changes in phospholipid level during high moisture storage of soybeans. *J. Am. Oil Chem. Soc.* 54 : 195-98.
- Huber, D. J. and Newman, D. W. 1975. Relationships between lipid changes and plastid ultrastructural changes in senescing and regreening soybean cotyledons. *J. exp. Bot.* 27 : 490-511.
- Joseph, H. R. 1954. The determination of dextran in blood and urine with anthrone reagent. *J. Biol. Chem.* 208 : 889-96.
- Koostra, P. T. and Harrington, J. F. 1969. Biochemical effects of age on membrane lipids of *Cucumis sativus* L. *Proc. Int. Seed Test. Assoc.* 34 : 329-40.
- Maguire, J. D., Kropf, J. P. and Steen, K. H. 1973. Pea seed viability in relation to bleaching. *Proc. Assoc. Off. Seed Anal.* 63 : 51-58.
- Mayer, A. M. and Poljakoff-Mayber, A. 1980. *The Germination of Seeds*. Pergamon Press, Oxford.
- Priestley, D. A. and Leopold, C. A. 1979. Absence of lipid oxidation during accelerated aging of soybean seeds. *Plant Physiol.* 63 : 726-29.
- Rao, A. S. and Wagle, D. S. 1980. Beta-amylase activity in artificially aged soybean seeds. *Biol. Plant.* 23 : 24-27.
- Rao, A. S. and Wagle, D. S. 1983. Effect of accelerated aging of soybean seeds on isocitrate lyase and malate synthetase activities. *Seed Res.* 11 : 82-86.
- Roberts, E. N. and Ellis, R. H. 1982. Physiological, ultrastructural and metabolic aspects of seed viability. In : *The Physiology, and Biochemistry of Seed Development, Dormancy and Germination*, pp. 465-506, Khan, A. A. (ed.). Elsevier Biomedical Press, Amsterdam.
- Sedenko, D. 1975. Phosphorus compounds and phytase activity in corn seeds of different values of initial moisture content. *Sov. Plant Physiol.* 22 : 193-96.
- Trevelyan, W. F. and Harrison, I. S. 1952. Studies on yeast metabolism. I. Fractionation and micro determination of cell carbohydrates. *Biochem. J.* 50 : 298-303.
- Verma, R. S. and Gupta, P. C. 1976. Storage behaviour of soybean variety vastly differing in seed size. *Seed Res.* 3 : 30-44.
- Villiers, T. A. 1973. Ageing and the longevity of seeds in field conditions. In : *Seed Ecology*, pp. 265-68. Heydecker, W. (ed.) Butterworths, London.

STUDIES ON MULTIPLE ANTIBIOTIC RESISTANCE PATTERN AND PLASMID CURING IN *RHIZOBIUM TRIFOLII*

R. K. VASHISHAT and A. S. YADAV

Department of Genetics

Haryana Agricultural University, Hisar

(Received : November 22, 1983; Revised : March 14, 1984)

ABSTRACT

A total of 110 isolates of *Rhizobium trifolii* isolated from natural environments were tested for their response to ampicillin (Ap), chloramphenicol (Cm), erythromycin (Em), kanamycin (Km) and streptomycin (Sm). Resistance to Ap was frequent and uniform, whereas resistance to other antibiotics was broader. About 80% of isolates examined were resistant to even 50 µg/ml of Ap, whereas 20% of the isolates showed resistance to the same concentration of the remaining four antibiotics. Thirtyeight isolates which were resistant to 5 µg/ml of each of the five antibiotics individually were tested for multiple antibiotic resistance which was found in 34% of these isolates. Treatment of multiple antibiotic resistant strain B88 with non-growth inhibitory concentration of SDS for seven days did not cause the loss of determinants conferring antibiotic resistance. However, growth of the same strain at 35°C for nine days resulted in elimination of nodulation ability in 7% of the clones tested but all of them were found to be antibiotic resistant. It is concluded that the genes for antibiotic resistance are chromosome associated, whereas genes for nodulation are plasmid linked.

Studies on multiple antibiotic resistance are mostly confined to pathogenic bacteria because of the extensive use of various antibiotics to control human and animal infections. However, multiple antibiotic resistance has also been reported in different species of *Rhizobium* (Pariiskaya and Gorelova, 1976; Cole and Elkan, 1979). There are conflicting reports regarding the location of genes conferring antibiotic resistance in *Rhizobium*. Some workers have reported plasmid associated antibiotic resistance (Cole and Elkan, 1973; Pariiskaya and Gorelova, 1976) but genes for resistance to some antibiotics have also been shown to be chromosomal (Kondorosi and

Johnston, 1981). If R factors exist in *Rhizobium* then their elimination from a particular strain may provide a selective method for the isolation of Nod⁻ strains if genes for both the properties are borne on the same plasmid. The purpose of the present investigation was to find R factors in *R. trifolii* and to eliminate these by curing and to investigate the possibility of association between drug resistance markers and genes for nodulation.

MATERIAL AND METHODS

Rhizobium Cultures

A total of 110 isolates were isolated from nodules of *Trifolium alexandrinum*

as described by Vincent (1970). The cultures were maintained on yeast extract-mannitol-agar slants stored at 4°C.

Media

Yeast extract-mannitol (YEM) medium contained (per litre): mannitol, 10g; K_2HPO_4 , 0.5g; $MgSO_4 \cdot 7H_2O$, 0.2g; NaCl, 0.1g; $CaCO_3$, 3g; and yeast extract, 1g. The glucose-salt-yeast extract (GSY) medium consisted of (per litre): glucose, 2g; K_2HPO_4 , 0.2g; KH_2PO_4 , 0.2g; $MgSO_4 \cdot 7H_2O$, 0.1g; $CaCl_2 \cdot 2H_2O$, 0.05g; and yeast extract, 1g. The pH was adjusted to 6.8 before autoclaving. Solid media was prepared by adding 2% agar. The plant nutrient medium contained (per litre): $CaHPO_4$, 0.5g; K_2HPO_4 , 0.1g; $MgSO_4 \cdot 7H_2O$, 0.1g; NaCl, 0.1g; $FeCl_3 \cdot 6H_2O$, 0.05g and 5 ml of the micro-nutrient solution having (per litre): H_3BO_3 , 0.57g; $MnSO_4 \cdot 4H_2O$, 0.31g; $ZnSO_4 \cdot 7H_2O$, 0.09g; $CuSO_4 \cdot 5H_2O$, 0.08g; $NaMoO_4$, 0.16g; and $CoCl_2 \cdot 6H_2O$, 0.008g. For solid plant nutrient medium 1.5% agar was added.

Testing Antibiotic Resistance

The levels of resistance to ampicillin (Ap), chloramphenicol (Cm), erythromycin (Em), kanamycin (Km) and streptomycin (Sm) were determined by spotting about 10^5 cells on GSY medium containing 5, 10, 20 or 50 µg of an antibiotic per ml of the medium. The plates were examined for growth of inocula after six to eight days of incubation at 30°C. Multiple antibiotic resistance pattern was determined by spotting cells on GSY plates containing 2.5 µg or 5.0 µg/ml each of the five antibiotics in all possible combinations.

Plasmid Curing Studies

For elimination of R factors, strain B88 having multiple antibiotic resistance was treated with sodiumdodecyl sulphate (SDS). Approximately 10^4 cells/ml were incubated in GSY containing non-growth inhibitory concentration of SDS (400 µg/ml). After overnight growth, half of this suspension was centrifuged and resuspended in fresh GSY medium containing SDS. The SDS treatment was repeated seven times continuously with the same strain. The suspension was then diluted and plated on YEM agar plates.

Non-nodulating variants of strain B88 were obtained by growing this strain in GSY medium at 35°C for nine days as described by Zurkowski and Lorkiewicz (1978).

Nodulation Test

The ability to form nodules was determined by inoculating seedlings of *Trifolium* (variety Mescavi) with a particular strain of *R. trifolii*. The seedlings were then transferred to plant nutrient agar tubes. The tubes were kept in sand in the net house under natural light and observations on nodulation were made 30 days after inoculation.

RESULTS AND DISCUSSION

Levels of Resistance to Antibiotics in 110 Isolates of *R. trifolii*

The response of 110 randomly selected isolates of *R. trifolii* towards five individual antibiotics is shown in Table 1. It is clear from the table that intrinsic resistance to Ap was more frequent and

CURING NODULATION IN RHIZOBIUM TRIFOLII

TABLE 1
Levels of resistance to antibiotics in
110 isolates of *R. trifolii*

Antibiotics	Conc. ($\mu\text{g/ml}$)	Isolate resistant	
		No.	(%)
Ap	5	109	99.09
	10	108	98.20
	20	105	95.50
	50	97	88.20
Cm	5	83	75.50
	10	69	62.70
	20	22	20.00
	50	21	19.09
Km	5	103	93.60
	10	92	83.60
	20	66	60.00
	50	25	22.70
Sm	5	67	60.90
	10	53	48.20
	20	27	24.50
	50	21	19.09
Em	5	92	83.60
	10	56	50.90
	20	32	29.09
	50	22	20.00

uniform, whereas the range of resistance to Cm, EM, Km and Sm was broader. Except Ap, about 20% of the isolates examined showed resistance to 50 $\mu\text{g/ml}$ of Cm, Em, Km and Sm. It shows that these isolates exhibit high levels of resistance to these antibiotics. Similar type of high levels of intrinsic resistance to various antibiotics have also been reported earlier in different species of *Rhizobium* (Schwinghamer, 1967; Pariiskaya and Gorelova, 1976; Cole and Elkan, 1979).

Multiple Antibiotic Resistance Pattern

Multiple antibiotic resistance pattern was studied in 38 isolates which were resistant to 5 $\mu\text{g/ml}$ of each of the five antibiotics individually. All possible combinations of two, three, four and five antibiotics were tested and the concentrations of each antibiotic were 2.5 and 5 $\mu\text{g/ml}$ of the medium. The multiple antibiotic resistance pattern of these isolates is given in Table 2. The results indicate that most of the isolates showed simultaneous resistance to all possible combinations of two, three and four antibiotics. Only 34% of the isolates tested showed simultaneous resistance to a combination of five antibiotics when the concentration of each antibiotic was 2.5 $\mu\text{g/ml}$. However, none of the isolates was resistant to a combination of five antibiotics when the concentration was 5 $\mu\text{g/ml}$. Multiple antibiotic resistance in different species of *Rhizobium* was also observed by Pariiskaya and Gorelova (1976) and Cole and Elkan (1979).

The present studies show that many isolates of *R. trifolii* are multiple drug resistant even in the absence of selection for antibiotic resistance. Then, how has this resistance been developed in *Rhizobium* which does not come in direct contact with the antibiotics? Cultivated soils are rich in actinomyces and other antibiotic producing microorganisms. Therefore, it seems logical to presume that the presence of these microorganisms in the legume rhizosphere might be responsible for conferring antibiotic resistance in *Rhizobium*. The rhizobia in soil will come in contact with the

TABLE 2
Multiple antibiotic resistance pattern of 38 isolates of *R. trifolii*

Combination of antibiotics	Isolates resistant to 2.5 μ g/ml of each antibiotic		Isolates resistant to 5 μ g/ml of each antibiotic	
	No.	%	No.	%
Ap, Cm	37	97.4	36	94.7
Ap, Em	38	100.0	32	84.2
Ap, Km	38	100.0	36	94.7
Ap, Sm	35	92.1	33	86.8
Cm, Em	38	100.0	37	97.4
Cm, Km	38	100.0	38	100.0
Cm, Sm	35	92.1	34	89.5
Em, Km	38	100.0	38	100.0
Em, Sm	36	94.7	35	92.1
Km, Sm	35	92.1	35	92.1
Ap, Cm, Em	38	100.0	35	92.1
Ap, Cm, Km	38	100.0	36	94.7
Ap, Cm, Sm	35	92.1	32	84.2
Ap, Em, Km	38	100.0	36	94.7
Ap, Em, Sm	35	92.1	31	81.6
Ap, Km, Sm	35	92.1	32	84.2
Cm, Em, Km	38	100.0	36	94.7
Cm, Em, Sm	35	92.1	26	65.8
Cm, Km, Sm	38	100.0	31	81.6
Em, Km, Sm	38	100.0	34	89.5
Ap, Cm, Em, Km	36	94.7	34	89.5
Ap, Cm, Em, Sm	33	86.8	23	60.5
Ap, Cm, Km, Sm	37	97.4	32	84.2
Ap, Em, Km, Sm	20	71.4	12	31.6
Cm, Em, Km, Sm	32	84.2	28	73.8
Ap, Cm, Em, Km, Sm	13	34.2	0	0

antibiotics produced by these microorganisms and are subjected to selection for antibiotic resistance. This suggests that intrinsic multiple antibiotic resistance in *Rhizobium* has some survival value in natural habitats. Therefore, it is suggested that multiple antibiotic resistant and efficient strains of *Rhizobium* should be used for inoculation of cultivated legumes.

Curing Studies

Based on curing studies the multiple antibiotic resistance in *Rhizobium* has been shown to be plasmid associated (Cole and Elkan, 1973; Pariiskaya and Gorelova, 1976). However, examination of genetic maps of *R. meliloti*, *R. leguminosarum*, *R. trifolii* and *R. phaseoli* indicates that determinants for resistance to

some of the antibiotics are on the bacterial chromosome (Kondorosi and Johnston, 1981). In view of the above mentioned conflicting reports, plasmid curing studies were undertaken to show whether or not the factors for antibiotic resistance are plasmid linked.

Out of 13 strains which were resistant to a combination of five antibiotics (Table 2), only one strain B88 was taken for curing of R factors. In all 400 clones surviving after SDS treatment were tested for their response to a combination of five antibiotics at a concentration of 2.5 µg/ml. All the clones were found to be resistant and all of them nodulated *Trifolium* plants. Retention of multiple antibiotic resistance even after SDS treatment indicates that the factors might be on the bacterial chromosome and not on the plasmid.

Incubation of *R. trifolii* at elevated temperature (35°C) results in loss of nodulating ability (Zurkowski and Lorkiewicz, 1978). Non-nodulation of Nod⁻ mutants was due to the absence of plasmid pWZ2 (Zurkowski and Lorkiewicz, 1979). Using the same procedure we attempted to cure the genetic factors for antibiotic resistance and nodulation ability. It was found that 7% of the clones selected after nine days of growth at 35°C were non-nodulating but all were found to be resistant to a combination of five antibiotics (Table 3). Nod⁻ strains were stable and no reversion of Nod⁻ to Nod⁺ phenotype was observed even after several transfers over a period of one year. This indicates that there is irreversible loss of nodulation trait in these

TABLE 3

Curing of R factors and nodulation ability in strain B88 of *R. trifolii*

Curing agent	No. of clones tested	No. of clones sensitive to a combination of five antibiotics (2.5 µg/ml)	No. of Nod ⁻ clones	(%) Nod ⁻
SDS	400	0	0	0
Growth at 35°C	300	0	21	7

strains. This loss is due to loss of plasmid because growth of *R. trifolii* at elevated temperature leads to elimination of plasmid controlling nodulation (Zurkowski and Lorkiewicz, 1979). So, it is concluded that the genes for nodulation are plasmid linked.

The retention of antibiotic resistance after growth at elevated temperature again confirms the view that drug resistance factors are not plasmid associated. The results also show that there is no linkage between genes for nodulation and antibiotic resistance because all the Nod⁻ strains were antibiotic resistant.

ACKNOWLEDGEMENTS

The authors are grateful to the Indian National Science Academy for financial help, Dr. J. B. Chowdhury for providing facilities and Dr. R. C. Dogra for critical reading of the manuscript.

REFERENCES

- Cole, M. A. and Elkan, G. H. 1973. Transmissible resistance to penicillin G, neomycin and chloramphenicol in *Rhizobium japonicum*. *Antimicrob. Agents Chemother.* **4** : 248-53.
- Cole, M. A. and Elkan, G. H. 1979. Multiple antibiotic resistance in *Rhizobium japonicum*. *Appl. Environ. Microbiol.* **37** : 867-70.
- Kondorosi, A. and Johnston, A. W. B. 1981. The genetics of *Rhizobium*. *Intern. Rev. Cytol. Suppl.* **13** : 191-223.
- Pariiskaya, A. N. and Gorelova, O. P. 1976. Factors of multiple resistance to antibiotics in rhizobia. *Microbiology* **45** : 747-50.
- Schwinghamer, E. A. 1967. Effectiveness of *Rhizobium* as modified by mutation for resistance to antibiotics. *Antonie Van Leeuwenhoek J. Microbiol. Serol.* **33** : 121-36.
- Vincent, J. M. 1970. *A Manual for the Practical Studies of the Root Nodule Bacteria*. Blackwell Scientific Publishers, Oxford. pp. 7-8.
- Zurkowski, W. and Lorkiewicz, Z. 1978. Effective method for isolation of non-nodulating mutants of *R. trifolii*. *Genet. Res.* **32** : 311-14.
- Zurkowski, W. and Lorkiewicz, Z. 1979. Plasmid mediated control of nodulation in *R. trifolii*. *Arch. Microbiol.* **123** : 192-201.

CYTOGENETIC EFFECTS OF FOOD ADDITIVES IN BARLEY. 2. CITRIC ACID, ACETIC ACID AND POTASSIUM METABISULPHITE

HARI OM MEHRA, P. K. SAREEN and R. K. AGGARWAL

Department of Genetics

Haryana Agricultural University, Hisar

(Received : May 3, 1982; Revised : November 29, 1984)

ABSTRACT

Three commonly used food additives viz., citric acid, acetic acid and potassium metabisulphite were tested for their cytogenetic effects in barley. All these were found to be clastogenic and mitodepressive. Potassium metabisulphite induced chromosomal breakage and tripolar mitosis. Citric acid and acetic acid were polyploidogenic also. Seed germination and root growth were also affected by these chemicals.

Food additives are extensively and indiscriminately used in our diet without much regard to their potential genetic hazards. The emphasis so far has been put only on their lethal, physiological or toxicological effects instead of their genotoxicity. However, cytogenetic damage induced by food additives may prove to be more dangerous than other effects. There are some reports on the effects of food additives commonly used in food preservation. On the basis of these reports people are warned against their extensive use and even some of them have been banned (Tazima *et al.*, 1975). Such instances have evoked a world-wide interest in assessing the potential genetic hazards of commonly used food additives using various test systems. In the present study, three very commonly used food additives viz., citric acid, acetic acid and potassium metabisulphite have been studied for their clastogenic effects using barley as the test system. Citric

acid is used in soft drinks to check the crystallization of sugar and adjustment of pH, acetic acid in addition to being used as a preservative is also used in the preparation of synthetic vinegar, and potassium metabisulphite is very commonly employed as a preservative in soft drinks and fruit jams and jellies.

MATERIAL AND METHODS

The three food additives tested at various concentrations were citric acid (0.5 and 1.0 per cent), acetic acid (4.0 per cent) and potassium metabisulphite (0.01, 0.0625, 0.125, 0.250, 1.0, 1.5 and 2.0 per cent). These concentrations were selected because these food additives are used commonly at these levels. The seeds of barley (*Hordeum vulgare*) cultivar C 164 were used as a test system for the present investigation.

The roots of germinating seeds were used for studying the cytological effects.

The treatments were given for 10 h, fixed in acetic alcohol (1:3) for 3 h and used for mitotic studies. The squashes were prepared in modified carbol fuchsin (Miller *et al.*, 1971). The frequency of chromosomal aberrations was calculated on the basis of number of dividing cells at the division phase to which a particular aberration belonged. For studying the effect on germination and root length, seeds were treated for 10 h, washed with distilled water and allowed to germinate. Data on these parameters were recorded after 24, 48 and 72 h of each treatment.

RESULTS AND DISCUSSION

All the three food additives tested were found to interact with the plant living system.

In the roots treated with different concentrations of citric acid and acetic acid, various types of abnormal cells could be seen (Table 1, Fig. 1). The anaphase bridges and telophase bridges were of true breakage fusion type. Acetic acid (4.0%) and higher concentrations of citric acid (1.0%) were found to be polyploidogenic. These observations mean that these chemicals are spindle poisons which interact with spindle proteins, destroy the spindle and lead to endomitosis. Treatment with 1.0% citric acid also led to metaphase and anaphase laggards. It can be speculated that somehow this chemical at higher concentrations affects the centromeric regions of chromosomes and makes them incapable of attachment to the spindle. Such chromosomes with defective/weak centromere form laggards later on and are eliminated resulting in production of aneuploid cells. The laggards were, however, absent in the cells

of roots treated with acetic acid. A high percentage of cells with fragmented chromosomes was also observed in the roots treated with these food additives. They were also found to have adverse effect on the cell division machinery as indicated by a reduction in mitotic index (Table 2). It is known for animal system that chemical agents which release calcium, facilitate cell division, whereas agents which bind calcium, inhibit cell division (Heilbrunn 1955). Citric acid and acetic acid also bind calcium and were thus responsible for the reduction in mitotic index in our studies.

Seed germination and root growth were also affected by these chemicals (Tables 3 and 4). Treatment with 4% acetic acid proved to be embryo toxic and thus no data on root length could be recorded. Citric acid also hampered with seed germination as revealed by a significant decrease in germination of the seeds treated with this chemical. But with time, the per cent germination became comparable to that in the control suggesting that the difference was not due to embryo toxicity but due to some inhibitory action on DNA replication or protein synthesis. When root meristems are treated with cycloheximide and puromycin, the cells neither synthesise DNA nor divide (Rost and Van't Hof, 1973). Van't Hof (1974) has also suggested that the lack of proteins for the G 1 to S and the G 2 to M transitions is responsible for cell arrest and these proteins must be made before the arrested cells can initiate DNA synthesis and mitosis. Inference drawn from our study falls in line with these observations. Citric acid also had adverse effect on root length but this effect was not prolonged when

TABLE 1
Frequency of chromosomal aberrations induced by some food additives in barley

Food additives	Total cells scored	Dose (% w/v)	Chromosomal aberrations (%)						Total aberrations
			Anaphase bridges	Telophase bridges	Fragments	Anaphase laggarads	Metaphase laggarads	Polyploid cells	
Citric acid	1151	0	0	0	0	0	0	0	0
		0.5	6.45	4.11	2.86	0	0	0	13.42
		1.0	10.90	5.19	4.67	1.18	0.67	1.04	23.65
Acetic acid	599	0	0	0	0	0	0	0	0
		4.0	10.0	8.82	6.20	0	0	4.08	29.10
Potassium metabisulphite	418	0	0	0	0	0	0	0	0
		0.01	0	0	0	0	0	0	0
		0.0625	0.77	0	0	0	0	0	1.63
									2.40

In potassium metabisulphite, concentrations from 0.125 to 2.0 per cent were also tried but data could not be recorded as very few or no dividing cells were observed.

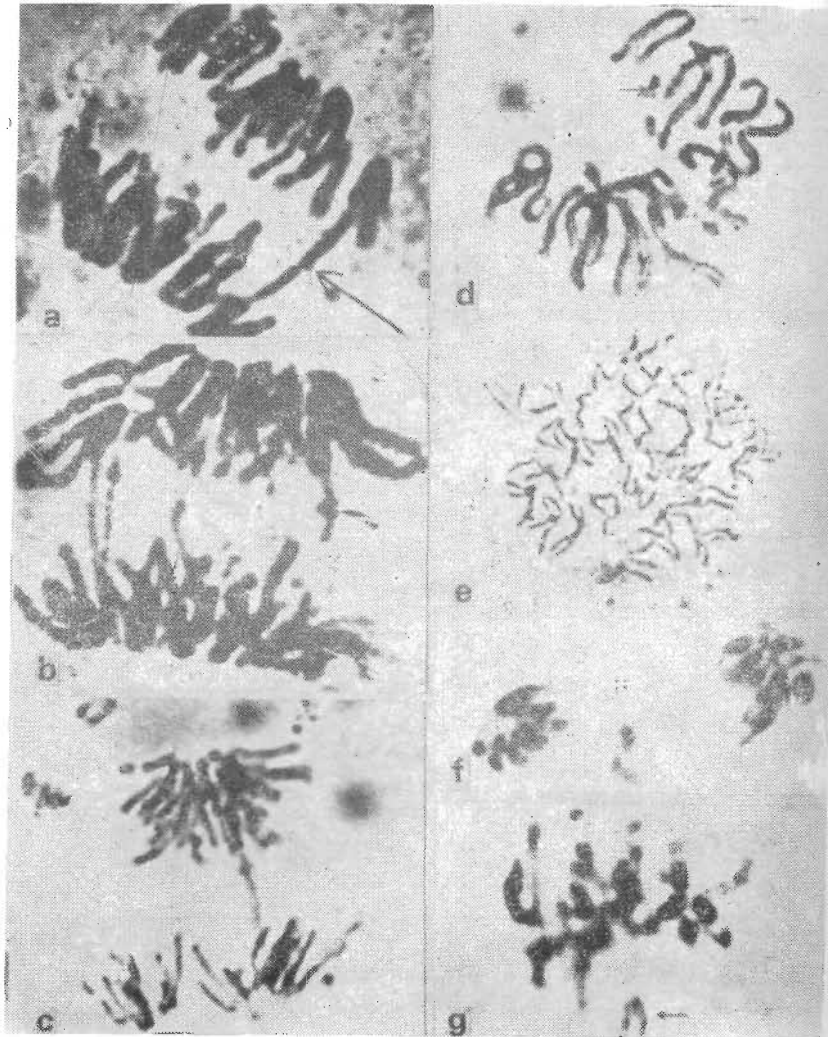


Fig. 1. Somatic cells of *Hordeum vulgare* showing abnormalities as a result of action of citric acid, acetic acid and potassium metabisulphite, (a) an anaphase bridge, (b) two bridges at anaphase—one bridge is still intact, (c) a tripolar cell with bridge, (d) chromosome fragment at metaphase, (e) a polyploid cell, (f) an anaphase laggard and (g) a metaphase laggard.

EFFECTS OF FOOD ADDITIVES

TABLE 2

Effect of some food additives on mitotic index in barley

Food additives	Dose (% w/v)	Mitotic index	Total number of cells scored
Citric acid	0	3.35	3229
	0.5	2.63	4005
	1.0	1.42	5238
Acetic acid	0	3.35	3229
	4.0	0.60	5218
Potassium metabisulphite	0	3.36	3123
	0.010	3.01	3486
	0.0625	2.87	3372
	0.125	0.94	6124
	0.250	0.59	5121
	0.5	0.15	7121
	1.0	0.00	9212
	1.5	0.18	5129
	2.0	0.18	5293

tested at 0.5%, as after 48 h of the treatment the root growth became normal.

Potassium metabisulphite was also found to interact with this test system leading to various types of cytological abnormalities. Cells with breakage-fusion type anaphase bridges unaccompanied by fragments were observed in the roots treated with this chemical. The telophase bridges were, however, absent. It seems that the action of this chemical was specific to the telomeric ends of the chromosomes and these small 'end fragments' did not get stained and were thus not resolvable. This chemical also induced tripolar mitosis. Cytological studies could not be done properly at higher concentrations because mitotic index was drastically reduced and there was extreme condensation of chromosomes which led to visual reduction in

their length. The effect on mitotic index was adverse and dose related (Table 2). At low concentration (0.125%) this chemical, like radiations and food dye azorubine, was found to have a stimulatory effect while at higher concentration (0.25%) it caused a reduction in seed germination (Nuttall *et al.*, 1968; Mehra, 1980). At still higher concentrations (0.5, 1.0, 1.5 and 2.0 per cent), it was embryo toxic and hampered with all metabolic activities of seeds as is evident from the failure of germination (Table 3). It also had adverse effect on root length when tested at higher concentration (0.25%) but at low concentration (0.125%) it did not prove very effective and root length became significantly different from control only after 72 h of the treatment.

Thus, as per barley test system, the three food additives are not quite safe.

TABLE 3
Effect of some food additives on seed germination in barley (mean of three replications taken after transforming the data by angular transformation)

Time after treatment (h)	Food additives	Dose (% w/v)								C. D. at 5%
		0	0.125	0.25	0.5	1.0	1.5	2.0	4.0	
24	Citric acid	74.77	—	—	28.83*	7.82*	—	—	—	6.761
	Acetic acid	—	—	—	—	—	—	—	0	—
	Potassium metabisulphite	68.70	71.18	60.23*	0	0	0	0	0	6.379
48	Citric acid	85.47	—	—	49.03*	14.76*	—	—	—	12.264
	Acetic acid	—	—	—	—	—	—	—	0	—
	Potassium metabisulphite	72.98	73.44	65.96	0	0	0	0	0	9.430
72	Citric acid	85.47	—	—	56.38*	19.37*	—	—	—	6.516
	Acetic acid	—	—	—	—	—	—	—	0	—
	Potassium metabisulphite	73.92	80.73*	67.67*	0	0	0	0	0	5.160

*Significant at 5% level

(—) = Observations not recorded.

EFFECTS OF FOOD ADDITIVES

TABLE 4
Effect of some food additives on root length (mm) in barley (mean of three replications)

Time after treatment (h)	Food additives	Dose (% w/v)								C. D. at 5%
		0	0.125	0.25	0.5	1.0	1.5	2.0	4.0	
24	Citric acid	5.93	—	—	1.86*	0	—	—	—	2.724
	Acetic acid	5.93	—	—	—	—	—	—	0	—
	Potassium metabisulphite	7.43	7.26	4.76*	0	0	0	0	—	1.705
48	Citric acid	13.4	—	—	10.73	2.17*	—	—	—	3.640
	Acetic acid	13.4	—	—	—	—	—	—	0	—
	Potassium metabisulphite	13.7	12.93	10.4*	0	0	0	0	—	2.767
72	Citric acid	36.43	—	—	29.73	7.7*	—	—	—	8.680
	Acetic acid	36.43	—	—	—	—	—	—	0	—
	Potassium metabisulphite	31.36	27.4*	29.33*	0	0	0	0	—	1.746

*Significant at 5% level

(—) = Observations not recorded.

In the present studies they proved to be mitotic poisons, clastogenic and polyploidogenic. Fragmentation of chromosomes, laggards, bridges and other associated effects on the chromosomes may lead to gene deletion, aneuploidy, chimeras and malignancy. Such chromosomal abnormalities in addition to putting the present generation into serious hard-

ships can also lead the future generations into genetic dangers of varying magnitudes once these enter the germ line. Mitodepressive effect as observed in this study can lead to serious consequences like stunted growth. However, before giving a final comment about their effects, they should be tested extensively in other test systems including mammalian ones.

REFERENCES

- Heilbrunn, L. V. 1955. *Dynamics of Living Protoplasm*. Academic Press, New York.
- Mehra, H. O. 1980. Studies on cellular and sub-cellular changes induced by some food additives using barley as the test system. M Sc. thesis, Haryana Agricultural University, Hisar.
- Miller, R. A., Gamborg, O. L., Keller, W. A. and Kao, K. N. 1971. Fusion and division of nuclei in multinucleated soybean protoplasts. *Can. J. Genet. Cytol.* **13** : 347-53.
- Nuttall, V. W., Lyall, L. H. and Lee, D. H. 1968. Response of garden crop plants to low dose gamma irradiation of seeds. *Can. J. Plant Sci.* **48** : 409-10.
- Rost, T. R. and Van't Hof, J. 1973. Radiosensitivity, RNA and protein metabolism of Leaky and arrested cells in sunflower root meristems (*Helianthus annuus*). *Am. J. Bot.* **60** : 172-81.
- Tazima, T., Kadda, T. and Murakama, A. 1975. Mutagenicity of nitrofurantoin derivatives, including furofuramide, a food preservative. *Mutat. Res.* **32** : 55-80.
- Van't Hof, J. 1974. The regulation of cell division in higher plants. *Brookhaven Symp. Biol.* **25** : 152-65.

RELATIVE EFFICACY OF DIFFERENT FUNGITOXICANTS AGAINST *CLAVICEPS FUSIFORMIS* (LOVELESS) *IN VITRO* AND *IN VIVO*

V. S. PAHIL and D. P. THAKUR
Department of Plant Pathology
Haryana Agricultural University, Hisar

(Received : February 22, 1983; Revised : February 20, 1985)

ABSTRACT

Fifteen chemicals were evaluated under laboratory conditions for spore germination inhibition. Ridomil 25 WP, Apron SD-35, Curzate, Delan, Cuman-L, Difolatan and Benlate completely inhibited spore germination and were further tested by poisoned food technique. Under field trials, the selected seven fungicides were used both as protective and curative spray. Ridomil 25 WP, a systemic fungicide specific for downy mildew fungi was found to be most effective under both methods of treatment in reducing the incidence of ergot in susceptible pearl millet hybrid BJ-104. Difolatan followed by Apron SD-35 and Cuman-L also gave satisfactory reduction of ergot when used as protective treatment.

Attempts have been made in the past to devise a fungicidal spray schedule for control of ergot disease on the susceptible pearl millet hybrids HB-1 and HB-3 (Sundaram, 1967; Reddy *et al.*, 1969; Brar *et al.*, 1976). In the present studies, efforts have been directed towards the use of several newly available fungicides of different active ingredient groups particularly systemic in nature alongwith previously declared effective ones.

MATERIAL AND METHODS

Fifteen different fungitoxicants both systemic and non-systemic were selected to find out the potential fungitoxicants effective against ergot disease of pearl millet. These fungitoxicants were tested for *in vitro* spore germination of *Claviceps fusiformis* (Loveless) as well as

application in field conditions both as protective and curative spray.

Spore Germination Inhibition

Fifteen fungitoxicants were screened at 500 ppm concentration against five different isolates of *C. fusiformis* by spore germination inhibition method. Double concentration of each of the fungitoxicants (1000 ppm) was prepared. The fungus was raised on Kirchoff's medium and the spore suspension of each isolate was prepared in sterile distilled water so that there was mixed population of 40-50 macro and micro conidia per microscopic field (10×10 magnification). Equal volume from double concentration of fungicidal suspension was taken in a test tube and mixed thoroughly. In case of acetone soluble fungitoxicants, one drop of spore suspension was mixed with one

drop of 20% acetone solution. Replicated drops of spore suspension on glass slides were incubated for 24 h at $27^{\circ} \pm 1^{\circ}\text{C}$ and observations were recorded on spore germination. The inhibition of spore germination was calculated on the basis of check (sterile distilled water).

Field Evaluation of Selected Fungitoxicants

Field experiments were conducted in which the selected fungitoxicants were applied both as protective and curative spray in order to evaluate the effective fungitoxicant(s) for controlling ergot of pearl millet. The test fungitoxicants were sprayed at the rate of 0.2% on commercial formulations basis.

Protective spray. Field plots of 5×3 m size were selected for this trial. Each fungitoxicant comprising individual treatment was sprayed on three plots randomly at boot-stage. After 24 h, each sprayed earhead was inoculated with spore suspension prepared from honey-dew stage of the fungus and covered with water-proof selfing bags to avoid pollen interference and for maintaining high humidity for seven days (Thakur, 1978). In case of control, only fungal spore suspension was sprayed. Fifteen days later, each earhead was observed for ergot development and intensity.

Curative spray. Plots of 5×3 m size were selected for this trial also. Three plots were kept for control. In this case the earheads at boot-stage were first sprayed with conidial suspension of *C. fusiformis* and covered with water-proof selfing bags. After 24 h, these

earheads were sprayed with selected fungitoxicants after removing selfing bags and again covered with bags for seven days. High humidity was maintained by repeated spray of water overhead. After 15 days, each inoculated earhead was observed for ergot development and intensity.

Control of earhead infection was calculated according to following formula :

$$\frac{C-T}{C} \times 100$$

Where,

C = Per cent earhead infection in check

T = Per cent earhead infection in fungitoxicant treatment.

Disease severity of individual infected earhead was calculated by following McKinney's (1923) formula and control of disease severity was calculated on the basis of fungicide free check.

RESULTS AND DISCUSSION

Seven fungitoxicants viz., Apron SD-35, Benlate, Cuman-L, Curzate, Delan, Difolatan and Ridomil 25 WP, out of fifteen chemicals evaluated *in vitro*, completely inhibited spore germination of all the five test isolates of *C. fusiformis* obtained from different geographical regions of India from pearl millet as well as from blue panic grass (Table 1).

On the basis of above test, seven fungitoxicants were further used as protective and curative sprays at 2000 ppm (0.2%) in pearl millet hybrid BJ-104 in statistically designed field trials during

CHEMICAL CONTROL OF CLAVICEPS FUSIFORMIS

TABLE 1

Relative efficacy of fungitoxicants on inhibition of spore germination of *C. fusiformis* isolates

S. No.	Fungitoxicant (500 ppm)	Per cent spore germination inhibition*			
		BJ-104 (Hisar)	BPG (Hisar)**	BJ-104 (Delhi)	BJ-104 (ICRISAT) (Jam Nagar)
1.	Apron SD-35	100	100	100	100
2.	Bavistin	89	89	87	88
3.	Bayletan	71	68	62	70
4.	Bayton	76	74	77	86
5.	Benlate	100	100	100	100
6.	Blitox	36	30	46	52
7.	Captan	28	27	39	36
8.	Cuman-L	100	100	100	100
9.	Curzate	100	100	100	100
10.	Delan	100	100	100	100
11.	Difolatan	100	100	100	100
12.	Dithane Z-78	24	25	25	32
13.	Ridomil 25 WP	100	100	100	100
14.	Sulphur WP	18	18	19	24
15.	Thiophenate-methyl	54	52	59	69
16.	Check (no spray)	0	0	0	0
	C. D. at 5%	1.9	1.9	1.7	2.8

*Average of three replications.

**Blue panic grass (*Panicum antidotale*).

1979 and 1980. None of these fungitoxicants could provide cent per cent disease control (Tables 2 and 3). Ridomil and Difolatan provided maximum reduction of earhead infection when used as protective sprays (Table 2), whereas performance of Benlate was found to be least effective. The computed values of disease severity of ergoty earheads revealed that Apron SD-35 followed by Delan were most effective chemicals when used as protective sprays.

The experiments on curative spray showed that Curzate and Ridomil 25 WP

provided maximum control of earhead infection (Table 3). On the other hand, Cuman-L and Delan provided least control. The efficacy of three test chemicals viz. Difolatan, Benlate and Curzate was maximum and also at par so far reduction of disease severity was concerned. Brar *et al.* (1976) also reported that Difolatan was effective in reducing ergot of pearl millet.

These results clearly indicate that the potentiality of fungitoxicants varies greatly in regard to control of earhead infection and reducing the disease severity of

TABLE 2

Relative efficacy of protective fungicidal spray on ergot reduction in pearl millet hybrid BJ-104

S. No.	Fungitoxicant (2000 ppm)	Per cent infected earhead*	Per cent control of infected earhead	Disease severity of earhead*	Per cent control of disease severity of earhead
1.	Apron SD-35	24.7	69.1	26.4	71.0
2.	Benlate	35.0	56.3	41.6	54.3
3.	Cuman-L	20.3	74.6	41.0	54.9
4.	Curzate	33.8	57.8	45.6	49.9
5.	Delan	26.2	67.3	36.3	60.2
6.	Difolatan	20.0	75.0	46.3	49.2
7.	Ridomil 25 WP	19.0	76.3	45.9	49.6
8.	Check (no spray)	80.0	—	90.1	—
	C. D. at 5%	11.1	—	—	—

*Average of three replications over two crop seasons.

TABLE 3

Relative efficacy of curative fungicidal spray on ergot reduction in pearl millet hybrid BJ-104

S. No.	Fungitoxicant (2000 ppm)	Per cent infected earhead*	Per cent control of infected earhead	Disease severity of earhead*	Per cent control of disease severity of earhead
1.	Apron SD-35	28.2	64.8	65.0	68.4
2.	Benlate	32.7	59.1	57.4	72.0
3.	Cuman-L	49.2	38.6	89.4	56.5
4.	Curzate	23.7	70.4	60.1	70.8
5.	Delan	48.8	39.0	69.5	66.2
6.	Difolatan	30.6	61.8	55.3	73.1
7.	Ridomil 25 WP	26.2	67.3	75.5	63.3
8.	Check (no spray)	80.0	—	205.5	—
	C. D. at 5%	6.0	—	—	—

*Average of three replications over two crop seasons.

CHEMICAL CONTROL OF CLAVICEPS FUSIFORMIS

ergot. The data also reveal that the disease control efficacy of fungitoxicants is dependent on time of application of chemicals, i.e., as protective and curative sprays. Keeping in view these facts, Ridomil 25 WP and Difolatan are being suggested for use as protective sprays to achieve satisfactory control of ergot of pearl millet under field conditions.

ACKNOWLEDGEMENTS

Authors are highly obliged to Dr. J. N. Chand, Professor and Head, Department of Plant Pathology for kindly providing necessary facilities and Dr. S. Gangopadhyay, Assistant Plant Pathologist for suggestions during the experiments and preparation of manuscript.

REFERENCES

- Brar, G. S., Chand, J. N. and Thakur, D. P. 1976. Fungicidal control of ergot of bajra. *Haryana agric. Univ. J. Res.* **6** : 1-5.
- McKinney, H. H. 1923. Influence of soil temperature on infection of wheat seedlings by *Helminthosporium sativum*. *J. agric. Res.* **26** : 195-217.
- Reddy, K. D., Govindaswamy, C. V. and Vidyasekharan, P. 1969. Studies on ergot disease of Cumbu (*Pennisetum typhoides*). *Madras agric. J.* **56** : 367-77.
- Sundaram, N. V. 1967. Ergot disease of bajra. *Indian Farm.* **17**(9) : 56-58.
- Thakur, D. P. 1978. Highlights of millets pathological investigation under All India Coordinated Millets Improvement Project (1977-78). Annual Workshop of Millet Workers (ICAR) held at Mysore, April 20-22, 1978.

EFFECT OF DIFFERENT POLLINIZERS ON FRUIT SET, FINAL RETENTION AND QUALITY OF FRUITS IN SWEET LIME

R. K. ARORA and R. YAMDAGNI

Department of Horticulture

Haryana Agricultural University, Hissar

(Received : May 21, 1983; Revised : May 1, 1985)

ABSTRACT

Kinnow—a mandarin hybrid, Marsh Seedless and Mosambi cultivars of grapefruit and sweet orange were the best pollinizers in increasing the fruit set and final fruit retention. Physico-chemical quality was best when Marsh Seedless grapefruit and Mosambi sweet orange were the pollen parents.

Sweet lime (*Citrus limettoides* Tanaka) is becoming commercial fruit crop in Haryana. New plantations are coming up on account of its lesser susceptibility to pests and diseases and also the least post-harvest problems. The young plants of sweet lime get established easily and make good growth. The yields are, however, inconsistent probably because of clonal variation and this poses a serious problem to the growers.

The main causes of shybearing in sweet lime are self-incompatibility (Singh and Dhuria, 1960) and production of large number of male flowers rather than hermaphrodite flowers. Dhillon *et al.* (1963) also reported that fruit set in case of individually bagged flowers of sweet lime was very low (3.5%) with zero per cent final fruit retention. The problem of unfruitfulness in sweet lime can be overcome by using suitable pollinizers (Ranjit Kumar, 1974).

Studies were, therefore, undertaken to find out the best pollinizers for sweet

lime in order to get higher yield and their effect on fruit quality.

MATERIAL AND METHODS

The studies were conducted at the Experimental Orchard where six trees of uniform age were divided into six portions. In every portion, almost equal number of hermaphrodite flowers was emasculated for different pollen parents. Pollination was done at full bloom stage. The bagged hermaphrodite flowers were emasculated one day before anthesis from 4 to 6 p.m. with the help of forceps and again bagged. Next morning, pollen from already bagged flowers of different species of citrus viz., Marsh Seedless, Pearl tangelo, Eureka lemon, Kinnow—a mandarin hybrid, and Campbell Valencia and Mosambi cvs. of sweet orange were collected in petridishes. The pollen grains were applied on the stigma with the help of brush at about 10.30 a.m. and rebagged.

The fruits were considered set when the style dropped, ovary developed and

EFFECT OF POLLINIZERS IN SWEET LIME

turned green. Per cent fruit set was calculated on the basis of number of flowers emasculated. Mature and harvestable fruits were counted on all the tagged branches and the percentage was calculated on the basis of set fruits. The chemical analysis was done by usual methods of AOAC (1960).

RESULTS AND DISCUSSION

Fruit Set

The data in Table 1 reveal that the fruit set was highest when pollen of Marsh Seedless cultivar of grapefruit were used and the fruit set was about six times as compared to the pollen of Eureka lemon. Kinnow was the next best pollinizer. Fruit set was increased four times by Mosambi pollen as compared to Eureka lemon. These observations are in agreement with the findings of Singh and Dhuria (1960), Dhillon *et al.* (1963) and Ranjit Kumar (1974) who also reported increased fruit set when Duncan grapefruit and Mosambi, Pineapple and Hamlin cultivars of sweet orange were used as pollen parents.

It appears that the differential response of sweet lime to various pollinizers could be due to variations in the compatibility with the pollen parents. These differences in the compatibility may be due to structural or some genetical differences. Dhillon *et al.* (1963) reported that the anther lobes were reflexed away from the stigma which reduced the chances of self pollination in sweet lime.

Final Fruit Retention

Final fruit retention on the basis of total set fruits was highest when Eureka lemon pollen was used. Pearl tangelo and Kinnow mandarin pollen gave more than 100 per cent higher final fruit retention as compared to Campbell Valencia pollen which gave minimum final fruit retention. The effect of pollination with Marsh Seedless and Mosambi pollen was of the medium order. Dhillon *et al.* (1963) also found an improvement in fruit retention when Duncan grapefruit and Mosambi pollen were used in sweet lime.

TABLE 1
Effect of different pollen parents on fruit setting, final fruit retention and drop

Pollen parents	Total number of flowers emasculated	Per cent fruit set	Per cent final fruit retention		Per cent fruit drop
			On fruit set basis	Over emasculated flowers	
Marsh Seedless	256	38.28	8.16	3.13	91.34
Pearl tangelo	270	10.00	14.81	1.48	85.19
Eureka lemon	256	5.47	21.42	1.17	78.58
Kinnow	258	34.90	13.33	4.65	86.67
Campbell Valencia	255	35.29	6.66	2.35	93.34
Mosambi	256	28.13	11.11	3.13	88.89

TABLE 2
Physico-chemical quality of fruit of sweet lime as influenced by different pollen parents

Pollen parents	Av. weight of fruit (g)	Size (cm)		Rind thickness (cm)	Seed number/fruit	Percent juice	P r cent T.S.S.	Per cent acidity (Citric acid)	Ascorbic acid (mg/100 ml juice)
		L	B						
Marsh Seedless	164.00	6.48	6.61	0.24	21.70	56.20	8.86	0.1109	44.58
Pearl tangelo	133.60	6.00	6.08	0.18	29.00	67.50	8.06	0.1109	35.83
Eureka lemon	134.00	6.19	6.17	0.15	15.00	60.80	7.00	0.1134	51.87
Kinnow	138.70	5.98	6.22	0.24	25.60	59.30	8.40	0.1237	47.08
Campbell Valencia	102.70	5.53	5.70	0.21	14.70	60.30	9.10	0.1066	60.28
Mosambi	135.70	6.06	6.14	0.22	19.30	51.10	9.00	0.1152	60.41
C. D. at 5%	23.89	0.48	0.36	0.06	6.20	3.98	0.65	0.04	6.34

EFFECT OF POLLINIZERS IN SWEET LIME

Maximum number of fruits was obtained in sweet lime because of higher fruit set, when kinnow followed by Mosambi sweet orange and Marsh Seedless grapefruit were the pollinizers.

Higher final retention in case of Eureka lemon did not mean higher yield because of minimum fruit setting (Table 1).

Fruit Quality

The data in Table 2 show that the average weight and size of fruit in sweet lime were significantly higher with Marsh Seedless pollen as compared to all other pollen parents. However, the differences in the rind thickness as a result of different pollen parents were non-significant.

Minimum seeds were observed in the fruits where Campbell Valencia pollen were used followed by Eureka lemon. Seed content was higher in the fruits when Pearl tangelo and Kinnow mandarin pollen were used. These observations are in agreement with the findings of Dhillon *et al.* (1963) who reported increased number of seeds in sweet lime with Duncan grapefruit and Mosambi pollen with the increase in the number of fruits retained. It seems that the increased number of developed seeds might have checked abscission of fruits.

Juice content was highest with Pearl tangelo pollen as compared to all the other pollen parents. It was minimum in fruits where Mosambi was used as pollen parent and was followed by Marsh

Seedless. The juice content in the fruits obtained as a result of Kinnow, Campbell Valencia and Eureka lemon pollen parents was at par with each other.

Highest T.S.S. content was obtained in the fruits with Campbell Valencia and Mosambi pollen closely followed by Marsh Seedless pollen parent.

The acid content was significantly lower when Campbell Valencia pollen was used relative to all other pollen parents. The highest acidity was recorded in the fruits when Kinnow pollen was used.

Ascorbic acid content was highest in the fruits when Campbell Valencia and Mosambi pollen were used, whereas it was lowest with Pearl tangelo.

It was interesting to note that the Mosambi pollen increased total soluble solids and ascorbic acid content significantly and reduced acidity of the fruit. Effect of pollen parents on sugar and acid content in apple has been reported by Dzeneev (1958) and Dzieciol (1961).

The variation in the maturity could be due to metaxenia response. Jaynes (1963) also reported that the maturation time was affected according to male parents used in cross pollination.

Thus, cross pollination with Marsh Seedless cv. of grapefruit, Kinnow—a mandarin and Mosambi cv. of sweet orange will provide means for increasing fruiting in sweet lime.

REFERENCES

- A O A C 1960. Official and tentative methods of analysis. Association of Official Agricultural Chemists, Washington, D. C.
- Dhillon, J. S., Singh, Kirpal and Bakshi, J. C. 1963. Investigation of flowering and fruiting problem in sweet lime (*C. limettioides*). *Punjab hort. J.* 3 : 46.
- Dzenosov, S. 1958. The development of apple fruits in relation to pollinating variety. *Agrobiologiya* 3 : 129-31.
- Dzienciol, W. 1961. A study of the phenomenon of metaxenia in apple. *Pomol. Franc.* 3: 12-17.
- Jaynes, R. A. 1963. Biparental determination of nut characters in *Castanea*. *J. Hered.* 54: 84-88.
- Ranjit Kumar, 1974. Studies on fruit setting in sweet lime (*C. limettioides* T.). M. Sc. thesis, Haryana Agricultural University, Hisar.
- Singh, J. P. and Dhuria, H. S. 1960. Studies on floral biology of sweet lime (*Citrus limettioides* T.). *Indian J. Hort.* 17: 9-20.

EFFECT OF SEEDING TIME AND PLANT GEOMETRY ON THE SEED YIELD AND WATER-USE OF TARAMIRA IN DRYLAND

B. P. SINGH, H. C. SHARMA and B. P. CHUGH

Haryana Agricultural University

Dry Farming Research Centre, Bawal

(Received : May 28, 1983; Revised : April 5, 1985)

ABSTRACT

Taramira (*Eruca sativa* Lam) sown on 15 and 30 October, 15 and 30 November and 15 December recorded the seed yield of 10.45, 7.45, 5.64, 4.59 and 3.27 q/ha, respectively. The last four sowing dates represented 71.2, 53.9, 43.9 and 31.2 per cent production, respectively of the first sowing date. Inter- and intra-row spacing had no significant effect. Consumptive use of water decreased from 177 to 122 mm/m soil profile with delayed planting dates. The water-use efficiency values were also gradually decreased with delayed sowing date. Taramira sown on 15 October, recorded W. U. E. values of 0.94 to 0.56 kg/m³ water, whereas at 15 December these decreased to 0.40 to 0.21 kg/m³ water.

Taramira (*Eruca sativa* Lam) is a neglected crop generally grown on rain-fed, most neglected piece of land where no other *rabi* crop can be taken successfully with good economic returns (Singh and Sharma, 1976). Dryland farmers are showing interest in its cultivation due to its adaptability in early and late sown conditions on the soils where other crops of rapeseed and mustard group cannot be taken profitably. These crops do well under well conserved moisture conditions but do not grow well in scarce moisture conditions where taramira shows comparatively better existence in term of yield as well as remunerative returns (Singh and Sachan, 1981). Singh and Sharma (1976) reported that taramira possessed the morphological character combinations and development rhythm conducive to a consistent level of production under low moisture conditions. Its extensively deep

tap root system with fibrous lateral branching extracted moisture from far deeper soil horizons. To fetch higher productivity under early, right and late plantings of taramira crop, optimum plant population may vary with the available moisture during crop season (Singh *et al.*, 1970).

Keeping in view the importance of sowing time and plant population, involving inter and intra-spacings, an investigation on these aspects was conducted on taramira in south-western Haryana on aridisols representing the semi-arid tract.

MATERIAL AND METHODS

The experiment was conducted during the *rabi* seasons of 1975-76 to 1978-79 at Dry Farming Research Centre, Bawal. The treatments comprised all combina-

tions of five sowing dates (October 15 and 30, November 15 and 30 and December 15), two row spacings (30 and 45 cm) and three intra-row spacings (10, 15 and 20 cm). The experiment was laid out in split plot design, keeping sowing dates in main plots and inter and intra-row spacings in sub-plots. There were four replications each year and the net plot size was 3.60×8 m. The experiment was planted each year in *kharif* fallow where moisture was conserved. During 1977-78 and 1978-79 intra-row spacing of 15 cm was deleted due to scarcity of land. The moisture at the first sowing date varied from 140 to 153 mm/m soil profile in different years, whereas at the last sowing date it varied from 115 to 123 mm/m soil profile. The experiment was sown with T-27 cultivar of taramira. The crop was fertilized with uniform recommended dose of nitrogen @ 40 kg N/ha, which was drilled below seed level in each case. The desired plant population was maintained by thinning at 2 weeks of crops' age.

Soil of the experimental field was classed as loamy sand having pH 7.8 and electrical conductivity of 0.20 mmhos/cm. It had low nitrogen, medium phosphorus and higher potassium content.

The weather during the four seasons was typical of semi-arid of south-western part of Haryana. The soil samples upto a depth of 100 cm were taken periodically for moisture determination by gravimetric method. Consumptive use of water or water-use under different treatments was calculated by adding the rainfall received during the crop season to the moisture in soil profile at sowing and

deducting from this the moisture left in profile at harvesting. These values were worked out for the years 1975-76, 1976-77 and 1977-78 only.

The rainfall data (meteorological week-wise) for the crop seasons are given in Table 1.

RESULTS AND DISCUSSION

Out of four years of experimentation, for the first three years viz., 1975-76, 1976-77 and 1977-78, the normal seed yield of taramira was recorded. In 1978-79, low seed yield level was obtained due to the damage caused by the hail storms in meteorological weeks 7 and 9 (Tables 1 and 2).

Effect of Sowing Time

Data in Table 2 show that dates of sowing had significant effect on seed yield of taramira. Sowing of taramira on 15 October gave significantly higher yield as compared to other dates of sowing. There was significant and gradual reduction in seed yield of taramira in late planted crop. Sowing of taramira on 15 October gave 7.8 q/ha more seed yield (10.45 q/ha) as compared to 15 December sowing (3.27 q/ha). Deferring the planting date from optimum sowing time (15 October) to 30 October, 15 and 30 November and 15 December gave 71.2, 53.9, 43.9 and 31.2 per cent seed yield of the optimum. These findings are in conformity with those of Singh *et al.* (1970). Singh and Sachan (1981) advocated taramira planting even in December under dryland condition, if winter showers are received. Their plea was to get substantially better comparative yield and returns

EFFECT OF PLANT GEOMETRY ON WATER-USE OF TARAMIRA

TABLE 1
Rainfall (mm) during different crop seasons

Periods	Meteorological week	1975-76	1976-77	1977-78	1978-79
15 Oct.—21 Oct.	42	—	—	—	—
22 Oct.—28 Oct.	43	4.3(1)	—	—	—
29 Oct.—4 Nov.	44	—	—	—	—
5 Nov.—11 Nov.	45	—	—	—	—
12 Nov.—18 Nov.	46	—	—	—	—
19 Nov.—25 Nov.	47	—	—	—	—
26 Nov.—2 Dec.	48	—	—	—	—
3 Dec.—9 Dec.	49	—	—	—	3.1(1)
10 Dec.—16 Dec.	50	—	—	—	—
17 Dec.—23 Dec.	51	—	—	—	—
24 Dec.—31 Dec.	52	—	—	—	—
1 Jan.—7 Jan.	1	—	—	—	—
8 Jan.—14 Jan.	2	—	—	—	3.8(2)
15 Jan.—21 Jan.	3	—	—	—	16.2(3)
22 Jan.—28 Jan.	4	—	21.5(4)	—	—
29 Jan.—4 Feb.	5	—	—	—	5.2(1)
5 Feb.—11 Feb.	6	—	—	—	1.1(1)
12 Feb.—18 Feb.	7	32.0(2)	—	25.4(3)	20.5(1)
19 Feb.—25 Feb.	8	4.0(1)	—	—	14.3(2)
26 Feb.—4 Mar.	9	—	—	41.0(1)	2.4(2)
5 Mar.—11 Mar.	10	—	—	4.2(1)	16.4(2)
12 Mar.—18 Mar.	11	—	—	13.3(1)	—
19 Mar.—25 Mar.	12	2.4(1)	—	—	—
26 Mar.—1 Apr.	13	—	—	1.1(1)	—
2 Apr.—8 Apr.	14	—	18.5(2)	2.1(2)	3.0(1)
Total		42.7 (5)	40.8(4)	87.1(9)	86.4(14)

Figures in parentheses are number of rainy days.

from taramira as compared to other rabi crops grown in dryland. Sharma (1982) also reported from Jobner (Rajasthan), the significant reduction in seed yield in delayed planting of taramira beyond 10 October.

Inter-row Spacing

Data in Table 2 reveal that inter-row spacing did not reach to the level of

significance in any of the year of investigation. However, closer row spacing of 30 cm produced 5.3% higher seed yield over wider inter-row spacing of 45 cm. This may be due to more plant population at closer spacing. Sharma (1982) could not find difference in 30 and 45 cm inter-row spacings, whereas differences were significant over 60 cm inter-row spacing, confirming the present findings.

TABLE 2

Effect of sowing time, inter- and intra-row spacings on seed yield (q/ha) of taramira

Treatments	1975-76	1976-77	1977-78	1978-79
Sowing date				
15 Oct.	13.82	12.76	9.99	5.25
30 Oct.	10.85	6.81	7.98	4.18
15 Nov.	6.66	5.99	6.56	3.36
30 Nov.	5.97	6.67	3.78	1.95
15 Dec.	5.11	2.62	3.47	1.89
C. D. at 5%	1.83	0.50	0.99	0.42
Inter-row spacing (cm)				
30	8.62	7.08	6.56	3.37
45	8.34	6.87	6.18	3.28
C. D. at 5%	NS	NS	NS	NS
Intra-row spacing (cm)				
10	8.66	6.08	6.25	3.27
15	8.50	7.17	—	—
20	8.29	6.56	6.56	3.38
C. D. at 5%	NS	0.58	NS	NS

Intra-row Spacings

Seed yield of taramira was not affected significantly by the intra-row spacing in any of the year of experimentation (Table 2). However, intra-row spacing of 20 cm gave 7.7% higher seed yield over 10 cm. Sharma (1982) found significantly higher seed yield with 20 cm intra-row spacing over 10 cm. Thus, the trend of present findings was in the same fashion though differences were little and did not reach to the level of significance.

Consumptive Use and Water-use Efficiency

Maximum consumptive use (mm) was recorded each year in the early planted

crop (Table 3). It decreased with delayed planting. Crop sown on 15 October obtained values of consumptive use, 147 to 177 mm/m, whereas in the crop sown on 15 December values were 122 to 149 mm/m. There was no large difference in inter- and intra-row spacings in respect of consumptive use.

Water-use efficiency (W.U.E.) values were large in the early sown crop and subsequently decreased with delayed sowing (Table 3). On 15 October sown crop W.U.E. values varied from 0.94 to 0.56 kg/m³ water used and on 15 December sown crop it recorded only 0.40 to 0.21 kg/m³ water used. There was not much difference in W.U.E. values recorded in inter-row spacing, though

EFFECT OF PLANT GEOMETRY ON WATER-USE OF TARAMIRA

TABLE 3

Effect of sowing time, inter- and intra-row spacings on the consumptive use (mm/m) and water-use efficiency (kg grain/m³ water used) of taramira

Treatments	1975-76		1976-77		1977-78	
	C. U.	W. U. E.	C. U.	W. U. E.	C. U.	W. U. E.
Sowing date						
15 Oct.	147	0.94	157	0.81	177	0.56
30 Oct.	141	0.77	143	0.47	173	0.46
15 Nov.	137	0.48	138	0.43	159	0.41
30 Nov.	129	0.46	127	0.52	153	0.24
15 Dec.	127	0.40	122	0.21	149	0.23
Inter-row spacing (cm)						
30	136	0.63	139	0.51	158	0.41
45	136	0.61	136	0.55	162	0.38
Intra-row spacing (cm)						
10	138	0.62	139	0.44	163	0.36
15	136	0.62	137	0.52	—	—
20	134	0.61	135	0.48	156	0.41

varied from 0.63 to 0.41 kg/m³ water at 30 cm and 0.61 to 0.38 kg/m³ water at 45 cm. Similarly, intra-row spacing also affected the values of W.U.E. to some extent. The W.U.E. values were greater where large seed yields were recorded and varied with the available soil profile moisture to the crop.

The relative water availability fluctuates according to the weather conditions as well as the soil moisture content (Shaw and Burrows, 1966). Thus, an

inadequate supply of soil moisture has an adverse effect on plant growth and productivity, the same is true for excess moisture in soil. Both conditions are, therefore conducive to low W.U.E. The above situations were observed during the investigation. For each treatment and combinations of environmental conditions, there is a narrow range of soil moisture level at which W.U.E. will be higher than with a lesser or greater supply of water.

REFERENCES

Sharma, S. L. 1982. Third annual report. Agriculture Production Research Centre for taramira,

University of Udaipur, Campus Jobner, 1981-82.

SINGH ET AL.

- Shaw, R. H. and Burrows, W. C. 1966. Water supply, water-use and water requirements. In : *Advances in Crop Production*, pp. 122-42. Pierre, W. H., Aldrich, S. A. and Martin, W. P. (eds.), Iowa State University, Ames, Iowa.
- Singh, B. P. and Sachan, P. L. 1981. Taramira—A versatile dry land crop. *Haryana Fmg.* 10 (2) : 5-7.
- Singh, B. P. and Sharma, S. C. 1976. In poor soils grow taramira for better returns. *Haryana Fmg.* 5 (4) : 5.
- Singh, B. P., Yadava, T. P. and Bhole, A. L. 1970. Effect of sowing time and seed rate on the seed and oil yield of taramira (*Eruca sativa* Lam). *Tilhan Patrika* 2 (2) : 1-5.

MORPHO-PHYSIOLOGICAL ATTRIBUTES IN RELATION TO SEED YIELD IN INDIAN MUSTARD

HARI SINGH, A. K. YADAV, T. P. YADAVA and V. S. LATHER

Department of Plant Breeding
Haryana Agricultural University, Hisar

(Received : August 4, 1983; Revised : August 17, 1984)

ABSTRACT

There was enough variability with regards to secondary branches per plant, total siliquae per plant, 1000-seed weight, biological yield and harvest index in Indian mustard. Total siliquae per plant, harvest index, secondary branches per plant and 1000-seed weight showed significant and positive correlations with yield ($r=0.67, 0.60, 0.54$ and 0.50 , respectively). Secondary branches with total siliquae, total siliquae with harvest index and 1000-seed weight with harvest index showed positive and significant associations. Total siliquae per plant, harvest index and 1000-seed weight showed direct effects in the expression of their respective correlations with yield.

Total siliquae per plant and harvest index were found to be the most important attributes and selection for these should be aimed at to increase the seed yield in Indian mustard.

Indian mustard (*Brassica juncea* (L.) Czern and Coss) occupies an important place in respect of both area and production in Northern parts of the country. Its cultivation is economical than wheat if grown as pure crop by following the proper package of practices. Due to less variability among the genotypes with respect to oil content, it is difficult to breed the varieties with higher oil content. However, the oil yield per hectare can be increased by upgrading the yield potential of the existing varieties. For this, correlation and path coefficient studies are useful to breeders in two ways. Firstly to pin point the character, which influences the yield directly or indirectly and secondly to improve upon a character without affecting the other characters due to undesirable genetic linkages. Path

coefficient analysis is of immense use to the breeders because it gives the clear picture of the correlations. In the present investigation, an attempt has been made to find out the important morpho-physiological characters influencing yield through correlation and path coefficient analysis so that desirable selection pressure may be put on these characters while following the selection for yield in this crop.

MATERIAL AND METHODS

Thirtyeight cultures of raya were grown for the present study in a randomized block design with three replications. Spacing between rows was 45 cm and plant to plant distance was kept at 15 cm. Data on 10 competitive plants in each

replication were recorded on days to first and 50 per cent flowering, days to maturity, number of primary and secondary branches per plant, total siliquae per plant, seeds per siliqua, seed yield, 1000-seed weight (g), biological yield (on dry weight basis), harvest index (proportion of seed yield to biological yield) and oil content (per cent). Correlation coefficient analysis was made by the method suggested by Fisher (1954) and Al-Jiboury *et al.* (1958). Path coefficients were worked out by solving the simultaneous equations (Dewey and Lu, 1959).

RESULTS AND DISCUSSION

Analysis of variance with respect to yield and yield attributes has been given in Table 1. As could be seen from the data, genotypes showed significant variation for the characters, yield per plant, days to 50% flowering, days to maturity, primary and secondary branches per plant, total siliquae per plant, seeds per siliqua, 1000-seed weight and harvest index. Genotypes did not show significant variation for seed filling period and biological yield. There was enough range of variation with respect to yield (6.5 to 14.7 g per plant). There was less variability for days to 50% flowering, days to maturity, seed filling period, primary branches per plant, seeds per siliquae and oil content. Though biological yield showed enough range of variation, yet the genotypic differences in this attribute were undetectable due to higher error variance which would be attributed to sampling error. Similar results were also reported by Thurling (1974).

Correlation Coefficients among Yield and Yield Attributes

The correlation coefficients at phenotypic and genotypic levels were worked out to identify the characters influencing yield as well as correlation coefficients among such attributes. The values of genotypic correlations were generally higher than phenotypic correlations except for the correlation coefficients between the characters secondary branches and seeds per siliqua and secondary branches and harvest index (Table 2).

As could be seen from Table 2, yield was significantly and positively correlated with total siliquae per plant, harvest index, secondary branches and 1000-seed weight, other characters were independent in yield expression. Characters pairs secondary branches vs total siliquae, total siliquae vs harvest index and seed weight vs harvest index showed significant and positive correlations with each other. Further analysis revealed harvest index to be dependent on the total siliquae and 1000-seed weight. More secondary branches led to more number of siliquae. High positive correlation of yield with secondary branches was also reported by Singh *et al.* (1969).

Path Coefficient Analysis

Association between desirable plant characteristics at phenotypic level is of immense value to the breeders who select the desirable plant based on the phenotypic appearance only. It was with this view that the significant phenotypic correlations between seed yield and other characters were used for path coefficient analysis so as to get the complete picture

TABLE 1
Analysis of variance and range of variation in respect of various characters in Indian mustard

d. f.	S. Characters No.	Source of Variation				CV	Mean	Minimum	Maximum
		Replications	Treatments	Error					
		2	37	34					
		Mean	Squares						
1.	Yield per plant	32.54	15.77**	8.25	26.62	10.79	6.50	14.70	
2.	Days to flowering	41.95	57.41**	3.55	2.34	80.41	6.70	8.90	
3.	Days to maturity	15.71	13.90**	3.29	1.30	130.57	133.0	144.0	
4.	Days to seed filling	27.03	34.31	111.33	18.16	58.10	53.0	65.0	
5.	Number of primary branches	8.03	2.01*	1.04	18.64	5.48	4.0	7.0	
6.	Number of secondary branches	13.13	12.98*	8.14	23.52	12.13	8.0	6.0	
7.	Total siliques per plant	3150.00	4675.65**	238.47	18.00	265.07	205.07	325.0	
8.	Number of seeds per silique	0.85	1.33*	0.69	6.00	13.37	12.0	15.0	
9.	1000-seed weight	0.19	0.25**	0.03	5.00	3.20	2.36	3.64	
10.	Biological yield	50889.29	7950.42	5726.95	12.14	6232.45	49.33	73.33	
11.	Harvest index	20.09	207.35**	127.89	48.08	23.52	19.58	27.52	
12.	Oil content	0.151	2.747**	2.337	1.57	36.71	34.74	38.57	

*Significant at 5% level.

**Significant at 1% level.

TABLE 2

Correlation coefficient at phenotypic (P) and genotypic (G) levels of various characters associated with seed yield

S. No.	Characters	Seed yield	Secondary branches	Total siliquae per plant	Seeds per siliqua	1000-seed weight	Harvest index
1.	Seed yield	P	0.54**	0.67**	0.35*	0.50**	0.60**
		G	0.602	1.32	0.57	0.75	1.08
2.	Secondary branches	P		0.67*	0.004	0.26	0.20
		G		1.48	-0.35	0.42	0.14
3.	Total siliquae per plant	P			0.18	0.25	0.36*
		G			0.35	0.38	0.53
4.	Seeds per siliqua	P				0.004	0.28
		G				0.100	0.51
5.	1000-seed weight	P					0.32*
		G					0.55
6.	Harvest index	P					
		G					

*Significant at 5% level.

**Significant at 1% level.

TABLE 3

Direct and indirect effects of the attributes associated with seed yield in Indian mustard

Characters	Secondary branches	Total number of siliquae	1000-seed weight	Harvest index	Correlation with seed yield
Secondary branches	0.143	0.259	0.066	0.072	0.54
Total number of siliquae	0.096	0.387	0.063	0.129	0.67
1000-seed weight	0.097	0.037	0.253	0.115	0.50
Harvest index	0.029	0.139	0.081	0.360	0.80

Values in bold indicate direct effect.

Residual path value = 0.351

of the validity of such correlation for effecting the seed yield improvement programme through selection based on phenotypic expression of various characters associated with seed yield. Correlation coefficient (0.54) between secondary branches and yield when partitioned

into its direct and indirect effects revealed that secondary branches have moderate direct effect (0.143) as compared to indirect effect via total siliquae in building up its significant positive correlation with yield. Contribution of secondary branches via seed weight and harvest index was

MORPHO-PHYSIOLOGICAL ATTRIBUTES IN INDIAN MUSTARD

less. Partitioning of significant positive correlation (0.67) between total siliquae and yield indicated very high direct effect (0.387) of total siliquae in building up its correlation with seed yield. Harvest index contributed appreciably towards this correlation, whereas secondary branches and 1000-seed weight contributed less. Thousand-seed weight showed high direct effect towards its significant and positive correlation with yield. Harvest index contributed appreciably, whereas secondary branches and total siliquae contributed least towards this correlation. Harvest index is an index of high yield in cereals (Singh and Stoskopf, 1971). Its high and positive correlation with yield (0.60) in this crop when partitioned into its direct and indirect effect revealed that

harvest index itself has high direct effect (0.360) in the expression of its correlation with yield. Indirect effects via total siliquae and seed weight were next in order. Secondary branches contributed minimum towards this correlation.

From this study it is evident that while attempting for varietal improvement in Indian mustard, selection should be based on high number of siliquae and harvest index. Adequate attention should also be given to seed weight.

ACKNOWLEDGEMENT

The authors are thankful to Indian Council of Agricultural Research for providing the financial help for this study.

REFERENCES

- Al-Jiboury, H. A., Miller, R. A. and Robinson, H. P. 1958. Genotypic and environmental variances and covariances in an upland cotton cross of inter specific origin. *Agron. J.* 50 : 633-63.
- Dewey, D. B. and Lu, K. H. 1959. A correlation and path coefficient analysis of components of crested wheat grass and production. *Agron. J.* 51 : 515-18.
- Fisher, R. A. 1954. *Statistical Method for Research Workers*. Oliver & Boyd Ltd., London.
- Singh, D. P., Singh, D., Singh, S. P., Singh, A. B. and Mishra, S. N. 1969. Relationship among important agronomic characters in Indian mustard (*Brassica juncea* (L.) Czern and Coss). *Indian J. agric. Sci.* 39 : 362-65.
- Singh, I. D. and Stoskopf, N. C. 1971. Harvest index in cereals. *Agron. J.* 63 : 224-26.
- Thurling, N. 1974. Morphological determinants of yield in rapeseed (*Brassica campestris* and *Brassica napus*). I. Growth and morphological characters. *Aust. J. agric. Res.* 15 : 697-710.

GENETIC ANALYSIS OF HEADING AND MATURITY IN BARLEY (*HORDEUM VULGARE* L.) IN A RANGE OF ENVIRONMENTS

C. R. BAINIWAL, R. R. KARWASRA and D. S. JATASRA

Department of Plant Breeding

Haryana Agricultural University, Hisar

(Received : September 9, 1983; Revised : May 17, 1984)

ABSTRACT

Genetic analysis of days to heading and days to maturity was carried out from a 8-parent diallel under eight environments of normal and regenerated barley. Both additive and non-additive gene effects were involved in the inheritance of these attributes. Presence of over-dominance and greater role of non-additive component of genetic variation for both the maturity traits were indicated. The dominant genes were in excess of recessive in the population and earliness was caused mostly by dominant genes. For every recessive gene, there appeared to be about two to four dominant genes for both the characters. Crop conditions like spacing and cutting did not seem to have altered the results and similar conclusions could be drawn from the eight environments. In the light of present findings, breeding procedure has been suggested.

Maturity traits are important to plant breeders for breeding cultivars of different maturity duration. In this era of intensive agriculture, early maturing varieties find favour with the farmers. Breeding efforts are, therefore, now directed on evolving short duration, well adapted and high yielding varieties which may well fit into the multiple cropping pattern. To achieve this objective, the knowledge of genetic mechanisms controlling these characters is essential. Obviously, genetic analysis of heading and maturity merits investigation. Only a few reports are available on this aspect in barley—a very important cereal crop. Moreover, these studies have been made in single environment and as such the conclusions lack general application. In the present study, genetics of heading

and maturity in barley is investigated using a 8-parent diallel set under eight environments.

MATERIAL AND METHODS

Eight genetically diverse barley genotypes viz., Jyoti, BP 204, BG 25, K 125, Ratna, RS 6 (late maturing), and DL 165 and BG 105 (early maturing) were crossed in all possible ways excluding reciprocals. The 8 parents and their 28 F_1 hybrids were grown under spaced and drilled conditions as well as under cut and no cut conditions for two consecutive years (Table 1). All the experiments were sown at Haryana Agricultural University Research Farm in randomised block design with three replications. Sowings were done in 3 m long

TABLE 1
Details of the environments

	E ₁	E ₂	E ₃	E ₄	E ₅	E ₆	E ₇	E ₈
Date of sowing	22.10.1979	25.10.1980	22.10.1979	25.10.1980	22.10.1979	25.10.1980	22.10.1979	25.10.1980
Fertility level (NPK kg/ha)	35:12:6	35:12:6	35:12:6	35:12:6	25:12:6	25:12:6	25:12:6	25:12:6
Level of planting	Space	Space	Drill	Drill	Space	Space	Drill	Drill
No. of irrigations	3	3	3	3	2	2	2	2
Date of cutting for fodder	23.12.1979	26.12.1980	23.12.1979	26.12.1980	—	—	—	—

TABLE 2
Estimates of genetic components of variation for days to heading

Components of variation	E ₁	E ₂	E ₃	E ₄	E ₅	E ₆	E ₇	E ₈
D	12.20* ± 0.48	1.39* ± 0.25	0.73* ± 0.36	23.65* ± 3.35	12.98* ± 1.97	13.42* ± 2.26	6.57* ± 0.89	1.38 ± 2.10
H ₁	6.72* ± 1.11	1.53* ± 0.57	3.41* ± 0.82	40.96* ± 7.70	17.59* ± 4.54	16.08* ± 5.19	6.99* ± 2.04	12.83* ± 4.82
H ₂	3.44 ± 0.96	1.19 ± 0.49	3.51 ± 0.72	32.23 ± 6.89	16.70 ± 3.95	11.47 ± 4.51	5.95 ± 1.77	11.07 ± 4.20
h ²	2.56 ± 0.65	0.04 ± 0.33	1.16 ± 0.48	15.62 ± 4.49	0.02 ± 2.65	7.61 ± 3.09	0.60 ± 2.19	0.37 ± 2.81
F	1.19 ± 1.14	0.85 ± 0.58	0.18 ± 0.85	14.05 ± 7.91	—1.01 ± 4.66	13.89 ± 5.33	2.55 ± 2.09	—1.46 ± 4.96
E	0.26 ± 0.16	0.40 ± 0.08	0.09 ± 0.12	0.70 ± 1.11	0.28 ± 0.66	0.29 ± 0.75	0.17 ± 0.29	0.59 ± 0.70
(H ₁ /D) ^{1/2}	0.74	1.05	2.72	1.31	1.16	1.09	1.03	3.05
H ₂ /4H ₁	0.13	0.19	0.16	0.20	0.24	0.18	0.21	0.22
(4DH ₁) ^{1/2} + F	4.83	1.82	1.09	1.58	0.94	2.79	1.46	0.70
(4DH ₁) ^{1/2} - F	0.75	0.04	0.33	0.48	0.01	0.66	0.10	0.03
h ² /H ₁	—0.94*	0.16	—0.57	—0.53	0.01	—0.24	—0.30	—0.71*
r ²	4.23	10.38*	2.81	1.46	0.43	0.44	0.01	13.90*
Heritability (%)	65.85	37.92	11.59	44.40	39.68	79.95	56.19	7.64

*Significant at 5 per cent.

rows spaced 45 cm apart in single-row plots by drilling and by dibbling the seeds in lines at a plant to plant distance of 15 cm. The data were recorded on five randomly selected competitive plants in space planted experiments and on 30 cm long line in drilled experiments. Characters scored were days taken to 75% flowering (heading) and maturity. The diallel analysis was performed according to the method proposed by Hayman (1954). The narrow sense heritability was calculated as $\frac{1}{4}D/(\frac{1}{4}D + \frac{1}{4}H_1 - \frac{1}{4}F + E)$ following Crumpacker and Allard (1962).

RESULTS AND DISCUSSION

The estimates of the components of genetic variation and their ratios for days to heading are given in Table 2. Both additive (D) and dominance (H_1) components of genetic variance were significant in all the environments except D in E_8 . However, the relative magnitude of non-additive component was higher than the additive component indicating predominance of non-additive component in the inheritance of heading in barley in the present genetic material. The mean degree of dominance also revealed the presence of over-dominance. Tandon *et al.* (1968) and Yap and Harvey (1972) observed additive type of gene effects to be more important for this character; while Johnson and Eunus (1964), Chaudhary (1973) and Abo-El-Enein and Morsi (1977) found greater magnitude of non-additive genetic variance for heading in barley. The ratio $H_2/4H_1$ indicated asymmetry of positive and negative genes in the parental population. Positive F values also suggested an excess of dominant genes.

The ratio $(4DH_1)^{\frac{1}{2}} + F/(4DH_1)^{\frac{1}{2}} - F$ revealed that for every recessive gene effecting days to heading, there were about two to four dominant genes or gene groups. The ratio h^2/H_2 appeared to have been under-estimated. The low computed value for this ratio may be due to genic interaction and asymmetry (Mather and Jinks, 1971). The negative value of correlation suggested that earliness was caused mostly by dominant genes. The heritability estimates were moderate to high.

Perusal of data in Table 3 revealed that additive and non-additive genetic variances were highly significant for days to maturity in all the environments. The magnitude of non-additive component was, however, higher than the additive component. The average degree of dominance also revealed the presence of over-dominance, thus indicating greater role of non-additive gene effects. The proportion $(4DH_1)^{\frac{1}{2}} + F/(4DH_1)^{\frac{1}{2}} - F$ ranged from 1.18 to 3.52 revealing thereby that for every recessive gene affecting maturity, there were about 2 to 4 genes or gene groups with dominance effect. Johnson and Paul (1958) observed two gene pairs in controlling the main expression of earliness, while Johnson and Eunus (1964) reported the involvement of 17 genes or group of genes. The correlation coefficient between parental performance and order of dominance was negative in majority of environments which indicated that mostly dominant genes were responsible for earliness in barley. Further, the character was found to be moderate to highly heritable.

A critical examination of Tables 2 and 3 revealed that the results obtained

TABLE 3
Estimates of genetic components of variation for days to maturity

Components of variation	E ₁	E ₂	E ₃	E ₄	E ₅	E ₆	E ₇	E ₈
D	3.27* ± 0.55	2.05* ± 0.19	0.81* ± 0.36	1.74* ± 0.67	8.50* ± 0.99	6.19* ± 0.55	6.97* ± 0.28	2.56* ± 0.23
H ₁	4.24* ± 1.27	2.41* ± 0.45	6.92* ± 0.83	6.25* ± 1.54	15.59* ± 2.28	5.49* ± 1.26	4.20* ± 0.66	5.48* ± 0.54
H ₂	2.81 ± 1.10	2.17 ± 0.39	6.24 ± 0.72	6.06 ± 1.34	14.53 ± 1.99	3.34 ± 1.09	3.34 ± 0.57	4.76 ± 0.47
h ²	1.43 ± 0.74	0.16 ± 0.26	22.31 ± 0.48	-0.07 ± 0.90	33.23 ± 1.33	1.29 ± 0.73	3.44 ± 0.38	24.07 ± 0.31
F	4.15 ± 1.30	0.36 ± 0.46	1.10 ± 0.85	0.69 ± 1.59	5.19 ± 2.35	1.87 ± 1.29	1.82 ± 0.67	1.54 ± 0.55
E	0.30 ± 0.18	0.13 ± 0.06	0.13 ± 0.12	0.16 ± 0.22	0.16 ± 0.33	0.11 ± 0.18	0.17 ± 0.09	0.23 ± 0.08
(H ₁ /D) ^{1/2}	1.14	1.08	2.92	1.89	1.35	0.94	0.77	1.46
H ₂ /4H ₁	0.17	0.23	0.23	0.24	0.23	0.15	0.20	0.22
(4DH ₁) ^{1/2} + F	3.52	1.18	1.61	1.23	1.58	3.87	1.40	1.51
(4DH ₁) ^{1/2} - F								
h ² /H ₂	0.31	0.07	3.58	-0.01	2.29	0.38	1.03	5.05
r	-0.94*	0.19	-0.94*	0.70	-0.96*	-0.55	-0.71	-0.80*
t ²	1.46	0.01	7.24*	1.11	0.06	0.65	0.94	2.27
Heritability(%)	70.90	44.58	11.31	21.97	43.47	60.39	69.49	34.46

*Significant at 5 per cent.

from various environments were similar and conclusions drawn from spaced and drill sowing as well as from normal crop and regenerated crop were same. Therefore, the genetic behaviour of barley cultivars could be predicted across these crop conditions. But before generalizing, more studies are required on this aspect.

From the foregoing discussion it could now be concluded that the two characters viz., days to heading and days to maturity were controlled by genes with additive and non-additive effects. Degree of dominance revealed over-dominance and greater role of non-additive component in the inheritance of these attributes. Further, both the maturity traits were moderate to highly heritable. There were more dominant genes in the population and earliness was caused by

dominant genes. Therefore, the maturity could be predicted from days to heading.

The breeding methodology depends on the nature and magnitude of gene effects governing a quantitative trait. The present study has demonstrated the presence of additive as well as non-additive type of gene effects, however, the magnitude of latter is more. Till the economic exploitation of non-additive gene action through heterosis breeding in barley becomes feasible, varietal breeding programme, which exploits mostly the additive components, through selection is suggested. Breeding procedure like diallel selective mating system (Jenson, 1970), appears to be appropriate approach for rapid genetic improvement in barley.

REFERENCES

- Abo-El-Enain, R. A. and Morsi, L. R. 1977. Heterosis and combining ability in barley by diallel analysis. *Egypt. J. Genet. Cytol.* **64** : 84-97.
- Chaudhary, B. D. 1973. Estimation of genetic parameters in barley (*Hordeum vulgare* L.) by the techniques of diallel analysis and its modifications. Ph.D. thesis, Haryana Agricultural University, Hisar.
- Crumpacker, D. W. and Allard, R. W. 1962. A diallel cross analysis for heading date in wheat. *Hilgardia* **32** : 275-318.
- Hayman, B. I. 1954. The theory and analysis of diallel crosses. *Genetics* **39** : 789-809.
- Jenson, N. F. 1970. A diallel selective mating system for cereal breeding. *Crop Sci.* **10** : 629-35.
- Johnson, L. P. V. and Eunus, A. M. 1964. Inheritance of earliness in a six-parent diallel cross of barley. *Adv. Frontiers Plant Sci.* **9** : 111-18.
- Johnson, L. P. V. and Paul, G. I. 1958. Inheritance of earliness in barley. *Can. J. Plant Sci.* **38** : 219-33.
- Mather, K. and Jinks, J. L. 1971. *Biometrical Genetics*. Chapman and Hall Ltd., London.
- Tandon, J. P., Joshi, A. B. and Jain, K. B. L. 1968. Genetic analysis of yield in six-row and two-row varietal crosses in barley. I. Genetics of yield and its primary components. *Indian J. Genet.* **28** : 239-51.
- Yap, T. C. and Harvey, B. L. 1972. Inheritance of yield components and morpho-physiological traits in barley (*Hordeum vulgare* L.). *Crop Sci.* **12** : 283-86.

POTATO YIELD IN RELATION TO SEED SIZE AND PLANT DENSITY

Y. S. MALIK, K. P. SINGH, M. L. PANDITA, K. K. THAKRAL and S. LAL

Department of Vegetable Crops
Haryana Agricultural University, Hisar

(Received : September 24, 1983; Revised : June 28, 1984)

ABSTRACT

Studies were conducted to see the effect of five seed tuber sizes, viz., less than 25, 25-50, 50-75, 75-100 and 100-125 g and three intra-row spacings of 15, 20 and 25 cm on potato yield. Inter-row spacing was kept 60 cm. Seed tuber size of 50-75 g and 15 cm intra-row spacing produced proportionately more mean seed tuber yield. The highest mean net yields were obtained with 50-75 g seed tubers and 20 cm intra-row spacing individually and with their interaction.

The seed is an important factor in potato cultivation because it alone accounts for nearly 50% of the cost of cultivation. The variety Kufri Chandramukhi usually produces large size tubers due to which its seed rate is higher. It is, therefore, essential to get large proportion of seed sized tubers from seed crop. Even in ware crop it has effect because we are mainly interested in increasing net yield of the potato crop. The seed sizes and intra-row spacings have been found to have great influence on proportion of seed size tubers and total crop yield (Kapoor, 1950; Azariah and Saptharishi, 1951; Patil, 1961; Taleb *et al.*, 1973). The present studies were undertaken to find out the feasibility of using varying seed size tubers at varying intra-row spacing in relation to total yield and proportion of seed size tubers.

MATERIAL AND METHODS

There were total 15 treatment combi-

nations comprising five seed tuber sizes viz., less than 25, 25-50, 50-75, 75-100, and 100-125 g and three intra-row spacings viz., 15, 20 and 25 cm. Inter-row spacing was kept 60 cm. The experiment was planted on 1st October in randomized block design with three replications in the plot size of 3×3 m² during the years 1981 and 1982. Crop was fertilized with 125 kg N, 50 kg P₂O₅ and 50 kg potash per hectare. Plant protection measures were adopted as and when needed. The haulms cutting was done on 1st January during both the years. The data were recorded on height of plant and number of stems per hill at the time of haulms cutting and on tuber yield at the time of harvest. The tuber yields were taken in two sizes : (i) Large—more than 60 g tubers, (ii) Medium—upto 60 g tubers. The net yield was also calculated by subtracting the seed used from gross tuber yield.

RESULTS AND DISCUSSION

Growth

Height of plant was significantly influenced by size of seed tubers planted and increased with increase in seed tuber size. Maximum height was recorded in plants from 100-125 g seed tubers (Table 1) while minimum was noted in plants raised from less than 25 g seed tubers. Increase of plant height in large size tubers may be due to more food available in the beginning in large size tubers. Similar results have been reported by Khurana and Pandita (1982). Effect of intra-row spacing was significant only during first year and height of plants increased with reduction in plant spacing (Table 1). The interaction between seed size and spacings was not significant during both the years.

The number of stems per hill increased with increase in seed size. The maximum number of stems per hill was noted with seed tuber size of 100-125 g and minimum in less than 25 g seed tuber as more eyes are present on large size tubers compared with small size tubers (Khurana, 1981).

Yield

Large size tubers. A perusal of average data of large size tubers presented in Table 1 indicates that yield of large size tubers increased significantly with increase in seed tuber size upto 50-75 g, whereas there was no significant difference between yield from 50-75, 75-100 and 100-125 g. The highest yield was recorded with 100-125 g seed tuber size and lowest from less than 25 g seed

tubers. Tuber yield decreased with increase in intra-row spacing (Table 1). At 25 cm intra-row spacing, tuber yield was significantly lower than at 15 and 20 cm spacing.

Medium size tubers. The highest yield of medium size tubers was recorded with 75-100 g seed tuber size which was statistically at par with 25-50, 50-75 and 100-125 g tuber size but superior to that of seed tuber size of less than 25 g. The tuber yield increased with decrease in intra-row spacing. Significantly highest tuber yield was recorded with 15 cm intra-row spacing while lowest was recorded with 25 cm intra-row spacing which was at par with 20 cm spacing.

Total tuber yield. Data in Table 1 reveal that total yield increased progressively with increase in seed size and decreased significantly with increase in intra-row spacing. The highest tuber yield was recorded with 15 cm intra-row spacing followed by 20 and 25 cm.

Net yield. The net yield, i.e., total yield minus seed rate used was also favoured significantly by seed sizes and spacings. Statistically similar net yields were recorded with seed tubers of 50-75 and 75-100 g (Table 2). Lowest net tuber yield was recorded with less than 25 g seed tubers. The maximum net yield (237.7 q/ha) was observed with 20 cm intra-row spacing closely followed by 15 cm (224.4 q/ha) intra-row spacing. The interaction between seed size and spacing was also significant for net yield. 50-75 g seed tubers planted at 20 cm intra-row spacing recorded highest net yield (273.6 q/ha) closely followed by

POTATO YIELD IN RELATION TO SEED SIZE

TABLE 1
Effect of seed size and spacing on growth and tuber yield in potato cv. Kufri Chandramukhi

Treatments	Height of plant (cm)		Number of stems per hill		Yield of large size tubers (g/ha)		Yield of medium size tubers (g/ha)		Total tuber yield (q/ha)	
	1981	1982	1981	1982	1981	1982	1981	1982	1981	1982
Seed size (g)										
Less than 25	51.0	45.4	2.4	2.2	105.1	157.6	131.3	70.9	64.3	67.4
25-50	59.9	53.5	3.2	2.6	149.6	210.4	178.9	98.9	77.2	88.0
50-75	65.4	61.2	3.9	3.8	166.4	243.4	204.8	109.9	100.1	105.0
75-100	65.4	67.2	4.6	3.9	167.1	260.3	213.7	111.3	102.8	107.2
100-125	69.1	70.3	5.3	4.5	173.7	256.5	216.2	106.6	103.6	105.1
C. D. at 5%	5.5	5.4	0.4	0.5	24.0	24.6	21.9	16.4	28.7	19.7
Intra-row spacing (cm)										
15	65.0	60.8	3.5	3.4	156.6	251.9	204.0	109.6	108.4	108.8
20	62.7	59.7	3.8	3.4	154.1	226.0	189.8	101.1	85.3	93.3
25	58.8	57.9	4.3	3.5	137.5	119.0	128.0	87.9	75.1	81.2
C. D. at 5%	1.5	NS	0.3	NS	NS	NS	17.0	12.7	22.2	15.2
									NS	28.7
										22.0

TABLE 2

Interaction of seed size and spacing on net yield of tubers (q/ha) of potato cv. Kufri Chandramukhi (average of two years)

Seed size (g)	Intra-row spacing (cm)			Average
	15	20	25	
Less than 25	195.8	178.6	170.3	181.6
25-50	251.6	245.0	199.4	232.0
50-75	250.7	273.6	238.7	254.3
75-100	230.8	257.0	245.2	244.3
100-125	193.2	234.3	245.4	224.3
Average	224.4	237.7	219.8	

C. D. at 5%

Seed size = 19.7

Spacing = 15.2

Seed size $\times$ spacing = 34.2

75-100 g seed tubers planted at 20 cm intra-row spacing (257.0 q/ha) and least in less than 25 g seed size tubers planted at 25 cm apart. It is also clear from the data that net yield increased with decrease in intra-row spacing in case of less than 25 and 25-50 g seed tubers. In 50-75 and 75-100 g seed tubers, 20 cm intra-row spacing is superior over 15 and

25 cm spacings, while in 100-125 g seed tubers, 25 cm spacing is superior over 20 and 15 cm intra-row spacings. The net yield data suggested that there is no use of planting seed tubers less than 25 g; and seed tubers weighing 50-75 g are ideal for planting of potato crop at spacing of 60 $\times$ 20 cm.

REFERENCES

- Azariah, M. D. and Saptharishi. 1951. Influence of seed size and spacing on the yield of potatoes. *Madras agric. J.* 38 : 503-07.
- Kapoor, S. L. 1950. Some studies on the influence of spacing, seed piece and manuring on the yield of potato crop. *Proc. Indian Acad. Sci. Section B*, 31 : 45-53.
- Khurana, S. C. 1981. Growth, development and yield of potatoes. Ph.D. thesis, University of Nottingham, U. K.
- Khurana, S. C. and Pandita, M. L. 1982. Effect of spacing and seed size on growth and yield of total and seed size tubers in potato. *J. Indian Potato Assoc.* 9 : 74-84.
- Patil, B. H. 1961. Influence of seed size and row spacing on the yield of potatoes in hills. *Indian Potato J.* 3 : 29-32.
- Taleb, A., Hussain, A. and Siddique, A. 1973. Effect of seed size and spacing on the yield of potato. *Indian J. agric. Sci.* 43 : 237-40.

EFFICACY OF GRAMOXONE, BOLLS EYE AND SODIUM CHLORATE AS DEFOLIANTS TO IMPROVE THE YIELD AND QUALITY OF COTTON H 777

S. N. NAGWEKAR, S. D. PAI, VIRESHWAR SINGH and M. S. KAIRON

Cotton Technological Research Laboratory

Department of Plant Breeding

Haryana Agricultural University, Hisar

(Received : September 26, 1983; Revised : December 21, 1984)

ABSTRACT

Defoliants enhanced the termination of cotton crop with the early boll-opening. Gramoxone, Bolls Eye and Sodium chlorate did not have any adverse effect on the crop yield, nor on fibre quality characteristics.

Early maturing cotton variety is the basic requirement in Haryana to adopt double cropping of cotton-wheat to increase the crop productivity per unit area and per unit time. In cotton, liberal application of nutrients particularly nitrogen and supply of adequate water bring about excessive vegetative growth, on account of which the crop is unnecessarily delayed. Poor boll-opening is a serious problem due to low temperature in November-December. Even completely matured bolls remain unopened. Defoliation with the help of chemicals shall expose the bolls to better circulation of air and sun which will favour quick opening and hence, enable early picking, reducing the physiological and pest complex problems. Zakirov and Vasilevskii (1966) and Zakirov and Sadikov (1967) showed that at 60-80% boll opening is the suitable time for the defoliant spray and recorded no adverse effect on kapas yield. Gramoxone accelerated the boll-opening and increased the yield in the first picking

(Topalov, 1973) without any adverse effect on the total yield. Walwood and Yamada (1972), Burhan and Gleadle (1973), Nagwekar *et al.* (1980) and Bangarva *et al.* (1981) have, also, successfully studied the effect of defoliation with chemical defoliant agents. Hence, studies on the use of defoliants/desiccants were undertaken at Hisar during 1978 and 1979.

MATERIAL AND METHODS

The field experiments were conducted in random block design with three replications. There were nine treatment combinations, including the control where no defoliant spray was applied.

The seeds of variety H 777 were sown by dribbling on 13 May at the normal spacing of 60×30 cm in a plot size of 4.2×4.8 m during the two seasons. The crop was irrigated four times excluding the pre-sowing irrigation. Fertilizer

TABLE 1
Effect of defoliant on the yield and fibre quality of H 777 cotton (average for two years)

Characters	Picking	Treatments										C.D. at 5%	CV %
		T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉	T ₁₀		
Total yield (kg/ha)		1530	1447	1699	1546	1608	1691	1778	1575	1525	NS	NS	—
2.5% span length (mm)	First	28.9	27.3	28.5	28.7	28.4	28.6	28.1	24.8	30.1	2.64	136.9	
	Second	28.7	28.0	28.1	28.1	28.4	29.4	29.4	27.6	28.6	2.16	112.8	
Fibre fineness (millitex)	First	138	146	155	154	145	141	141	155	157	NS	5.90	
	Second	146	145	147	143	155	154	150	175	153	NS	10.12	
Maturity coefficient	First	0.73	0.74	0.77	0.75	0.74	0.75	0.75	0.77	0.77	NS	2.64	
	Second	0.75	0.75	0.75	0.74	0.76	0.76	0.76	0.80	0.76	NS	4.95	
Tenacity at 1/8" gauge (g/t)	First	24.6	23.7	24.1	24.5	25.0	23.6	23.6	23.3	25.3	1.26	3.01	
	Second	25.0	23.3	24.1	24.5	25.0	25.2	23.8	22.4	24.1	NS	3.55	

Treatments : T₁—Control, i. e., no defoliant; T₂—Gramoxone 1.25 l/ha; T₃—Gramoxone 2.50 l/ha; T₄—Boils Eye 1.25 l/ha; T₅—Boils Eye 2.50 l/ha; T₆—Sodium chlorate 10 kg/ha; T₇—Gramoxone 0.75 l/ha + Sodium chlorate 5 kg/ha; T₈—Sodium chlorate 5 kg/ha at last irrigation; T₉—2, 4-D 0.025 kg + Cycocel 0.5 kg/ha.

EFFECT OF DEFOLIANTS ON THE QUALITY OF COTTON

N 80 kg/ha in two splits, half at first irrigation and the remaining half at the flower initiation were applied. Normal plant protection measures were observed.

Spraying of the defoliants, as per assignment of treatments was done just before the first picking on 30 October. Kapas was picked in two separate lots; first picking (i. e., lower portion) on 15 November and second picking (i. e., upper portion) on 20 December. Kapas was ginned and the fibre quality characters were determined by standard laboratory methods. 2.5% span length was determined on Fibrograph, fibre fineness on Micronaire, maturity coefficient on Micronaire with spacer technique, and fibre tenacity at 1/8" gauge on Stelometer (Sundaram, 1979).

RESULTS AND DISCUSSION

Out of the nine different treatment combinations of defoliants tested (Table

1) on H 777, the combination of Gramoxone 0.75 l/ha + Sodium chlorate 5 kg/ha recorded the highest yield, followed by Gramoxone 2.5 l/ha and Sodium chlorate 10 kg/ha (being almost equal), and Bolls Eye 2.5 l/ha. Higher doses of Gramoxone and Bolls Eye yielded more than the lower doses. The pooled analysis did not show any adverse effect on the yield due to any of the defoliant treatments confirming the earlier work (Nagwekar *et al.*, 1979).

In this trial (Table 1), defoliant treatments slightly reduced the 2.5% span length in first as well as in second pickings. Sodium chlorate 5 kg/ha significantly reduced the fibre length in both the pickings. Treatments increased the fibre weight and Sodium chlorate 5 kg/ha produced the coarsest fibre with highest maturity, but the difference was non-significant. In respect of fibre tenacity too, there was no significant effect of treatments on first and second pickings. Thomson and Basinski (1964) and Barker and Thomas

TABLE 2

Ancillary data on the effect of defoliants on H 777 cotton (average for two years)

Treatments	Plant height (cm)	Bolls/plant		Yield/plant	
		U	L	U	L
T ₁	144	5.8	1.8	12.9	4.9
T ₂	136	5.0	2.1	12.8	5.8
T ₃	139	5.3	2.6	12.2	6.7
T ₄	143	5.5	1.8	13.6	3.9
T ₅	141	5.3	2.0	12.5	5.2
T ₆	134	5.9	2.3	14.3	5.7
T ₇	134	4.6	1.8	11.1	4.2
T ₈	141	5.7	1.8	13.8	4.6
T ₉	151	4.6	1.8	11.2	4.2
S. Em±	6.94	0.42	0.29	0.40	0.77
C. D. at 5%	NS	NS	NS	NS	NS
CV %	7.1	12.2	19.7	13.4	17.9

U=Upper portion

L=Lower portion

(1967) also, on defoliation, did not find any improvement nor any adverse effect on fibre length and weight. Similarly, Sarkis'yan and Bulkova (1973) showed no effect of defoliants on fibre tenacity and other qualities. Brown and Hyer (1956) recorded decrease in fibre length and simultaneous increase in fibre weight when defoliants were sprayed at prematuration stage.

It is, thus, concluded that defoliants Gramoxone, Bolls Eye and Sodium chlorate did not affect the quality of

cotton as stated by the earlier workers (Swan and Trudgian, 1970; Radzabova, 1972; Nagwekar *et al.*, 1979; Bangarva *et al.*, 1981).

ACKNOWLEDGEMENTS

Authors sincerely thank Dr. V. G. Munshi, Senior Scientist, CTRL, and Dr. V. Sundaram, Director, Cotton Technological Research Laboratory (ICAR), Bombay, for the timely suggestions and permission to publish this paper.

REFERENCES

- Bangarva, A. S., Singh, Chokhey and Malik, R. K. 1981. Effect of defoliation treatments on fibre quality of H. 14 cotton. *Cotton Dev.* 10 : 9-10.
- Barker, G. L. and Thomas, R. D. 1967. Three systems of defoliants tested in Delta. *Misc. Farm Res.* 30 : 1-8.
- Brown, L. C. and Hyer, A. H. 1956. Chemical defoliation of cotton. V. Effect of premature defoliant and desiccant treatments on boll components, fibre properties, germination and yield of cotton. *Agron. J.* 48 : 50-55.
- Burhan, H. O. and Gleadle, G. C. 1973. Trials of defoliants on cotton in Sudan. *Cotton Grow. Rev.* 50 : 327-33.
- Nagwekar, S. N., Singh, Mehar and Jain, D. K. 1979. Effect of defoliants on fibre qualities of American Cotton H. 14. *Haryana agric. Univ. J. Res.* 9 : 149-52.
- Nagwekar, S. N., Singh, Mehar and Jain, D. K. 1980. Effect of defoliants on yield and fibre characteristics of Desi G. 27 and American H. 14 cotton varieties. *ISCI J.* 5 : 76-80.
- Radzabova, G. 1972. Effect of defoliation on the sowing quality of seeds and the technological quality of fibre. *Sbornik robot po genetice, selektsii i semenovodstvu Khlopchatnitsa Tashkent, Uzbek, USSR (FAN)*. pp. 220-27.
- Sarkis'yan, G. G. and Bulkova, V. Y. 1973. Effect of defoliation on fibre quality of cotton cv. Tashkent I. *Khlopkovodstvo* 8 : 19.
- Sundaram, V. 1979. Hand book of methods of tests for cotton fibres, yarns and fabrics. *CTRL publication, ICAR Bombay* : pp. 5-59.
- Swan, I. F. and Trudgian, K. G. 1970. Effect of defoliation on grade of cotton lint. *Q. J. agric. Anim. Sci.* 27 : 265-68.
- Thomson, N. J. and Basinski, J. J. 1964. Harvesting practices, quality and yields of cotton in the Orel Valley, Northern Australia. *Cotton Grow. Rev.* 41 : 81-93.
- Topalov, V. 1973. A study of defoliation of cotton for mechanical harvesting. *Resteniev dni. nauki.* 9 : 145-57.
- Walwood, Y. T. and Yamada, H. 1972. Varietal characteristics and irrigation practices as harvest aids in narrow cotton. *Beltwide Cotton Production Res. Conf. Proceedings Memphis, Tennessee, USA. National Cotton Council* : 43-44.
- Zakirov, T. S. and Sadikov, S. B. 1967. Defoliation of cotton cv. 153-F. *Khlopkovodstvo* 8 : 46-48.
- Zakirov, T. S. and Vasilevskii, I. G. 1966. Use of Butifos on cotton. *Khim. Sel'sk. Khoz.* 4 : 45-48.

EFFECT OF DIFFERENT HEIGHTS OF STACKS OF COTTON STICKS ON THE SURVIVAL OF OVERWINTERING *PECTINOPHORA GOSSYPIELLA* (SAUNDERS) LARVAE

A. S. NANDAL and ZILE SINGH*

Department of Entomology
Haryana Agricultural University, Hisar

(Received : October 6, 1983; Revised : June 1, 1984)

ABSTRACT

Investigations were carried out on four stack heights (0.5, 1.0, 1.5 and 2.0 m) of cotton sticks each with two levels of sampling depths in each of the two cotton varieties 'H-777' (*G. hirsutum*) and 'G-27' (*G. arboreum*) to study the survival pattern of *Pectinophora gossypiella* (Saunders). The larval survival was high in all the stacks during February-March. Survival decreased slightly in April but there was a sharp decline in the surviving population from mid-May to mid-June. Bigger stacks (2 m in height) did contribute to the survival of pink bollworm larvae. Differences in larval population in stacks between the two varieties were non-significant. Survival pattern of larvae in lower layers of stacks was statistically at par with that in the upper portions.

The pink bollworm, *Pectinophora gossypiella* (Saunders) is the most serious pest of cotton in Haryana. It remains active in the field from the month of August to October-November and overwinters as larva (Gupta and Khurana, 1971). These overwintering larvae undergo diapause for 8-10 months in various carryover sources like seed-cotton, cotton seed, gin trash, shed bolls and stacked sticks. These develop into moths which fly to newly sown cotton crop to initiate fresh infestation. Left over bolls and burs on stacked cotton sticks are reported to contribute maximum towards the carryover of this pest to newly sown cotton crop. Eightytwo per cent of the surviving population which infests the

new crop has been reported to come from the cotton sticks (Sidhu and Dhawan, 1977).

Stacking of cotton sticks in the fields and houses for their utilization as fuel is a common practice amongst the farmers in Haryana. Most of these stacks are 1.5 to 2.0 m high. Keeping this stacking pattern in view, the studies were undertaken to determine the effects of stack heights on the survival of the diapausing larval population of the pink bollworm

MATERIAL AND METHODS

The cotton sticks of the *hirsutum* variety H-777 and the *arboreum* variety

*Director, Project-cum-Plan Formulation.

G-27 were stacked in the month of January during the years 1981 and 1982 at the Haryana Agricultural University Farm, Hisar. Length and breadth of each stack was 2 m. Four stacks of different heights replicated three times were made from the sticks of each of the two varieties (Table 1).

TABLE 1

Stack heights and sampling depths

S. No.	Stack height (m)	Sampling depth from ground to top (cm)	
		Lower layer	Upper layer
1.	0.5	0-25	25-50
2.	1.0	0-50	50-100
3.	1.5	0-75	75-150
4.	2.0	0-100	100-200

Left over bolls and burs on randomly selected 20 sticks from each of the lower and upper layers of each stack were removed at fortnightly intervals during the period from February to June. These were examined to record the presence of living and dead larvae.

RESULTS AND DISCUSSION

Data on the average number of living larvae of *P. gossypiella* at fortnightly intervals from February to June in all the four heights (0.5, 1.0, 1.5 and 2 m) of stacked sticks of two varieties (H-777 and G-27) are presented in Table 2. Irrespective of varieties, sampling depths and heights; the data indicate that the number of living larvae of pink bollworm in sticks was quite high in the months of February-March. The larval popula-

tion decreased slightly in the month of April but from mid-May onwards the surviving population of larvae was considerably reduced. Only a few larvae survived in sticks in the last fortnight of June. From mid-May onwards, the low survival of pink bollworm larvae in sticks seemed to be due to high temperature in summer months of May-June. The temperature at Hisar remained at 40°C and above for 22 and 5 days in the month of May and 28 and 17 days in the month of June during 1981 and 1982, respectively. It could have proved fatal to the larvae of pink bollworm in sticks. High temperature ranging from 40-50°C during summer months had earlier been reported lethal to resting larvae of pink bollworm (King and Giffard, 1924; Hussain *et al.*, 1931; Pruthi and Ahmed, 1941; Fye, 1971). According to Tawfik and El-sheirif (1974) mortality of pink bollworm larvae in stored sticks in Egypt ranged between 48-95 per cent upto end of May. Their findings further suggested that 95% of the total larval population failed to initiate infestations in the next years' crop. Sidhu *et al.* (1981) recorded 31.6, 49.3 and 71.4 per cent mortality of pink bollworm during April, May and June, respectively, in stacked sticks at farmers' field in Punjab. However, Sukhija and Sidhu (1975) reported that more than 60% larvae survived in sticks during June.

Statistical analysis of the pooled data (1981 and 1982) provided the following interesting information :

(i) Bigger stacks (2 m in height) contributed to the survival of pink bollworm larvae. The number of living

SURVIVAL OF PINK BOLLWORM LARVAE

TABLE 2

Effect of stack heights on the survival of pink bollworm larvae

Period of observation		Average number of living larvae of pink bollworm*							
Month	Fortnight	V ₁	V ₂	L ₁	L ₂	H ₁	H ₂	H ₃	H ₄
Feb.	I	63.74	59.53	61.07	62.19	63.13	65.92	61.30	56.17
	II	54.47	56.84	56.92	54.38	53.38	57.71	55.42	56.09
Mar.	I	53.47	52.84	54.06	53.26	52.80	50.80	55.33	53.67
	II	49.07	46.46	48.28	47.26	47.49	50.34	44.59	48.80
Apr.	I	45.36	48.42	48.48	43.30	42.22	44.80	49.63	46.92
	II	40.04	36.63	40.50	36.17	34.00	38.00	39.33	41.96
May	I	34.00	32.67	34.07	32.60	32.84	30.80	34.12	35.99
	II	16.46	16.32	18.17	14.61	14.63	14.09	17.63	19.21
June	I	6.09	5.32	7.05	4.36	3.67	4.96	7.50	6.67
	II	1.28	0.92	1.25	0.95	0.22	0.80	2.09	1.30

*Population per 20 sticks.

V₁=H-777

V₂=G-27

L₁=Upper layer of stack

L₂=Lower layer of stack

H₁=0.5 m stack height

H₂=1.0 m stack height

H₃=1.5 m stack height

H₄=2.0 m stack height

(i) Figures are average of two years data (1981 and 1982)

(ii) Statistical analysis of pooled data showed that C. D. at 5% for V (varieties) L (layers) and H (heights) were non-significant.

larvae was numerically more in higher than lower stacks during June but the survival in bigger stacks (1.5 and 2.0 m in height) was at par with smaller stacks (0.5 and 1.0 m in height).

(ii) The number of living larvae was numerically more in upper than lower layers of stacks but the survival pattern of larvae in upper layers was at par with that in lower layers of the stacks.

(iii) Differences in larval population in stacks of H-777 (*hirsutum*) and G-27

(*arboreum*) varieties, however, were non-significant.

ACKNOWLEDGEMENTS

Financial help given by the Indian Council of Agricultural Research, to the first author, in the form of Senior Research Fellowship is gratefully acknowledged. Thanks are also due to Head, Department of Entomology, Haryana Agricultural University, Hisar for providing facilities.

REFERENCES

- Fye, R. E. 1971. Mortality of mature larvae of pink bollworm caused by high soil temperature. *J. econ. Entomol.* **64** : 1568-69.
- Gupta, D. S. and Khurana, A. D. 1971. Seasonal activity and chemical control of pink bollworm. *Plant Prot. Bull., FAO* **19** : 131-35.
- Hussain, M. A., Bindra, S. S., Ladha Ram, Ganga Ram and Dev Raj. 1931. Studies on *Platyedra gossypiella* (Saunders) in Punjab. Part II. The source of *Pectinophora gossypiella* infestation. *Indian J. agric. Sci.* **1** : 264-85.
- King, H. H. and Giffard, W. E. 1924. The control of pink bollworm *Platyedra gossypiella* (Saunders) in the Sudan. *Bull. Wellwine trap. Res. Labs. ent. Sac.* No. 21, pp. 16.
- Pruthi, H. S. and Ahmed, T. 1941. Fatal temperature for pink bollworm (*Pectinophora gossypiella*) of cotton. *Indian J. agric. Sci.* **11** : 906-26.
- Sidhu, A. S. and Dhawan, A. K. 1977. Strategy for the control of pink bollworm in the Punjab. Paper presented at Seminar 'Self-sufficiency in Cotton Research Imperatives, Development Efforts and other Strategies to meet this goal' held at Bombay on Feb. 9-10, 1977.
- Sidhu, A. S., Simwat, G. S. and Dhawan, A. K. 1981. Natural mortality of diapausing larvae of pink bollworm in cotton stacks. Progress report on All-India Coordinated Cotton Improvement Project (Punjab State) for the year 1980-81.
- Sukhija, H. S. and Sidhu, A. S. 1975. Studies on the carryover of the pink bollworm (*Pectinophora gossypiella* (Saunders)) in the Punjab. *Indian J. Ecol.* **2** : 51-57.
- Tawfik, M. F. S. and El-sheirif, S. I. 1974. Status of dead cotton as a source for infestation of cotton plant for *Pectinophora gossypiella* (Saunders). (CF-RAE/A 64 : 3704).

INCIDENCE, BIOLOGY AND NATURE OF DAMAGE BY *NEPHOPTERIX INFUSELLA* MEYRICK (= *PHYCITA* *INFUSELLA* MEYRICK) ON COTTON IN HARYANA

R. K. SAINI

Department of Entomology
Haryana Agricultural University, Hisar

(Received : December 3, 1983; Revised : April 11, 1984)

ABSTRACT

Studies were carried out on the incidence, biology and nature of damage by *Nephoterix infusella* Meyrick (Pyralidae : Lepidoptera). The pest was observed throughout the crop season (May to November) and on ratoon cotton during April-May, attacking both *hirsutum* and *arborescens* cotton. Infestation of the pest on variety H-777, during August-September was 7-11 larvae and 11-16 larvae/100 plants in 1982 and 1983, respectively. Female moth laid 48-95 eggs on terminal, delicate parts of the plant. The larva damaged leaves, squares, flower buds, flowers and bolls. The larval period was 18-27 days. The larva was parasitized by *Bracon* sp. (Braconidae : Hymenoptera) and 1-6 parasites emerged from a single parasitized larva. The mean parasitization during September was 26.01 per cent. Pupal period was 6-9 days. The moth life was 5-9 days when fed on glucose and 3-4 days without food.

The cotton bud-moth, *Nephoterix infusella* Meyrick (= *Phycita infusella* Meyrick), Pyralidae: Lepidoptera, has been reported to be a minor pest of cotton in southern India (Fletcher, 1914). But it was reported as a serious pest of cotton in some localities of undivided Punjab (Hussain and Lal, 1924). Its damage to cotton crop during June-July has been reported in Punjab (Dastur *et al.*, 1960) and Haryana (Vevai, 1968). Biology of this pest has been studied in detail (Prabha *et al.*, 1978; Dhawan and Sidhu, 1980). However, little information on the incidence and nature of damage of this pest is available.

MATERIAL AND METHODS

The larval population of this pest, during 1982 and 1983, was recorded by

observing 200 plants from the unsprayed field of the *hirsutum* cotton variety H-777. The same plants were observed for subsequent data of larval population.

Biology of this pest was studied during April-May in the greenhouse. The larvae from the sprouts of ratoon cotton were reared to obtain moths. Six such sprouted plants were collected from the field and grown in the pots in the greenhouse. A pair of newly emerged male and female moths was released on each of the potted plants and covered with the muslin-cloth cage. Observations were made on the various stages of the pest. The temperature during these observations ranged from 29° to 37.5°C and mean relative humidity from 40.38 to 73.86 per cent. During crop season,

the larvae were collected from the field and reared in the laboratory to determine the natural parasitization, if any.

RESULTS AND DISCUSSION

The population ranged from 7-11 larvae/100 plants during August-September in 1982 but was 11-16 larvae/100 plants in the corresponding period during 1983 (Table 1). The population declined after September. However, Singh *et al.* (1975) reported 7-27.8 per cent incidence of this pest on plant basis in Punjab. The pest also attacked *arboreum* cotton but to a lesser extent.

TABLE 1

Larval population of *Nephoterix infusella* on variety H-777 (*Gossypium hirsutum* L.)

S. No.	Date of observation	No. of larvae/100 plants	
		1982	1983
1.	20 April	—	3
2.	27 April	—	4
3.	4 May	—	5
4.	12 May	—	1
5.	6 August	7	11
6.	26 August	8	14
7.	13 September	11	16
8.	22 September	—	14
9.	6 October	—	3

— Observations not taken.

Description of Various Stages

Egg

The female moth started laying eggs one day after mating and continued for 3-4 days. It laid 48-95 eggs during its life time. The eggs were small,

round to oval, shining, uncovered and creamy in colour which became light brown after one day and later on turned reddish brown. Generally, they were laid singly but sometimes in batches of 2-3 on either side of the terminal delicate leaves, leaflets, small young leaves, petioles of young leaves, bracts of squares, flower buds and occasionally on the older leaves. The eggs slightly shrank one day before hatching. It took 3-4 days to hatch and the tiny larvae moved towards underside of the leaf surface.

Larva

The young larvae were light green in colour with dark brown head. The body was sparsely hairy. Longitudinal stripes of dark green colour became apparent on the second stage larvae. The older larvae turned brownish green in colour with reddish stripes (Fig. 1). There were seven longitudinal stripes on the larvae. The full fed larvae, before pupation, shrank a little and turned pinkish red in colour towards the dorsal and lateral surface and remained green on the ventral surface. Stripes of pinkish red colour were very prominent at this stage. There were five larval instars. The larval period varied from 18-27 days. This duration was prolonged during October-November and the larvae hibernated.

The larvae were parasitized by *Bracon* sp. (Braconidae : Hymenoptera). In unsprayed fields, 10.53 to 44.44 per cent (mean 26.01%) parasitization was observed during the month of September 1983 (Table 2). The parasite attacked larval stages beyond second instar. From a single parasitized larva, emergence of 1-6 parasites was recorded.

INCIDENCE, BIOLOGY AND DAMAGE BY COTTON BUD-MOTH

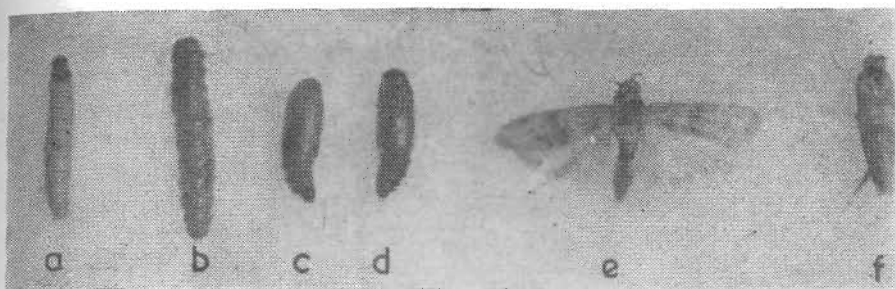


Fig. 1. a, b —young and full-fed larva; c, d —pupa; e, f —adult moth.

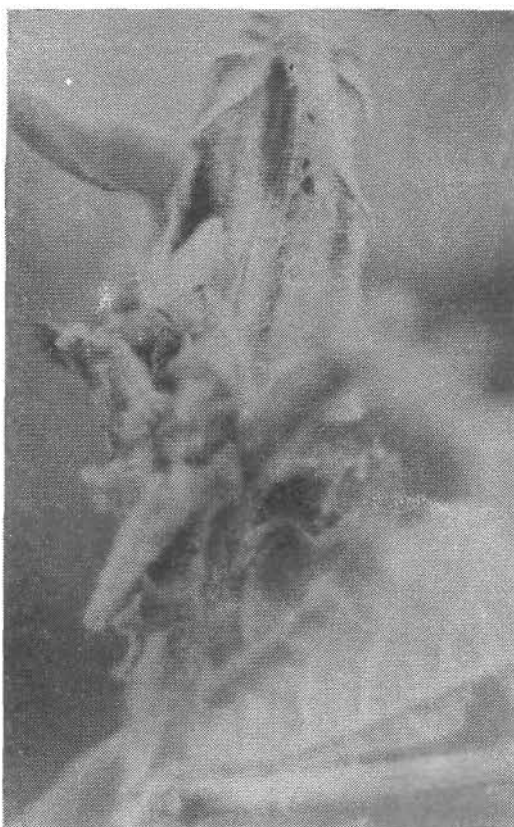


Fig. 2. Webbed leaves; 3 holes in the petiole of a leaf are distinct.

TABLE 2

Parasitization of *Nephoterix infusella* by *Bracon* sp.

S. No.	Date of observation during Sep. 1983	No. of larvae under observation	Dead due to unknown reasons	Parasitized larvae	Per cent parasitization
1.	10	29	8	10	34.48
2.	11	20	5	8	40.00
3.	12	9	1	4	44.44
4.	13	35	13	6	17.14
5.	14	11	1	3	27.27
6.	17	16	4	3	18.75
7.	18	43	18	14	32.56
8.	19	22	10	3	13.64
9.	20	30	12	5	16.67
10.	21	21	9	3	14.29
11.	22	19	14	2	10.53
12.	23	22	9	9	40.91
13.	24	17	8	4	23.53
14.	27	19	8	5	26.32
15.	28	15	9	5	33.33
16.	30	18	9	6	33.33

Mean per cent parasitization = 26.01.

Larval Behaviour and Nature of Damage

The larvae were very active. They showed quick movement and had a tendency to hide themselves in the silken tubes (spun over the body) when disturbed. The larval population was active on the crop through the season (i.e., from April to November). The infested plants could be recognised from a distance by the presence of clubbed dried and green leaves together. Further, presence of dark brown necrotic patches on webbed green leaves and squares, on the terminal portions of the branches, could also be seen.

Damage to leaves. The first and second stage larvae fed for sometime

on the tender, terminal leaves and leaflets at the growing point by nibbling the chlorophyll content. It, then, cut 1-3 deep holes in the petiole of one of the top small young leaf and consequently the leaf drooped and started drying (Fig. 2). The larvae fed on the chlorophyll content of this leaf in small patches from the underside. The larva lived in the folds of dried leaf and spun over it a white silken tube with its one end attached to the adjacent green leaf or square or flower bud and the other to the dried leaf itself. As the larva continued to feed and grow, the silken tube was extended to include adjacent leaves. The larva fed on the green leaves from within the silken tube. The larva, sometimes, fed from underside of the older leaves in the upper canopy of the plant.

INCIDENCE, BIOLOGY AND DAMAGE BY COTTON BUD-MOTH

The feeding was not continuous but in the form of small, irregular, close patches. The eaten portions became membranous.

Damage to squares. The larva attacked the square in three ways. First, by making a hole in the young square and consuming the internal contents; second, by cutting the young as well as old squares from the plant and attaching it to the adjacent leaf with the help of white silk; and third, by eating chlorophyll content of the bracts of the square and thus causing irregular necrotic patches on the bracts. The bracts of the square were webbed with each other and loose excreta could be seen in the webbing. It also scrapped the body of the square, occasionally. The larva had the habit of webbing all the attacked portions, including leaves, squares, flower buds and corolla, so that these did not drop down and remained hanging from the branches. In the older squares, the larva generally did not make a hole but confined its feeding to the bracts only.

Damage to flower-buds. The damage to flower-buds and flowers was to a lesser extent. The larva consumed the petals of the bud. It resulted in the exposure of the reproductive organs of the bud to the outside. The stamens, sometimes, emerged out of the bud through the damaged portion, before opening. The larva also fed on flowers and ate both petals and pollens. After fertilization, the corolla dried but was kept intact with the boll with the help of silken tube.

Damage to bolls. The larva attacked the boll from within the silken tube,

with its one end attached to the dried corolla or square and the other to the surface of the boll. It fed on the rind portion for about a day or so by scrapping the rind at 2-3 places. The scraps were irregular and shallow. But after 2-3 days it penetrated deep into the boll feeding both on the fibres and the developing seeds. On disturbance, it generally preferred to come out and hide in the silken tube, but sometimes it hid inside the bored boll itself. Only one larva was found in one gallery.

Pupa

The full fed larva either pupated in the folds of the dried leaves or on the ground. The pupa, in the beginning, was greenish towards its broader end and brown towards the tapering end, but later on turned reddish brown. The pupal period was 6-8 days.

Moth

The moth was small, dull coloured with the forewings divided into two distinct areas by a thin light brown line. The lower portion of the wings was darker. The hind wings were membranous. The adult life was 5-9 days when fed on glucose and 3-4 days when kept without food.

ACKNOWLEDGEMENTS

Thanks are due to Dr. J. D. Bradley and Dr. A. D. Austin, Commonwealth Institute of Entomology, London, for identifying the insects. The author is also thankful to Dr. A. N. Verma, Senior Entomologist, HAU, Hisar for valuable suggestions.

REFERENCES

- Dastur, R. H., Asana, R. D., Sawhney, K., Sikka, S. M., Vasudeva, R. S., Khan, Q., Rao, V. P. and Sethi, B. L. 1960. *Cotton in India*, A Monograph. I.C.C.C., Bombay pp. 339.
- Dhawan, A. K. and Sidhu, A. S. 1980. Biology of cotton bud-moth (*Phycita infusella* Meyr.) in the Punjab. *J. Res. Punjab agric. Univ.* 17 : 272-74.
- Fletcher, T. B. 1914. *Some South Indian Insects and other Animals of Importance*. The Superintendent Government Press, Madras. pp. 565.
- Hussain, M. A. and Lal, M. M. 1924. Annual Reports of the Entomologists to the Government of Punjab, Lyallpur for the year 1920-23. *Rept. Dept. Agric. Punjab* (cited from *Rev. appl. Ent.* A 12 : 90-91).
- Prabha, S., Dhindsa, M. S., Dhawan, A. K. and Dhillon, S. S. 1978. Biology of the cotton bud-moth, *Phycita infusella* Meyr. (Lepidoptera : Pyralidae). *J. entomol. Res.* 2 : 33-39.
- Singh, Joginder, Gatoria, G. S. and Sidhu, A. S. 1975. Studies on the biology and chemical control of the cotton bud-moth (*Phycita infusella* Meyr.) at Faridkot, Punjab. *J. Res. Punjab agric. Univ.* 12 : 59-61.
- Veal, E. J. 1968. Degree of attack by the various pests of cotton in the different states of India. *Pesticides* 2(3) : 25-26.

INTERACTION BETWEEN SEED RATE, CROP STAND AND SOWING MACHINERY IN COTTON

N. K. BANSAL, D. N. SHARMA and M. L. JAIN

Department of Agricultural Engineering
Haryana Agricultural University, Hisar

(Received : December 1, 1983; Revised : June 13, 1984)

ABSTRACT

In order to know the factors affecting yields on the farmers' fields, data were collected from a number of villages in two districts largely producing cotton. Inadequate germination and poor crop stand came out to be the constraints in increasing and stabilizing yields. The results indicated that there was linear relationship between plant population and seed rate. The required plant population which directly affects the yield could be achieved only by proper seed treatment, desired seed rate and use of improved sowing machines. A regression equation has been developed on the basis of recorded data.

India occupies first position in the world by producing cotton over an area of 8.1 million hectares, but the production per unit area is one of the lowest, i. e., 167 kg/ha. According to Haryana Statistical Abstract (1981-82), Haryana state grows cotton on nearly 3.163 lac hectares of which about 98.5% is irrigated. The production was 643.01 thousand bales (1 bale=170 kg) in 1980-81. The average cotton production in Haryana was 327 kg/ha trailing behind Punjab untill 1977-78. It overtook Punjab in 1978-79 by averaging 358 kg/ha, which was the highest then.

Still, this level of production is very low in comparison to the average yield of 600 kg/ha on research fields. This indicates a wide gap in production on research farms and at farmers' fields. It should be attributable to constraints in increasing and stabilizing the yields on farmers' fields. So, there is a need to

identify the constraints in order to achieve higher yields per unit area under cotton.

MATERIAL AND METHODS

Data were collected over a period of three years, i. e., 1979-80, 1980-81 and 1981-82 from a number of villages in the two districts viz., Sirsa (district A) and Hisar (district B) to assess the density of plants and the extent of use of machinery. In each district, 15 villages were selected and observations were recorded by counting the plants in 10 randomly selected rows each 30 m long. The plant counts were taken in three replications in each field for obtaining representative data. Variety of seed, seed treatment, type of machine used, seed rate and method of sowing were recorded for determining the right type of machine which could sow/drill the seeds and fertilizer to achieve the optimum plant population. Four machines viz., bullock drawn single row

seed-cum-fertilizer drill, bullock drawn three row seed-cum-fertilizer drill, tractor drawn seed-cum-fertilizer drill and tractor drawn cotton planter over the control, i.e., single row cotton drill as used in para method were tested on the Research Farm of HAU, Hisar. Number of seedlings per square meter was recorded in each treatment.

RESULTS AND DISCUSSION

The data collected on plant population of cotton in the two districts are given in Tables 1-3. In district 'A' at location-1, being the Cotton Research Station, the sowing was accomplished by the use of sowing machines. The data show that the plant population was the highest for all the three years and incidentally much above the desired population, i. e., 55,000

plants/ha which according to Singh and Bhatia (1976) gives the maximum yield of cotton. All other locations were the farmers' fields where, in general, sowing was done by the traditional practices. Data in Table 1 indicate that the plant population at all the locations except at location-2 in the year 1981-82 was lower than desired. The range was 23,000 to 50,000 plants/ha.

In district-B, locations-1 and 4 which were HAU Research Farm and Central State Farm, respectively, the sowing was done with the help of sowing machines and this gave the plant population nearly equal or little above the desired plant population, as is evident from Table 2. At other locations, being the farmers' fields, the plant population was below optimum ranging from 16,000 to 49,000 plants/ha.

TABLE 1
Plant population in cotton crop at farmers' fields in district A

Locations	Average plant population/ha		
	1979-80	1980-81	1981-82
1	59,346 $\pm$ 9,450	58,110	60,984
2	37,573 $\pm$ 6,039	41,082 $\pm$ 4,852	58,537 $\pm$ 3,863
3	50,124 $\pm$ 5,645	35,665 $\pm$ 2,360	38,268 $\pm$ 2,889
4	—	40,666 $\pm$ 4,115	47,638 $\pm$ 2,987
5	37,640 $\pm$ 5,425	31,248 $\pm$ 4,967	35,301 $\pm$ 3,930
6	30,260 $\pm$ 8,975	—	—
7	—	30,547 $\pm$ 5,849	—
8	—	34,369 $\pm$ 6,622	—
9	—	36,360 $\pm$ 1,522	—
10	—	29,110 $\pm$ 1,494	—
11	—	23,673 $\pm$ 3,400	—
12	—	—	46,437 $\pm$ 2,985
13	—	—	45,348 $\pm$ 3,973
14	—	—	35,643 $\pm$ 1,519
15	—	—	41,349 $\pm$ 7,063
Average	42,290	36,083	45,502
SEm $\pm$	5,190	2,965	3,085

INTERACTION BETWEEN SCM IN COTTON

TABLE 2

Plant population in cotton crop at farmers' fields in district B

Locations	Average plant population/ha		
	1979-80	1980-81	1981-82
1	51,055±6,670	51,369±2,467	54,110
2	32,324±4,985	—	—
3	—	29,449±9,445	37,556±2,146
4	46,122±4,590	49,055±3,812	73,471±3,355
5	—	20,617±3,100	38,208±1,979
6	—	30,985±4,237	—
7	—	16,110±1,956	—
8	—	23,832±1,611	—
9	29,403±4,735	23,747±3,298	25,340±4,822
10	35,170±6,700	36,008±5,620	41,424±5,226
11	—	—	43,723±2,480
12	—	—	32,290±2,457
13	—	—	36,764±4,875
14	—	—	49,188±6,582
15	—	—	33,053±5,637
Average	38,480	31,247	42,284
SEm±	3,880	4,084	3,936

TABLE 3

Effect of seed rate on plant population in cotton variety H-777 at farmers' fields sown by traditional (Pora) method

S. No.	Seed rate (kg)	Average plant population/ha in the fields surveyed		
		1979-80	1980-81	1981-82
1.	7.5	16,418	19,694	20,686
2.	10.0	25,500	30,999	31,607
3.	12.5	33,930	32,971	35,146
4.	15.0	47,730	41,562	47,086

There was, in general, considerable variation in plant population among all the locations. This was due to poor quality of seed, different methods of seed treatment, varying seed rates and different methods of sowing, i. e., by Kera, Pora or seed drills, besides varying poor soil conditions from field to field. Adequate germination and proper crop stand can

be obtained by seed treatment, i. e., acid delinting, desired seed rate and sowing by improved machines. The data obtained from different locations using varying seed rates with traditional methods of sowing seeds in the variety H-777 indicate that plant population has a linear relationship with the seed rate (Table 3). When seed rate was 7.5 kg/ha, the aver-

age plant population was 16,418, 19,694 and 20,686 plants/ha, respectively, for the three years. When it was 10 kg/ha, population increased to 25,500, 30,999 and 31,607 plants/ha. The plant population was about three times in 1979-80 and more than double in 1980-81 and

1981-82 when the seed rate was increased to 15 kg/ha. There was variation in plant population viz-a-viz seed rate in all the years in both the districts. This may be due to variation in the quality of seed and the dynamics of seed dropping mechanism. A curve (Fig. 1) was drawn

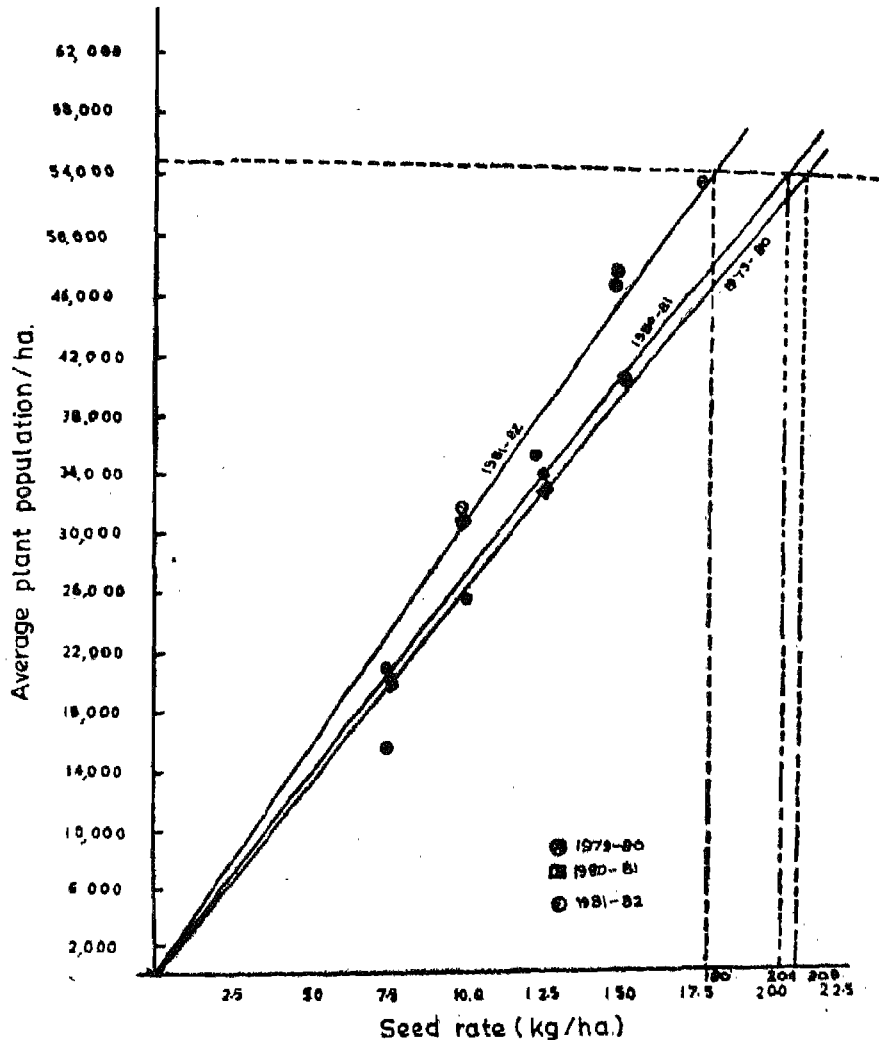


Fig. 1. Relationship between seed rate and plant population.

INTERACTION BETWEEN SCM IN COTTON

on the basis of data given in Table 3. From this curve, the required seed rate of 18.0 to 20.9 kg/ha was determined for obtaining desired plant stand, i. e., 55,000 plants/ha. According to Jain and Bahl (1981), 22.4 kg/ha seed is required to achieve desired plant stand when the percentage of germination was 59. Obviously, most of the farmers were using lower seed rate, traditional methods of seed treatment and sowing.

Data in Table 4 show the effect of sowing machines on plant stand. Four sowing implements were used for sowing seed of variety H-777 with a seed rate of 15 kg/ha (acid delinted) except in cotton planter (10 kg/ha). Lower seed rate was used in cotton planter to obtain optimum plant population, i. e., 55,000

plants/ha, as it has cell plate type of seed metering system which accommodates only two seeds per hill at a distance of about 30 cm. While, in seed-cum-fertilizer drill, to obtain desired plant population a minimum seed rate of 15 kg/ha was required because of its fluted roller type of seed metering mechanism, which, ultimately required more thinning in the latter case. Highest average germination of 23.83 seedlings/m² was observed with single row seed-cum-fertilizer drill followed by tractor drawn seed-cum-fertilizer drill (Swastik) giving 13.65 seedlings/m² and three row bullock drawn seed-cum-fertilizer drill giving 12.3 seedlings m². Lowest germination of 3.76 seedlings/m² was recorded under control, i. e., single row cotton drill.

TABLE 4
Effect of sowing machines on plant stand in cotton

S. No.	Name of implement	Average germination/m ²	Average plant population before thinning (No. of plants/ha)	Average plant population after thinning	
				No. of plants/m ²	No. of plants/ha
1.	Single row seed-cum-fertilizer drill (B. D.)*	23.83	2,38,300	8.37	83,700
2.	Three row seed-cum-fertilizer drill (B. D.)*	12.30	1,23,000	7.31	73,100
3.	Tractor drawn seed-cum-fertilizer drill (Swastik)	13.65	1,36,500	6.18	61,800
4.	Tractor drawn cotton planter	6.33	63,300	4.36	43,600
5.	Single row cotton drill (Pora)	3.76	37,600	3.33	33,300

*Developed in the Department of Agricultural Engineering, HAU, Hisar.

Location : Research Area, Dept. of Agronomy, HAU, Hisar.

Date of sowing : 12.6.1980

Variety : H-777 (acid-delinted)

Seed rate : 15 kg/ha

Row to row spacing : 60 cm

Recording of germination date before thinning : 20.6.1980

Recording of plant stand after thinning : 25.8.1980.

Plant population was recorded after proper thinning of the crop. It is clear from Table 4 that except cotton planter and single row cotton drill, all the other machines gave plant population more than the desired. This indicates that further thinning is required in these treatments to obtain desired plant stand of 55,000 plants/ha. Otherwise, there will be reduction in yield. Though plant population with tractor drawn planter was only 43,600 plants/ha, yet it was quite uniform. Lowest plant stand of 33,300/ha was obtained under control because of improper placement of seed in the soil. According to Sharma *et al.*

(1983) there is 15-20% increase in yield with the use of seed-cum-fertilizer drill over control (Pora).

The farmers should sow good quality properly treated (acid delinted) seeds with improved machines to facilitate proper placement for better germination. The seed rate may be nearly 20 kg/ha for the variety H-777. This will give the optimum plant population when the sowing is done using a seed-cum-fertilizer drill or a planter. Since, the placement of seed will be in lines, thinning will be possible to achieve proper plant stand.

REFERENCES

- Jain, M. L. and Bahl, V. P. 1981. Improvement in cotton cultivation through mechanization. *J. Inst. Eng. (India)* 62 : 137-39.
- Sharma, D. N., Bansal, N. K. and Jain, M. L. 1983. Design, development and testing of bullock-drawn single row seed-cum-fertilizer drill. *J. Agric. Mechanization* 14 : 37-40.
- Singh, Vreshwar and Bhatia, Krishan. 1976. Importance of required plant population in cotton. *Haryana Kheti* 8 : 8.
- Statistical Abstract of Haryana. 1981-82. 16 : 95-97.

EFFECT OF SEEDLING TREATMENT AND FOLIAR APPLICATION OF CYTOZYME ON GROWTH AND YIELD OF TOMATO, BRINJAL AND CHILLI

R. S. HOODA*, A. S. SIDHU and M. L. PANDITA

Department of Vegetable Crops

Haryana Agricultural University, Hisar

(Received : December 17, 1983; Revised : May 7, 1984)

ABSTRACT

Cytozyme was found beneficial in improving growth and yield of tomato, brinjal and chilli and optimum treatment was the concentration of 10% seed treatment and 1.25% crop⁺ spray.

A number of studies have been conducted on the effect of growth regulators in various crops. It has also been reported that growth regulators are highly specific in nature. Recently a growth regulator 'Cytozyme' has been used for improvement of growth, yield and quality in several crops including vegetable crops (Pandita and Hooda, 1979; Singh and Kaur, 1981; Pandita *et al.*, 1981, 1982, 1983). It constitutes related micronutrients, enzyme and hormones (mainly Cytokinins). The product is available in two formulations, i.e., seed treat and crop⁺ spray, the former being used for treatment of seed or seedling and latter for the foliar spray. The present investigations were carried out to study the effect of seedling treatment and foliar application of cytozyme on growth and yield of tomato, brinjal and chilli.

MATERIAL AND METHODS

The experiments were carried out at Vegetable Research Farm during 1977 and 1978. The soil of the experimental site was sandy loam with pH 8.25 and contained 0.45% organic carbon, 40 kg/ha available P, 560 kg/ha available K and 0.51 mmhos/cm Ece. Experiments were conducted with four levels of seed treat (0, 5.0, 7.5 and 10.0 per cent) and four levels of crop⁺ foliar spray (0, 0.75, 1.00 and 1.25 per cent solution) in a randomized block design in three replications and varieties HS-101 (tomato), pH-4 (brinjal) and Pusa Jwala (chilli) were grown. Transplanting was done in third and second week of August during 1977 and 1978, respectively for all the crops. Seedling treatments were done for 15 min before transplanting in the field during both the

*Directorate of Research.

years. Two foliar sprays were given after 21 and 42 days after transplanting. Tween-20 was used as surfactant at 0.005 per cent. Control plots were sprayed with canal water. Transplanting was done on raised beds 60×45 cm (row×plant), 60×60 cm and 45×30 cm for tomato, brinjal and chilli, respectively. Well rotten farm yard manure was added to the field at the rate of 20 tonnes/ha before sowing. All the plots were given uniform dose of fertilizers (100 kg N, 50 kg P₂O₅ and 50 kg K₂O per hectare). Plant protection measures were adopted uniformly in all the treatments as and when needed. The observations on growth characters were recorded at the time of final harvest.

RESULTS AND DISCUSSION

Tomato

Seedling treatments. The differences in the height of plant due to various treatments were significant only during 1977 (Table 1). Maximum height of plant was recorded from 10% seedling treatment closely followed by 7.5% during both the years. Similar results of increase in plant height by cytozyme were recorded by Pandita and Hooda (1979) in potato, Pandita *et al.* (1983) in bhindi and Pandita *et al.* (1982) in muskmelon. Minimum plant height was obtained under control. The differences in the number of branches per plant due to various treatments were significant during both the years. The maximum number of branches per plant was recorded from 10% seedling treatment. The data on number of fruits per plant have indicated significant differences due to various treatments during both the years.

Maximum number of fruits per plant was recorded under 10% seedling treatment closely followed by 7.5% and least number of fruits was obtained from control. The increase in number of fruits per plant may be due to the formation of higher number of branches per plant. The differences in yield due to various treatments were significant during both the years. Maximum fruit yield was obtained under 10% seedling treatment, whereas minimum yield was recorded in control. All other treatments were slightly superior to control and the yield increased with the increase in concentration.

Foliar spray. Maximum height of plant was recorded from 1.25% crop⁺ spray followed by 1% crop⁺ spray during both the years. Minimum plant height was recorded in control. The maximum number of branches per plant was recorded in 1.25% crop⁺ spray. The highest number of fruits per plant and maximum fruit yield were obtained under 1.25% crop⁺ spray followed by 1% crop⁺ spray. On an average there was an increase of 11% yield over control due to 1.25% crop⁺ spray.

Brinjal

Seedling treatment. The data on the height of plant reveal that the differences between various treatments were significant during both the years (Table 2). Increase in the concentration of cytozyme increased the height of plant. Maximum plant height was obtained under 10% seedling treatment followed by 7.5 and 5.0 per cent in descending order. The plant height was minimum in control. Same was true for

EFFECT OF CYTOZYME ON TOMATO, BRINJAL AND CHILLI

TABLE 1
Effect of seedling treatment and foliar application of cytozyme on growth and yield of tomato

Treatments	Height of plant (cm)		Number of branches per plant		Number of fruits per plant		Total fruit yield (q/ha)	
	1977	1978	1977	1978	1977	1978	1977	1978
Seedling treatments								
Control	67.33	75.58	11.79	7.15	54.48	22.74	372.05	233.21
5%	68.38	75.94	12.00	6.88	58.34	24.33	387.70	241.78
7.5%	68.81	79.13	12.19	7.20	59.81	25.25	402.90	243.00
10%	70.58	80.78	13.05	7.93	61.81	26.38	414.50	249.20
Foliar spray								
Control	66.88	74.78	11.79	7.00	54.53	22.73	367.77	235.51
0.75% crop [†]	68.06	76.43	12.18	7.02	58.05	23.60	389.16	234.82
1% crop [†]	69.67	78.67	12.30	7.18	59.95	25.14	403.40	245.15
1.25% crop [†]	70.49	80.24	12.77	7.97	61.90	27.21	416.81	251.70
C. D. at 5%	1.31	NS	0.35	0.44	1.86	1.08	9.75	4.77
							9.54	9.54

TABLE 2
Effect of seedling treatment and foliar application of cytozime on growth and yield of brinjal

Treatments	Height of plant (cm)		Number of branches per plant		Number of marketable fruits per plant		Number of unmarketable fruits per plant		Total number of fruits per plant		Fruit yield (q/ha)		
	1977	1978	1977	1978	1977	1978	1977	1978	1977	1978	1977	1978	Mean
Seedling treatments													
Control	97.50	76.42	8.36	7.65	23.11	24.40	7.80	4.71	30.91	30.29	623.87	570.42	597.15
5%	99.45	77.30	8.73	7.88	24.10	26.23	7.77	6.00	31.87	32.23	648.03	576.89	612.46
7.5%	99.82	78.87	9.23	8.45	24.99	26.84	8.12	5.51	33.11	32.35	667.18	583.91	625.55
10%	100.61	82.37	9.28	8.48	26.37	27.41	7.97	5.79	35.35	33.20	669.83	593.62	631.73
Foliar spray													
Control	96.86	75.45	8.62	7.53	22.92	25.38	7.88	5.72	30.80	31.10	629.84	560.95	595.40
0.75% crop [†]	99.15	77.50	8.88	8.13	24.39	25.36	7.75	6.01	32.14	31.36	641.84	575.31	608.58
1% crop [†]	100.24	80.42	9.18	8.30	25.32	27.08	7.92	6.65	33.24	32.73	661.82	590.38	626.10
1.25% crop [†]	101.13	81.58	9.19	8.50	25.95	27.17	8.11	5.81	34.06	32.88	675.42	598.20	636.81
C. D. at 5%	1.42	1.88	0.45	0.41	0.41	1.08	NS	NS	0.90	1.12	9.71	12.10	10.38

the number of branches per plant. In both the years the number of fruits per plant was also increased with the increase in the concentration of cytozyme seedling treatment and the maximum number of fruits per plant was observed under 10% seedling treatment, whereas minimum in control. The highest yield was observed under 10% seedling treatment which was followed by 7.5% seedling treatment, whereas the lowest yield was obtained from control plots. This may be attributed to significantly greater number of fruits per plant.

Foliar spray. The data on height of plant, number of branches per plant, number of fruits per plant and fruit yield (Table 2) indicate significant differences among various cytozyme treatments. Height of plant was maximum under 1.25% crop+ spray followed by 1% spray, whereas the shortest plants were noted in control. The highest number of branches per plant was recorded in plots which received 1.25% crop+ spray closely followed by 1% spray. Foliar spray of cytozyme was also helpful in improving the number of fruits and highest number of fruits per plant was recorded under 1.25% crop+ spray, whereas control plots had lowest number of fruits. A significant difference in fruit yield due to different concentrations was obtained in both the years.

Chilli

Seedling treatment. The data in Table 3 indicate significant differences in height of plant due to various treatments during both the years. Maximum plant height was recorded from

10% seedling treatment. Minimum plant height was obtained under control. The differences in number of primary branches per plant and number of fruits per plant due to various treatments were significant during both the years. Maximum number of branches per plant was recorded from 10% seedling treatment. Maximum number of fruits per plant was recorded under 10% seedling treatment closely followed by 7.5 per cent and least number was obtained from control. The differences in yield due to various treatments were significant during 1977 as well as in pooled data. Maximum fruit yield was obtained under 10% seedling treatment followed by 7.5 and 5.0 per cent during both the years, whereas minimum yield was recorded in control.

Foliar spray. The trend in the foliar spray for various characters was similar to that of seedling treatments. Increase in concentration of cytozyme foliar spray increased the height of plant, number of branches, number of fruits per plant and fruit yield during both the years.

The increase in the height of plant in all the three crops during both the years at a particular concentration could be attributed to an increased rate of photosynthetic activity, accelerated translocation and efficiency of utilizing photosynthetic products, thus resulting in cell elongation and rapid cell division in the growing portion (Sargent, 1965). Another reason for increased growth may be probably the stimulating action of auxins which soften the cell wall by increasing its plasticity (Tagawa and Bonner, 1967). The increase in the number of branches per plant may be due to the increase in

TABLE 3
Effect of seedling treatment and foliar application of cytozime on growth and yield of chilli

Treatments	Height of plant (cm)		Number of primary branches per plant		Number of secondary branches per plant		Number of fruits per plant		Fruit yield (q/ha)		
	1977	1978	1977	1978	1977	1978	1977	1978	1977	1978	Mean
Seedling treatments											
Control	49.41	63.60	2.44	3.16	8.14	6.28	135.67	77.23	129.40	119.18	124.29
5%	50.98	64.55	2.58	3.25	8.25	6.48	140.76	79.86	136.40	122.13	129.47
7.5%	51.92	66.33	2.58	3.38	8.26	6.63	141.92	89.08	140.89	126.24	133.57
10%	52.23	66.73	2.73	3.48	8.59	6.89	152.64	96.06	144.73	127.43	136.08
Foliar spray											
Control	50.65	63.12	2.74	3.19	8.13	6.32	133.90	77.08	131.67	118.58	125.13
0.75% crop ⁺	50.79	65.38	2.56	3.21	8.10	6.56	139.96	81.24	138.11	123.50	130.81
1% crop ⁺	51.10	66.03	2.61	3.36	8.49	6.67	145.75	90.08	139.75	124.64	132.20
1.25% crop ⁺	52.01	66.68	2.69	3.52	8.50	6.75	151.39	93.83	142.20	128.27	135.24
C. D. at 5%	1.32	1.71	0.11	0.18	NS	NS	4.45	4.04	2.55	NS	3.21

the plant height as a result of osmotic uptake of water under the influence of plant growth regulators which maintain swelling force by the softening of cell wall or due to the stimulus caused by growth regulators in the absorption of available nutrients present in the soil (Kato, 1958). The most probable reason for increased fruit yield may be increased translocation or organic material in the treated plants (Shindy and Weaver, 1967). The mobilization or movement of nutrients into flowers and fruits by

cytozyme application might have improved the yield. The other possible reason for better fruiting with cytozyme application may be that external application of cytozyme increased the endogenous auxin content of flowers which improved fruit yield (Virzilov and Mihteleva, 1968). The increased fruit yield may also be due to the reason that plants remained physiologically more active to build up sufficient food stock for the developing flowers and fruits, ultimately leading to higher yield.

REFERENCES

- Kato, J. 1958. Studies on the physiological effect of GA. II. On the interaction of GA with auxins and growth inhibitors. *Sov. Plant Physiol.* 11 : 10-15.
- Pandita, M. L., Arora, S. K. and Sidhu, A. S. 1982. Effect of cytozyme on growth, yield and quality of muskmelon. *Haryana agric. Univ. J. Res.* 12 : 75-79
- Pandita, M. L. and Hooda, R. S. 1979. Effect of seed treatment and foliar application of cytozyme on growth, yield and quality of potatoes (*Solanum tuberosum* L.). *J. Indian Potato Assoc.* 6 : 219-21.
- Pandita, M. L., Hooda, R. S. and Sidhu, A. S. 1983. Effect of seed treatment and foliar application of cytozyme on growth and green pod yield of okra (*Abelmoschus esculentus* L.). *Haryana agric. Univ. J. Res.* 13 : 245-48.
- Pandita, M. L., Sidhu, A. S. and Hooda, R. S. 1981. Effect of cytozyme on growth and yield of radish. *Haryana J. hort. Sci.* 10 : 207-08.
- Sargent, J. A. 1965. The penetration of growth regulators into leaves. *Ann. Rev. Plant Physiol.* 16 : 1-8.
- Shindy, W. and Weaver, R. J. 1967. Plant regulators after translocation of photosynthetic products. *Nature* 214 : 1024-25.
- Singh, G. and Kaur, M. 1981. Effect of cytozyme on potato. *J. Indian Potato Assoc.* 8 : 9-14.
- Tagawa, T. and Bonner, J. 1967. Mechanical properties of the *Avena* coleoptile as related to auxin and to ionic interactions. *Plant Physiol.* 32 : 207-12.
- Virzilov, V. F. and Mihteleva, L. A. 1968. Effects of growth substances on the ripening and yield of tomatoes. *Hortic. Abstr.* 39 : 5003.

INTERFERENCE OF *AMARANTHUS TRICOLOR* WITH THE GROWTH AND DEVELOPMENT OF *VIGNA RADIATA*

ARUN BHASKAR, KALPANA G. VYAS* and B. K. SINGHAL

Department of Botany
University of Jodhpur, Jodhpur

(Received : January 12, 1984; Revised : April 1, 1985)

ABSTRACT

Interference of *Amaranthus tricolor* L., a dominant weed of leguminous crop fields, with the growth of *Vigna radiata* was studied by growing them in pure and mixed stands. Increasing density of the weed considerably reduced the assimilatory efficiency and nutrient absorption by the legume. Slower growth rate and reduced productivity consequently resulted in reduced dry matter production of legume at higher weed densities. The weed appears to depress the growth of the legume by means of exerting its allelopathic influence.

In cropland ecosystem the green plants are the primary producers. The crop plants are cultivated by man for his requirements of food and fibre, however, there are other plants coming up of their own in the crop fields, referred to as 'weeds'. The leguminous grain crops are sown as kharif crops at Rajkot. They are sown after the first monsoon showers. During this period the conditions also become favourable for the germination of weed seeds which after germination grow rapidly and interfere with the growth of the crop plants. *Amaranthus tricolor* L. is a preponderate weed of legume crop fields and results in a considerable competition with the crop for various essential growth factors.

MATERIAL AND METHODS

Interference of *Amaranthus tricolor* with the growth of *Vigna radiata* (L.)

Wilczek (mungbean) was studied at the Experimental Garden of Biosciences Department, Saurashtra University, Rajkot. Soil is typical sandy-clayey loam with pH ranging between 7.6 to 7.8 during the experimental period. The field was ploughed and 100 kg/ha of FYM was mixed with the soil before planting.

The seeds of mungbean (cv. G-2), obtained from the Gujarat Agricultural University, Junagadh Campus, Junagadh and seeds of *A. tricolor* (collected from the local crop fields) were sown in plots of 1 m² in the month of July. The plots were surrounded by ridges about 15 cm high and 30 cm fallow area between the two plots. Pure and mixed stands had the constant density of mungbean (12 plants/m²) with varying densities of the weed plants resulting in following combinations :

*Department of Biosciences, Saurashtra University, Rajkot.

TABLE 1
Structural and functional attributes of *Vigna radiata* in pure stands and in *Amaranthus tricolor* mixtures

Attributes	Density/m ² (Crop : Weed)			
	12 : 0	12 : 3	12 : 6	12 : 24
Structural				
1. Biomass (g/m ²)	71.21	52.97	57.26	31.51
Root (%)	9.25	10.87	10.18	11.29
Stem (%)	22.46	23.06	23.01	24.41
Leaf (%)	52.33	48.22	48.16	53.48
Pod (%)	15.96	17.85	18.65	10.83
2. Leaf area index	0.590	0.461	0.443	0.370
3. Nitrogen content (%)	2.13	2.06	2.49	2.23
4. Phosphorus (%)	0.34	0.43	0.43	0.35
5. Potassium (%)	2.05	1.55	1.60	1.18
6. Nitrogen content (g/m ²)	1.594	1.036	1.240	0.751
7. Phosphorus (g/m ²)	0.247	0.222	0.172	0.109
8. Potassium (g/m ²)	1.534	0.826	0.999	0.453
Functional				
9. Relative growth rate (mg/g/day)	72.00	66.00	66.00	57.00
10. Net primary productivity (g/m ² /day)	1.288	1.075	1.026	0.485
11. Nitrogen uptake (g/m ² /day)	0.0367	0.0205	0.0260	0.0145
12. Phosphorus uptake (g/m ² /day)	0.0114	0.0099	0.0069	0.0048
13. Potassium uptake (g/m ² /day)	0.0403	0.0237	0.0256	0.0099

Mungbean	12	12	12	12	12
<i>A. tricolor</i>	0	3	6	12	24

Weeding was done frequently to avoid the invasion of other weed species. Three replications for each treatment were maintained. The crop plants were harvested 20, 40, 60 and 80 days of their emergence and results are expressed average of these four harvests. Plant material was dried in hot air oven at 80°C to constant weight and dried powdered plant material was analysed for nitrogen, phosphorus and potassium as per the methods of Allen *et al.* (1974).

RESULTS AND DISCUSSION

Dry matter production of mungbean was considerably reduced at higher densities of the weed and in 12:24 crop: weed mixture it was less than half that recorded in pure stands of mungbean (Table 1). There are several reports of reduction in dry matter production of crops with increasing interference from weeds (Bleasdale, 1960; Thurlow and Buchanan, 1972; Kapoor and Ramakrishnan, 1975; Hawton and Drennan, 1980; Bhaskar *et al.*, 1983; Singhal, 1984). Relative accumulation of biomass in component plant parts was, however, little affected by weed interference. The scarcity of vital factors in weed mixtures also reduced the leaf area of mugbean as well as their assimilatory efficiency. In consequence, net primary productivity was also severely curtailed at high weed densities. Slower growth rate at higher weed densities also reduced the growth of mung-

bean. Increasing interference from weed also deleteriously affected the uptake of nitrogen, phosphorus and potassium as concentration of these minerals in mungbean was considerably reduced at higher weed densities. Weeds have been demonstrated to absorb more amounts of mineral nutrients at the expense of crop plants (Vengris, 1956). Despite smaller in size in comparison to mungbean, the weed considerably reduced the growth and development of mungbean. As competition is regarded as closer between the species of like forms and greater the difference between the species in one or all the characters, the less severe is the competition (Ramakrishnan and Kumar, 1971), allelopathy seems to play a crucial role in limiting the growth of mungbean. Allelopathic potential of this weed has been demonstrated by Vyas (1982).

The effect of weed interference on energy captured and nitrogen uptake by the legume plants has been represented in the form of compartmental model (Fig. 1). As the number of weed plants per unit area increased, the environmental resources were utilised less efficiently by the legume, and lesser solar energy was trapped per unit land surface. Besides the energy, the total amount of nitrogen being input into the legume plants also decreased with the rising weed density. The extent of dry matter yield and nitrogen yield losses express the need for more detailed studies on the interference of the weed, especially biochemical interference with the growth of mungbean and other legumes.

CROPLAND ECOSYSTEM

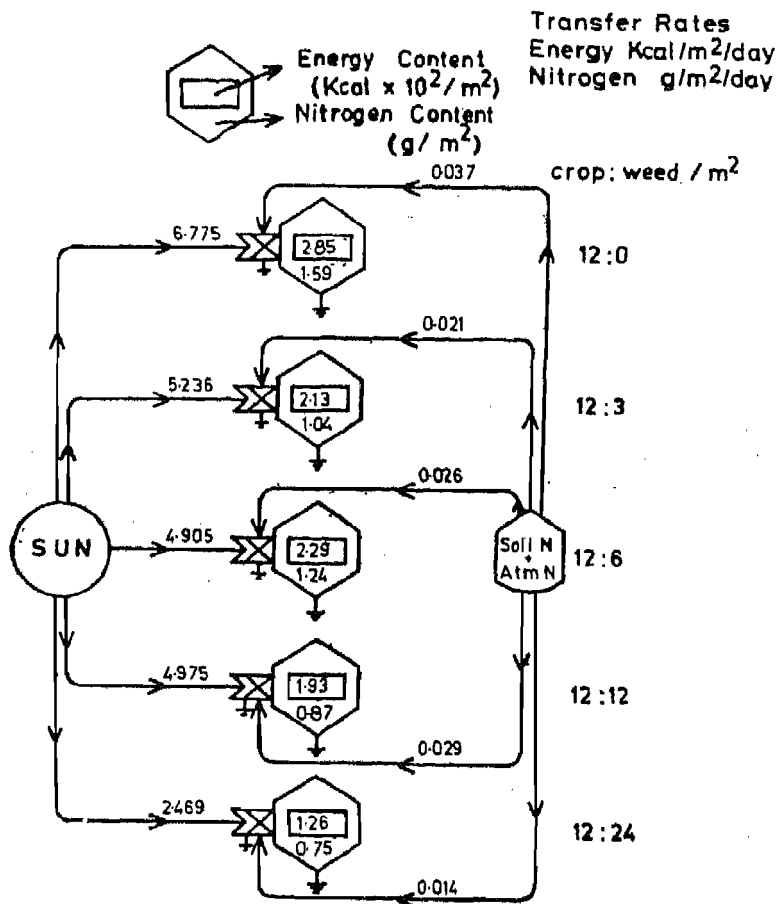


Fig. 1. A compartmental model showing the effect of *Amaranthus tricolor* on structural and functional attributes of *Vigna radiata* at different densities.

REFERENCES

- Allen, S. E., Grimshaw, H. M., Parkinson, J. A. and Quarmby, C. 1974. *Chemical Analysis of Ecological Material*. Blackwell Scientific Publ. Ltd., Oxford, London.
- Bhaskar, A., Vyas, K. G. and Pandya, S. M. 1983. Nitrogen relationships of *Vigna mungo* in pure stands and in *Celosia argentea* mixtures. *Ann. Bot.* (in press).
- Bleasdale, J. K. A. 1960. Studies on plant competition. In : *The Biology of Weeds*, pp. 133-42. Harper, J. L. (ed.). Blackwell Scientific Publ. Ltd., Oxford.
- Hawton, D. and Drennan, D. S. H. 1980. Studies on competition between *Setaria anceps* and *Eleusine indica*. *Weed Res.* 20 : 211-15.
- Kapoor, P. and Ramakrishnan, P. S. 1975. Weed-crop behaviour in pure and mixed stands of maize and *Echinochloa colona* Link. *Proc. Indian Acad. Sci.* 82-B : 175-94.
- Ramakrishnan, P. S. and Kumar, S. 1971. Mortality, plasticity and productivity of interfering model populations of maize and *Cynodon dactylon* (L.) Pers. *J. Indian bot. Soc.* 50 : 321-31.
- Singhal, B. K. 1984. Ecological studies on *Amaranthus* spp. as weed and as vegetable in Indian arid zone. Ph. D. thesis, University of Jodhpur, Jodhpur.
- Thurlow, D. L. and Buchanan, G. A. 1972. Competition of sickle pod with soybeans. *Weed Sci.* 20 : 379-84.
- Vengris, J. 1956. Weed-robbers of our farms. *Bett. Crops* 40 : 9-12.
- Vyas, K. G. 1982. Nitrogen fixation by leguminous crop plants and interference thereof by dominant weeds. Ph. D. thesis, Saurashtra University, Rajkot.

POLLINATION IN RELATION TO SEED YIELD IN SUNFLOWER

HARI SINGH and A. K. YADAV

Department of Plant Breeding

Haryana Agricultural University, Hisar

(Received: August 26, 1983; Revised: January 2, 1985)

Sunflower is a widely adapted crop, which can be cultivated round the year in India (Rajan, 1974; Yadava *et al.*, 1976). Owing to its photo-insensitive nature, it can be grown in any season but its yield fluctuates considerably from season to season (Yadava *et al.*, 1976). These variations in yield could be largely attributed to the variations in seed filling and seed setting which also vary over seasons. Khanna (1972) and Kandilkar and Mahajan (1975) listed various factors responsible for poor seed setting in this crop. Poor seed set which is attributed to the lack of pollination is directly responsible for reduction in seed yield. The present study was, therefore, undertaken with the objectives to see the effect of pollination on seed setting, seed yield, seed weight and oil content in different seasons.

For the above objectives, three well adapted sunflower populations viz., EC 68415, Romsun Record and EC 68414 were maintained by two treatments, i. e., open pollination and hand pollination. For latter treatment, bulk of the pollens was dusted every day up to the emergence of last flower in a capitulum. The experiment was conducted in randomized block design in four

replications. There were total six treatments (three varieties each having open pollinated and hand pollinated treatments) each consisted of four rows each of 6 m length. The spacing between rows and between plants within row was kept at 45 and 30 cm, respectively. Twenty plants from two middle rows for each treatment were tagged for observations on seed yield, seed setting (per cent), 100-seed weight (g) and oil content (per cent). The experiment was conducted at Haryana Agricultural University, Research Farm, during rainy season of 1977 and winter season of 1978. All the recommended package of practices were adopted to raise a good crop.

The data were analysed statistically and the results are presented in Tables 1 and 2. The perusal of the data presented in Table 1 revealed that during 1977, there were significant differences among two treatments (open pollination and hand pollination) in respect of all the characters. There were significant differences among varieties for per cent seed setting, 100-seed weight and oil content. During this year, variety $\times$ treatment interactions were significant for seed setting and oil content. This indicated that there was differential effect of

TABLE 1

Analysis of variance for four characters during 1977 and 1978

Source	d. f.	M. S. for the characters (1977 rainy season)				M. S. for the characters (1978 winter season)			
		Yield	Seed setting	100-seed weight	Oil content	Yield	Seed setting	100-seed weight	Oil content
Replications	3	20.81	23.01	0.413	2.540	31.41	3.07	0.023	2.210
Treatments	1	493.23**	1626.91**	6.890**	15.360**	337.63**	1493.10**	2.870	1.371
Varieties	2	18.88	128.21*	4.271**	16.780**	55.46**	1180.59**	2.060	2.194
Treatment × Variety	2	6.50	110.10*	0.842	2.320*	27.89*	19.78	0.245	2.187
Error	15	12.89	21.85	0.356	0.569	4.41	13.39	0.968	1.205

*Significant at 5% level

**Significant at 1% level.

TABLE 2

Effect of hand pollination on yield, seed setting, seed weight and oil content

Varieties	Treatments	Yield per plant (g)		Seed setting (%)		100-seed weight (g)		Oil content	
		R	W	R	W	R	W	R	W
EC 68415	Open pollinated	13.72	35.70	21.32	71.67	10.18	5.70	35.78	41.94
	Hand pollinated	22.67	43.06	46.35	90.05	8.30	5.02	33.04	40.70
EC 68414	Open pollinated	15.40	32.00	20.42	83.97	9.01	5.37	38.18	41.60
	Hand pollinated	26.32	36.52	32.27	96.02	7.63	5.02	34.73	42.21
Romsun Record	Open pollinated	16.87	31.95	21.37	56.97	8.09	6.67	37.57	42.70
	Hand pollinated	24.20	43.87	33.90	76.07	7.50	5.62	30.97	41.54
C. D. at 5% for									
Variety		—		4.98		0.64		0.80	
Treatment		3.12		1.83		4.07		—	
Variety × Treatment		—		3.16		7.04		—	
C. V. (%)		18.08		5.65		15.97		4.59	
R—1977 rainy season.						7.05		5.58	
W—1978 winter season.								2.11	
								2.63	

POLLINATION IN SUNFLOWER

treatment depending upon the genotypic background. During winter season of 1978, there were significant differences among the treatments for seed yield and seed setting. Varieties also exhibited significant differences for these characters. A review of the data in Table 2 indicated that hand pollination increased the seed yield (averaged over all the varieties) by 59.3% in rainy season and 23.9% in winter season. Higher seed set by hand pollination in rainy season may be attributed to the fact that in this season there was inadequate number of pollinators due to rains and cloudy weather prevailed during flowering period. Seed setting was 78.2% higher in hand pollinated plants over the open pollinated ones during rainy season. In winter season, however, hand pollination increased the seed setting by 26.6% over open pollination (averaged over all the varieties). Appreciably higher seed set in winter season in open pollination was apparently due to presence of higher number of bamboo beetles and bees in surrounding *Brassica* crops. EC 68415 in rainy season and Romsun Record in winter season responded most for hand pollination resulting into higher per-

centage of seed set and increased seed yield. The seed size was decreased by hand pollination. Open pollination resulted into increased 100-seed weight by 16.4% in rainy and 13.3% in winter seasons over controlled pollination. The increased seed weight in open pollinated plants could be attributed to the less number of seeds set in the head (capitulum) which eventually provided more space and nutrition for seed development and filling. Hand pollination led to decrease in oil content in rainy season. However, in winter season the oil content remained unaffected.

Based on two seasons, hand pollination led to increased seed setting and seed yield. It, therefore, envisaged that the differences in seed yield over seasons and lower yields of the crop, could be attributed to the lack of pollination. Present study indicated that yield levels of these varieties could be further increased by ensuring an adequate number of pollinators by keeping beehives in the fields and/or by hand pollination through rubbing two capitula in the morning hours.

REFERENCES

- Kandilkar, B. J. and Mahajan, A. G. 1975. The problem of seed filling and seed setting in sunflower. *Punjab Rao Krishi Vidyapeeth Res. J.* 3 (8) : 118-20.
- Khanna, K. R. 1972. Factors affecting the production of filled seeds in sunflower. *Euphytica* 21 : 384-87.
- Rajan, S. S. 1974. Sunflower as a potential oilseed crop for India. *SABRAO (Suppl.)* : 669-74.
- Yadava, T. P., Singh, Hari and Yadav, A. K. 1978. Yield response of sunflower variety Armavirskij to dates of planting in arid-climate. *Haryana agric. Univ. J. Res.* 6 : 229-31.

EFFECT OF CULTURE MEDIA, TEMPERATURE AND pH ON GROWTH AND SPORULATION OF FUNGAL FOLIAR PATHOGENS OF COTTON

B. K. SHARMA and M. S. CHAUHAN

Department of Plant Pathology

Haryana Agricultural University, Hisar

(Received : November 10, 1983; Revised : December 20, 1984)

Leaf spot diseases of cotton (*Gossypium hirsutum* L.) caused by fungal pathogens are serious as reported from several parts of India (Rane and Patel, 1956 a, b; Munjal, 1960; Patil and Gadage, 1972). Considerable losses are caused to this crop through drying and shedding of the leaves. Studies on the pathogenic behaviour of isolates of *Myrothecium roridum* Tode ex. Fr; *Alternaria macrospora* Zimm., *Helminthosporium spiciferum* (Bain.) Nicot. and *Curvularia lunata* (Wakk.) Boed. from cotton have shown that the organisms are mainly confined to the leaves but occasionally affect other parts of the plant.

The fungi were isolated from diseased cotton leaves collected from different cotton growing areas of Haryana and were purified by single spore isolation technique of Keitt (1915) as modified by Ezakiel (1930). Stock cultures were maintained on Potato Dextrose Agar (PDA). Richard's solution was used as basal medium for all the isolated pathogens except for *Curvularia lunata* for which Asthana Hawkar's solution was used for nutritional studies.

Fifty ml of medium was dispensed into 150 ml Erlenmeyer flasks. Similarly 90 mm petriplates were used for solid media studies. The inoculum (6 mm circular disc) was prepared from one week old culture on PDA. The flasks and petriplates were incubated at $25^{\circ} \pm 1^{\circ}\text{C}$ (except where mentioned otherwise). Ten flasks and petriplates were used for each treatment and each treatment had four replications. The growth on solid media was determined by measuring the radial diameter of the colony after 9 days while in liquid media the growth was determined by taking the dry weight of mycelium after 15 days of incubation and the degree of sporulation was determined on the basis of spores per microscopic field seen through low power.

Effect of Different Culture Media

To find out a suitable basal medium for conducting further nutritional studies, six media viz., Potato Dextrose Agar, Richard's Agar, Brown's Agar, Czapek's Agar, Modified Czapek's Agar and Asthana Hawkar's Agar were used. The data regarding the radial growth and

sporulation are summarised in Table 1 which indicated that radial growth of *A. macrospora*, *H. spiciferum*, *M. roridum* and *C. lunata* was maximum in Richard's Agar followed by Modified Czapek's Agar. The sporulation of all the fungi except *C. lunata* was also abundant on both the media while maximum sporulation in case of *C. lunata* was observed on Asthana Hawkar's Agar and was scanty on Richard's Agar. Munjal (1960) and Chauhan (1967) have also reported that semi-synthetic media like PDA did not excel some of the synthetic media in supporting the growth and sporulation of the organisms. Rane and Patel (1956b), Chauhan (1967) and Goyal (1977) also reported that Richard's Agar was the best for growth and sporulation of *Alternaria*, *Helminthosporium* and *Myrothecium* species.

Effect of Different Temperatures

The data presented in Table 2 regarding the dry weight of mycelium revealed that *A. macrospora* grew and sporulated well in the temperature range of 15-30°C while maximum growth and sporulation were observed at 25°C and minimum at 35°C. Padmanabhan and Narayanasamy (1977) and Rane and Patel (1956a) also observed maximum growth at 27°C. Maximum growth and abundant sporulation of *H. spiciferum* were observed at 30°C followed by 35°C. The pathogen grew and sporulated well in the temperature range of 15-35°C, least growth was observed at 10°C. Reddy (1975) also observed 30°C as the optimum temperature for growth. *M. roridum* grew well in the temperature range of 20-30°C, with maximum at 25°C and least growth was

observed at 10°C but sporulation was abundant at higher temperature and poor at lower one. Munjal (1960) and Chauhan and Suryanarayana (1970) also reported that this fungus grows well at temperature range of 10-35°C with an optimum at 25°C and maximum sporulation was at 35°C. Temperature range of 20-35°C was observed optimum for growth and sporulation of *C. lunata*. The growth was maximum at 25°C and least at 10°C; abundant sporulation was observed in the range of 20-35°C while sporulation was absent at 10°C. Singh (1972) also observed 25°C to be the best temperature for growth of two species of *Curvularia*.

Effect of Different H-ion Concentrations

The data regarding the dry weight of mycelium in Table 3 revealed that pH range of 4 to 6 was best for growth and sporulation of *A. macrospora*. Growth and sporulation were maximum at pH 5 and minimum at pH 3. In case of *H. spiciferum* maximum growth and abundant sporulation were observed at pH 6 while it grew and sporulated well at pH range of 5-7. Maximum growth and abundant sporulation of *M. roridum* were observed at pH 6. The fungus grew well in the pH range of 4.9-7.0 while pH 5-6 was optimum for sporulation. The pH range of 5-7 was observed best for growth and sporulation of *C. lunata* with maximum at 6 and minimum at pH 3. Chauhan and Suryanarayana (1970), Reddy (1975) and Goyal (1977) also observed that growth decreased in high acidity and alkalinity, range of optimum reaction lies between 4.2-6.0. It

TABLE 1
Effect of different culture media on growth and sporulation of different fungal foliar pathogens of cotton

Solid medium used	Average colony diameter after 9 days (mm)					
	<i>A. macrospora</i> *		<i>H. spiciferum</i> **		<i>M. roridum</i> *	
	Colony diameter	Sporulation***	Colony diameter	Sporulation	Colony diameter	Sporulation
Potato Dextrose Agar	82.1	3	75.2	4	85.1	4
Richards' Agar	90.0	4	90.0	4	89.0	4
Czapek's Agar	87.2	3	82.5	3	86.8	3
Brown's Agar	75.6	2	61.7	2	76.7	2
Modified Czapek's Agar	88.1	4	87.9	4	88.1	4
Asthana Hawkar's Agar	86.2	3	85.0	3	89.4	3
C.D. at 5% level	2.98		3.48		2.63	
					1.78	

*Incubated at $25^{\circ}\pm 1^{\circ}\text{C}$.**Incubated at $30^{\circ}\pm 1^{\circ}\text{C}$.

***0—Absent, 1—Scanty, 2—Moderate, 3—Good and 4—Abundant.

TABLE 2
Effect of temperature on growth and sporulation of different fungal foliar pathogens of cotton

Temperature (°C)	Dry weight of mycelium after 15 days (mg)					
	<i>A. macrospora</i> *		<i>H. spiciferum</i> **		<i>M. roridum</i> *	
	Dry weight	Sporulation***	Dry weight	Sporulation	Dry weight	Sporulation
10	162.24	2	374.98	2	90.75	1
15	285.76	3	487.02	3	204.51	1
20	434.30	4	529.43	3	398.81	2
25	518.57	4	614.24	3	650.21	3
30	227.28	2	951.65	4	368.72	4
35	129.96	1	793.24	4	365.13	4
C.D. at 5% level	8.02		21.72		6.30	
					5.99	

*Incubated at $26^{\circ} \pm 1^{\circ}\text{C}$.

**Incubated at $30^{\circ} \pm 1^{\circ}\text{C}$.

***0—Absent, 1—Scanty, 2—Moderate, 3—Good and 4—Abundant.

TABLE 3
Effect of different Hydrogen-ion concentrations on growth and sporulation of different fungal foliar pathogens of cotton

pH of the medium		Dry weight of mycelium after 15 days (mg)							
Before sterilization	After sterilization	<i>A. macrospora</i> *		<i>H. spiciferum</i> **		<i>M. roridum</i> †		<i>C. lunata</i> *	
		Dry weight	Sporulation***	Dry weight	Sporulation	Dry weight	Sporulation	Dry weight	Sporulation
3.0	2.0	27.52	1	231.42	1	316.75	1	56.84	1
4.0	3.9	395.24	2	388.52	3	671.20	2	72.44	2
5.0	4.8	593.69	4	528.46	4	747.23	4	89.92	4
6.0	5.8	306.72	3	665.26	4	753.69	4	95.21	4
7.0	6.7	181.26	2	488.93	3	691.92	3	79.63	3
8.0	7.8	98.17	1	287.66	1	287.88	1	60.69	1
C.D. at 5% level		6.35		5.37		6.04		5.66	

*Incubated at $25^{\circ} \pm 1^{\circ}\text{C}$.

**Incubated at $30^{\circ} \pm 1^{\circ}\text{C}$.

***0—Absent, 1—Scanty, 2—Moderate, 3—Good and 4—Abundant.

FUNGAL FOLIAR PATHOGENS OF COTTON

has also been noticed that the growth of the pathogens was less in neutral and alkaline mediums than that of acidic medium. Hence, our results are in agree-

ment with others (Munjai, 1960; Chauhan and Suryanarayana, 1970; Reddy, 1975; Padmanabhan and Narayanasamy, 1977).

REFERENCES

- Chauhan, M. S. 1967. Studies on the *Myrothecium* leaf spot disease of cotton caused by *Myrothecium roridum* in Haryana State. M.Sc. thesis, Punjab Agricultural University, Hisar.
- Chauhan, M. S. and Suryanarayana, D. 1970. Effect of temperature, pH and light on growth and sporulation of *Myrothecium roridum*, causal organism of leaf spot disease of cotton in Haryana State. *Indian Phytopathol.* **23** : 560-63.
- Ezakiel, W. N. 1930. Modified procedure with the Keitt Single spore method. *Phytopathology* **20** : 583-86.
- Goyal, K. N. 1977. Effect of pH, carbon and nitrogen nutrition on growth and sporulation of *Alternaria tenuis* (*A. alternata*). *Indian J. Mycol. Plant Pathol.* **7** : 155-57.
- Keitt, G. W. 1915. Simple technique for isolating single spore strain of certain types of fungi. *Phytopathology* **5** : 266-69.
- Munjai, R. L. 1960. A commonly occurring leaf spot disease caused by *Myrothecium roridum* Tode ex. Fr. *Indian Phytopathol.* **13** : 150-55.
- Padmanabhan, P. and Narayanasamy, P. 1977. Growth studies of *Alternaria macrospora* Zimm; an Incitant of leaf spot disease of cotton. *Madras agric. J.* **64** : 258-61.
- Patil, B. P. and Gadage, N. B. 1972. *Curvularia* leaf spot of cotton in Maharashtra. *Curr. Sci.* **4** : 343.
- Rane, M. S. and Patel, M. K. 1956a. Diseases of cotton in Bombay. I. *Alternaria* leaf spot. *Indian Phytopathol.* **9** : 106-12.
- Rane, M. S. and Patel, M. K. 1956b. Diseases of cotton in Bombay. II. *Helminthosporium* leaf spot. *Indian Phytopathol.* **9** : 169-72.
- Reddy, S. M. 1975. Influence of pH, temperature and carbon concentration on the growth of five species of *Helminthosporium*. *Labdev J. Sci. Technol.* **13B** : 83-88.
- Singh, B. P. 1972. Nutritional studies on two species of *Curvularia* causing leaf spot disease. II. Temperature requirements. *Proc. Nat. Acad. Sci. India, Sec. B.* **42** : 229-30.

RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XV, No. 3, pp. 350—352 (September 1985)

EFFECT OF CARBOFURAN ON PADDY INFECTED WITH RICE-ROOT NEMATODE, *HIRSCHMANNIELLA ORYZAE*

R. K. WALIA and D. S. BHATTI*
Department of Nematology
Haryana Agricultural University, Hisar

(Received : November 21, 1983; Revised : March 5, 1984)

The rice-root nematode (*Hirschmanniella* spp.) is known to occur in all the rice growing areas of the world and causes significant reduction in yield (Mathur and Prasad, 1972; Fortuner, 1974). In the present studies, the efficacy of carbofuran (Furadan 3 G) was tested on the growth of paddy, loss in yield due to *H. oryzae* and its population under field conditions.

A field naturally infested with *H. oryzae* @ 250 nematodes per 100 ml soil was selected in the village Bhateri (District Kurukshetra, Haryana). At the time of nursery sowing on 3.6.1981 with paddy cv. Jaya, half of the area was treated with carbofuran @ 1 kg a. i./ha and the other half left untreated. During

transplanting on 9.7.1981, ten seedlings were taken at random from both the treated and untreated halves and observations were recorded on seedling height, fresh root weight and nematode population in roots (Table 1). The carbofuran treated seedlings had 27.2 and 15.3 per cent more height and fresh root weight, respectively, as compared to untreated ones. However, the increase in fresh root weight did not differ significantly. There was a marked reduction (69%) in the root population of nematodes in treated seedlings over untreated ones.

Transplanting was done, in a field having same level of initial population, in plots of 4 × 2 m size. In the main-field, the treatments were : T₁ = control (seed-

TABLE 1
Effect of carbofuran on paddy seedlings infected with *H. oryzae* in nursery

Treatment	Seedling height (cm)	Per cent increase over control	Fresh root weight (g)	Per cent increase over control	Nematode population per g of root	Per cent decrease over control
Control (untreated nursery)	16.8	—	1.0	—	12.6	—
Carbofuran (Furadan 3G) @ 1 kg a. i./ha	21.4	27.2	1.1	15.3	3.9	69.0
C. D. at 5%	3.3	—	NS	—	3.1	—

*Present address : Directorate of Extension Education.

TABLE 2
Effect of carbofuran on paddy plants infected with *H. oryzae* and nematode population (average of five replicates with each replicate containing ten seedlings)

Treatment	Plant height (cm)		Fresh root weight (g)		No. of tillers (flowering)		Soil		Nematode population		Yield per plot (kg)		Percent increase in yield over control
	1*	2**	1	2	1	2	1	2	1	2	1	2	
T ₁	60.9	65.2	5.6	9.2	7.4	9.1	196.0	240.9	25.4	38.2	221.4	279.1	5.31
T ₂	62.1	66.5	6.2	9.6	7.2	9.6	188.3	223.8	24.9	36.6	213.2	260.4	5.37
T ₃	67.5	72.3	6.1	9.8	7.4	9.4	104.4	157.0	10.0	15.4	114.4	172.4	6.23
C. D. at 5%	3.9	4.8	NS	NS	NS	NS	49.0	54.2	9.5	12.5	—	—	0.77

*After 50 days of transplanting.

**At harvest.

lings from untreated nursery); T₂=seedlings from treated nursery; T₃=as T₂ but followed by soil application of carbofuran @ 1 kg a.i./ha each at 7 and 50 days after transplanting. Observations were recorded on plant height, number of flowering tillers, fresh root weight, nematode population in soil and roots after 50 days of transplanting and at the time of harvest (30.10.1981) along with yield data (Table 2).

The plant height after 50 days of transplanting and at the time of harvest was significantly more in T₃ (nursery as well as main-field treated plants) compared to T₁ (untreated plants) and T₂ (only nursery treated plants). As far as the fresh root weight and number of flowering tillers are concerned no significant differences were noticed among the treatments. The

nematode population in soil and root, 50 days after transplanting and at the time of harvest was slightly less in T₂ as compared to T₁, but was significantly less only in T₃. Slight increase in yield in T₂ (1.1%) over control was non-significant but it was significantly more in T₃ (12.2%) over both T₁ and T₂. Muthukrishnan *et al.* (1977) obtained 34.8% increase in yield by applying carbofuran 30 days after planting @ 1 kg a.i./ha in field experiments in Tamil Nadu.

It can be concluded that nursery treatment alone with carbofuran @ 1 kg a.i./ha is not sufficient to get more yield. But if it is followed by application of carbofuran again @ 1 kg a.i./ha each 7 and 50 days after transplanting, significant increase in yield can be recorded (17.2%).

REFERENCES

- Fortuner, R. 1974. Evaluation of damage caused by *Hirschmanniella oryzae* (Van Breda de Haan, 1902) Luc and Goodey, 1963, an endoparasitic nematode of irrigated rice roots. *Agron. Trop.* 29 : 708-14.
- Mathur, V. K. and Prasad, S. K. 1972. Role of rice-root nematode, *Hirschmanniella oryzae* in rice culture. *Indian J. Nematol.* 2 : 158-68.
- Muthukrishnan, T. S., Rajendran, G., Ramamurthy, V. V. and Chandrasekaran, J. 1977. Pathogenicity and control of *Hirschmanniella oryzae*. *Indian J. Nematol.* 7 : 8-16.

STUDY OF SELF-DISCLOSURE IN RURAL AND URBAN BOYS

S. PUNIA and T. R. VERMA
College of Home Science
Haryana Agricultural University, Hisar

(Received : August 24, 1983; Revised : April 23, 1985)

ABSTRACT

The study undertaken in the village Muklan and city Hisar on 50 rural and urban boys revealed that both the groups have obtained lower disclosure score in comparison to the norms of Sinha (1977). Pattern of disclosure among rural and urban boys was high on areas of study and feeling-ideas, however, for sex it was found to be the least. The target group with maximum preference comprised father and mother in both the cases. The pattern of disclosure on different areas of self and target groups was found similar among rural and urban boys, however, rural boys were higher in their disclosure in comparison to the urban boys.

'Self' is the inner image of ones own personality which manifests itself overtly through self-disclosure. Sinha (1973) explained this as a direct means through which an individual is known to other persons and is must for the healthy mental personality.

The study conducted by Jourard (1971), Brown and Weiner (1979) and Saxena and Kapoor (1979) highlighted specific areas of self-disclosure, extent to which feelings have been shared and the target groups of disclosure. These studies confirmed the fact that self-disclosure is highly personalized and follows a definite set pattern. If the pattern of disclosure is known, the counselling and guiding young adolescent for their educational, social and personal development could be strategically formulated. With these intentions in mind the present study was undertaken to find out the self-disclosure pattern in rural and urban adolescent boys

with special reference to the pattern of disclosure and target groups.

METHODOLOGY

Twentyfive boys from Govt. High School, Muklan in Hisar Block-I and 25 boys of C. R. High School in Hisar City were selected for the present study. The criteria of selection were restricted to specific age category, i. e., middle adolescent (17 years) and education upto 10th standard. Disclosure inventory of Sinha (1977) was used for obtaining disclosure scores. This inventory included eight areas of disclosure viz., money, personality, study, body, interest, feeling-ideas, vocation and sex. Each area comprised 10 problems for which the adolescent were to give their disclosure under six target groups, viz., mother, father, brother, sister, friend and teacher. The data were collected personally and were analysed to obtain total disclosure scores on

different areas and patterns of disclosure. The medium scores for each area and target groups were adjudged against the standard norms developed by Sinha (1977) for rural and urban boys.

RESULTS AND DISCUSSION

Parents Socio-Personal and Economic Profile

The study revealed that all of the rural boys belonged to joint families comprising 5 to 10 members, whereas urban boys in majority of the cases belonged to families with 3 to 4 members. Majority of the rural boys reported that their parents were illiterate (96% mothers and 56% fathers), whereas only 20% fathers had acquired high school and above level education. The urban boys confirmed that 68% fathers had high school and above level education, and only 20% were illiterates. As regards their mothers, 60% were illiterates and 40% had primary school education. Majority of the parents were occupied in government services. Majority of the rural boys reported their parents income in the range of Rs. 801 to 1000 and above, whereas urban boys reported that in majority (60%) of the cases their parents income ranged between Rs. 200 to 400 and 401 to 600 per month.

Disclosure Areas and Patterns Among Rural and Urban Boys

The data in Table 1 confirmed that 52% rural boys and 28% urban boys got the average disclosure scores, when compared with the scores categories of Sinha (1977). It may be concluded that rural boys disclose more than urban boys. This might be due to the fact that

TABLE 1

Distribution of rural and urban boys according to their disclosure scores

Category	Disclosure scores*	Percentage	
		Rural	Urban
Very high	600 and above	20	0
High	500-599	12	12
Average	400-499	20	16
Low	300-399	4	60
Very low	299 and below	44	12

*Sinha (1977).

in rural areas boys do not have much scope of leisure time activities, therefore, most of their time is spent with peer groups and family members. Hence, their disclosure pattern becomes more stronger in comparison to urban boys. Studies conducted by Saxena and Kapoor (1979) confirmed the similar trend of disclosure, however, in different type of community and reported that tribals scored significantly higher than the non-tribal counter part.

Data in Table 2 indicate that rural boys were lower in their disclosure in comparison to the norms on different areas of self and also in their disclosure to different target groups. But on areas of self, viz., money, personality and study their obtained scores got nearer conformity with the standard norms. As regards the target figures almost all targets got low scores, than the standard norms, except sister who got similar scores. The pattern of disclosure to different target groups among rural boys revealed that mothers, fathers and friends occupy the highest position and the sister the least. As regard different areas of self among

SELF-DISCLOSURE IN RURAL AND URBAN BOYS

TABLE 2
Comparison of median scores of rural and urban boys with their age norms

		Areas of self										Target figures						
		M	P	St	B	I	F-I	V	S	To	Mo	Fa	Br	Si	Fr	Te	To	
Rural	Standard norms	50	49	64	50	56	60	58	50	437	81	94	80	35	87	58.5	435.5	
	Obtained scores	49	46	59	48	52	55	42	34	385	73	82	68	35	78	49	385	
Urban	Standard norms	54	51	71	56	65	65	61	24	447	88	80	85	51	97	44	445	
	Obtained scores	41	44	52	46	48	49	49	39	368	85	101	82	35	46	19	368	

M—Money, P—Personality, St—Study, B—Body, I—Interests, F-I—Feeling-Ideas, V—Vocation, S—Sex, To—Total.
Mo—Mother, Fa—Father, Br—Brother, Si—Sister, Fr—Friend, Te—Teacher.

rural boys the disclosure was found more frequent in case of study followed by their feelings and ideas and least about the sex and personality. These findings are in agreement with Jourard (1971) who confirmed that some of the relatively safe topics shared were about work, interest, tastes, hobbies and to a lesser extent the attitudes. More reluctant areas to be shared were financial affairs, feeling, and problems relating to personality and sex life. The target persons among males were both the parents but disclosure was to a larger extent to their close friends.

As regards urban boys they were low in their disclosure in comparison to the standard norms of Sinha (1977), for all areas of self except sex. Even the information disclosed to different target figures was found to be low in comparison to the standard norms. Their target figure of disclosure was father followed by mother and brothers. Urban boys disclosed more about study followed by interest and feeling and least about sex. The target figures who got highest scores were father, mother, brother and the least was sister.

Comparison of Self-Disclosure and Target Groups Pattern of Rural and Urban Boys

The data confirm the fact that rural boys were higher in their disclosure in comparison to the urban boys on different 'areas of self' except vocation and sex. The accorded reason could be rural boys still report to agricultural vocation and yet varied vocation are not their general topics of discussion. As regards sex, this topic was considered private, therefore, urban boys might have had more exposure to the literature, movies and likewise find scope to discuss and reveal this aspect of life also to their friends. The rural boys disclosed less to their mothers, fathers and brothers but more to their friends and teachers in comparison to urban boys. The reason could be that educated rural boys find more confirmity about their changed feeling with their friends and teachers than their own relatives, as in majority of the cases they are illiterates. But reverse phenomenon exists in case of urban boys where most of their family members were happened to be educated.

REFERENCES

- Brown, T. L. and Weiner, A. E. 1979. *Introduction to Psychology*. Winthrop Publishers Inc., Cambridge, Massachansetts.
- Jourard, Sidney. 1971. *The Transparent Self*. Van Nostrand Reinhold, New York.
- Saxena, N. K. and Kapoor, K. D. 1979. Differences in self-disclosure among tribal and non-tribal boys in India. *Social Psychology* 109: 139-40.
- Sinha, V. 1973. Self-disclosure: An index of healthy personality. *J. Res.* 21 : 14-18.
- Sinha, V. 1977. *Manual for Self-disclosure Inventory for Adolescent*. National Psychological Corporation, Agra.

PATTERN OF SPATIAL MOBILITY IN HARYANA : A SOCIOLOGICAL ANALYSIS

SAVITA MEHRA, M. L. SHARMA and T. M. DAK

Department of Sociology
Haryana Agricultural University, Hisar

(Received : August 3, 1983; Revised : January 18, 1985)

ABSTRACT

The study revealed that the people of upper and untouchable castes, higher socio-economic status and those who are young and educated are spatially more mobile than their counterparts. A significant influence of development of the region on the mobility rates was clearly discernible. Further, more mobiles than non-mobiles were achievement oriented as reflected in their views about status determinants and education of boys and girls. The study calls for greater stress on education and development for reducing pressure on land and increasing mobility through occupational diversification.

It is generally believed that rural people are far less mobile than people in urban areas. This relative immobility is often attributed to the socio-economic conditions (Jorapur, 1971) such as joint family system, caste structure, attachment to land, low education, absence of skills, poor communication, lack of opportunities, etc. In recent decades, however, the chances for social and spatial mobility have greatly increased following technological advancement, industrial development, urbanisation, educational expansion, development of communication and the like. In addition to marriage, education and employment have emerged as important factors accounting for spatial mobility of the people. The upward mobility goals, particularly those held by lower and upper strata are reinforced and achieved through spatial mobility

as the two are closely associated (Chekki, 1971).

The available evidence suggests that the mobility in Haryana has also registered a steady increase (Dak *et al.*, 1982; Mehra, 1982). It is evident from the fact that during 1961-81, the proportion of urban population has gone up from 17.2 to 22.0, the percentage of workers in secondary and tertiary occupations went up from 28.6 to 38.6 and correspondingly the proportion of workers in agricultural sector came down from 71.4 to 61.4 and the literacy rate rose from 19.9 to 35.8. However, no assessment of the nature and extent of spatial mobility in rural Haryana and its socio-cultural determinants has so far been made. The present study is an attempt to bridge this gap.

METHODOLOGY

Using selected indices of socio-economic advancement*, all the districts of the State were ranked in descending order and two districts, one most advanced (Karnal) and the other least advanced (Bhiwani) were selected. From each district, one block was randomly selected. All the villages of each selected block were ranked in terms of socio-economic advancement and two advanced and two backward villages were selected from upper 5% and lower 5% of the ranked villages. The groups of two villages selected from Karnal district were termed as 'Most advanced' and 'Backward' and those from Bhiwani district as 'Advanced' and 'Most backward'.

From the list of the heads of households in each village, 10% sample was drawn for total of 404. From most advanced region, 155 respondents were selected followed by 134 from advanced, 60 from backward and 55 from most backward region. Data were collected through pretested structured interview schedule. The respondents who have turned to the urban market for employment but at the same time maintaining linkages with the village have been defined as spatially mobile.

RESULTS AND DISCUSSION

The pattern of spatial mobility of the respondents and the association of selected socio-economic characteristics with it are analysed in Table 1. It may be seen from the data that out of the total 404 respondents, only 104 (25.7%) were found spatially mobile. Their occupational distribution revealed that a majority of such respondents (51.9%) was engaged in semi-skilled jobs and one-fourth in clerical jobs; the proportion of those in professions and unskilled jobs was found to be only 15.4 and 7.7, respectively. It was further observed that while respondents of upper caste (Brahmins and Banias) were concentrated in professions; intermediate castes which comprise Jats, Jat Sikh, Rores, Sunars, Khatis, Sainis and Ahirs, figured in semi-skilled jobs followed by clerical and unskilled jobs.** It was further noted that majority of respondents with higher education (75.5%) were professionals while those upto matric were engaged in clerical jobs (65.6%). The illiterates were concentrated in unskilled jobs.

Socio-Economic Factors

Caste. Data in Table 1 throw light on the factors that affected spatial mobility. Evidently, a much larger propor-

*Following indices were used for the purpose :

Percentage of area under high yielding varieties to the total cropped area; percentage of gross area irrigated to the total cropped area; amount of fertilizers used per unit of irrigated area; farm mechanisation index, i.e., number of tractors and tube-wells/pumping sets; percentage of agricultural labourers to total agricultural workers; literacy rate; proportion of scheduled castes population to total population; value productivity per hectare and soil rating index.

**Mutual ranking method was used to measure caste status. Based on the ranking assigned to each caste, grouping was made into upper, intermediate, lower and untouchable castes. Lower castes constitute Jhimmers, Kumhars, Gadaries, Bhurbhuja, Nai, Jogi, Dhobis and Maniars and untouchables include Chamar, Nains, Balmikies, Dhanaks, Sansis and Dekpachies.

SPATIAL MOBILITY IN HARYANA

TABLE 1

Spatial mobility of respondents as per socio-economic characteristics

Factors/categories	Spatially mobile (N=104)	Spatially non-mobile (N=300)	Total (N=404)
Caste			
Upper	25(33.7)	49(66.3)	74(18.3)
Intermediate	31(18.4)	137(81.6)	168(41.6)
Lower	11(24.4)	34(75.6)	45(11.1)
Untouchable	37(31.6)	80(68.4)	117(29.0)
$\chi^2=9.33$, $df=3$, $P=<.05$, $C=.15$			
Education			
Illiterate	26(14.7)	151(85.3)	177(43.8)
Primary	4(8.7)	42(91.3)	46(11.4)
Matric	51(34.5)	97(65.5)	148(36.6)
Above Matric	23(69.7)	10(30.3)	33(8.2)
$\chi^2=57.54$, $df=3$, $P=<.01$, $C=.35$			
Age (years)			
20-30	34(27.2)	91(72.8)	125(30.9)
31-40	38(34.9)	71(65.1)	109(27.0)
41-50	21(23.3)	69(76.7)	90(22.3)
Above 50	11(13.9)	69(86.1)	80(19.8)
$\chi^2=11.17$, $df=3$, $P=<.05$, $C=.16$			
Socio-economic status			
Low	12(17.1)	58(82.9)	70(17.3)
Lower middle	38(21.2)	141(78.8)	179(44.3)
Upper middle	29(32.2)	61(67.8)	90(22.3)
Upper	25(38.5)	40(61.5)	65(16.1)
$\chi^2=12.09$, $df=3$, $P=<.01$, $C=.17$			
Landholding (acres)			
Landless	49(32.4)	102(67.6)	151(37.4)
Below 5	28(23.1)	93(76.9)	121(29.9)
5.1-10.0	13(17.8)	80(82.2)	73(18.1)
10.1-15.0	5(21.3)	18(78.7)	23(5.7)
Above 15.0	9(25.0)	27(75.0)	36(8.9)
$\chi^2=3.54$, $df=3$, $P=>.05$, $C=.09$			
Family size			
Below 5	21(33.3)	42(66.7)	63(15.6)
6-9	65(26.5)	180(73.5)	245(60.6)
10-14	15(20.2)	59(79.8)	74(18.3)
Above 14	3(13.6)	19(86.4)	22(5.5)
$\chi^2=4.82$, $df=3$, $P=<.05$, $C=.11$			

* χ^2 was calculated by combining the categories of landless and the respondents with landholding up to 5 acres.

tion of upper (33.7%) and untouchable (31.6%) castes was spatially mobile than the lower ones (24.4%); the intermediate castes (18.5%) were least mobile. Chi-square test indicated significant differences between castes in this respect. It is well known that urban occupations require special skill and higher education which are generally possessed by upper caste members. Also, this group is composed of mainly Brahmins whose occupation in the traditional setting is losing importance. In case of untouchables, the considerations of survival in absence of non-farm jobs and improvement in status by following non-traditional occupations in urban areas seem to have been responsible for spatial mobility. However, Bailey (1957) found the absence of spatial occupational mobility, while Beteille (1969), Chekki (1971), Sharma (1971) and Sharma (1974) confirmed the findings of the present study.

Education. The educated persons are more capable than the uneducated for taking up specialised jobs in the urban areas. Also, rural areas do not offer jobs commensurate with one's education. This explains why more educated are spatially mobile. Data in Table 1 revealed that with the increase in educational level of the respondents, the proportion of mobile persons has correspondingly increased, the highest being in case of those educated above matriculation (69.7%). The chi-square results indicated statistically significant association. Evidently, illiterates and low educated persons are less equipped to take up skilled jobs outside and that educated persons are less interested in

working in rural areas. Singh (1976) also reported the same.

Age. It may be noted that the respondents in the younger age groups are more mobile than those of higher age groups; mobility was more pronounced in the age group of 31-40 followed by 20-30 and least in the age group of above 50. It appears, increasing education and greater mobility orientation among younger groups are responsible for their higher rate of mobility.

Socio-economic status. Data in Table 1 showed that with the increase in the socio-economic status of the respondents, the proportion of spatially mobile respondents has correspondingly increased, the highest being in case of upper category (38.5%) and the lowest in the low (17.1%). The chi-square test indicated significant association between the two. The urge to improve socio-economic status, relatively greater ability to adopt urban jobs and limited opportunities in the village itself for improvement appear to have made the people of upper socio-economic status more mobile.

Landholding. It may be seen from Table 1 that landless followed by smaller holders were relatively more spatially mobile; medium-sized respondents were least mobile. Absence of land or only small piece of land following sub-division and fragmentation make people move and work elsewhere. In absence of job opportunities for all such people in the village itself, many of them are compelled to move out. The mobility rate was relatively higher among larger landholders. It is so partly because of their

SPATIAL MOBILITY IN HARYANA

capacity to acquire education and training required for taking up urban occupations. The association between landholding and spatial mobility, however, was not found significant.

Family size. It is evident that with the increase in family size, percentage of mobile persons correspondingly declined. It seems, individual enjoys greater freedom to act in smaller families than in larger ones where decisions are generally taken by family elders and other members can act against them only at the cost of family unity and cohesiveness. The association was, however, not significant.

Development Context

As the population acquires education and as the society develops technologically and industrially, people in increasing numbers tend to shift towards new and urban occupations. The tendency to migrate from rural to urban areas was, therefore, more pronounced in the developed areas than in under-developed areas. The support for such an assumption comes from data presented in Table 2.

As can be seen that advanced regions contained a larger proportion of spatially

mobile people as compared to backward regions. As the region's advancement increases, percentage of mobile population also correspondingly increases. Obviously advanced regions, by virtue of greater technological and industrial growth and greater occupational diversification, could make people occupationally more mobile and in order to avail of the opportunities, people have to leave villages. Sharma (1974) also reported that more the village community is affected by urbanization the greater is the occupational diversification and migration.

Value Orientations

The process of social and spatial mobility in modern times is facilitated more by achieved variables like power, wealth, education, specialised skill, etc. than by ascribed ones like caste and hereditary occupations. Traditional determinants of individual's status are no longer helpful in improving the status. Such a change in values and attitudes is more likely among mobiles than among non-mobiles. Data in Table 3 throw light on this aspect.

It is evident that though education and land have been considered more important as status indicators by both

TABLE 2
Development context of spatial occupational mobility

	Most advanced	Advanced	Backward	Most backward
Non mobile	107(69.0)	97(72.4)	49(81.7)	47(85.6)
Mobile	48(31.0)	37(27.6)	11(18.3)	8(14.4)
Total	155(38.4)	134(33.1)	60(14.9)	55(13.6)

TABLE 3
Spatial mobility and value orientation

(N=404)

	Mobile (N=104)	Non-mobile (N=300)
Status determinants		
Education	75(72.1)	120(40.0)
Land	20(19.2)	110(36.7)
Caste	5(4.9)	40(13.3)
Family	4(3.8)	30(10.0)
Preferred level of children's education		
(a) Boys		
Primary	12(11.5)	70(23.4)
Matric	20(19.2)	140(46.6)
Graduation	50(48.1)	75(25.0)
Post-graduation	22(21.2)	15(5.0)
(b) Girls		
No Education	—	30(10.0)
Primary	10(9.4)	75(25.0)
Matric	38(36.6)	120(40.0)
Graduation or above	56(54.0)	75(25.0)

mobiles and non-mobiles, a much greater proportion of the former than latter considered education important; in contrast, land was more important for non-mobiles than for mobiles. The position of caste and family as status-determinants tended to recede but more so for mobiles than non-mobiles.

In consistent with the above, more mobiles favoured higher education of their children than did non-mobiles. Whereas over two-thirds of the mobiles were in favour of educating their sons upto graduation or above, most non-mobiles preferred education upto matriculation only. Likewise, more mobiles than non-mobiles were in favour of

higher education of girls. Those who did not favour girl's education at all were only non-mobiles. Quite clearly, mobiles have relatively better appreciation of education as means to improve their status and achieve success in the world and therefore, were in favour of children's education.

The analysis of data suggests that spatial occupational mobility, though not so widespread, was more pronounced among upper castes and untouchables, young, educated and upper class respondents. Landholding and family size did not affect the mobility to any significant extent. The development of the region has exerted positive influences.

SPATIAL MOBILITY IN HARYANA

Mobile persons are also becoming more and more achievement oriented. The findings suggest that increased mobility may reduce the pressure on land and expansion of education facilities and programmes of economic development would greatly help in accelerating this process.

REFERENCES

- Bailey, F. G. 1957. *Caste and the Economic Frontier*. Manchester University Press, Manchester.
- Beteille, A. 1969. *Castes : Old and New*. Asia Publishing House, Bombay.
- Chekki, Dan A. 1971. Social stratification and trends of social mobility in modern India. *Indian J. Social Work* 31 : 367-80.
- Dak, T. M., Grover, R. P. and Sharma, M. L. 1982. Industrialization and development in Haryana. Paper presented at XVI All India Socio. Conference held at Annamalai, Tamilnadu, December, 29-31.
- Jorapur, P. B. 1971. Intergenerational occupational mobility. *Indian J. Social Work* 31 : 461-67.
- Mehra, Savita 1982. Social mobility in rural Haryana. Ph. D. thesis, Haryana Agricultural University, Hisar.
- Sharma, K. L. 1974. *Changing Rural Stratification System : A Comparative Study in Six Villages in Rajasthan*. Orient Longman, Delhi.
- Sharma, K. N. 1971. *Institution Network and Social Change*. Indian Institute of Advanced Study, Simla.
- Singh, Y. 1976. *Social Stratification and Change in India*. Manohar Publication, New Delhi.

ECONOMIC EFFICIENCY OF SUBSIDISED LOANS DISBURSED UNDER RURAL DEVELOPMENT PROGRAMMES IN HARYANA

U. K. PANDEY*, K. S. SUHAG and O. P. CHHIKARA

Department of Agricultural Economics

Haryana Agricultural University, Hisar

(Received : September 9, 1983; Revised : April 17, 1985)

ABSTRACT

Both Ambala and Hisar districts had the highest number of landless agricultural labourers followed by marginal and small farmers where subsidised loan disbursement was as per Government of India guidelines for implementing (RDP, i. e., 'Poorest amongst the Poor'. However, a great majority of rural poor was still non-beneficiaries. Although subsidised loan disbursement concentrated for purposes such as buffaloes, sheep, goats, agricultural equipments, pumpsets and tubewells, bullock/camel and carts, sewing machines, etc. yet only buffalo and bullock/camel and cart loans seem to be both financially and economically sound propositions. Moreover, the present size of supply units for sheep, goats and poultry was non-viable. There also existed the backwash effects of the subsidised loan disbursement.

Haryana is predominantly an agricultural state and about 85% of its population live in rural areas. At the end of 1980-81, about 51% of the total operational holdings in the state were below 2 hectares of which about 32% were below 1 hectare. Besides, about 38% of the rural and 31% of the urban population was below poverty line (at the end of 1978-79) mainly because of low savings, low investments, low returns, etc. (Anonymous, 1980). As a result, the Government drew its attention and the development of rural poor became the focal point of Indian planning so as to bring about social and economic transformation. In order to achieve this, special programmes, viz., Small Farmer's Development Agency (SFDA) and

Marginal Farmers and Landless Agricultural Labourer Agency (MFAL), were set up in 36 selected districts of the country during the fourth Five-Year plan and were also extended in the fifth Five-Year Plan.

The integrated rural development programmes for 'Poorest amongst the Poor', i. e., 'Antodyaya' were launched in 1978-79 in 2300 selected blocks all over the country based on the experience gained through implementation of above special developmental programmes. The programme emphasized the family approach in identification of beneficiaries. Consequent upon the extension of I. R. D. Programmes to all the development blocks in the country

*Directorate of Project-cum-Plan Formulation.

EFFICACY OF SUBSIDISED LOANS

during the sixth plan period, Government of India, recommended setting up of SFDA and/or similar type of district level agencies wherever they did not exist for the implementation of IRD and other programmes. Later, it was desired to have only one agency for implementing all such programmes and the agency was named as the District Rural Development Agency (DRDA). How far these developmental programmes have been implemented so as to help the rural poor in improving their ability to invest through subsidised grants, will ultimately depend upon the efficacy of the programmes undertaken by the Agency. Therefore, the present study was undertaken in Haryana state with the following specific objectives :

- (i) To study the nature, magnitude and efficacy of the subsidised loan disbursement under DRDA programmes ;
- (ii) to asses the economic feasibility of these loans disbursed under various programmes; and
- (iii) to know the backwash effects of subsidised loan disbursement under these programmes.

MATERIAL AND METHODS

Multi-stage random sampling technique was adopted so as to select the ultimate units of the sample. Ambala and Hisar districts of Haryana state were purposively selected because of the pre-dominance of the weaker sections in these districts and also due to the operation of DRDA for the upliftment of these people. Barara and Ambala blocks of

Ambala district and Hisar-I and Hisar-II blocks of Hisar district were randomly selected amongst the blocks where number of beneficiaries and average amount of subsidised loans disbursement were high. Five per cent of the total number of villages from each block were randomly selected. Thus, ten villages in Ambala district and five villages in Hisar district were chosen for this study. In view of the small number of beneficiaries of DRDA scheme in each village, it was decided to include all the beneficiaries in the sample. Amongst the total number of non-beneficiaries in each village, 10% of them were randomly selected to represent the sample. In all, 50 beneficiaries and 65 non-beneficiaries from each district were selected. The primary data with regard to the farm inventory, cropping pattern, consumption expenditure, loans borrowed, etc. were collected from these selected farmers for the years 1978-79 and 1981-82 with the help of pre-structured schedules. Similarly, secondary data pertaining to subsidised loans disbursement and number of beneficiaries were also collected from DRDA Ambala and Hisar. Tabular analysis has been done in order to derive the inferences.

RESULTS AND DISCUSSION

Disbursement of Subsidised Loans

The District Rural Development Agency (DRDA) helps in improving the ability of the rural poor to purchase a particular asset through subsidised grants. The category-wise disbursement of subsidised loans to the weaker sections in Ambala and Hisar districts is presented in Table 1. Of the total

TABLE 1
Category-wise disbursement of subsidised loans to the rural poor of Haryana (1977-78 to 1981-82)

S. No.	Particulars	Average amount of annual subsidised loans disbursed (lakh Rs.)		Average number of beneficiaries		Total number of households according to 1980-81 census		Gini concentration ratio* for subsidised loans disbursement	
		Ambala	Hisar	Ambala	Hisar	Ambala	Hisar	Ambala	Hisar
1.	Marginal farmers	7.67 (36.49)	6.92 (16.62)	2,193 (43.14)	4,044 (35.80)	33,415 (28.73)	25,881 (20.15)	0.1145	0.3386
2.	Small farmers	3.75 (17.84)	6.25 (15.01)	1,196 (23.53)	3,294 (29.16)	15,471 (13.30)	22,118 (17.22)	0.2719	0.3981
3.	Landless agricultural labourers	9.60 (45.67)	28.47 (68.37)	1,694 (33.33)	3,959 (35.04)	67,415 (57.97)	80,438 (62.63)	0.4856	0.5388
Total		21.02 (100.00)	41.64 (100.00)	5,083 (100.00)	11,297 (100.00)	1,16,301 (100.00)	1,28,437 (100.00)		

Figures in parentheses are the percentages.

Source : District Rural Development Agency, Ambala and Hisar.

*Gini concentration ratio =

$$1 - \sum_{j=1}^n P_j (Q_j + Q_{j-1})$$

Where,

P_j = Proportion of beneficiaries in the j th group.

Q_j = Cumulative proportion of subsidised loans disbursed in the j th group.

n = Total number of groups.

EFFICACY OF SUBSIDISED LOANS

subsidised loans disbursed by DRDA during the period 1977-78 to 1981-82, nearly 46, 37 and 18 per cent was given to the landless agricultural labourers, marginal farmers and small farmers, respectively, of Ambala district. Similarly, in Hisar district nearly 68, 17 and 15 per cent of the total subsidised loan was given to them, respectively. It clearly reveals that in both the districts the highest amount of subsidised loans had been given to the landless agricultural labourers and marginal farmers, i. e., 'Poorest amongst the poor', i. e., 'Antodyaya Approach'. Thus, District Rural Development Agency, Ambala and Hisar had adopted the guidelines given by the Government of India while disbursing subsidised loans to the rural poor. The average number of beneficiaries during the study period was highest among marginal farmers category followed by landless agricultural labourers and small farmers in both the districts. It is also evident from Table 1 that bulk of the rural poor could not get subsidised loans under DRDA programmes in both the districts. Therefore, in order to fulfill the national objective, the amount of subsidised loans/grants sanctioned to the DRDA should be increased and the agency should concentrate in disbursing the same to the large number of non-beneficiaries. Table 1 further reveals that although the extent of inequality in the disbursement of loans is not high, yet the inter class inequality is high in Ambala district as compared to Hisar district. Moreover, concentration of subsidised loans is high in landless agricultural labourers followed by small and marginal farmers. Therefore, in future, more number of marginal

farmers may be included in disbursing the subsidised loans as compared to small farmers in both the districts.

The programme-wise disbursement of subsidised loans to the rural poor in Haryana is given in Table 2 which shows that animal husbandry accounted for the major portion of the subsidised loans disbursed in Ambala and Hisar districts followed by agriculture and other rural development programmes. The data further reveal that in animal husbandry programme, the amount of subsidised loans disbursed was highest for buffaloes in both the districts. A substantial amount of subsidised loans was also disbursed for cross-bred cows, draught animals, poultry, sheep and goats in Hisar district. A negligible amount was also given for pigs in both the districts but due attention had not been given to the poultry and goat enterprises in Ambala district. In agriculture, highest amount of subsidised loan was disbursed for farm forestry in both the districts. Due emphasis had also been given for input subsidy, agricultural implements, tubewells, bullock/camel and carts in both the districts. The programmes such as carpentry, shoe, carpet, mudha making, etc. also received some attention in Ambala district and for sewing machines in Hisar district, while disbursing the subsidised loans. The implication of these findings is that the DRDA has to cover a large number of non-beneficiaries in the animal husbandry programmes besides buffaloes. But due emphasis needs to be given to provide viable units specially for poultry, sheep, goats and pigs together with other suitable infrastructures so that these enterprises can sus-

TABLE 2
Programme-wise disbursement of subsidised loans to the rural poor in Haryana (1977-78 to 1981-82)

S. No.	Particulars	Average amount of subsidised loan sanctioned (lakh Rs.)		Average amount of subsidised loan disbursed (lakh Rs.)		Average number of beneficiaries	
		Ambala	Hisar	Ambala	Hisar	Ambala	Hisar
A. Animal Husbandry							
1.	Buffaloes	26.39	34.95	10.95	10.68	1490	1302
2.	Cross-bred cows	5.33	—	4.09	0.80	72	64
3.	Draught animals (Bullock/camels)	8.68	11.34	3.11	3.62	261	382
4.	Poultry	—	5.97	—	2.69	—	121
5.	Sheep	3.57	29.27	3.15	8.35	177	821
6.	Goats	—	11.72	—	2.98	—	293
7.	Pigs	0.76	1.24	1.03	0.64	83	56
	Sub-total	44.93	94.49	21.41	29.76	2083	3039
B. Agriculture							
1.	Input subsidy	0.53	—	1.14	3.37	881	4011
2.	Land levelling	0.33	—	0.14	0.17	23	172
3.	Farm forestry	6.00	—	6.00	7.50	1372	2500
4.	Demonstration plots	0.24	—	0.83	0.84	480	508
5.	Agricultural equipments/implements*	2.04	—	2.06	1.13	2478	1442
6.	Bullock/camel carts**	3.17	—	0.94	2.15	160	261
7.	Tubewells	9.29	10.13	2.46	1.67	147	99
	Sub-total	21.80	10.13	13.57	16.83	5541	8993
C. Other Rural Development Programmes							
1.	Sewing machines	0.52	—	0.44	2.77	543	2550
2.	Any other (such as carpet, shoe, carpentry, mudha making, etc.)	10.05	—	10.05	1.79	2425	1422
	Sub-total	10.57	—	10.49	4.56	2968	3972
	Total (A+B+C)	77.10	104.62	45.47	51.15	10,592	16,004

Source : District Rural Development Agency, Ambala and Hisar.

*It includes improved iron ploughs, harrows, chaff-cutters, spray pumps, dusting machines and also storage metallic bins.

**It also includes kachchar rehra and He-buffalo and carts.

tain on sound economic footing. Similarly, in agriculture besides farm forestry, programmes such as bullock/camel and carts, tubewells and input subsidy should be covered. Amongst other rural development programmes although emphasis needs to be given to both the programmes yet development of suitable market infrastructure is also essential. Moreover, emphasis has to be laid on the quality of above items. Thus, DRDA has a great role to play in the disbursement of subsidised loans to a large number of non-beneficiaries under different programmes.

Efficacy of the Subsidised Loans Disbursement

In order to know the soundness of loan, the three economic feasibility tests were applied to each type of loan, i. e., bullock/camel loan (draught animal loan), bullock/camel and cart loan, buffalo loan, poultry loan, sheep loan and goat loan. These tests included (a) additional returns generated from the subsidised loan, (b) repaying capacity it will generate and (c) the risk bearing ability of the borrowers. The economic feasibility tests for the soundness of credit indicated that the subsidised loan for draught animal, poultry, sheep and goat could not qualify even the first test of economic feasibility in both the districts (Table 3). Similarly, the repaying capacity estimated for these loans was less than the respective loan instalments, thus indicating the failure of second test too. The deflated repaying capacity for these loans was negative indicating that these borrowers have poor risk bearing ability. Thus, these loans could not qualify any test of economic feasibility. The income

through sheep, goats and poultry enterprises could be increased by providing viable units of animals/birds, necessary marketing facilities and technical know-how. However, the returns over variable cost in case of sheep (Rs. 2338) and goat (Rs. 1205) on these units were positive thereby indicating sound investment. Thus, sheep and goat enterprises can be financed specially for the marginal farmers and landless agricultural labourers. The economic feasibility tests applied to bullock/camel and carts and buffalo subsidised loans revealed that these loans could qualify the first two tests of the economic feasibility and the bullock/camel and cart loan will pay only if the sufficient demand for custom service (transport) exists in the area. Advancing subsidised loans for buffalo seems feasible and is expected to provide income and employment to the rural poor. However, in order to benefit this group, proper marketing of their produce, supply of inputs and veterinary facilities have to be ensured.

Dependency Syndrome

The distribution of viable and non-viable marginal and small farmers and landless agricultural labourers amongst beneficiaries and non-beneficiaries is presented in Table 4. It is evident from the data that DRDA had made positive impact on the viability levels, viz., comfortably/moderately viable farmers of rural poor. The proportion of viable small farmers during 1978-79 was high in case of beneficiaries in both the districts. Data further reveal that the proportion of moderately viable small farmers was higher as compared to those of comfortably viable small farmers

TABLE 3
Economic feasibility of subsidised loans disbursed to the rural poor in Haryana (1977-78 to 1981-82) (In rupees)

S. No.	Particulars	Ambala				Hisar					
		Net margi- nal returns	Loan in- stalment due	Repaying capacity	Risk bearing ability		Net margi- nal returns	Loan in- stalment due	Repaying capacity	Risk bearing ability	
					Deflated repaying capacity @ 18%	Deflated repaying capacity @ 36%				Deflated repaying capacity @ 16%	Deflated repaying capacity @ 32%
I. Draught animal loan (Bullock/camels)											
	Marginal farmers	-774	450	296	-1077	-2339	-789	350	279	-923	-2216
	Small farmers	-842	450	268	-1323	-2847	-746	335	260	-1282	-2528
	Landless agricultural labourers	—	—	—	—	—	-686	286	178	-993	-2012
II. Bullock/camel and cart loan											
	Marginal farmers	485	600	1437	277	-1896	550	525	1266	256	-1014
	Small farmers	525	600	1897	298	-1641	469	500	1345	-297	-1178
	Landless agricultural labourers	771	600	1312	-248	-1376	916	515	1439	136	-1267
III. Buffalo loan											
	Marginal farmers	696	500	1289	-569	-2213	618	420	1227	-568	-2413
	Small farmers	623	500	1372	-652	-2673	684	500	1449	-196	-2097
	Landless agricultural labourers	767	500	1347	-358	-1908	765	438	1295	-98	1872
IV. Poultry loan (110)**											
	Marginal farmers	-837	917	280	-1409	-3089	-529	834	253	-1083	-2515
	Small farmers	-687	917	246	-1503	-3264	-481	834	278	-1146	-2648
	Landless agricultural labourers	-817	917	288	-1132	-2976	-576	834	331	-949	-2422

EFFICACY OF SUBSIDISED LOANS

V. Sheep loan (20 E + 1 R)***

Marginal farmers	-2725	2014	1990	1693*	1396**	-2725	2014	1990	1693*	1396**
Small farmers	-2725	2014	1990	1693*	1396**	-2725	2014	1990	1693*	1396**
Landless agricultural labourers	-2725	2014	1990	1693*	1396**	-2725	2014	1990	1693*	1396**

VI. Goat loan (10 D + 1 B)***

Marginal farmers	-1357	1007	972	834*	694**	-1357	1007	972	834*	694**
Small farmers	-1357	1007	972	834*	694**	-1357	1007	972	834*	694**
Landless agricultural labourers	-1357	1007	972	834*	694**	-1357	1007	972	834*	694**

*Deflated repaying capacity @ 11% variability in income.

**Deflated repaying capacity @ 22% variability in income.

***Figures in parentheses are the size/units supplied by DRDA.

E=Ewe (Female sheep); R=Ram (Male sheep);

D=Does (Female goat); B=Buck (Male goat)

TABLE 4
Dependency syndrome of the rural poor in Haryana

S. No. Particulars	1978-79			1981-82		
	Beneficiaries	Non-beneficiaries	Total	Beneficiaries	Non-beneficiaries	Total
Ambala						
1. Non-viable marginal and small farmers and landless agricultural labourers	22 (44.00)	42 (64.62)	64 (55.65)	31 (62.00)	44 (67.69)	75 (65.22)
2. Viable small farmers	28 (56.00)	23 (35.38)	51 (44.35)	19 (38.00)	21 (32.31)	40 (34.78)
(a) Comfortably viable	11 (22.00)	9 (13.85)	20 (17.39)	8 (16.00)	7 (10.77)	15 (13.04)
(b) Moderately viable	17 (34.00)	14 (21.53)	31 (26.96)	11 (22.00)	14 (21.54)	25 (21.74)
Total	50 (100.00)	65 (100.00)	115 (100.00)	50 (100.00)	65 (100.00)	115 (100.00)
Hisar						
1. Non-viable marginal and small farmers and landless agricultural labourers	20 (40.00)	39 (60.00)	59 (51.30)	35 (70.00)	41 (63.08)	76 (66.09)
2. Viable small farmers	30 (60.00)	26 (40.00)	56 (48.70)	15 (30.00)	24 (36.92)	39 (33.91)
(a) Comfortably viable	12 (24.00)	10 (15.38)	22 (19.13)	5 (10.00)	8 (12.31)	13 (11.30)
(b) Moderately viable	18 (36.00)	16 (24.62)	34 (29.57)	10 (20.00)	16 (24.61)	26 (22.61)
Total	50 (100.00)	65 (100.00)	115 (100.00)	50 (100.00)	65 (100.00)	115 (100.00)

Figures in parentheses are percentages.

EFFICACY OF SUBSIDISED LOANS

(Pandey and Kaushal, 1980) among beneficiaries and non-beneficiaries in both the districts. It is, thus, reflecting the fact that as a result of the implementation of the rural development programmes, a large proportion of the marginal and small farmers and landless agricultural labourers had become viable.

The viability level of these farmers was re-investigated by collecting data for the period 1981-82. All the beneficiaries of period 1978-79 were re-surveyed and it was noted that they were not given subsidised loans afterwards while a matching sample was also taken. Data in Table 4 reveal that a great

proportion of viable small farmers of the period 1978-79 became non-viable small farmers during 1981-82 in both the districts. Furthermore, the proportion of moderately viable to total viable small farmers was also high in both the districts as compared to the comfortably viable small farmers. It is in fact, reflecting the backwash effects of the subsidised loans disbursement. Of course, due to disbursement of subsidised loans their ability to invest improved but when it was stopped it re-deteriorated. Therefore, it is essential to disburse the subsidised loans to these farmers again when their first loan had been repaid.

REFERENCES

Anonymous, 1980. National Sample Surveys; 33 round (1978-79), Sixth Five-Year Plan, 1980-85, Draft-Proposals, Planning Department, Government of Haryana.

Pandey, U. K. and Kaushal, A. K. 1980. The economic viability of small farmers in Haryana. *Finan. Agric.* 12 (2) : 11-17.

AGRICULTURAL DEVELOPMENT OFFICERS' PERCEPTION OF SUITABILITY OF EXTENSION EDUCATION INPUT IN THEIR UNDER-GRADUATE TRAINING

V. B. DIXIT, V. K. MAKHIJA and HIRA NAND

Department of Extension Education

Haryana Agricultural University, Hisar

(Received : December 30, 1983; Revised : September 22, 1984)

ABSTRACT

Agricultural Development Officers of Haryana perceived the Extension Education course contents related to communication media as the first priority item to be included in the course curriculum of B. Sc. (Agri.). The items related to programme development, different developmental programmes in vogue, adoption of agricultural technology and principles of extension education associated with it were perceived by the ADOs to be included in the second priority list. 'May include' category for producing practical agricultural graduates included items mostly related to subject matter contents of village extension practicals and evaluation of extension programmes.

The respondents were found to be highly consistent while giving their perception on the degree of suitability of extension education course contents in relation to their job.

Despite a major break through in agricultural production in the late sixties and continued upward trend in the food-grain production, it is commonly felt that there is a wide gap between the farm innovations developed by the scientists and their actual application by the tillers of soil. This gap is mostly attributed to the weak linking system, indirectly conveying the poor efficiency of the extension workers. Agricultural Development Officer in Haryana is the key extension functionary in direct contact with the farmers who are the ultimate users of the innovations. If only this institution could be improved, the major task of improving the 'linking system' should be considered as successfully accomplished. The need

of the hour, therefore, is to produce practical agricultural graduates to join the task force of ADOs. Atwal (1969), Subramaniam (1972) and Fletcher (1973) have confirmed our above contention by reporting that there is a need for producing quality graduates, able to solve the problems of rural poor and emphasized that under-graduate agricultural curriculum should be practical oriented.

A Bachelor's degree in agriculture is the minimum requirement for the job of ADO. As many as 40% bachelors in agriculture produced by Haryana Agricultural University join the cadre of ADOs annually. Therefore, it was considered pertinent to know how far the training

imparted to them during their under-graduate programme suited to their job requirements. With this aim in mind, the present investigation was undertaken.

The curriculum for B. Sc. (Agri.) Hons. degree of Haryana Agricultural University and for that purpose of any other agricultural university, could be divided into two parts: (a) subject matter contents of the discipline constituting what to communicate, and (b) the one pertaining to social science disciplines related with how to communicate. Singh (1982) suggested that the teaching programme both at under-graduate and postgraduate levels need re-orientation. The extension programmes and syllabus should have a well balanced mix of subject-matter as well as extension education and other social sciences. The area of training and management needs special attention. The present study was confined to see the suitability of subject matter contents of extension education, one of the social sciences included in the curriculum of B. Sc. (Agri.) Hons. programme in relation to the job requirement of Agricultural Development Officers.

During the B. Sc. (Agri.) studies, the ADOs of today were offered two core courses worth 7 credit hours in Extension Education, viz., 'Introduction to Extension Education' and 'Extension Methods and Programme Development' besides six elective courses which were opted by a few students preparing themselves for specialization in Extension Education. The scope of the present study was, therefore, confined to suitability of two core courses in relation to the job of Agricultural Development Officers.

METHODOLOGY

It was an evaluatory study conducted in the state of Haryana. Agricultural Development Officers (ADOs) employed in the State Department of Agriculture constituted the respondent population. All those ADO's who were serving in the districts of Hisar, Mahendergarh, Ambala, Sonapat and Rohtak, had graduated from Haryana Agricultural University and had 3 years of work experience to their credit as ADO formed the respondent sample for the study. The districts were selected purposively, on the basis of agro-climatic conditions of the state. In all, the study was finally confined to the data collected from 120 respondents. A well-structured and pretested mailed questionnaire technique was used for the collection of data.

The course curriculum of these two extension education courses was split up into 42 items of the study and every respondent was requested to rate 42 items on a three point continuum of 'most relevant', 'relevant' and 'least relevant', to measure the degree of suitability of the subject matter items in relation to the job of ADO. To quantify this data, scores of 3, 2 and 1 were assigned to 'most relevant', 'relevant' and 'least relevant', respectively. The weighted mean suitability score was worked out, using normal statistical techniques for calculating averages.

RESULTS AND DISCUSSION

Suitability of Extension Education Course Contents

The weighted mean suitability score of all the 42 items of extension education

course contents in descending order is given in Table 1. A perusal of data reveals that the weighted mean suitability score of items ranged from 1.77 to 2.89 out of a maximum possible score of 3.00. Out of 42 items, 37 had weighted mean score of above 2.00.

In a bid to suggest a job oriented B. Sc. (Hons.) Agri. curriculum in extension education for Agricultural Officers, an exercise was undertaken to arrange extension education course content items

into five categories ranging from 'must include' to 'must exclude', on the basis of perceived weighted mean suitability score received by the items to work out the priority order. The five categories of extension education course contents so reformulated are given in Table 2 with the number of items falling in each of these categories.

A perusal of Table 2 indicates that only one item, evaluation-meaning, concept, etc. fell in the category of 'exclude'

TABLE 1
Mean suitability score of 120 respondents of 42 items

S. No.	Item	Weighted mean suitability score	S. No.	Item	Weighted mean suitability score
1.	Training and visit system	2.89	23.	To practise rapport building	2.42
2.	How to conduct method demonstration	2.80	24.	Community development programme	2.42
3.	How to conduct result demonstration	2.77	25.	Important development schemes in Haryana	2.37
4.	Communication process	2.76	26.	Concept of extension education	2.36
5.	How to call on a farmer	2.76	27.	Programme planning, meaning, etc.	2.35
6.	Group meetings	2.74	28.	Learning process	2.30
7.	To plan and conduct demonstrations	2.74	29.	Characteristics of extension education	2.26
8.	Essentials of agricultural development	2.67	30.	Familiarization with working of audio-visual aids	2.24
9.	Extension teaching method	2.66	31.	Preparation of simple farm plans	2.22
10.	Audio-visual aids, meaning, concept	2.66	32.	Familiarization with block agencies	2.19
11.	Layout and designing of audio-visual aids	2.63	33.	To practise living in a team	2.18
12.	High yielding varieties programme	2.60	34.	To exercise in scientific thinking	2.15
13.	Adoption process	2.57	35.	Philosophy of extension education	2.14
14.	Principles of extension education	2.56	36.	To practise and respect moral values	2.11
15.	Accelerators of agricultural development	2.50	37.	Early extension efforts in India	2.10
16.	Intensive agricultural district programme	2.50	38.	Relation of extension with other social sciences	1.98
17.	Intensive agricultural area programme	2.50	39.	To practise in handling of audio-visual aids	1.96
18.	Application of principles of extension education in fields	2.49	40.	Communication drill	1.93
19.	Small farmers development agency	2.47	41.	Evaluation of an extension programme	1.81
20.	Principles of programme planning	2.46	42.	Evaluation meaning, concept, etc.	1.77
21.	Process of agricultural development	2.45			
22.	Teaching process	2.43			

ADO'S PERCEPTION REGARDING EXTENSION EDUCATION

TABLE 2

Re-grouping of the extension education content items

S. No.	Category	Weighted mean	No. of items	S. No. of items as given in Table 1
1.	Must include	2.61 to 3.00	11	1 to 11
2.	Should include	2.21 to 2.60	20	12 to 31
3.	May include	1.81 to 2.20	10	32 to 41
4.	Exclude	1.41 to 1.80	1	42
5.	Must exclude	1.01 to 1.40	—	—

and none in the category of 'must exclude'. The remaining 41 items fell in the first three categories of 'may include', 'should include' or 'must include'. Even the item number 42 was a marginal case with a weighted mean score of 1.77. Further, placing of this item under the 'exclude' category might be due to the reason that ADO's were not required to do evaluation work and therefore, they tended to underestimate the importance of this topic.

A perusal of Table 1 in the light of Table 2 reveals that almost all the items falling in the category of 'must include', but for the item numbers 1 and 8, relate to communication media. The ADO's found the knowledge of different communication media as most suitable in performing their jobs. Those falling in the category of 'should include' relate to programme development and different developmental programmes in operation, adoption of agricultural technology and principles of extension education associated with it. Price (1961) also revealed that county extension agents needed training in the following areas written in order of their preference: 'programme planning and development', understanding human development', and 'communi-

cation and understanding social system'. The third category 'may include' included items mostly related to the subject matter contents of village extension practical and evaluation of extension programmes, besides philosophy of extension education.

Interestingly, the item 'training and visit system' secured the highest weighted mean suitability score. This appears to be logical now because the state has recently shifted to the reorganised extension system, officially named 'training and visit system' and the Agricultural Development Officers were very much alive to get more and more information on this item.

To examine the consistency in the rating of subject matter contents by ADOs, the respondents were asked to list 10 most suitable items out of the whole inventory. These 10 items thus emerging were tallied with 10 most suitable items of Table 1, emerging on the basis of weighted mean suitability score. Table 3 lists these items, both as emerging on the basis of weighted mean suitability score and again as emerging by independent picking up of the 10 most suitable items by the respondents.

The perusal of Table 3 indicates that but for the two items viz., 'principles of extension education' and 'high yielding variety programme' all the eight items emerging by independent picking also emerged in the inventory based on the weighted mean score.

These two items were replaced in the inventory of 10 most suitable items by 'essentials of agricultural development' and 'to plan and conduct demonstration'. The comparison, therefore, speaks of very high consistency of response.

An effort was also made to work out the rank order correlation between the eight most suitable items emerging out of weighted mean score and out of independent picking, the two items being different in both the sets. The calculated rho-value of 0.45 was found to be non-significant at 5% level of significance, though the eight items were common in both the sets, yet their positioning in rank order was different and varying.

Conclusively, it may be said that the perceived weighted mean suitability score of extension education contents ranged from 1.77 to 2.89, out of a maximum possible obtainable score of 3.00. As many as 37 items out of 42 items had a weighted mean suitability score of 2.00. When all the 42 items were regrouped into five categories of 'must include', 'should include', 'may include', 'exclude' and 'must exclude' only one item viz., evaluation meaning, concept, etc. was found to fall in the category of 'exclude'. None was found to fall in the category of 'must exclude'. The remaining 41 items fell in first three categories.

Nine of the eleven items, falling in the category of 'must include' related to communication media, indicating that the knowledge of communication media was perceived most suitable by the Agricultural Development Officers in performing their duties. Items relating to programme development and different developmental programmes, adoption of agricultural

TABLE 3

Ten most suitable items of extension education curriculum (in descending order)

S. No.	As emerging from weighed mean score A	As reported by independent picking B
1.	Training and visit system	Training and visit system
2.	How to conduct method demonstrations	How to call on a farmer
3.	How to conduct result demonstrations	How to conduct result demonstrations
4.	Communication process	Communication process
5.	How to call on a farmer	Group meetings
6.	Group meetings	Extension teaching methods
7.	To plan and conduct demonstration	Principles of extension education
8.	Essentials of agricultural development	Audio-visual aids, meaning, concept, etc.
9.	Extension teaching methods	How to conduct method demonstrations
10.	Audio-visual aids, meaning, concept, etc.	High yielding variety programmes

ADO'S PERCEPTION REGARDING EXTENSION EDUCATION

technology and principles of extension education associated with it, were perceived to be suitable in the second priority list. 'May include' category contained items mostly related to subject matter contents of village extension practicals, evaluation of extension programmes and

philosophy of extension education. The respondents were found to be highly consistent while giving their perception on degree of suitability of extension education course contents in relation to their job.

REFERENCES

- Atwal, A. S. 1969. A model course curriculum for agricultural universities : New concepts in agriculture. Punjab Agricultural University, Ludhiana. pp. 190-209.
- Fletcher, A. L. 1973. Role of agricultural universities as an effective instrument of service to the people. Proceedings of the Fourth Convention of Association of Indian Agricultural Universities. Haryana Agricultural University, Hisar. pp. 3-4.
- Price, R. E. 1961. An analysis of educational needs of Arkansas extension agents. Ph.D. thesis, University of Wisconsin.
- Singh, K. N. 1982. Challenges of extension in eighties. *Indian J. Ext. Educ.* 18 : 1-9.
- Subramaniam, C. 1972. Convocation address. Annual Convocation, Haryana Agricultural University, Hisar, April 9.

EFFECT OF EARLY PROTEIN RESTRICTION ON BODY WEIGHT, PHYSICAL MEASUREMENTS, COOKING LOSS AND CHEMICAL COMPOSITION OF SEXED BIRDS

M. K. CHAUDHARY, C. K. AGGARWAL, S. P. PRUTHI and S. K. CHOPRA

Department of Livestock Production & Management

Haryana Agricultural University, Hisar

(Received : August 6, 1984; Revised : April 23, 1985)

ABSTRACT

Three levels of protein (23, 18 and 13 per cent) were fed to purebred broiler chicks in starter ration during two durations (0-4 and 0-6 weeks of age) followed by a 20% protein finisher ration. Higher protein levels in the starter diet resulted in higher body weight. Compensatory growth was observed in female birds fed 18% protein ration upto 4 or 6 weeks followed by a 20% finisher ration. The magnitude of compensatory growth was more in females than males. The shank length, breast angle and keel length of birds given higher per cent protein in starter diets were longer/bigger. Compensatory growth was not observed for shank and keel length. However, compensatory growth of small magnitude was observed for breast angle. The minor changes in protein levels in diet (between 18-23%) did not have an appreciable effect on size of breast angle. Males had longer shank and keel and more breast angle than females. With an increase in protein level in feed there was a decrease in per cent cooking loss in meat. Low protein feeding had virtually no effect on ash percentage but increased the percentage of ether extract and decreased the percentage of protein contained in broiler meat.

The cost of poultry feed accounts for more than 70% of total cost of poultry production. Protein is one of the most expensive nutrients in poultry feed. Efforts to reduce its cost without affecting the performance of birds will result in cheaper production of poultry meat. One of the methods of reducing cost of poultry feed is by employing the phenomenon of compensatory growth. Although compensatory feeding regime has been found successful in turkeys (Auckland *et al.*, 1969; Auckland and Morris, 1971a, b; Moran, 1981) but the effects have not been studied in chickens in detail

excepting a few reports (Moran, 1979, 1980).

MATERIAL AND METHODS

Nine hundred day-old purebred broiler chicks of similar genetic make up were used in the experiment. Three groups of 300 chicks each hatched at an interval of 20 days constituted a replication. Each hatch of 300 chicks (replicate) was randomly distributed into six groups (treatments) of 50 birds each. Experimental birds were reared on deep litter and randomly assigned to various

treatments at day-old age. They were provided 5.2 sq. cm of brooder space under wooden floor brooder and 9.29 sq. cm floor area per chick. Feed mash and water were provided *ad lib*. Composition of experimental rations is presented in Table 1.

The chicks were weighed individually at day-old and subsequently at 2, 4, 6, 8 and 9 weeks of age.

Average shank and keel bone lengths were measured with the help of a scale in centimeter and breast angle with a breastometer in degrees at the end of 4, 6, 8 and 9 weeks of age.

Five males and five females of a treatment within a replication were

randomly selected at the end of 4, 6 and 8 weeks of age and processed by standard procedure. Cooking loss was calculated as per the method described by Moran *et al.* (1971) on three males and three females of a treatment within a replication. Samples of two male and two female carcasses per treatment within a replication were used for chemical analysis of meat. Breast, thigh and drumstick muscles excluding skin of each bird were combined, minced and thoroughly homogenised. The muscles from male and female birds were treated separately. The moisture was determined by using the method given in AOAC (1975). Dried samples obtained after moisture determination were used for estimation of protein, ether extract and ash (AOAC, 1975).

TABLE 1
Composition of experimental rations

Ingredients	Kg per 100 kg feed			
	Ration I	Ration II	Ration III	Ration IV
Yellow maize	43.2	59.3	59.4	60.0
Rice polish	—	—	8.0	29.0
G. N. cake	45.9	32.0	24.0	3.0
G. N. oil	2.9	0.7	0.6	—
Fish meal	5.0	5.0	5.0	5.0
Mineral mixture	3.0	3.0	3.0	3.0
Total	100.0	100.0	100.0	100.0
Crude protein ¹ (%)	23.0	19.9	18.0	13.1
ME ² (Kcal/kg)	3195	3196	3203	3203

Each ration was supplemented with

- (i) Rovimix containing Vit. A 40,000 I.U., Vit. B₁ 20 mg, Vit. D₃ 5,000 I.U. per g @ 25 g/100 kg feed.
- (ii) Bifuran feed supplement containing 25% W/W nitrofuraz-olidone and 36% W/W furazolidone @ 50 g/100 kg feed.
- (iii) Mineral mixture contained moisture 3%, Ca 32%, P 6%, Cu 100 ppm, Mn 0.27%, I 0.01%, Fe 1000 ppm, Zn 0.26% and F1 0.03%.

¹Estimated

²Calculated

Means and standard errors of each treatment were calculated. Analysis of variance was run and the pairwise comparisons between means of different treatments were made using Duncan's Multiple Range Test (Steel and Torrie, 1981).

RESULTS AND DISCUSSION

Body Weight

At day-old age the body weights of male and female birds allotted to different treatments were non-significant (Tables 2 and 3).

At 2, 4 and 6 weeks of age, body weight of males was significantly affected by protein levels (Table 2). A positive relationship was observed between protein levels and body weights at these ages. The highest 2 weeks body weight in males was obtained with diet containing 23% protein, followed by diets containing 18 and 13 per cent protein, respectively. These results are in agreement with the findings of Haque (1975) who reported that the protein content of diet had maximum effect on growth during 0-4 weeks of age. Moran (1980) reported significantly reduced body weight in birds offered 22% protein in comparison to those fed 26 and 24 per cent.

The body weight of males at 4 weeks age had a similar trend as reported for 2 weeks age. The results agreed with the findings of Twining *et al.* (1974), Haque (1975) and Mathur and Reddy (1975).

At 6, 8 and 9 weeks ages, no significant difference in body weights of males

was observed between pairs of treatments T_1 , T_4 and T_2 , T_5 inspite of the fact that the birds belonging to T_4 and T_5 groups were given different protein levels during 4 to 6 weeks of age than T_1 and T_2 groups. The birds fed 23% protein ration during starting phase followed by 20% protein finisher rations (T_1 and T_4) as well as those given 18% protein ration during starting phase followed by 20% finisher ration (T_2 and T_5) had similar body weight indicating that minor changes in protein levels during 4-6 weeks of age did not affect the body weight significantly.

An increase in protein level from 13 to 20 per cent at the end of 4 weeks of age (T_6) resulted in significantly higher 6 and 8 weeks body weight of males compared to the birds continued on 13% protein level (T_3) upto 6 weeks.

Unexpectedly the 2 and 4 weeks body weight of females subjected to treatments T_1 and T_4 , i. e., similar rations, presented significant differences in body weight (Table 3). This discrepancy might be due to individual variation in appetite or possible differences in efficiency with which the protein was utilised as has also been reported by Auckland (1972). However, the differences in body weight of birds belonging to T_2 and T_5 as well as T_3 and T_6 were non-significant as was observed for males.

The 6, 8 and 9 weeks body weight of birds belonging to T_4 , T_5 and T_6 groups was higher than those belonging to T_1 , T_2 and T_3 , respectively suggesting that the finisher ration should be shifted at 4 weeks age (Table 3).

TABLE 2
Effect of various treatments on body weight (g) of male birds

Treatments			Age					
Protein level (%)	Duration of feeding (age in weeks)	Treat-ment code	Day-old	2 weeks	4 weeks	6 weeks	8 weeks	9 weeks
23	0-6	T ₁	41.17±0.47 ^a (75)	96.40±2.35 ^a (74)	259.18±7.66 ^a (71)	483.18±13.16 ^a (56)	776.50±21.43 ^a (40)	916.73±28.81 ^a (26)
20	6-9							
18	0-6	T ₂	40.92±0.33 ^a (75)	80.61±1.67 ^b (72)	185.97±7.00 ^b (62)	350.34±13.15 ^b (47)	626.41±24.04 ^b (32)	745.29±41.18 ^b (17)
20	6-9							
13	0-6	T ₃	40.69±0.38 ^a (75)	63.25±1.02 ^c (73)	97.22±2.61 ^c (66)	136.08±5.22 ^c (52)	289.05±17.16 ^c (37)	322.27±29.34 ^c (22)
20	6-9							
23	0-4	T ₄	40.79±0.41 ^a (75)	95.99±2.18 ^a (73)	257.44±6.79 ^a (66)	486.35±12.70 ^a (51)	775.57±21.33 ^a (35)	920.00±40.08 ^a (20)
20	4-9							
18	0-4	T ₅	41.08±0.43 ^a (75)	80.60±1.78 ^b (73)	175.73±5.94 ^b (67)	350.10±11.75 ^b (52)	609.59±21.46 ^b (37)	725.00±35.41 ^b (22)
20	4-9							
13	0-4	T ₆	41.27±0.40 ^a (75)	62.58±1.15 ^c (74)	97.94±2.49 ^c (65)	229.46±8.86 ^d (50)	442.57±18.37 ^d (35)	516.50±27.59 ^d (20)
20	4-9							

Figures in parentheses are number of observations. Means having common superscripts within a column do not differ significantly ($P < 0.05$) from each other.

EFFECT OF PROTEIN RESTRICTION ON SEXED BIRDS

TABLE 3
Effect of various treatments on body weight (g) of female birds

Treatments			Age					
Protein level (%)	Duration of feeding (age in weeks)	Treatment code	Day-old	2 weeks	4 weeks	6 weeks	8 weeks	9 weeks
23	0-6	T ₁	40.28±0.48 ^a (75)	88.75±1.79 ^c (72)	218.34±6.57 ^c (71)	412.44±14.97 ^b (55)	654.27±26.57 ^b (41)	759.00±43.18 ^a (25)
20	6-9							
18	0-6	T ₂	39.92±0.40 ^a (75)	79.72±2.07 ^a (75)	170.28±6.01 ^a (75)	302.67±12.43 ^a (60)	504.55±21.87 ^b (45)	647.67±36.57 ^b (30)
20	6-9							
13	0-6	T ₃	40.85±0.38 ^a (75)	61.12±0.93 ^b (75)	89.01±2.05 ^b (75)	113.63±4.04 ^c (60)	224.89±13.45 ^c (44)	270.00±25.54 ^c (29)
20	6-9							
23	0-4	T ₄	41.07±0.42 ^a (75)	95.81±2.17 ^d (75)	247.65±5.90 ^d (75)	455.12±11.51 ^d (60)	733.00±21.64 ^e (45)	928.83±30.90 ^d (30)
20	4-9							
18	0-4	T ₅	41.07±0.43 ^a (75)	78.78±1.65 ^a (74)	168.59±0.19 ^a (74)	322.63±12.09 ^a (59)	573.22±20.82 ^d (45)	673.17±30.52 ^{ab} (30)
20	4-9							
13	0-4	T ₆	40.68±0.42 ^a (75)	61.09±1.06 ^b (74)	89.39±2.05 ^b (69)	189.35±6.53 ^e (54)	380.13±14.47 ^f (38)	472.86±23.70 ^e (21)
20	4-9							

Figures in parentheses are number of observations. Means having common superscripts within a column do not differ significantly ($P < 0.05$) from each other.

An interesting example of compensatory growth was observed in T_5 group of birds. These birds were significantly lower in body weight compared to T_1 at 6 weeks age but by 9 weeks age the difference was non-significant ($P < 0.05$).

In males the T_5 group showed a very small amount of compensatory growth. At 4 weeks age the body weight of T_1 group of males was about 1.5 times higher than T_5 group (Table 2), whereas at 9 weeks it was only 200 g lesser than T_1 group showing the phenomenon of compensatory growth. For other treatments the compensatory growth in males was either of a lower order or absent.

In females (Table 3) the T_2 group compared to T_1 showed sizeable amount of compensatory growth. From these results it appeared that the females showed substantial amount of compensatory growth than males. The severely undernourished birds (13% protein starter ration against 23% optimum) did not show compensatory growth. This was contrary to the findings of Auckland *et al.* (1969), Auckland and Morris (1971a, b), Auckland (1972) and Moran (1979) who observed comparable body weight in undernourished birds when shifted to normal feeding. The reason for such a difference was the severity of restriction. The restriction was more severe in the present study compared to the one in experiments conducted by other workers.

Shank Length

Significant differences were observed in shank length in the pair of treatments T_1 , T_4 ; T_2 , T_5 and T_3 , T_6 in males and in most of cases in females in spite of the

fact that similar rations were fed to these birds upto the end of 4 weeks of age (Tables 4 and 5). These unexpected differences might be due to error in measurement of shank length which is too small in size at this age (Auckland, 1972).

The birds fed higher level of protein had larger shank length which agreed with the findings of Auckland (1972) who observed that length of lower leg was significantly shorter in retarded birds. The significant effect of treatments on shank length at 6 weeks age continued upto 9 weeks. From this it may be inferred that significant amount of compensatory growth was not observed for this trait. The size of shanks of birds belonging to T_3 and T_6 groups was smaller compared to other treatments which had almost similar or comparable shank length at 8 and 9 weeks age. Males had longer shanks than females at all ages.

Breast Angle

The breast angle of T_1 and T_4 groups of birds was biggest, whereas the treatments T_3 and T_6 had smallest breast angle (Tables 4 and 5). At 4 weeks age significant difference for breast angle was observed between most of the treatments. The T_4 and T_5 groups of birds where the protein level was changed to 20% at 4 weeks age did not differ in breast angle from T_1 and T_2 groups changed to 20% finisher ration at 6 weeks age. However, the birds belonging to T_6 group where severe restriction was imposed only upto 4 weeks performed significantly better than those belonging to T_3 group. At 8 weeks age out of pairs of treatments, T_4 , T_1 ; T_5 , T_2 and T_6 , T_3 , the former three

EFFECT OF PROTEIN RESTRICTION ON SEXED BIRDS

TABLE 4
Effect of various treatments on physical measurements of male birds

Treat- ments	Shank length (cm)				Breast angle (°)				Keel bone length (cm)			
	4 weeks	6 weeks	8 weeks	9 weeks	4 weeks	6 weeks	8 weeks	9 weeks	4 weeks	6 weeks	8 weeks	9 weeks
T ₁	3.79 ^a ±0.07 (71)	4.84 ^a ±0.05 (56)	5.15 ^a ±0.07 (41)	6.48 ^a ±0.08 (26)	20.80 ^a ±0.36 (71)	26.61 ^a ±0.13 (56)	27.76 ^{bc} ±0.47 (41)	31.42 ^a ±0.57 (26)	4.95 ^a ±0.08 (71)	6.60 ^a ±0.11 (56)	8.34 ^a ±0.16 (41)	8.61 ^{ab} ±0.18 (26)
T ₂	3.62 ^b ±0.06 (62)	4.31 ^b ±0.06 (47)	5.51 ^b ±0.09 (32)	5.98 ^b ±0.13 (17)	19.77 ^b ±0.37 (62)	23.57 ^b ±0.44 (47)	26.75 ^c ±0.57 (32)	29.59 ^a ±0.80 (17)	4.48 ^b ±0.08 (62)	5.81 ^b ±0.13 (47)	7.76 ^b ±0.15 (32)	8.24 ^b ±0.19 (17)
T ₃	2.92 ^c ±0.04 (67)	3.02 ^c ±0.05 (52)	4.05 ^c ±0.09 (37)	4.29 ^c ±0.14 (22)	15.69 ^c ±0.31 (67)	16.60 ^c ±0.36 (52)	20.51 ^d ±0.75 (37)	22.64 ^b ±0.81 (22)	3.44 ^c ±0.08 (67)	3.87 ^c ±0.10 (52)	5.42 ^c ±0.15 (37)	5.68 ^c ±0.18 (22)
T ₄	3.92 ^d ±0.05 (66)	4.83 ^a ±0.06 (51)	6.13 ^a ±0.10 (36)	6.54 ^a ±0.11 (21)	22.80 ^d ±0.35 (66)	26.25 ^a ±0.52 (51)	29.78 ^a ±0.38 (36)	30.62 ^a ±0.62 (21)	5.15 ^d ±0.07 (66)	6.54 ^a ±0.11 (51)	8.26 ^a ±0.11 (36)	8.85 ^a ±0.14 (21)
T ₅	3.42 ^e ±0.05 (67)	4.33 ^b ±0.06 (52)	5.56 ^b ±0.11 (37)	5.98 ^b ±0.15 (23)	20.49 ^{ab} ±0.35 (67)	24.23 ^b ±0.48 (52)	28.57 ^{ab} ±0.58 (37)	30.65 ^a ±0.86 (23)	4.29 ^e ±0.08 (67)	5.73 ^b ±0.12 (52)	7.41 ^b ±0.15 (37)	7.66 ^d ±0.17 (23)
T ₆	2.79 ^f ±0.04 (65)	3.52 ^d ±0.06 (50)	4.87 ^d ±0.11 (35)	5.10 ^d ±0.13 (20)	13.71 ^c ±0.23 (65)	21.26 ^d ±0.48 (50)	25.03 ^e ±0.54 (35)	27.50 ^c ±0.66 (20)	3.44 ^c ±0.06 (65)	4.90 ^d ±0.09 (50)	6.59 ^d ±0.14 (35)	7.08 ^e ±0.17 (20)

Figures in parentheses are number of observations. Means having common superscripts within a column do not differ significantly ($P < 0.05$) from each other.

TABLE 5
Effect of various treatments on physical measurements of female birds

Treat- ments	Shank length (cm)				Breast angle (°)				Keel bone length (cm)			
	4 weeks	6 weeks	8 weeks	9 weeks	4 weeks	6 weeks	8 weeks	9 weeks	4 weeks	6 weeks	8 weeks	9 weeks
T ₁	3.48 ±0.05 (71)	4.54 ±0.07 (55)	5.64 ±0.12 (40)	6.08 ±0.14 (25)	20.27 ±0.42 (71)	25.47 ±0.53 (55)	26.77 ±0.64 (40)	29.44 ±0.82 (25)	4.61 ±0.08 (71)	6.08 ±0.12 (55)	7.69 ±0.16 (40)	8.02 ±0.19 (24)
T ₂	3.48 ±0.05 (75)	4.12 ±0.05 (60)	5.07 ±0.08 (45)	5.61 ±0.11 (30)	19.19 ±0.37 (75)	22.53 ±0.52 (60)	25.13 ±0.65 (45)	28.97 ±0.78 (30)	4.20 ±0.08 (75)	5.45 ±0.13 (60)	6.93 ±0.13 (45)	7.53 ±0.19 (30)
T ₃	2.87 ±0.05 (75)	2.86 ±0.05 (60)	3.69 ±0.08 (44)	3.97 ±0.15 (28)	15.16 ±0.24 (75)	15.68 ±0.31 (60)	19.95 ±0.57 (44)	21.89 ±0.75 (28)	3.24 ±0.07 (75)	3.55 ±0.08 (60)	4.89 ±0.11 (44)	5.29 ±0.18 (28)
T ₄	3.90 ±0.06 (75)	4.67 ±0.06 (60)	6.02 ±0.09 (45)	6.56 ±0.10 (30)	22.69 ±0.31 (75)	25.78 ±0.46 (60)	29.27 ±0.48 (45)	30.37 ±0.45 (30)	5.06 ±0.06 (75)	6.42 ±0.10 (60)	8.16 ±0.10 (45)	8.79 ±0.13 (30)
T ₅	3.45 ±0.04 (74)	4.15 ±0.06 (59)	5.37 ±0.10 (44)	5.71 ±0.12 (29)	20.03 ±0.39 (74)	23.19 ±0.55 (59)	27.00 ±0.59 (44)	29.52 ±0.75 (29)	4.17 ±0.08 (74)	5.40 ±0.12 (59)	7.10 ±0.14 (44)	7.55 ±0.17 (29)
T ₆	2.71 ±0.03 (69)	3.36 ±0.05 (54)	4.58 ±0.09 (39)	4.88 ±0.10 (24)	13.59 ±0.25 (69)	19.70 ±0.47 (54)	22.92 ±0.48 (39)	26.29 ±0.91 (24)	3.25 ±0.05 (69)	4.43 ±0.09 (54)	5.94 ±0.12 (39)	6.49 ±0.13 (29)

Figures in parentheses are number of observations. Means having common superscripts within a column do not differ significantly ($P < 0.05$) from each other.

registered bigger breast angle indicating that a change to 20% finisher ration should be done at 4 weeks of age. Some signs of compensatory growth in breast angle of T_5 group of birds were visible at 8 weeks of age. These birds were significantly smaller in size than T_1 group at 6 weeks but at 8 weeks, these differences were levelled off because of relatively higher growth rate in breast of birds of this group. At 9 weeks of age the T_3 and T_6 groups of birds had significantly smaller breast angle, whereas the differences in breast angle of birds belonging to T_1 , T_2 , T_4 and T_5 groups were statistically similar. The results indicated that minor changes in protein levels do not affect the breast angle marketing age (8 or 9 weeks) but severe protein restriction to the extent of 13% in broiler starter rations will adversely affect the size of the breast angle. Males had larger breast angle than females.

Keel Bone Length

The trend of performance of birds for keel bone length (Tables 4 and 5) was similar to that reported for shank length and breast angle.

Cooking Loss

The effect of treatments for this trait (in most of the cases) in both sexes (Table 6) was found non-significant but gross observations lead to conclude that with an increase in protein level in the feed there was a decrease in per cent cooking loss. This might be due to an increase in ether extract percentage in groups fed low protein diets (Table 8). Wilson (1972) reported that higher proportion of cooked weight is due to

residual body fat. Lowe and Verman (1927) stated that fatty birds have higher cooking loss. At 6 weeks of age the trend that higher the protein level lower the cooking loss continued barring a few cases.

At 8 weeks of age, the T_3 group (that had higher per cent cooking loss at 6 weeks) was found to have non-significant difference from other treatments. It appears that the change of ration from 13 to 20 per cent protein during 6 to 8 weeks of age had resulted in significant decrease in cooking loss in birds of this treatment. The cooking loss decreased with an increase in age.

Chemical Composition of Meat

The effect of treatments on moisture content of meat was non-significant (Tables 7 and 8). The effect of sex and age also did not show a definite trend by which it can be said that this trait is affected by sex or age. It could be generalised that with a decrease in protein content a slight increase in moisture content can be observed. The results are in agreement with those of Donaldson *et al.* (1958) and Auckland and Morris (1971b).

Low protein feeding resulted in decrease in per cent protein content of the meat in both sexes. The results are in agreement with Combs (1964) and Auckland and Morris (1971b).

The effect of low protein levels of diet on per cent ether extract of meat indicated that protein content of diet is inversely related to ether extract percentage (Auckland and Morris, 1971b; Prasad, 1976).

TABLE 6
Effect of various treatments on per cent cooking loss in total carcass*

Treatments	4 weeks		6 weeks		8 weeks	
	Male	Female	Male	Female	Male	Female
T ₁	34.58±2.64 ^a	35.65±5.34 ^a	28.63±0.87 ^a	27.51±3.92 ^b	23.31±2.17 ^a	24.52±4.46 ^a
T ₂	34.31±0.69 ^a	36.32±3.72 ^a	24.36±0.48 ^a	28.12±1.58 ^b	22.16±4.77 ^a	20.47±1.19 ^a
T ₃	47.23±6.59 ^a	39.74±2.77 ^a	38.24±3.42 ^b	38.78±0.68 ^a	23.21±1.71 ^a	24.32±6.01 ^a
T ₄	29.87±5.66 ^a	28.78±3.54 ^a	24.14±1.42 ^a	31.00±0.86 ^b	26.34±2.08 ^a	25.87±2.00 ^a
T ₅	36.68±1.77 ^a	36.25±2.31 ^a	30.38±3.94 ^a	28.99±3.84 ^b	22.71±1.22 ^a	23.93±4.67 ^a
T ₆	39.81±2.59 ^a	36.36±5.33 ^a	26.87±2.78 ^a	33.75±0.27 ^{ab}	20.77±3.32 ^a	22.65±6.01 ^a

Each value represents average of nine observations (three replications of three observations).

*Chilled eviscerated weight including neck but excluding giblets.

Means having common superscripts within a column do not differ significantly ($P < 0.05$) from each other.

TABLE 7
Effect of various treatments on chemical composition of male broilers meat

Treatments	Moisture (%)			Crude protein* (%)			Ether extract* (%)			Ash* (%)		
	4 weeks	6 weeks	8 weeks	4 weeks	6 weeks	8 weeks	4 weeks	6 weeks	8 weeks	4 weeks	6 weeks	8 weeks
T ₁	73.84 ±1.91	75.18 ±0.49	75.71 ±0.43	73.48 ±1.68	78.29 ±2.35	82.23 ±2.10	24.97 ±2.50	18.17 ±1.98	14.66 ±1.99	4.05 ±0.31	4.63 ±0.38	4.20 ±0.13
T ₂	74.92 ±0.38	75.65 ±0.55	75.60 ±0.43	71.90 ±2.39	72.63 ±3.06	79.83 ±1.05	24.01 ±2.54	23.94 ±2.87	16.26 ±1.13	4.67 ±0.41	4.50 ±0.36	4.09 ±0.19
T ₃	76.79 ±0.80	76.13 ±1.08	75.01 ±0.96	69.05 ±3.42	71.67 ±3.08	75.17 ±1.41	25.41 ±3.32	24.38 ±3.19	22.04 ±1.67	4.40 ±0.25	4.32 ±0.98	4.23 ±0.10
T ₄	74.69 ±0.93	74.44 ±0.75	74.90 ±0.77	71.71 ±0.68	77.38 ±1.84	78.61 ±1.72	23.24 ±0.75	19.39 ±1.84	18.77 ±1.71	4.69 ±0.29	4.24 ±0.20	3.86 ±0.23
T ₅	74.58 ±0.38	75.39 ±0.65	75.24 ±0.46	69.85 ±1.44	74.63 ±1.86	81.59 ±0.99	25.74 ±1.55	19.63 ±2.74	15.84 ±1.20	3.89 ±0.15	4.46 ±0.27	4.26 ±0.15
T ₆	74.34 ±0.99	75.14 ±0.39	74.11 ±0.71	66.77 ±2.31	73.58 ±2.38	76.02 ±1.69	28.61 ±2.67	22.43 ±2.14	21.23 ±1.80	4.34 ±0.13	4.13 ±0.34	3.76 ±0.35

*Per cent of dry weight.

Each value represents average of six observations.

Means having common superscripts within a column do not differ significantly ($P < 0.05$) from each other.

TABLE 8
Effect of various treatments on chemical composition of female broilers meat

Treatments	Moisture (%)			Crude protein* (%)			Ether extract* (%)			Ash* (%)		
	4 weeks	6 weeks	8 weeks	4 weeks	6 weeks	8 weeks	4 weeks	6 weeks	8 weeks	4 weeks	6 weeks	8 weeks
T ₁	74.26 ±0.78	74.37 ±0.70	75.27 ±0.26	75.81 ^a ±1.68	78.16 ^a ±1.83	78.84 ^a ±2.11	20.73 ^a ±1.19	18.64 ^a ±1.50	17.33 ^a ±2.32	4.32 ±0.53	4.52 ±0.29	4.22 ±0.24
T ₂	76.14 ±1.12	75.66 ±0.52	74.14 ±0.70	75.38 ^a ±1.69	76.76 ^a ±1.47	74.44 ^a ±2.36	24.28 ^{ab} ±1.68	19.43 ^a ±1.58	22.04 ^a ±2.38	4.08 ±0.34	4.64 ±0.33	4.19 ±0.30
T ₃	74.57 ±0.94	75.78 ±0.28	76.29 ±0.39	63.20 ^b ±1.97	70.69 ^a ±2.07	77.27 ^a ±1.86	31.66 ^a ±2.49	24.58 ^a ±2.33	18.61 ^a ±1.90	5.14 ±0.57	4.47 ±0.21	4.56 ±0.13
T ₄	73.61 ±0.56	73.45 ±0.46	75.28 ±0.48	75.03 ^a ±2.27	73.27 ^a ±2.58	79.81 ^a ±1.64	22.89 ^b ±3.17	22.83 ^a ±2.34	17.62 ^a ±1.60	4.43 ±0.38	3.87 ±0.14	3.93 ±0.23
T ₅	74.43 ±0.94	73.81 ±0.82	75.02 ±0.68	70.26 ^a ±2.62	73.53 ^a ±2.75	73.38 ^a ±1.81	25.85 ^{ab} ±2.63	22.48 ^a ±2.72	18.14 ^a ±2.08	3.80 ±0.21	4.18 ±0.25	4.18 ±0.15
T ₆	76.05 ±0.66	74.50 ±0.55	74.31 ±0.01	68.65 ^{ab} ±2.27	72.16 ^a ±2.04	74.78 ^a ±3.11	27.17 ^{ab} ±2.50	23.19 ^a ±2.25	21.91 ^a ±3.40	3.95 ±0.23	3.79 ±0.50	4.09 ±0.37

*Per cent of dry weight.

Each value represents average of six observations.

Means having common superscripts within a column do not differ significantly ($P < 0.05$) from each other.

EFFECT OF PROTEIN RESTRICTION ON SEXED BIRDS

The treatments had no significant effect on ash percentage in both sexes (Tables 7 and 8). This is in close agreement with the findings of Gowda (1974), Prasad (1976) and Twining *et al.* (1978).

ACKNOWLEDGEMENT

The authors are thankful to Indian Council of Agricultural Research, New Delhi, for providing financial help in the form of Senior Research Fellowship.

REFERENCES

- AOAC. 1975. Official Methods of Analysis. Association of Official Agricultural Chemists, Washington, D. C.
- Auckland, J. N. 1972. Compensatory growth in turkeys. Practical implications and limitations. *World Sci. J.* 28 : 291-300.
- Auckland, J. N. and Morris, T. R. 1971a. Compensatory growth in turkeys. Effect of undernutrition on subsequent protein requirements. *Br. Poult. Sci.* 12 : 41-48.
- Auckland, J. N. and Morris, T. R. 1971b. Compensatory growth after undernutrition in market turkeys. Effect of low protein feeding and realimentation on body composition. *Br. Poult. Sci.* 12 : 137-50.
- Auckland, J. N., Morris, T. R. and Jennings, R. C. 1969. Compensatory growth after undernutrition in market turkeys. *Br. Poult. Sci.* 10 : 293-302.
- Combs, G. F. 1964. Predicting amino acid requirements of chicks based on growth rate, body size and body composition. *Proc. Fedn. Am. Soc. exp. Biol.* 23 : 46-51.
- Donaldson, W. E., Combs, G. F. and Romoser, G. L. 1958. Studies on energy levels in poultry rations. 3. Effect of calorie-protein ratio of the ration on growth, nutrient utilization and body composition of poult. *Poult. Sci.* 37 : 614-19.
- Gowda, G. Devi. 1974. Studies on the protein requirement of purebred broiler chicks. *Indian J. poult. Sci.* 9 : 29-30.
- Haque, N. 1975. Review of energy : protein ratio on performance of chicks. *Poult. Guide* 12 : 23-25.
- Lowe, B. O. and Verman, V. M. 1927. Poultry for the table as influenced by market class and grade. *Poult. Sci.* 6 : 51-61.
- Mathur, C. R. and Reddy, C. V. 1975. Effect of floor and feeding space on the performance of broiler chicks. *Indian J. poult. Sci.* 10 : 190.
- Moran, Jr. E. T. 1979. Carcass quality changes with the broilers chicken after dietary protein restriction during the growing phase and finishing period compensatory growth. *Poult. Sci.* 58 : 1257-70.
- Moran, Jr. E. T. 1980. Early protein restriction of the broiler chicken and carcass quality upon later marketing. *Poult. Sci.* 59 : 378-82.
- Moran, Jr. E. T. 1981. Early protein nutrition, compensatory growth and carcass quality of broiler type tom turkeys. *Poult. Sci.* 60 : 401-06.
- Moran, Jr. E. T., Orr, H. L. and Larmond, E. 1971. Sex and age related production efficiency, grades and yields with the small White Broiler-Fryer type turkey. *Poult. Sci.* 50 : 411-25.
- Prasad, A. 1976. Effect of dietary protein and calorie-protein ratio on dressing percentage and carcass composition of crossbred broilers. *Indian Poult. Gaz.* 60 : 24-27.
- Steel, R. G. D. and Torrie, J. H. 1981. *Principles and Procedures of Statistics*. Mc Graw Hill International Book Co., London.
- Twining, P. V., Thomas, Jr. O. P., Bossard, E. H. and Nicholson, J. L. 1974. The effect of amino acid and protein level on body composition of 8½ weeks broilers. *Proc. Maryland Nutr. Conf.* pp. 89-95.

- Twining, P. V., Thomas, O. P. and Bossard, E. H.
1978. Effect of diet and type of birds on
the carcass composition of broilers at 28, 49
and 59 days of age. *Poult. Sci.* **57**:
492-97.
- Wilson, B. J. 1972. Yield of raw and cooked
components from table duckling carcass.
Br. Poult. Sci. **13**: 415-17.

HISTOMORPHOLOGICAL STUDIES ON THE ENDOMETRIAL EPITHELIUM OF BUFFALO DURING ESTROUS CYCLE

HARCHARAN SINGH and D. N. SHARMA
Department of Veterinary Anatomy & Histology
Haryana Agricultural University, Hisar

(Received : August 13, 1984; Revised : February 25, 1985)

ABSTRACT

Uterine tissues from 25 adult, cyclic, multiparous buffaloes in different phases of estrous cycle were studied. The lining epithelium of the uterine mucosa was pseudostratified columnar, occasionally ciliated type and often showed striated distal border. The epithelium grew taller from the follicular phase to the mid luteal phase. These variations in the epithelial height might be under the control of estrogen and progesterone hormones.

Veterinary histology textbooks (Trautmann and Fiebiger, 1957; Friedkaufs, 1981) have described the characters of the endometrial epithelium in various species of domestic animals. Larson *et al.* (1965, 1970), Marinov and Lovell (1968) and Hackett and Hafs (1969) have recorded their observations in cattle and El-Sheikh and Abdelhadi (1970), Sundaravadanan and Venkateswami (1973) and Agarwal *et al.* (1978) in buffalo. But scanty information is available on this aspect in buffalo during the different phases of the estrous cycle.

MATERIAL AND METHODS

Twentyfive adult, healthy, multiparous female Murrah buffaloes were included in this investigation. Based on the ovarian morphology, the animals (samples) were classified into early follicular (5), late follicular (5); early luteal (5), mid luteal (5) and late luteal (5) phases. Tissues were collected immediately after

exsanguination and fixed in 10% neutral buffered formalin. These were then processed and paraffin sections of 5-6 μ thickness were stained with H & E (Luna, 1968).

Duncan's new multiple range test was employed to check the variability in micrometric data (Steel and Torrie, 1960) in various phases of the cycle. Contraction factors in histological processing have not been considered.

RESULTS AND DISCUSSION

The epithelial lining of the cavum uteri consisted of pseudostratified columnar cells (Figs. 1 and 2). Occasionally ciliated cells occurred throughout the estrous cycle. Marinov and Lovell (1968) have reported the occurrence of less than 1% ciliated cells in the cow endometrium. However, El-Sheikh and Abdelhadi (1970) did not describe any ciliated cell in the lining epithelium of buffalo endometrium.

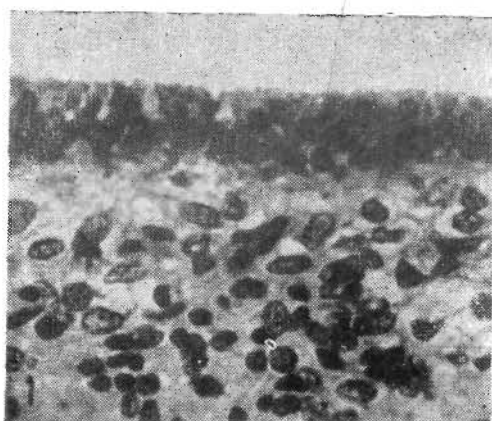


Fig. 1. Photomicrograph showing a comparatively low height of the pseudostratified columnar epithelium of the endometrium in follicular phase. H. & E $\times 400$.

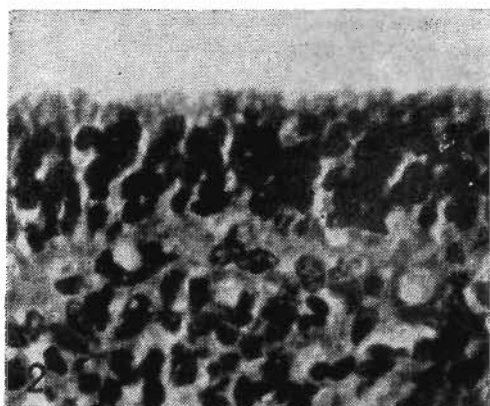


Fig. 2. Photomicrograph of the endometrium showing tall pseudostratified columnar epithelium in mid luteal phase. H. & E $\times 400$.

The cytoplasm was homogeneously eosinophilic. The distal border of these cells quite often showed striated border or secretory blebs, indicating their secretory or absorptive nature. The microvilli have been reported in the endometrial lining of cows (Stinson *et al.*,

1962). The lateral border of these cells close to their juxta-luminal ends showed terminal bars. The nuclei were round to oval, placed in basal half of the cells, their chromatin being coarsely granular and randomly distributed. Occasionally, a few cells showed chromatin attached to their nuclear membrane. Basal border of these cells rested upon a distinct eosinophilic basement membrane.

Data presented in Table 1 indicated that, although the epithelial lining over the caruncular area was slightly higher than that of the intercaruncular area through all the phases of cycle, yet, their growth pattern remained essentially similar. It was further evident that the epithelial height varied significantly during different phases of the estrous cycle. Maximum epithelial height in caruncular and intercaruncular areas was recorded in the mid-luteal phase and the minimum in the late luteal phase of the cycle. The lining epithelium started growing right from the early follicular phase and continued up to mid luteal phase. Ramchandraiah *et al.* (1980) in sheep and Heranjali *et al.* (1976) in buffaloes also reported increased epithelial height in mid luteal phase. The present investigations confirm the findings of Asdell *et al.* (1949) who reported increased uterine epithelial height upto 8th day post-estrus in cattle.

The increased epithelial height from early follicular to mid luteal phase can be correlated with the histochemical findings of Singh and Sharma (1984). They enunciated that the initial increase in the epithelial height during the follicular phase was due to increased protein

ENDOMETRIAL EPITHELIUM OF BUFFALO

TABLE 1

Duncan's new multiple range test showing phasic variations in the mean uterine epithelial height (μ) during different phases of estrous cycle

Uterine region	Follicular phase		Luteal phase		
	Early	Late	Early	Mid	Late
Caruncular	23.80 ^a (0.65)	24.80 ^{ab} (0.95)	26.31 ^a (0.93)	33.83 ^b (0.98)	21.97 ^c (0.66)
Intercaruncular	20.15 ^a (0.51)	23.31 ^b (0.97)	25.23 ^b (0.98)	32.11 ^c (0.59)	17.32 ^d (0.67)

n=40 for each observation.

Values with similar superscripts do not differ significantly but with dissimilar superscripts differ significantly.

Values in parentheses indicate standard error.

synthesis under the effect of estrogen, while the final increase during the mid luteal phase was due to heavy accumulation of fat particles in the cells under progesteronal response. They further observed that the enzymic activity of the epithelium was also increased during the mid luteal phase, indicating high cell activity during this time. Increased mitochondria and Golgi complex in the supranuclear zone of these cells during mid luteal phase have also been reported by Marinov and Lovell (1968). Moss *et al.* (1954) and Sykes *et al.* (1955) have also recorded high alkaline phos-

phatase activity in the uterine epithelium of cattle during the mid luteal phase. A low epithelial height during the late luteal phase on contrary might indicate the decreased cellular activity in this phase.

ACKNOWLEDGEMENTS

The authors are indebted to Dr. L. D. Dhingra, Dean, College of Veterinary Sciences and Dr. Yashwant Singh, Head of Department of Anatomy & Histology for providing the facilities.

REFERENCES

- Agarwal, K. P., Raizada, B. C. and Pandey, M. D. 1978. Post parturient changes in uterus of buffalo cow. *Indian J. anim. Sci.* **48** : 492-502.
- Asdell, S. A., Alba, I. De. and Roberts, S. J. 1949. Studies on the estrous cycle of dairy cattle, cycle length, size of corpus luteum and endometrial changes. *Cornell Vet.* **39** : 389-402.
- El-Sheikh, A. S. and Abdelhadi, H. A. 1970. Anatomy and histology of reproductive tract in the Egyptian buffalo. *Indian J. anim. Sci.* **40** : 213-22.
- Hackett, A. J. and Hafs, H. D. 1969. Biochemical and morphological changes in bovine tubular genitalia during estrous cycle. *J. anim. Sci.* **29** : 35-38.

SINGH AND SHARMA

- Heranjal, D. D., Nagulu, V. and Rao, S. S. 1976. Histological changes in reproductive tract of Indian she buffalo (*Bubalus bubalis*) during various phases of estrous cycle. *Indian J. anim. Sci.* **46** : 583-86.
- Larson, L., Marion, G. B. and Gier, G. T. 1965. Cyclic changes in the bovine endometrium. *J. anim. Sci.* **24** : 923.
- Larson, L., Marion, G. B. and Gier, H. T. 1970. Glycogen metabolism in bovine endometrium. *Am. J. vet. Res.* **31** : 1929-35.
- Luna, L. G. (ed.). 1968. *Manual of Histological Staining Methods of Armed Forces Institute of Pathology*. Mc-Graw Hill Book Co., New York.
- Marinov, U. and Lovell, J. E. 1968. Cytology of bovine uterine epithelium during estrous cycle. *Am. J. vet. Res.* **29** : 13-30.
- Moss, S., Wrenn, T. R. and Sykes, J. F. 1954. Alkaline phosphatase, glycogen and PAS positive substances in bovine uterus during estrous cycle. *Endocrinology* **55** : 261-73.
- Priedkalns, J. 1981. Female reproductive system. In : *Textbook of Veterinary Histology*. Dellmann, H. D. and Brown, E. M. (eds). pp. 309-36. Lea & Febiger, Philadelphia.
- Ramchandraiah, S. V., Rao, P. R. and Rao, A. R. 1980. Histological, histometrical and histochemical changes in the uterine and oviducal epithelium of ewe during oestrous cycle. *Indian J. anim. Sci.* **50** : 41-45.
- Singh, Harcharan and Sharma, D. N. 1984. Histological and histochemical studies on buffalo endometrium during estrous cycle. All India Seminar on Role of Anatomy in Production and Reproduction of Farm Animals held at Haryana Agricultural University. Hisar, 23-25 March, 1984.
- Steel, R. G. D. and Torrie, J. H. 1960. *Principles and Procedures of Statistics*. Mc-Graw Hill Book Co., New York.
- Stinson, A., Weber, A. F. and Zemjanis, R. 1962. The bovine endometrium. An electron microscopic study. *Am. J. vet. Res.* **23** : 1164-81.
- Sundaravadanan, V. K. and Venkatswami, V. 1973. Histology and histochemistry of bovine uterus. *Indian J. anim. Sci.* **43** : 1050-53.
- Sykes, J. F., Moss, S. and Wrenn, I. R. 1955. The distribution of alkaline phosphatase and glycogen in ovaries and uterus of the bovine (Michigan State University Continental Symposium Report : Reproduction and Infertility) Michigan State University Press (1955). pp. 63 (cited by Larson *et al.*, 1970).
- Trautmann, A. and Fiebiger, J. 1957. *Fundamentals of the Histology of the Domestic Animals*. Translated and revised by Habel, R. E. and Biberstein, E. L. Comstock Publishing Associates, Cornell University, Ithaca.

DAMAGE REDUCTION WITH GIBBERELIC ACID POST-TREATMENT IN GAMMA IRRADIATED CARYOPSES OF *AVENA FATUA* L.

N. MAHERCHANDANI and M. VASUDEVA

Department of Genetics

Haryana Agricultural University, Hisar

(Received : March 23, 1984; Revised : November 15, 1984)

ABSTRACT

Post-treatment with 10 ppm of gibberellic acid (GA_3) following gamma-irradiation reduced the mitotic anaphase abnormalities by 70% in *Avena fatua* L. caryopses and restored seedling growth. GA_3 treatment was also effective in seeds imbibed in water prior to irradiation. GA_3 possibly prevented the lesions from materializing as chromosomal aberrations.

Pre-treatment with many chemicals reduces the damage caused by ionizing radiations. Cysteine injected into rats and mice before irradiation increased their survival percentage (Patt *et al.*, 1949). Subsequently other aminothiol compounds were found to give protection against radiations (Bacq and Alexander, 1961). Pre-treatment with BAL (=Dimercaptopropanol), Sodium hydrosulphite, Glutathione, Thiourea and Dimethyl sulphoxide has been found to reduce chromosomal damage in various species of plants (Wolff, 1954; Mikaelson, 1952, 1955; Riley, 1955, 1957; Kaul, 1969). Among the plant growth regulators gibberellic acid (GA_3) is known to reduce gamma radiation effects on plant growth in maize and wheat (Gaur and Notani, 1960; Haber and Luipold, 1960). Kumar (1967) reported that cytological damage due to gamma radiation was reduced by soaking irradiated barley seeds in 1000 ppm GA_3 solution, but Minocha and Saini (1971) did not find increase in mutation rates

with GA_3 post-treatment. In the present study, effects of a low concentration (10 ppm) of GA_3 on the seedling growth and cytological damage in the gamma-irradiated *Avena fatua* L. seeds have been reported.

MATERIAL AND METHODS

Naked caryopses of *Avena fatua* with a moisture content of 10 ± 1 per cent were irradiated with 10 to 30 kR gamma rays at a dose rate of 800 R/min. These were germinated in 9 cm petri-plates on a single layer of Whatman No. 1 filter paper soaked to saturation with either distilled water or 10 ppm GA_3 solution. Few drops of distilled water were added each day to keep the filter papers wet. There were three plates per treatment, each containing 25 seeds.

After 72 h, roots (5-6 mm) were fixed in acetic acid ethanol (1:3). After 24 h, these roots were transferred to 70%

ethanol. Root tips were hydrolysed in 1N HCl for 10 min, stained in Feulgen reagent for 1 h and squashed in 45% acetic acid. Frequency of abnormal anaphases was estimated in each treatment from 500 anaphase cells scored from at least 5 slides from 10 root tips. Mitotic index was estimated from 1300-2000 cells. Seedling height was recorded on the 12th day.

RESULTS AND DISCUSSION

Frequency of cells with anaphase bridges as well as fragments, increased

with increase in radiation dose (Table 1). Post-treatment with GA₃ reduced the frequency of anaphase bridges as well as fragments, which were relatively more frequent in pre-soaked seeds than in dry-irradiated ones. The seeds pre-soaked in GA₃ exhibited a low frequency of chromosomal aberrations than those soaked in water.

Mitotic index in the control decreased with increase in radiation dose but in GA₃ post-treated seeds some stimulation was observed in 10 kR treatment (Table 2). In pre-soaked seeds some stimulation

TABLE 1

Effect of GA₃ on frequency of mitotic anaphase anomalies in root tips of gamma irradiated *Avena fatua* seeds

Seed treatment	Dose kR	Without GA ₃			With GA ₃		
		Bridges	Fragments	Total	Bridges	Fragments	Total
Dry	0	0.6	0.2	0.8±0.397	0.2	0.2	0.4±0.281
	10	3.8	1.0	4.8±0.957	2.8	0.8	3.6±0.833
	20	7.6	3.0	10.6±1.376	6.2	2.0	8.2±1.226
	30	11.4	6.0	17.4±1.695	8.2	4.0	12.2±1.463
Pre-soaked	0	0.8	0.8	1.6±0.560	0.6	0.4	1.0±0.445
	10	7.8	2.6	10.4±1.365	4.6	3.2	7.8±1.199
	20	9.0	4.8	13.8±1.542	6.8	3.8	10.6±1.376

TABLE 2

Effect of GA₃ on mitotic index in root tips of gamma irradiated *Avena fatua* seeds

Seed treatment	Dose kR	Without GA ₃		With GA ₃	
		No. of cells	Mitotic index	No. of cells	Mitotic index
Dry	0	1801	5.05±0.515	1685	5.40±0.549
	10	1873	4.75±0.491	1237	7.33±0.741
	20	1319	4.55±0.573	1310	6.49±0.680
	30	1748	3.32±0.427	2757	3.16±0.331
Pre-soaked	0	557	7.72±1.130	456	8.33±1.293
	10	525	9.14±1.264	413	10.65±1.517
	20	694	6.05±0.904	639	6.88±1.00

REDUCTION OF GAMMA RADIATION DAMAGE

TABLE 3

Effect of GA₃ on seedling height of gamma irradiated *Avena fatua* seeds

Seed treatment	Dose kR	Shoot length (cm)		
		Without GA ₃	With GA ₃	Difference
Dry	0	9.1±0.36	11.7±0.43	+ 2.6
	10	10.1±0.38	13.4±0.44	+ 3.3
	20	4.6±0.44	8.9±0.32	+ 4.3
	30	1.6±0.24	5.3±0.58	+ 3.7
Pre-soaked	0	10.2±0.57	13.1±1.02	+ 2.9
	10	7.2±0.64	8.5±0.62	+ 1.3
	20	*0.0	*0.0	

*Leaf did not emerge from the coleoptile, therefore, height was not recorded.

was observed in 10 kR treatment, but little effect of GA₃ treatment was seen.

Gamma rays at 10 kR stimulated seedling height but higher doses were detrimental. Reduction in height was more pronounced in the absence of GA₃ (50% at 20 kR and 83% at 30 kR) as compared to 34 and 55 per cent in GA₃ treated (Table 3).

This study has shown that post-treatment with very low concentration of GA₃ decreased the frequency of anaphase aberrations due to gamma irradiation. The damage reduction due to GA₃ treatment was from 23 to 45 per cent in pre-soaked as well as dry irradiated seeds. Pre-soaked seeds, however, were more sensitive to irradiation. No seedlings were obtained at 20 kR in pre-soaked seeds, even though the seeds germinated and produced some roots. Similar protective effects of GA₃ could also be seen on seedling growth and mitotic index (Tables 2 and 3).

Chemicals such as aminothiols, that are known to give protection against

radiation damage, must be present at the time of irradiation and are effective only as pre-treatments. These may act either as free-radical scavengers or by causing anoxia in the system (Bacq and Alexander 1961; Alper, 1979). Gibberellic acid enhances metabolic rate (Jones, 1973) and increases peroxidase activity (Thakral, 1979; Jain *et al.*, 1980). Due to higher respiratory activity in GA₃ treated seeds, a local state of relative anoxia may be created in the cell so that there is low cell damage (Alper, 1979) or due to enhanced peroxidase activity, surviving peroxy radicals may be eliminated such that the resultant detectable damage is less. A third possibility is that gamma radiation caused potential lesions (Bacq and Alexander, 1961) which are normally converted to real cytological damage on imbibition of seed, are eliminated due to high metabolic rate of GA₃ treated seeds.

ACKNOWLEDGEMENT

The authors are thankful to Professor J. B. Chowdhury, Dean, College of Basic Sciences & Humanities, for his keen interest in this study.

REFERENCES

- Alper, T. 1979. *Cellular Radiobiology*. Cambridge University Press, Cambridge.
- Bacq, Z. M. and Alexander, P. 1961. *Fundamentals of Radiobiology*. ELBS and Pergamon Press, New York.
- Gaur, B. K. and Notani, N. K. 1960. Effect of gibberellic acid on radiation stunted seedlings of maize. *Int. J. Radiat. Biol.* 2: 257-59.
- Haber, A. H. and Luipold, H. J. 1960. Effect of gibberellic acid on gamma irradiated wheat. *Am. J. Bot.* 47: 140-44.
- Jain, R. K., Maherchandani, N., Sharma, D. R. and Chowdhury, V. K. 1980. Effect of gamma-radiations on haploid cultured cells of *Datura innoxia*. In: *Plant Tissue Culture, Genetic Manipulation and Somatic Hybridization of Plant Cells*. Rao, P. S., Heble, M. R. and Chadha, M. S. (eds.). Bhabha Atomic Research Centre, Bombay.
- Jones, R. L. 1973. Gibberellins, their physiological role. *Ann. Rev. Plant Physiol.* 24: 571-98.
- Kaul, B. L. 1969. Protection against radiation induced chromosome breakage in *Vicia faba* by dimethyl sulphoxide. *Radiat. Bot.* 9: 111-14.
- Kumar, S. 1967. Effect of gibberellic acid on gamma irradiated barley seeds. *Indian J. Genet.* 27: 154-56.
- Mikaelsen, K. 1952. The protective effect of glutathione against radiation induced chromosome aberrations. *Science* 116: 172-74.
- Mikaelsen, K. 1955. The protective property of thiourea against radiation induced chromosome aberrations. *Exp. Cell Res.* 8: 400-03.
- Minocha, J. L. and Saini, R. C. 1971. Mutation frequency in barley following treatment with EMS or gamma rays and post-treatment with GA. *Indian J. Genet.* 31: 223-27.
- Patt, H. W., Tyree, E. B., Staube, R. L. and Smith, D. E. 1949. Cysteine protection against X-irradiation. *Science* 110: 213-14.
- Riley, H. P. 1955. The protective effect of various chemical compounds against damage to chromosomes by gamma radiation. *Am. J. Bot.* 42: 765-69.
- Riley, H. P. 1957. Chemical protection against X-ray damage to the chromosomes. *Genetics* 42: 593-600.
- Thakral, V. P. 1979. The effects of gamma radiation, gibberellic acid and amino acids on the aleurone tissue and embryo of *Avena fatua*. M. Sc. thesis, Haryana Agricultural University, Hisar.
- Wolff, S. 1954. Some aspects of chemical protection against radiation damage to *Vicia faba* chromosomes. *Genetics* 39: 356-64.

RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XV, No. 4, pp. 403—405 (December 1985)

PRODUCTION OF HYDROLYTIC ENZYMES IN WILD-TYPE AND NON-NODULATING STRAINS OF *RHIZOBIUM TRIFOLII*

R. K. VASHISHAT, A. S. YADAV and KAMLA CHAUDHARY*

Department of Genetics

Haryana Agricultural University, Hisar

(Received : February 20, 1984; Revised : October 27, 1984)

Rhizobia infect legumes by hydrolyzing the root hair cell wall at the highly localized site of infection (Hubbell *et al.*, 1978; Martinez-Molina *et al.*, 1979). Studies on the presence or absence of hydrolytic enzymes like pectinases, hemicellulases and cellulases in non-nodulating strains of *Rhizobium trifolii* obtained after curing of wild-type strain, will help in finding the location of genes specifying these enzymes. Growth of *R. trifolii* at 35°C leads to elimination of a plasmid controlling nodulation (Zurkowski and Lorkiewicz, 1978, 1979). Using the same procedure, we isolated

10 non-nodulating strains of *R. trifolii*. These strains and wild-type strain (Table 1) are capable of producing hydrolytic enzymes : pectinases, hemicellulases and cellulases.

Pectolytic enzymes were induced by growing cells on yeast extract mannitol medium containing 0.25% pectin as described by Hubbell *et al.* (1978). A loop-full of cell suspension of each strain was spotted on agar plates which were incubated for 12 days at 30°C. Presence of pectolytic activity was determined by flooding the plates with 2%

TABLE 1
Production of hydrolytic enzymes in *R. trifolii*

Bacterial strain used	Nodulation	Pectinase activity	Carboxymethyl cellulase activity n mol glucose/min/ml	Xylanase activity n mol xylose/ min/ml
B 88 (WT)	+	+	6.0	8.8
T ₂	—	+	6.0	8.7
T ₁₀	—	+	5.3	8.7
T ₂₈	—	+	6.0	8.7
T ₃₉	—	+	5.3	8.7
T ₄₂	—	+	5.7	8.8
T ₆₀	—	+	5.3	8.8
T ₁₂₆	—	+	5.9	8.8
T ₁₄₅	—	+	5.8	8.8
T ₁₄₇	—	+	6.0	8.7
T ₁₄₉	—	+	5.3	8.6

*Department of Microbiology.

aqueous solution of hexadecyltrimethyl ammonium bromide, taking care not to dislodge the colonies. After 20-30 min, the plates were examined and the appearance of a clear zone around the colonies was considered as a proof of pectin decomposing potential of that strain.

Strains to be tested for the presence of hemicellulases and cellulases were grown on basal hemicellulose or cellulose induction medium containing 0.1% cellobiose or cellulose (Martinez-Molina *et al.*, 1979). Flasks of broth were inoculated with a cell suspension from yeast extract mannitol agar plates and incubated on a shaker at 30°C for 7 days. Cellulase (carboxymethyl cellulase) activity was determined by using carboxymethyl cellulose (CMC) as substrate. The method of Mendels and Weber (1969) was used with slight modification. One ml of 1% CMC solution in 0.05 M citrate buffer pH 4.8 was incubated for 10 min at 40°C. To this, 1 ml of culture filtrate was added and the mixture was incubated at 40°C for 1 h. The total reducing sugars were determined as described by Nelson (1944). Hemicellulase (xylanase) activity was determined by using 1 ml of 1% xylan (Linko *et al.*, 1978) and reducing sugars released were determined

as xylose. Enzyme activity is expressed as n mol of glucose or xylose produced per min per ml of the culture filtrate.

The results in Table 1 show that wild-type as well as all the non-nodulating strains are capable of producing pectinase, carboxymethyl cellulase and xylanase enzymes. The activities of these enzymes were similar in wild-type and non-nodulating strains. Thus, these studies confirm the earlier observation that *R. trifolii* is capable of producing these enzymes.

The role of these enzymes in the infection process and improving infection and nodulation under field conditions has been discussed by Hubbell (1981). However, the best way to know the functions of these enzymes in the infection process would be to isolate mutants defective in these enzymes and testing them for nodulation. Absence of an enzyme activity as well as nodulation ability in particular strain will be a direct proof for the participation of that enzyme in the infection process.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. J. B. Chowdhury for providing facilities and Dr. R. C. Dogra for critically going through the manuscript.

REFERENCES

- Hubbell, D. H. 1981. Legume infection by *Rhizobium*: A conceptual approach. *Bioscience* 31: 832-37.
- Hubbell, D. H., Morales, V. M. and Umali-Garcia. 1978. Pectolytic enzymes in *Rhizobium*. *Appl. Environ. Microbiol.* 35: 210-13.
- Linko, M., Markkaren, P., Bailey, M. and Leisola, L. 1978. Production of cellulases and hemicellulases by *Trichoderma viride*. In: *Bioconversion of Cellulosic Substances into Energy, Chemicals and Proteins*, pp. 329-50. Ghosh, T. K. (ed.). Thompson Press, New Delhi.

HYDROLYTIC ENZYMES IN RHIZOBIUM

- Mendels, M. and Weber, J. 1969. The production of cellulases. *Adv. Chem. Ser.* **95** : 391-414.
- Martinez-Molina, E., Morales, V. M. and Hubbell, D. H. 1979. Hydrolytic enzymes production by *Rhizobium*. *Appl. Environ. Microbiol.* **38** : 1186-88.
- Nelson, N. 1944. A photometric adaptation of the Somogyi method for the determination of glucose. *J. Biol. Chem.* **153** : 375-80.
- Zurkowski, W. and Lorkiewicz, Z. 1978. Effective method for isolation of non-nodulating mutants of *R. trifolii*. *Genet. Res.* **32** : 311-14.
- Zurkowski, W. and Lorkiewicz, Z. 1979. Plasmid mediated control of nodulation in *R. trifolii*. *Arch. Microbiol.* **123** : 195-205.

GENE EFFECTS STUDIES OF CURD COMPACTNESS IN CAULIFLOWER

R. N. VASHISTHA, SABITA JYOTI NEOG and M. L. PANDITA

Department of Vegetable Crops
Haryana Agricultural University, Hisar

(Received : February 27, 1984; Revised : September 24, 1984)

ABSTRACT

The six generation means (P_1 , P_2 , F_1 , F_2 , B_1 and B_2) of five crosses were used for studying gene effects of curd compactness (curd angle) in mid-season cauliflower. Four crosses had shown interacting effect and one (Punjab Giant-35 $\times$ No. 74-6-C) as non-interactor cross. In crosses 2 and 4, additive gene effect with digenic interaction was found dominating and in crosses 1 and 5, simple dominance and dominance $\times$ dominance gene action were the characteristic feature. Curd angle was found highly heritable character.

Curd compactness is one of the important characters in cauliflower (*Brassica oleracea* var. *Botrytis* L.) which determines the quality of curd and has direct bearing on marketability of the crop. Earlier some workers (Lal *et al.*, 1976; Chand, 1980) have reported gene effects of curd compactness in cauliflower. The purpose of the present study was to obtain information on inheritance of compactness (curd angle) in mid-season group of cauliflower.

MATERIAL AND METHODS

The material consisted of 4 inbred lines of cauliflower used as parents, i.e., Improved Japanese, Selection-1, Punjab Giant-35 and No. 74-6-C and were crossed to raise five F_1 's. The F_2 and back cross progenies of these F_1 progenies were also obtained. All the six generations, viz. P_1 , P_2 , F_1 , F_2 , B_1 and B_2 of

above five crosses were raised in a randomized block design with three replications during first week of October, 1982 at Vegetable Research Farm of Haryana Agricultural University, Hisar. In each replication, 10 plants from each of the parents and F_1 's, 20 plants from each of the back crosses and 40 plants from each of the F_2 were taken for recording observations. Each plot consisted of 6 m long row spaced 60 cm apart having 10 plants each spaced 60 cm apart. Curd compactness was determined by measuring curd angle (Fig. 1) between the centre of the curd stalk and the point of attachment of the last button in the stalk with the help of protector (D). In this way, the angles on the both right and left sides were measured and averaged.

The estimates of six genetic parameters were calculated using the formulae given by Hayman (1958). Heritability and

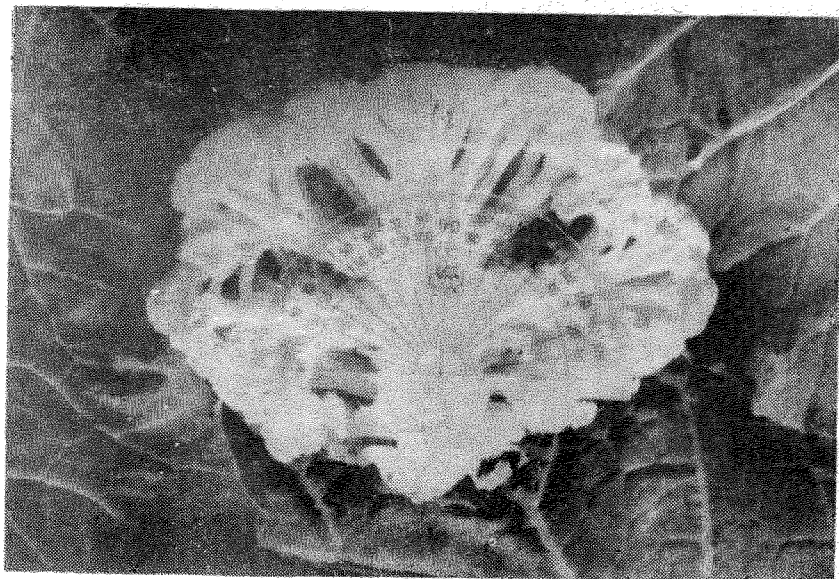


Fig. 1. Measurement of curd angle.

genetic advance were calculated using the formula as suggested by Warner (1952) and Lush (1949), respectively.

RESULTS AND DISCUSSION

The estimates of gene effects for six parameters (m , d , h , i , j , l) for interacting crosses and three parameters (m , d , h) for non-interacting crosses for curd angle are presented in Table 1. The interacting crosses showing duplicate or complementary epistasis have also been indicated.

Among the five crosses, four were classified as interacting crosses and one was grouped as non-interactor cross. Among the four interacting crosses, crosses No. 1 and 2 exhibited duplicate types of epistasis and crosses No. 4 and 5 gave complementary type of epistasis. Simple additive effect, additive $\times$ additive,

and additive $\times$ dominance interaction effects were the characteristic features of cross 2. Cross 4 had only simple additive and additive $\times$ additive interaction, whereas cross 1 was found rich with dominance effect, and cross 5 was availing of simple dominance and dominance $\times$ dominance type of gene action. This was in agreement with the earlier findings of Chand (1980). In crosses 2 and 4 additive gene effect with digenic interaction was found dominating for the character curd angle. Deshpande (1975) and Lal *et al.* (1976) also reported importance of additive effect for this character. Curd angle was found highly heritable trait. Cross 2 (Punjab Giant-35 $\times$ Selection-1) exhibited maximum heritability, h^2 b. s. (74%) for curd angle and cross No. 1 exhibited h^2 n. s. (58.1%). Genetic advance was found very high (4.86%) for this character (Table 2). It

TABLE 1
Estimates of gene effects based on generation means for compactness (curd angle)

Cross	Gene effect							Type of epistasis
	m	d	h	i	j	l	x ²	
1. Improved Japanese x Punjab Giant-35	137.29	-14.33**	20.56**	15.48	-7.68	-26.96	8.64*	Duplicate
2. Punjab Giant-35 x Selection-1	126.79	6.90**	12.75	19.67**	-14.23**	-9.34	14.41**	-do-
3. Punjab Giant-35 x No. 74-6-C***	139.42	4.75*	-3.61	—	—	—	5.45	
4. Improved Japanese x No. 74-6-C	126.28	-7.10*	4.88	22.24*	2.08	22.19	24.93**	Complimentary
5. Selection-1 x No. 74-6-C	116.49	1.42	6.42**	10.72	-3.36	42.89**	25.49**	-do-

*P < 0.05

**P < 0.01

***Non-interacting cross

INHERITANCE OF CURD COMPACTNESS IN CAULIFLOWER

TABLE 2

Heritability in broad (h^2 b. s.) and narrow (h^2 n. s.) sense and genetic advance in five crosses of cauliflower for compactness (curd angle)

Crosses	h^2 (b. s.)	h^2 (n. s.)	Genetic advance
1. Improved Japanese X Punjab Giant-35	67.0	58.1	4.86
2. Punjab Giant-35 X Selection-1	74.0	52.0	4.70
3. Punjab Giant-35 X No. 74-6-C	71.4	35.3	4.08
4. Improved Japanese X No. 74-6-C	61.9	11.3	0.89
5. Selection-1 X No. 74-6-C	49.9	44.0	2.45

indicates that recurrent selection may be effective for this character in crosses 2 and 4 where additive component is involved and in case of crosses 1 and 5 where dominance, and dominance $\times$ dominance

components of genetic variance are mainly involved, heterosis breeding may be advantageous for obtaining higher gain in this character.

REFERENCES

- Chand, Jagdish. 1980. Studies on selection for yield and curd quality in cauliflower. Ph. D. thesis, Indian Agricultural Research Institute, New Delhi.
- Despande, A. A. 1975. Genetical studies in early Indian cauliflower. M. Sc. thesis, Indian Agricultural Research Institute, New Delhi.
- Hayman, B. I. 1958. The separation of epistatic from additive and dominance variation in generation mean. *Heredity* 12 : 371-90.
- Lal, Gulshan, Chatterjee, S. S. and Swarup, V. 1976. Gene effects in crosses involving parents from different maturity groups of Indian cauliflower. *Veg. Sci.* 3 : 138-46.
- Lush, J. L. 1949. *Animal Breeding Plans*. The Collegiate Press, Ames, Iowa.
- Warner, J. N. 1952. A method for estimating heritability. *Agron. J.* 44 : 427-30.

EFFECT OF GIRDLING ON THE STORAGE BEHAVIOUR OF GRAPES

O. P. GUPTA, SUNEEL SHARMA, R. YAMDAGNI and NEENA MEHTA

Department of Horticulture
Haryana Agricultural University, Hisar

(Received : November 25, 1983; Revised : June 6, 1985)

ABSTRACT

Trunk girdling, done at veraison stage on Perlette and Beauty Seedless grapevines, significantly reduced the weight loss and decay in both the cultivars. The grapes of Perlette and Beauty Seedless cultivars were stored for 9 and 6 days, respectively, at room temperature, whereas under cold storage conditions cvs. Beauty Seedless and Perlette stored well upto 48 and 66 days, respectively.

Grape is one of the important fruit crops of northern India. The growers are getting very high premium for their produce. However, with the increase in area and production under this crop, there is every likelihood of a glut in the local market and with the result grower may not get even normal price. Being a perishable fruit, it cannot stand long transportation and storage. Girdling is a commercial practice in grapes for quality improvement (Winkler *et al.*, 1974; Sharma and Jindal, 1984). The present study was, therefore, conducted to see utility of trunk girdling in improving storage behaviour of grapes.

MATERIAL AND METHODS

Six uniform vines each of Beauty Seedless and Perlette were selected for the studies during 1983. Three vines of each cultivar were trunk girdled (1/8th of an inch) at veraison stage and rest were kept as control. Grape bunches were harvested at firm ripe stage and

packed in wooden boxes (36×25×20 cm), weighing around 4 kg in each, using paper cuttings as packing material and covered with lid. Each box formed one replication, and was replicated three times. One more box under each treatment was kept for quality analysis. One set of these boxes was kept at room temperature ($34^{\circ}\pm 1^{\circ}\text{C}$ and 40 to 50% R.H.) and the other in cold storage ($0^{\circ}\pm 1^{\circ}\text{C}$ with 80 to 85% R.H.). The observations on physico-chemical characteristics viz. loss in weight, total soluble solids and per cent acidity were recorded after every three days interval under room temperature upto 9 days and at six days interval under low temperature storage upto 66 days in Perlette and 48 days in Beauty Seedless grapes.

RESULTS AND DISCUSSION

Trunk girdling reduced the loss in weight markedly in both the cultivars irrespective of storage conditions (Fig. 1).

GIRDLING AND STORAGE BEHAVIOUR OF GRAPES

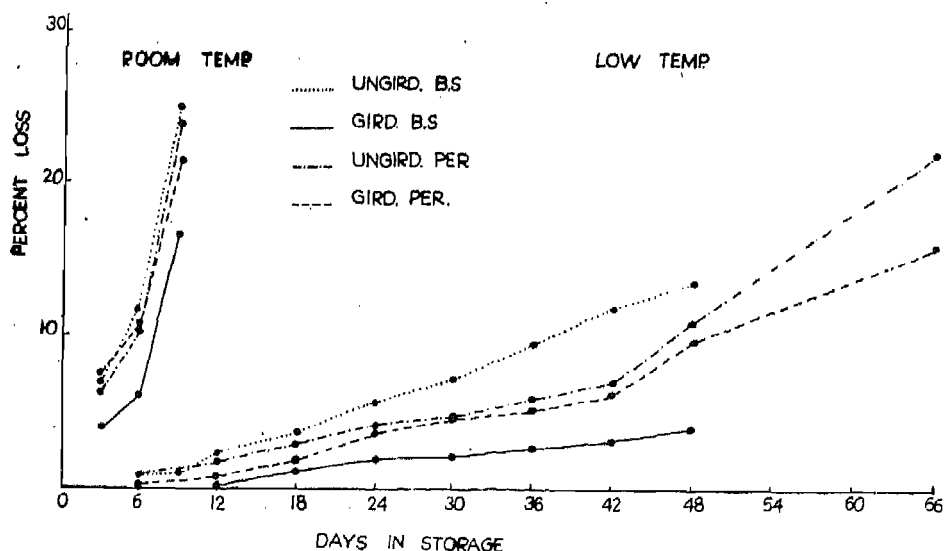


Fig. 1. Effect of girdling on per cent weight loss in grapes under storage.

Loss in weight was found less at low temperature storage as compared to room temperature storage. This reduction in rate of weight loss was obvious under low temperature as evapo-transpiration and respiration processes reduced at low temperature. However, the reduction in weight loss in grapes from girdled vine is commendable feature. This might be due to greater supply of food material to the developing berries and increased level of endogenous gibberellins in fruit (Weaver and Pool, 1965; Hale and Weaver, 1962). The possible reason for checking loss in weight by gibberellins is that they might have caused some chemical changes within the fruit possibly by altering some of proteinous constituents of the cell so as to increase the affinity for water which could retain more water against the force of evapo-transpiration (Mitchell, 1949). Higher weight loss observed in Beauty Seedless grapes as compared to Perlette might be due to

lower inherent calcium content (Kumar, 1983). The rate of weight loss was accelerated with the increased period of storage. This might be due to reduction in the resistance force of the berries for evapo-transpiration and also increased enzymatic activities.

The girdling of vines increased the T.S.S. content of berries irrespective of any type of storage and this lead was maintained throughout the period of storage (Fig. 2). This increase in T.S.S. by girdling might be due to more translocation of photosynthates from leaves to berries. There was an increase in T.S.S. content with increased period of storage upto 6 days at room temperature and upto 30 days at low temperature and later a decrease was observed. The increase in T.S.S. content was much higher in berries from girdled vines compared to ungirdled ones in both the cultivars. The reason for increase in

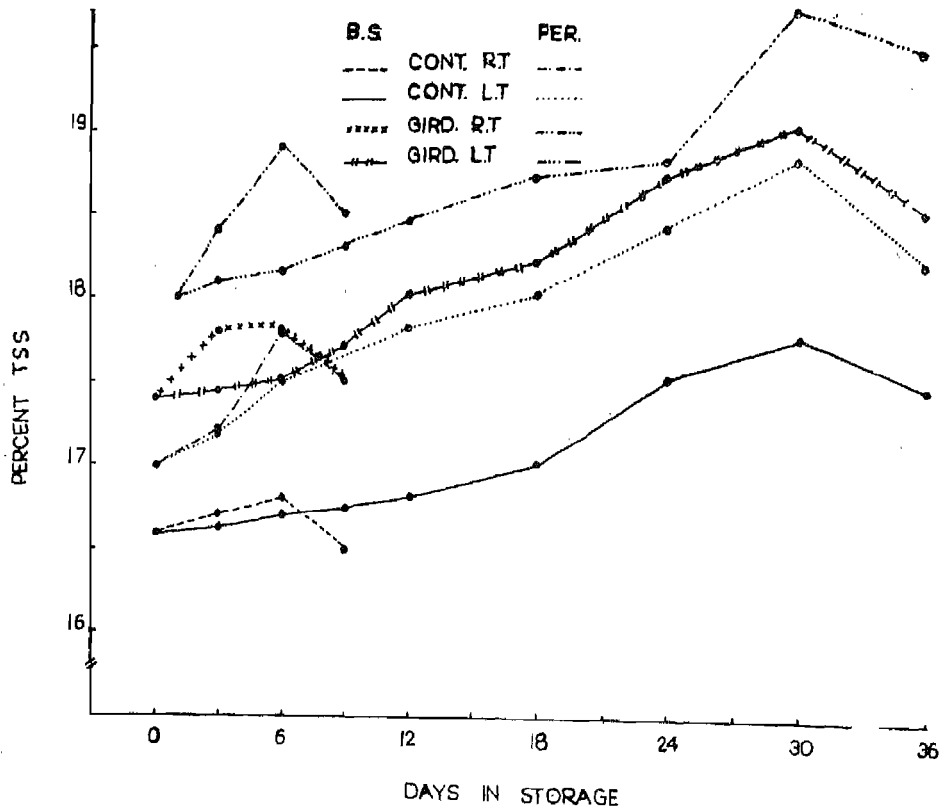


Fig. 2. Effect of girdling on per cent total soluble solids in grapes under storage.

T.S.S. content in berries from girdled vines might be due to low respiration and enzymatic activities in the berries. The normal increase in sugars at room as well as cold storage in control was probably brought by the water loss from the berries. The decrease in sugars during the later period of storage may be due to increased ethylene production by senescent berries, which might be responsible for increased respiration rate. Similar findings were also given by Dzeneev (1965) and Hifney and Abdel-All (1977).

It was observed that, in general, girdling treatment reduced the acidity in the two cultivars (Fig. 3). The reduction in acidity by girdling treatment may be due to less moisture loss in grape berries. The acidity increased first upto 6 days storage at room temperature and upto 26 days at low temperature storage and after that a decrease in acidity was observed. The possible rise and fall in per cent acidity may be contributed to moisture loss from the berries and enhanced respiration.

GIRDLING AND STORAGE BEHAVIOUR OF GRAPES

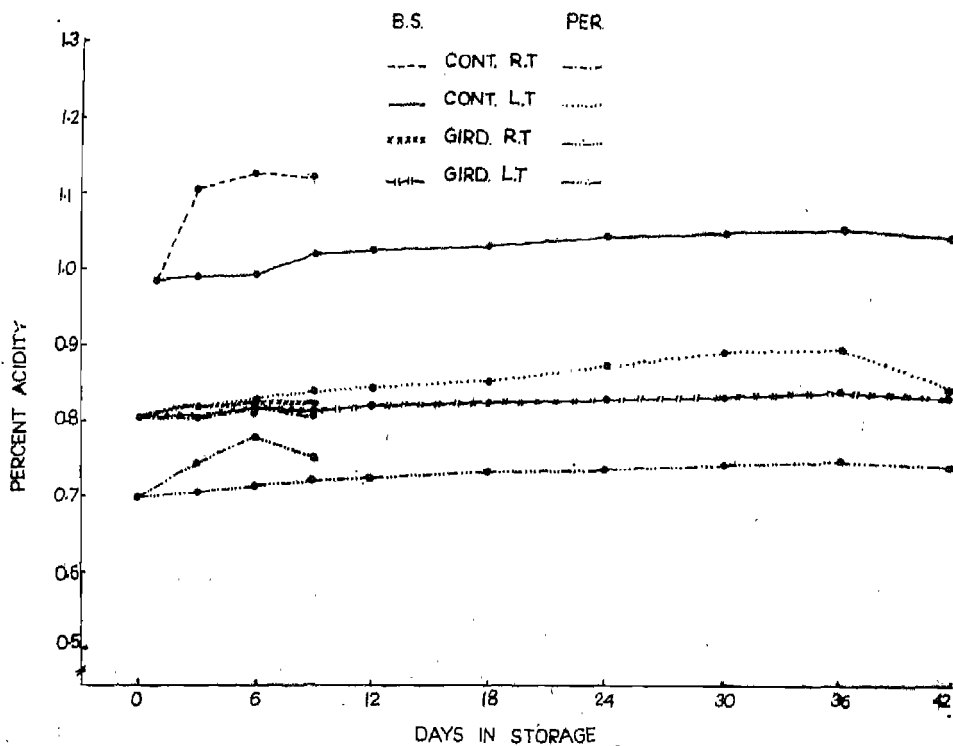


Fig. 3. Effect of girdling on per cent acidity in grapes under storage.

It is concluded from the above study that trunk girdling increased the shelf-life of grapes by decreasing weight loss under both room as well as cold storage conditions.

REFERENCES

- Dzensev, S. Ju. 1965. Changes in chemical composition of grape during storage. *Vinodel. Vinograd.* **25** : 20-22.
- Hale, C. R. and Weaver, R. J. 1962. The effect of developmental stage on direction and translocation of photosynthates in *V. vinifera* L. *Hilgardia* **33** : 89-131.
- Hifney, H. A. A. and Abdel-All, R. S. 1977. Effect of GA and CCC on physical and chemical changes in seedless grapes. *Vitis* **16** : 27-31.
- Kumar, Ranjit. 1983. Studies on storage in grapes. Ph.D. thesis, Haryana Agricultural University, Hisar.
- Mitchell, J. W. 1949. *Fruit Growth and Maturation*. Inter Congr. Crop Protection, London.
- Sharma, Suneel and Jindal, P. C. 1984. Responses of girdling and crop load on berry drop and yield of Beauty Seedless grapes (*V. vinifera* L.). *Indian J. agric. Res.* **18** : 95-98.
- Weaver, R. J. and Pool, R. M. 1965. Relation of ringing to gibberellin like activity in berries of *V. vinifera* L. *Nature* **206** : 318-19.
- Winkler, A. J., Cook, J. A., Kilewar, W. M. and Lider, L. A. 1974. *General Viticulture*. Univ. Press, Berkley and Los Angeles.

EVALUATION OF ALDICARB (TEMIK 10 G) AND MALATHION SPRAYS AGAINST APHIDS IN SEED CROP OF RADISH

R. K. KASHYAP, J. P. BHANOT*, U. C. PANDEY** and S. LAL

Department of Vegetable Crops
Haryana Agricultural University, Hisar

(Received: January 23, 1984; Revised: July 25, 1984)

ABSTRACT

For the control of *Lipaphis erysimi* Kalt. on seed crop of radish, stacking treatment with 0.2% aldicarb slurry and soil application of this insecticide @ 1.0 kg a.i./ha was evaluated against the standard application of 0.08% malathion spray. Aldicarb was applied either as split (half at planting and half at pest appearance) or full (whole at pest appearance) dose. Considering both aphid counts and seed yield, split dose soil application proved the best. The cost-benefit ratio with split dose soil application and stacking treatment with aldicarb was 83.8 and 34.5, respectively.

The aphids (*Lipaphis erysimi* Kalt.) are a serious threat to the seed crop of radish (*Raphanus sativus* L.) in the north Indian plains. This results in both quantitative as well as qualitative loss of yield. In radish, effective control of this pest has been obtained by using high doses of aldicarb, disulfoton, phorate (Bindra and Sekhon, 1969; Sinha *et al.*, 1977) and dimethoate (Sinha *et al.*, 1977). It was, therefore, considered desirable to protect the crop, if possible, with small doses of insecticides and it was with this objective that the present study was initiated.

MATERIAL AND METHODS

The experiment was conducted at the Vegetable Research Farm, Haryana Agricultural University, Hisar. The treatments were: soil application of

aldicarb (Temik 10 G) at the rate of 1.0 kg a.i./ha either as split (half at planting and half at pest appearance) or full (whole at the time of pest appearance) dose or 0.2% slurry for stacking (cut end) treatment at planting and 0.08 per cent malathion spray at 10 day intervals as well as control. These treatments were compared in a randomised block design with five applications. All the recommended agronomic practices were followed (Anonymous, 1980). Plots were irrigated immediately after planting and soil application of aldicarb.

For preparing 0.2% aldicarb slurry, 15 g Temik 10 G was dissolved in 300 ml of water and to this solution, 400 g soil was added. The contents were thoroughly mixed to obtain a uniform slurry. Thus, prepared slurry was found

*Department of Entomology.

**Present address: Department of Crop Science, University of Maiduguri, NIGERIA.

ALDICARB AND MALATHION AGAINST APHIDS

sufficient to treat 150 stacklings. Similarly for soil application the quantity of the insecticide required per plot was mixed with 400 handfuls of soil, there being 400 plants per plot. Soil from about 5 cm depth around each planted stackling or established plant was removed and one handful of soil-insecticide mixture was applied in this pit which was then levelled with soil. Crop was sprayed six times with 0.08% malathion.

The aphid counts were recorded after 35 days of planting at 10-day intervals. In malathion treated plots, the aphid populations were recorded before each spray. On each treatment, six aphid counts were taken, in which the first three observations were recorded on leaves

(two lower and two upper leaves from five randomly selected plants) while for the later three observations, five randomly selected inflorescence panicles (15 cm long) were used.

At harvest, mean seed yield per plot, 1000-grain weight, number of seeds per pod and number of pods per plant were recorded. For recording the last two observations, 100 pods and 10 plants were examined, respectively. The data were subjected to the analysis of variance.

RESULTS AND DISCUSSION

The data in Table 1 reveal that the use of split dose of aldicarb was better than

TABLE 1
Effectiveness of different insecticides against aphids in seed crop of radish (Var. HR-1)

Treatments	Mean number of aphids* per 60 leaves + 15 inflorescence panicles	Mean seed yield/plot** (kg)	1000-grain weight (g)	Number of pods per plant	Number of seeds per pod
A. Soil application					
(a) Half at planting and half at pest appearance					
(i) aldicarb @ 1 kg a. i./ha	77.4(8.53)***	14.76	8.70	333	8.30
(b) Full at pest appearance					
(ii) aldicarb @ 1 kg a. i./ha	179.8(13.06)	12.13	8.00	291	8.00
B. Dipping of stacklings in slurry†					
(iii) aldicarb @ 0.2 per cent	105.6(10.40)	11.38	8.00	256	8.00
C. Spray slurry					
(iv) Malathion @ 0.8 per cent	439.8(20.95)	8.88	6.90	247	6.80
D. Control	471.0(21.44)	3.25	5.00	160	5.00
p=0.05	(3.37)	2.22	0.85	18.32	1.25

*Cumulative total of six observations—three each on leaves and inflorescence panicles

**10 × 10 m

***√n transformation

†15 g Temik 10 G+400 g soil+300 ml water.

the full dose with respect to mean aphid population counts. Application of full dose of aldicarb at pest appearance was at par with stackling treatment with 0.2% slurry. Malathion sprays proved no better than the control. The mean number of aphid counts was highest (471/60 leaves+15 inflorescence panicles) in case of control and minimum (77.4) in case of split dose soil application.

For seed yield, all the treatments proved better than the control. Highest seed yield (14.76 kg/plot) was obtained in case of split dose soil application and differences amongst all other treatments were non-significant. When 1000-grain weight was considered, all the treatments gave higher weight than the control. This may be due to the bolder seeds in the protected crop. No significant difference

in 1000-grain weight was observed among aldicarb treatment plots. Similarly for number of seeds per pod, all the treatments gave significantly more number of seeds per pod than the control. No difference in number of seeds/pod was observed in aldicarb treated plots. The highest (333) number of pods/plant was recorded in split dose of soil application, whereas minimum (160) in control.

Economics of the insecticidal treatments is presented in Table 2. Minimum (Rs. 3900/ha) gross income was obtained in case of control and maximum (Rs. 17700/ha) in split dose soil application of aldicarb. The gross income with slurry treatment was Rs. 13650/ha. Since the slurry treatment required only 280 g a.i./ha instead of 1.0 kg a.i./ha, the cost of the treatment was much less. Since the

TABLE 2

Economics of insecticidal treatments for the control of aphids in seed crop of radish

Treatments	Mean seed yield per ha (q)	Cost of insecticide and its application per ha (Rs.)	Gross income per ha (Rs.)	Net gain over the control (Rs.)	Benefit-cost ratio
A. Soil application					
(a) Half at planting and half at pest appearance					
(i) aldicarb @ 1 kg a. i./ha	14.76	400.0	17700.0	13800.0	34.5
(b) Full at pest appearance					
(ii) aldicarb @ 1 kg a. i./ha	12.13	400.0	14550.0	10650.0	26.6
B. Dipping of stacklings in slurry					
(iii) aldicarb @ 0.2 per cent	11.38	116.4	13650.0	9750.0	83.8
C. Spray slurry					
(iv) Malathion @ 0.8 per cent	8.88	458.0	10650.0	6750.0	14.7
D. Control	3.25	—	3900.0	—	—

Calculated at: Aldicarb (Temik 10 G) @ Rs. 38/kg; Malathion 50 EC @ Rs. 43/l; Labour for insecticidal application @ Rs. 10/day/man.
Cost of radish seed @ Rs. 1200/q.

ALDICARB AND MALATHION AGAINST APHIDS

cost-benefit ratio in case of stackling treatment (83.8) is higher than the split dose soil application (34.5), it is advisable for the farmers to use the former method of control.

In these studies, split dose soil application of aldicarb, and stackling treatment with aldicarb proved the most promising. By using the stackling treatment the quantity of aldicarb required could also be reduced from 1 kg a.i. to as low as 280 g a.i./ha. The cost-benefit

ratio with these two treatments, i.e., split dose soil application of aldicarb and 0.2% slurry treatment with aldicarb, worked out to 34.5 and 83.8, respectively. Though the full dose soil application of aldicarb (Bindra and Sekhon, 1969) gave good results in earlier studies, this treatment, however, did not prove better than stackling treatment of aldicarb slurry in the present studies. The present findings are in line with the results earlier reported from smaller plots by Bhanot and Verma (1978).

REFERENCES

- Anonymous. 1980. *Haryana Agricultural Hand Book*. Haryana Agricultural University, Hisar. pp. 276.
- Bhanot, J. P. and Verma, A. N. 1978. Effectiveness of three granular systemic insecticides applied by different methods and malathion sprays on aphid control and seed yield of radish. *Seed Res.* 6 (1): 48-57.
- Bindra, O. S. and Sekhon, S. S. 1969. Control of aphids on seed crop of radish. Annual Report of the Department of Zoology-Entomology for the year 1969-70. Punjab Agricultural University, Ludhiana.
- Sinha, S. N., Peshwani, K. M., Chakarvarti, A. K. and Sexana, A. N. 1977. Control of mustard aphid, *Lipaphis erysimi* Kalt in radish seed crop. *Seed Res.* 5 (1): 49-51.

FUNCTIONAL CLASSIFICATION OF DRY AGRICULTURAL LANDS OF TEHSIL BAWANIKHERA OF BHIWANI DISTRICT (HARYANA)

DAYA RAM

Department of Soils

Haryana Agricultural University, Hisar

(Received : January 17, 1984; Revised : October 30, 1984)

ABSTRACT

A village-wise functional classification of dry cropped areas over five kharif and five rabi harvest seasons from kharif 1971 to rabi 1976, of tehsil Bawanikhera has been presented. In the tehsil, 92.1% of the total cropped area, 94.4% of the kharif sown area and 41.3% of the rabi sown area was found suitable for dry crop cultivation. The study also revealed that 7.2% of the total cropped area, 4.2% of the kharif sown area and 38.9% of rabi sown area showed high possibilities for making such lands suitable for dry crop cultivation with proper management of the existing resources. The rest of the area was not suitable for dry crop cultivation, though it was suited to grazing and forestry.

The tehsil Bawanikhera of Bhiwani district lies in the western part of Haryana state and is bound by 28° 51' to 29° 4' N latitude and 75° 32' to 76° 15' E longitude. In all, there are 64 villages with a total area of 99,050 ha out of which 89,326 ha is cultivated. Of the cultivated land, 52.2% is rainfed. Location and Hadbast numbers of the villages of the tehsil are shown in Fig. 1. It has the sub-tropical continental-hot and dry climate with monsoonal regime of rainfall. The soils comprise loamy sands and sandy loams. In places, there are some ridges of sandy

soil. Sub-soil water is deep seated and mostly brackish.

METHODOLOGY

The study is based on the dry cropped areas of tehsil Bawanikhera. The village-wise crop sown and crop matured/failed data for five years were taken from the *Lal Kitabs* of the Kanungo of the tehsil.

Duggal's (1978) 'Crop Maturity Index' (CMI) was adopted for making out the land resource classes. In a given area and a given period of time, the CMI can be expressed mathematically as under :

$$(i) \text{ CMI of kharif/rabi harvest} = \frac{\text{Matured area of kharif/rabi harvest}}{\text{Sown area of kharif/rabi harvest}} \times 100$$

$$(ii) \text{ CMI of total of kharif and rabi harvests} = \frac{\text{Total matured area of kharif and rabi harvests}}{\text{Total sown area of kharif and rabi harvests}} \times 100$$

419

$$(iii) \text{ Ratio of rabi cropped maturity to kharif cropped maturity} = \frac{\text{CMI of rabi harvest}}{\text{CMI of kharif harvest}}$$

The categories of the total crop maturity of kharif and rabi harvests and that of the ratio of rabi cropped maturity to kharif cropped maturity were then grouped together for determining the possible dry agricultural land types.

RESULTS AND DISCUSSION

Land classification according to the CMI of kharif harvest, rabi harvest and the total of kharif and rabi harvests is presented in Table 1.

Land Classification of Dry Sown Areas under Kharif Season

Out of the total dry sown land in kharif season, 94.4% area (in 59 villages) was above the Threshold index* (i. e. suitable for crop cultivation). Cultivable land of very good quality was observed in 2.7% area, good cultivable land in 10.6%, moderately good cultivable land in 39.2% and fairly good land suitable for limited cultivation in 41.9% area. The remaining 5.6% of the kharif sown area (in 5 villages) was below the Threshold index (i. e. not suitable for arable farming). Of this 5.6% area, 4.2% was very well suited to grazing and animal husbandry and 1.4% was well suited to grazing/forestry (Table 1).

The main possible factors responsible for the variation in the CMI of kharif harvest were :

- (i) Inherent fertility and water holding capacity of the soil profile,
- (ii) Variation in the amount and distribution of rainfall,
- (iii) Farm management practices,
- (iv) Economic conditions of the farmers (Malik and Oswal, 1981), and
- (v) Size of land holdings (Duggal and Daya Ram, 1979).

Land Classification of Dry Sown Areas under Rabi Season

Out of the total dry sown land in rabi season, 41.3% area (in 27 villages) was above the Threshold index. Cultivable land of good quality was found in 5.1% area, moderately good cultivable in 6.4% and fairly good land suitable for limited cultivation in 29.8% area. The remaining 58.7% of rabi sown area (in 37 villages) was below the Threshold index. Of this 58.7% area, 38.9% was very well suited to grazing and animal husbandry, 11.9% was well suited to grazing/forestry and 7.9% was fairly suited to grazing/forestry (Table 1).

In addition to the factors responsible for the variation in the CMI of kharif harvest, the sowing of rabi crops on current fallow lands seems to be the notable factor for the variation in CMI of rabi harvest.

* Threshold index drawn under the CMI 45 classifies the cropped areas into two categories, i.e. (i) land suitable for crop cultivation on and above it, and (ii) land unsuitable for crop cultivation below it.

CLASSES OF DLA IN BAWANIKHERA

TABLE 1
Classification of dry cropped areas of tehsil Bawanikhera (1971-72 to 1975-76)

Cate- gory No.	Crop Maturity Index	Land resource classes	Kharif season		Rabi season		Total of kharif & rabi seasons	
			Sown area		Sown area		Cropped area	
			ha	%	ha	%	ha	%
			No. of villages		No. of villages		No. of villages	
			Threshold index					
I	90.1—100	Very good cultivable land	5,792	2.7	3	—	—	—
II	75.1—90	Good cultivable land	22,239	10.6	8	4,801	5.1	11,215
III	60.1—75	Moderately good cultivable land	92,811	39.2	25	6,048	6.4	90,147
IV	45.1—60	Fairly good land suitable for limited cultivation	88,397 (1,99,239)	41.9 (94.4)	23 (59)	27,912 (38,761)	29.8 (41.3)	1,79,478 (2,80,830)
V	30.1—45	Not suitable for crop cultivation; but very well suited to grazing and animal husbandry	8,895	4.2	3	36,483	38.9	22,030
VI	15.1—30	Not suitable for crop cultivation; but well suited to grazing/forestry	3,008	1.4	2	11,225	11.9	2,150
VII	0.1—15	Not suitable for crop cultivation; but fairly suited to grazing/forestry	—	—	—	7,399	7.9	—
VIII	<0.1	Not suitable for crop cultivation; but suitable for wild life, recreation, water conservation and supply, and for non-agricultural use	(11,903)	(5.6)	(5)	(55,107)	(58.7)	(24,180)
								(7.9)
								(8)

Data in parentheses in front of category IV are totals for areas suitable for crop cultivation and those in front of category VIII are totals for areas unsuitable for crop cultivation.

Land Classification on Dry Sown Areas under the Total of Kharif and Rabi Seasons

Out of the total dry cropped land in this tehsil, 3.7% (in 3 villages) was good cultivable land, 29.6% (in 21 villages) was moderately good cultivable, 58.8% (in 32 villages) was fairly good and suitable for limited cultivation; 7.2% area (in 7 villages) was not suitable for crop cultivation, but very well suited to grazing and animal husbandry and 0.7% area (in one village) was not suitable for crop cultivation, but well suited to grazing/forestry (Table 1). While the last two categories of land should be put to non-arable uses, efforts should be made to improve CMI of other categories.

Village-wise distribution of the percentage matured area of the total of kharif and rabi sowings is shown in Fig. 2. The areas not suitable for crop cultivation but well suited to grazing, animal husbandry and forestry were localized mostly in the western and south-western parts of the tehsil (excluding the areas of village Hadbast No. 133/B) which fall in the hot and arid zone of the state comprising comparatively low soil fertility status. Moreover, the soils of these areas were suffering with moderate salinity and slight alkalinity (Duggal, 1975).

Ratio of Rabi Cropped Maturity to Kharif Cropped Maturity

Rabi cropped maturity was higher than kharif cropped maturity in 10.1%

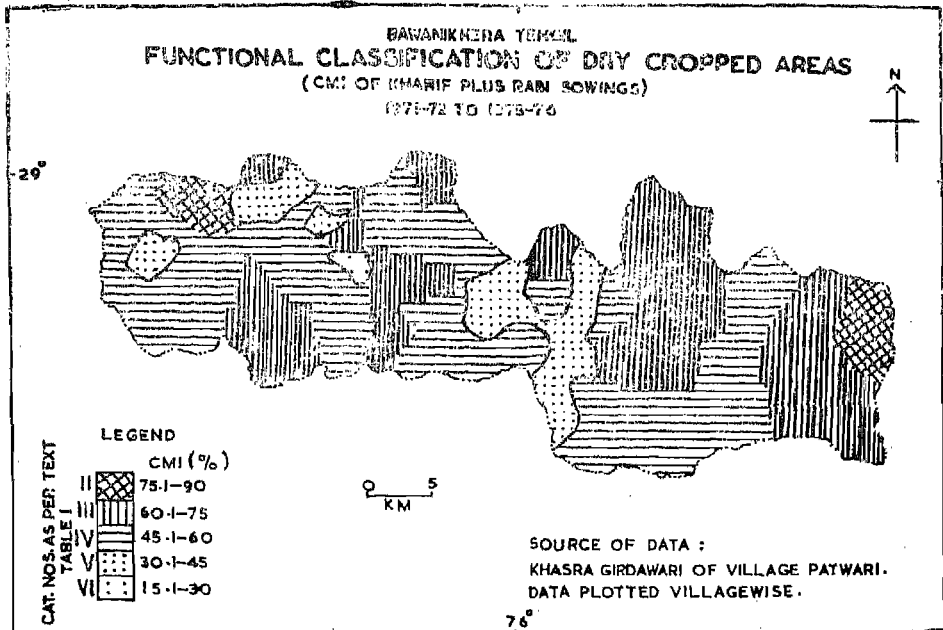


Fig. 2

CLASSES OF DLA IN BAWANIKHERA

TABLE 2

Ratio between **rabi** sowing maturity and **kharif** sowing maturity of dry cropped areas of tehsil Bawanikhera (1971-72 to 1975-76)

Category	Ratio between kharif sowing maturity and rabi sowing maturity	Class ratio (rabi sowing maturity when compared with kharif sowing maturity)	Dry cropped area		No. of villages
			ha	%	
I	1 : >4.00	Very high	—	—	—
II	1 : 2.01 to 4.00	High	2,150	0.7	1
III	1 : 1.01 to 2.00	Moderately high	28,658	9.4	9
IV	1 : 0.51 to 1.00	Moderately low	1,83,310	60.1	29
V	1 : 0.25 to 0.50	Low	52,984	17.4	16
VI	1 : <0.25	Very low	37,918	12.4	9

of the total dry cropped area in 10 villages (Table 2). This may be perhaps due to either sowing of **rabi** crops on current fallow lands which had conserved soil moisture and fertility to protect the maturity of crops or the sowing of more drought and disease-resistant crops/crop varieties. Of this 10.1% area 0.7% had high and 9.4% had moderately high ratios of **rabi** cropped maturity. Of the remaining 89.9% of the total dry cropped area (in 54 villages), 60.1% area, had moderately low, 17.4% area had low and 12.4% area had very low ratios of **rabi** cropped maturity. This reveals that **rabi** harvest was less successful in almost whole of the total dry cropped area.

The areas having low and very low ratios of **rabi** cropped maturity to **kharif** cropped maturity, should be devoted to either **kharif** crops or alternating fallow unless irrigation becomes available or more drought and disease-resistant crops/crop varieties are grown.

Dry Agricultural Land Types

The analysis in Table 3 shows that the villages of the tehsil fall into 15 dry agricultural land types (Fig. 3). One village from each of the important dry agricultural land types was selected for detailed plot-wise study which could help in better understanding of the practices and problems of dry agriculture in this tehsil. The representative villages are listed in Table 4 alongwith their characteristics, and these are shaded in Fig. 1. To sum up, it may be concluded that :

1. The tehsil as a whole is suitable for dry crop cultivation. However, **kharif** harvest is more successful than the **rabi** harvest.
2. The large areas particularly in the **rabi** season, lying in transition between the land suitable for dry crop cultivation and the land unsuitable for dry crop cultivation require less efforts to improve their crop maturity index.

TABLE 3

Dry agricultural land types on the basis of (i) crop maturity of total of kharif and rabi harvests and (ii) ratio of rabi harvest maturity to kharif harvest maturity of tehsil Bawanikhara (1971-72 to 1975-76)

Category	I & I	I & II	I & III	I & IV	I & V	I & VI
Type	1	2	3	4	5	6
Dry cropped area (%)	—	—	—	—	—	—
No. of villages	—	—	—	—	—	—
Category	II & I	II & II	II & III	II & IV	II & V	II & VI
Type	7	8	9	10	11	12
Dry cropped area (%)	—	—	2.9	0.8	—	—
No. of villages	—	—	1	2	—	—
Category	III & I	III & II	III & III	III & IV	III & V	III & VI
Type	13	14	15	16	17	18
Dry cropped area (%)	—	—	1.7	19.8	6.5	1.6
No. of villages	—	—	2	13	4	2
Category	IV & I	IV & II	IV & III	IV & IV	IV & V	IV & VI
Type	19	20	21	22	23	24
Dry cropped area (%)	—	—	3.8	37.5	8.4	9.1
No. of villages	—	—	5	13	8	6
Category	V & I	V & II	V & III	V & IV	V & V	V & VI
Type	25	26	27	28	29	30
Dry cropped area (%)	—	—	0.9	2.1	2.5	1.7
No. of villages	—	—	1	1	4	1
Category	VI & I	VI & II	VI & III	VI & IV	VI & V	VI & VI
Type	31	32	33	34	35	36
Dry cropped area (%)	—	0.7	—	—	—	—
No. of villages	—	1	—	—	—	—
Category	VII & I	VII & II	VII & III	VII & IV	VII & V	VII & VI
Type	37	38	39	40	41	42
Dry cropped area (%)	—	—	—	—	—	—
No. of villages	—	—	—	—	—	—
Category	VIII & I	VIII & II	VIII & III	VIII & IV	VIII & V	VIII & VI
Type	43	44	45	46	47	48
Dry cropped area (%)	—	—	—	—	—	—
No. of villages	—	—	—	—	—	—

First Roman numerals indicate the category of crop maturity index of the total of kharif and rabi harvests and second Roman numerals indicate the category of the ratio of rabi harvest maturity to kharif harvest maturity.

CLASSES OF DLA IN BAWANIKHERA

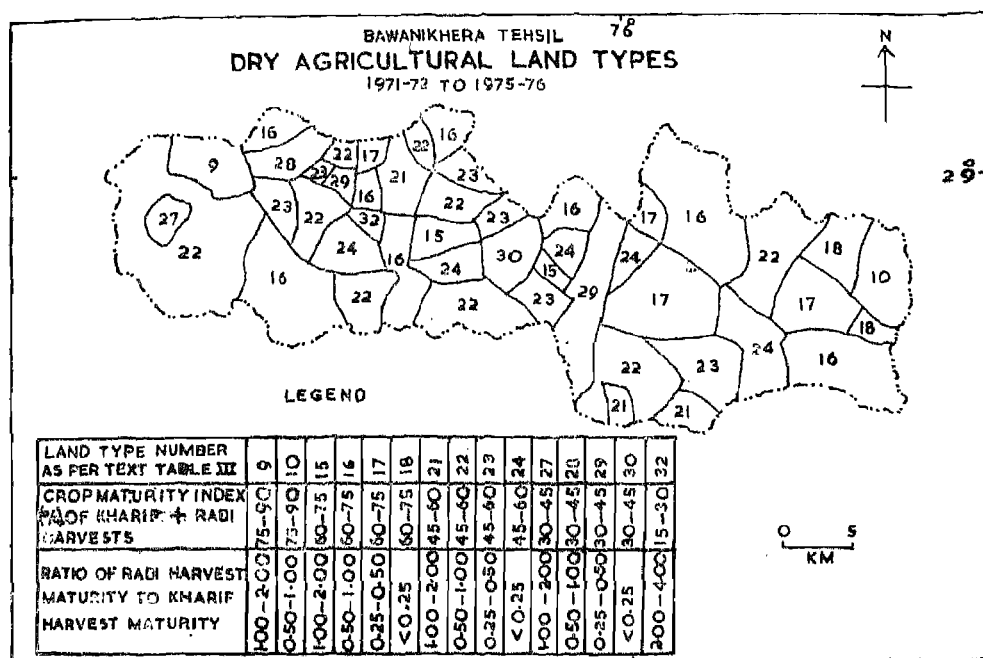


Fig. 3

TABLE 4

Dry agricultural land type characters of tehsil Bawanikhera (1971-72 to 1975-76)

S. No.	Name of village	Village Hadbast No.	Crop maturity index of total of kharif and rabi sowings	Ratio between kharif sowing maturity and rabi sowing maturity	Dry agricultural land type No. as per Table 3
1.	Mudhal Kalan	65	75.1-90	1 : 0.51-1.00	10
2.	Dhulkot	127	60.1-75	1 : 0.51-1.00	16
3.	Bharri	8	60.1-75	1 : 0.25-0.50	17
4.	Taga	45	45.1-60	1 : 1.01-2.00	21
5.	Kungar	131	45.1-60	1 : 0.51-1.00	22
6.	Dhamiyan	29/H	45.1-60	1 : 0.25-0.50	23
7.	Nalwa	33/H	45.1-60	1 : <0.25	24
8.	Bhurtana	39	30.1-45	1 : 0.25-0.50	29

DAYA RAM

REFERENCES

- Duggal, S. L. 1975. *Soil Geography of Haryana*. Publication Division, Haryana Agricultural University, Hisar. pp. 23-31.
- Duggal, S. L. 1978. Crop Maturity Index (CMI). A simple method for functional classification of dry agricultural lands. *Natl. Geogr. J. India* **24** : 29-35.
- Duggal, S. L. and Daya Ram. 1979. A functional classification of dry agricultural lands in village Ludas of tehsil Hisar. Bulletin on Desert Management of Haryana. Directorate of Project-cum-Plan Formulation, Haryana Agricultural University, Hisar. pp. 134-41.
- Malik, D. S. and Oswal, M. C. 1981. A decade of dryland research achievements and practical recommendations for Haryana State (1971-81). All India Coordinated Research Project for Dryland and Agriculture, Haryana Agricultural University, Hisar. pp. 10-35.

EFFECT OF TIME OF SOWING ON GROWTH AND YIELD OF PIGEONPEA CULTIVARS

GURMEET SINGH*, H. S. MAVI and K. K. DHINGRA**

Department of Agricultural Meteorology
Punjab Agricultural University, Ludhiana

(Received : January 25, 1984; Revised : May 14, 1984)

ABSTRACT

The crop cultivars T 21 and AL 15 were planted on May 1, May 15, June 1 and June 15 after rauni in split plot design at 50 × 30 cm spacing during kharif 1980. The recommended dose of fertilizers (15 kg N and 40 kg P₂O₅ per hectare) was applied to the soil at sowing time. The irrigation to the crop was given at every 150 mm cumulative evaporation recorded from U. S. open pan evaporimeter. It was observed that cv. T 21 produced taller plants in the earlier sowings. The dry matter yield was also higher in May 1 sowing and it decreased with the delay in sowing. The data on the grain yield indicated that cv. T 21 produced the highest yield when sown on May 1 and cv. AL 15 when sown on June 1.

Pigeonpea (*Cajanus cajan* (L.) Millsp.) commonly known as arhar has become an important pulse crop in the recent years. The time of sowing is an important factor which affects the growth and yield of pigeonpea crop. Dhillon (1972), Ahlawat *et al.* (1975) and Dahiya *et al.* (1974) reported direct influence of date of sowing on various growth and yield characteristics of pigeonpea cultivars. In Punjab, it has been reported that sowing after mid-June delay the maturity of pigeonpea thus reducing the yield considerably. Hence, there is every possibility that planting of pigeonpea, in the month of May, may result in its timely maturity without decreasing the yield. This experiment was thus planned

to study the effect of time of sowing on the growth and yield of pigeonpea cultivars.

MATERIAL AND METHODS

The experiment was conducted at the Research Farm of Punjab Agricultural University, Ludhiana, during kharif 1980 on a loamy sand soil, low in organic content (21%) and available N (205 kg/ha), medium in available P (50 kg/ha) and K (130 kg/ha) and normal (pH 8.3) in reaction. The crop was sown after rauni in split plot design keeping dates of sowing (May 1, May 15, June 1 and June 15) in the main plots and cultivars (T 12 and AL 15) in the sub-plots at a

Present address : *Haryana Agricultural University, Hisar.

**Department of Agronomy, Punjab Agricultural University, Ludhiana.

distance of 50 × 30 cm in four replications. A basal dose of 15 kg N and 40 kg P₂O₅ per hectare was applied to the soil at the time of sowing and the crop was irrigated with every 150 mm cumulative evaporation recorded from the U. S. open pan evaporimeter in the adjoining Meteorological Observatory.

RESULTS AND DISCUSSION

Growth Attributes

The data indicate that cv. T 21 produced taller plants (237.0 and 242.3 cm) when sown on May 1 and May 15 and a significant reduction (203.9 and 184.0 cm) was observed when the sowing was delayed to June 1 and June 15 (Table 1). Contrary to this, maximum plant height (186.4 cm) of cv. AL 15 was recorded in June 1 sowing and

significant reduction was observed both in early as well as delayed sowings. Hammerton (1971, 1976) also observed a considerable difference in plant height with change in time of sowing. On an average cv. T 21 produced significantly taller plants (216.8 cm) as compared to cv. AL 15 (159.0 cm). These observations get the support of Singh *et al.* (1971) and Singh (1980) who reported that plant height varied amongst the cultivars.

Time of sowing markedly influenced the dry matter yield of the pigeonpea cultivars (Table 2). Maximum dry matter yield of 10782 and 9721 kg/ha in cvs. T 21 and AL 15, respectively was obtained in the crop sown on May 1 and a sizeable reduction was recorded with each delay in sowing. This could be attributed to the

TABLE 1

Effect of date of sowing on the growth and yield attributes of pigeonpea cultivars

Date of sowing	Plant height (cm)	Branches/ plant	Pods/plant	Grains/ pod	1000- grain weight (g)	Harvest index
Cultivar T 21						
May 1	237.0	99.8	172	4.2	83	13.55
May 15	242.3	86.3	136	3.6	81	13.09
June 1	203.9	70.0	128	3.3	79	12.56
June 15	184.0	83.3	124	3.1	77	12.09
Mean	216.8	85.0	140	3.6	80	12.82
Cultivar AL 15						
May 1	160.3	71.0	117	3.0	68	10.69
May 15	158.4	65.8	113	3.3	70	11.25
June 1	186.4	82.0	138	3.8	79	15.38
June 15	130.9	51.6	121	3.5	75	14.28
Mean	159.0	67.6	122	3.4	73	12.90
C. D. at 5%						
Dates	16.5	NS	NS	NS	NS	NS
Cultivar	5.8	NS	15	NS	NS	NS
D × C	11.6	NS	NS	NS	NS	NS

GROWTH AND YIELD OF PIGEONPEA CULTIVARS

TABLE 2

Effect of date of sowing on the dry matter and grain yield (kg/ha) of pigeonpea cultivars

Date of sowing	Cultivar	
	T 21	AL 15
Dry matter yield		
May 1	10782	9721
May 15	10023	9013
June 1	9490	8113
June 15	8287	8109
Mean	9646	8739
Grain yield		
May 1	1461	1039
May 15	1312	1014
June 1	1192	1248
June 15	1002	1158
Mean	1242	1115
C. D. at 5%	Dates NS	
	Cultivar 80	
	D × C 161	

reduction in total growth period with delay in sowing. Akinola and Whiteman (1975) also reported the reduction in dry matter yield with delay in sowing due to decreased growth period. Cultivar T 21 recorded more dry matter (average 9646 kg/ha) under all the dates of sowing as compared to that in cv. AL 15 (8739 kg/ha). It could be due to difference in the vegetative phase of both the varieties. Singh (1980) also reported that cv. T 21 produced more dry matter as compared to cv. AL 15 under different dates of sowing due to the difference in their vegetative growth.

Time of sowing and cultivars failed to influence the number of branches per plant (Table 1). However, cv. T 21 bear the maximum number of branches when

sown on May 1 and AL 15 when sown on June 1, corresponding to the highest yield obtained.

Yield Attributes

Cultivar T 21 produced 15% more pods as compared to cv. AL 15 (Table 1). This could be due to the reason that cv. T 21 being longer in duration produced more photosynthates and hence more number of pods per plant. Dhingra *et al.* (1980) also reported that cv. T 21 produced more pods due to its longer duration. The time of sowing has a profound effect on this yield attributing character. Cultivar T 21 produced the maximum number of pods (172) per plant when sown on May 1 and it declined to 124 with the delay in sowing to June 15, whereas in case of AL 15, the highest number of pods (138) per plant were recorded in June 1 sowing corresponding to the highest yield obtained. Similar observations were also recorded with respect to grains per pod and 1000-grain weight. On an average cv. T 21 produced 1242 kg grain per hectare compared to 1115 kg/ha produced by cv. AL 15 (Table 2). However, the performance of both the cultivars was not similar under different dates of sowing. In the earlier sowings of May 1 and May 15, cv. T 21 yielded higher than AL 15, whereas in later sowings of June 1 and June 15 cv. AL 15 produced higher grain yield. This may be because of the reason that in the latter two dates of sowing, the difference in the vegetative phase was quite narrow. However, in early sowing cv. T 21 being longer in duration recorded much longer vegetative phase

than AL 15 and produced more leaves which in turn produced a large amount of photosynthates and ultimately resulted in higher grain yield. This is also clear from dry matter yield, number of pods per plant, grains per pod and 1000-grain weight.

The date of sowing failed to influence the yield due to the difference in the performance of cultivars because of time of sowing. However, the interaction was found to be significant. The maximum grain yield (1461 kg/ha) in cv. T 21 was recorded in May 1 sowing and it declined with every fortnightly delay in sowing. On the other hand in cv. AL 15 the highest yield (1248 kg/ha) was obtained by sowing the crop on June

15 and the yield declined significantly by advancing the sowing to May 1 and May 15. Reduction in yield was also observed with the delay in sowing (June 15) which, however, was found to be non-significant. This may be due to the reason that this cultivar recorded lower harvest index (Table 1) in the earlier sowings and maximum corresponding to June 1 sowing indicating that cv. AL 15 better utilized the source in terms of photosynthates produced, thus increasing the number of sink in terms of pods per plant, grains per pod and test weight and ultimately the yield. Faroda and Singh (1977) and Singh (1980) also reported different varietal performance under different dates of sowing.

REFERENCES

- Ahluwat, I. P. S., Saraf, C. S. and Singh, A. 1975. Studies on the performance of pigeonpea varieties to dates of planting and row spacing. *Indian J. Agron.* 20 : 245-47.
- Akinola, J. O. and Whiteman, P. C. 1975. Agronomic studies on pigeonpea (*Cajanus cajan* (L.) Millsp.). 1. Field response to sowing time. *Aust. J. agric. Res.* 26 : 43-56.
- Dahiya, B. S., Brar, J. S. and Kaul, J. N. 1974. Change in growth habit of pigeonpeas (*Cajanus cajan* (L.) Millsp.). *J. agric. Sci.* 83 : 379-80.
- Dhillon, M. S. 1972. Effect of planting dates on the performance of pigeonpea (*Cajanus cajan* (L.) Millsp.) T 21 sown under different row spacings in arhar-wheat rotation. M.Sc. thesis, Punjab Agricultural University, Ludhiana.
- Dhingra, K. K., Singh, S. and Tripathi, H. P. 1980. Phenological behaviour and yield of pigeonpea (*Cajanus cajan* (L.) Millsp.) genotypes under different dates of planting and row spacing. Paper presented at International Workshop on Pigeonpeas held at ICRISAT from 15-19 Dec., 1980.
- Faroda, A. S. and Singh, R. C. 1977. Date of planting, row spacing and varietal trial on arhar. Report on kharif pulses, Department of Plant Breeding, Haryana Agricultural University, Hisar. pp. A33-34.
- Hammerton, J. L. 1971. A spacing/planting date trial with *Cajanus cajan* (L.) Millsp.). *Trop. Agric.* 48 : 341-50.
- Hammerton, J. L. 1976. Effect of planting date on growth and yield of pigeonpea (*Cajanus cajan* (L.) Millsp.). *J. agric. Sci.* 87 : 649-60.
- Singh, L., Maheshwari, S. K. and Sharma, D. 1971. Effect of date of planting and plant population on growth yield, yield components and protein content of pigeonpea. *Indian J. agric. Sci.* 41 : 535-38.
- Singh, S. 1980. Effect of date of sowing and plant population on the growth and yield of arhar genotypes. M.Sc. thesis, Punjab Agricultural University, Ludhiana.

PRELIMINARY CLASSIFICATION OF BROAD BEAN GERMPLASM LINES

ASHOK CHHABRA, MADUPURI R. NAIDU and V. P. SINGH

Department of Plant Breeding
Haryana Agricultural University, Hisar

(Received : January 30, 1984; Revised : June 1, 1985)

ABSTRACT

Ninetythree germplasm lines of broad bean (*Vicia faba* L.) from West Germany and different regions of northern India have been classified based on metroglyph analysis. All exotic strains except one clustered in low-yielding group. Seven local cultivars represented medium-yielding group. The high-yielding group included only two lines, one exotic and other local. The genetic stocks of low- and high-yielding group exhibited low and high manifestation of several characters in desirable direction. The medium-yielding lines appeared to be intermediate between those of high- and low-yielding group for expression of many characters. Selection of parent lines from different groups has, therefore, been suggested to ensure genetic divergence for most of the characters.

Broad bean (*Vicia faba* L.) is sporadically grown in India as a minor crop but it is likely to be valuable crop if improved cultivars and cultural techniques are developed. The seeds are reported to have protein content ranging from 28 to 40 per cent and to be good complement to cereal diets. Considering the productivity and nutritional potentials, the need for popularisation of broad bean in this country is obvious. The foremost step for improvement of any new crop by plant breeding is the establishment of germplasm collection and identification of early maturing and high yielding types with high protein and good amino acid balance. A further basic pre-requisite is the systematic classification of diverse germplasm collection into groups of similar or closely related cultivars. Such a classification is a useful source of information to the plant breeder, revealing the range of morphological features avail-

able and providing base for selection of parents for hybridization programme. This paper deals with the grouping of large number of broad bean germplasm lines originated from different geographical regions by using a simple technique known as metroglyph analysis.

MATERIAL AND METHODS

A collection of 84 broad bean strains was obtained from West Germany in 1981. These exotic strains alongwith additional nine Indian cultivars were raised in replicated plots during November 1982-May 1983. The plots were single rows of 3 m long with 50 cm inter-row and 20 cm plant to plant spacing. Individual plant observations on days to flower, days to maturity, plant height, branches per plant, internode length, clusters per plant, pods per plant, seeds per pod, 1000-seed weight and single plant seed yield were recorded with

emphasis on seed and agronomic characters.

The mean values were used to construct metroglyph diagram following the semi-graphical method (Anderson, 1957). In the metroglyph diagram, each genetic strain was represented by small circle, the x-ordinate being seed yield and y-ordinate being the number of branches. The branches per plant were chosen to represent y-axis because there was a wide genetic variability for this attribute. Apart from variability, the number of branches has been reported to have strong association with seed yield (Mahmoud *et al.*, 1978). The other characters were represented as rays on the circles. The index values determined the length of rays : no ray, short ray or long ray. These index values were obtained by allotting numerical values (0, 1 or 2) to three grades of expression recognised for each character (Table 1); while index score for each strain was estimated by summing up the index values of all the characters.

RESULTS AND DISCUSSION

The variability pattern of the present broad bean collection as indicated by metroglyph diagram (Fig. 1) seemed to be quite interesting. Wide genetic divergence was evident between exotic and indigenous accessions. Superimposed on the metroglyph depiction were the groups obtained, primarily, on the basis of yielding and branching ability. On the basis of seed yield potential, the lines were grouped into three broad categories, viz., low-, medium- and high-yielding groups. The seed yield of lines in low-yielding group ranged from 2 to 18 g, in medium-yielding group ranged from 19 to 34 g and in high-yielding group ranged from 35 to 50 g. The strains in each group had mostly similar characters.

The low-yielding group included one indigenous and 83 exotic strains. In the pictorial diagram, however, only 53 lines could be depicted because of much

TABLE 1
Index values of variables in broad bean collection

Characters	Low (0)	Medium (1)	High (2)
Days to flower	≥ 87	79-86	≤ 78
Days to maturity	≥ 167	144-166	≤ 143
Plant height (cm)	≥ 82	63-81	≤ 62
Branches per plant	≤ 2.7	2.8-4.5	≥ 4.6
Internode length (cm)	≤ 2.3	2.4-3.3	≥ 3.4
Clusters per plant	≤ 18.1	18.2-32.3	≥ 32.4
Pods per plant	≤ 27	28-50	≥ 51
Seeds per pod	≤ 2.3	2.4-2.7	≥ 2.8
100-seed weight (g)	≤ 38	39-59	≥ 60
Seed yield (g)	≤ 18	19-34	≥ 35

CLASSIFICATION OF BROAD BEAN LINES

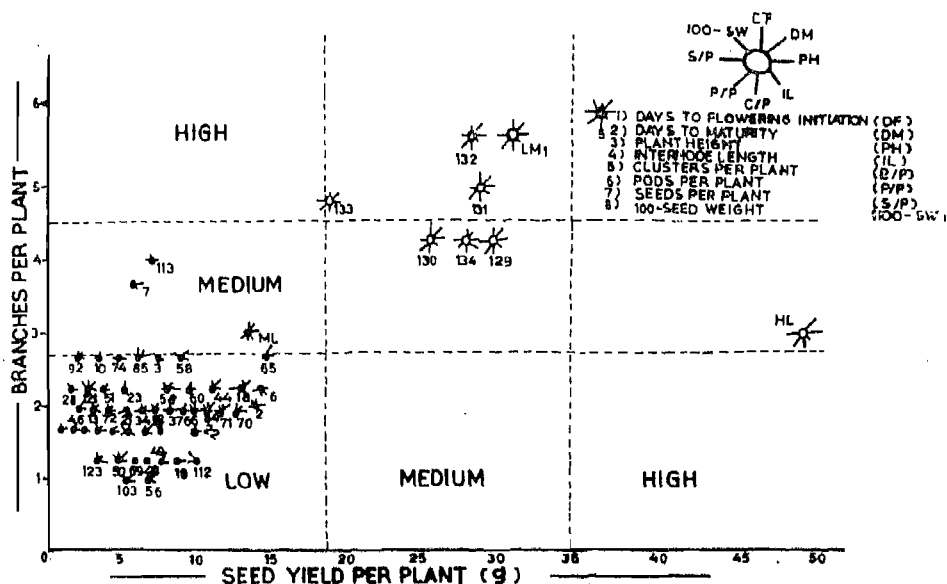


Fig. 1. Metroglyph diagram showing the distribution of the characters among broad bean strains.

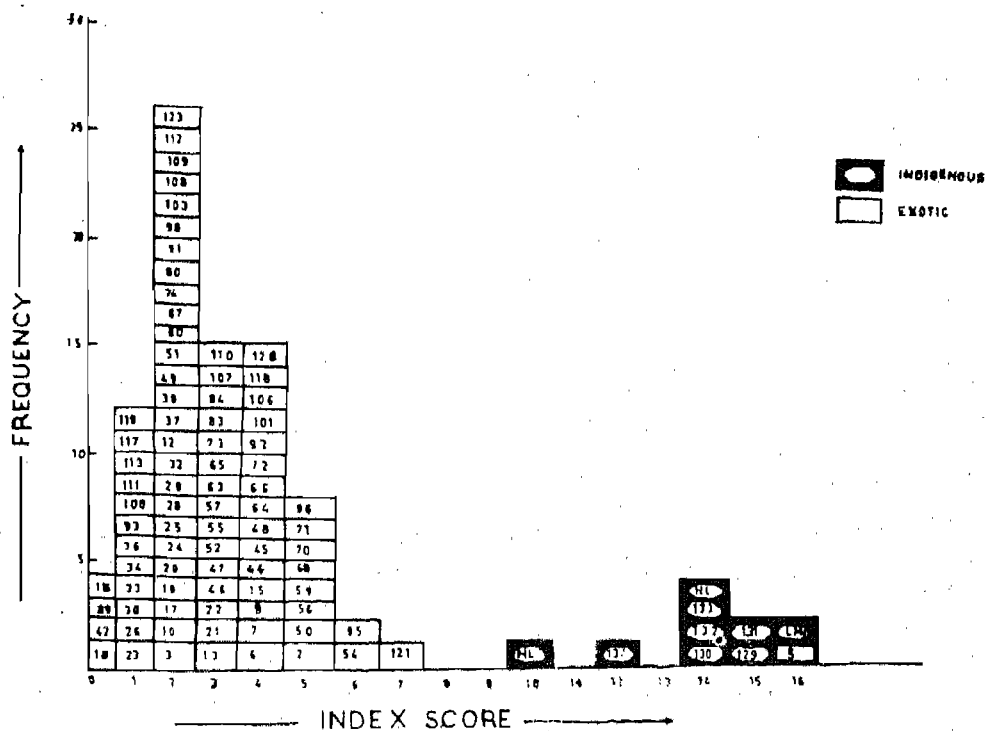


Fig. 2. Frequency distribution of Index score values of broad bean strains.

overlapping. Index score of low-yielding lines varied from 0 to 7 (Fig. 2). Maximum number of strains had index score of 2. Overall mean performance (Table 2) revealed that the low-yielding group was characterized by late flowering, late maturity, tall plants, short internode, medium seed weight and low number of branches, clusters, pods and seeds.

The cultivars included in medium-yielding group were predominantly indigenous type. The index score of this group ranged between 10 to 16. Invariably the medium-yielding lines were dwarf and early flowering. On an average, they produced long internodes and more clusters per plant. Interestingly, seed weight of all medium-yielding lines was low.

The high-yielding group was represented by one indigenous (Hisar Local) and one exotic (VH-5) strain. These two lines, on an average, performed relatively well for early maturity, branches, clusters and pods per plant, seed per pod and

seed weight. While comparing the two-yielding lines with each other VH-5 scored better than Hisar Local for flowering time, number of branches and seed weight (Table 3). Despite VH-5 having higher index score than Hisar Local, the latter was better than former for yielding ability.

On the basis of number of branches, the collection was classified into low-, medium- and high-branching groups. All the strains included in low-branching group were poor yielders. The medium-branching group consisted of one high-yielding, three medium-yielding and three-low yielding strains. One high- and four medium- yielding cultivars formed the high-branching group. Apparently the grouping of lines based on branching ability was more or less similar to that based on yielding ability.

The metroglyph analysis thus aided to classify the present broad germplasm collection into distinct groups. Jain *et al.* (1978) demonstrated in wheat that precise classification by metroglyph ana-

TABLE 2
Group means for broad bean collection classified on the basis of yielding potential and number of branches per plant

Groups	Days to flower	Days to maturity	Plant height (cm)	Branches per plant	Internode length (cm)	Clusters per plant	Pods per plant	Seeds per pod	100-seed weight (g)	Seed yield (g)
Low-yielding	85	160	76.2	1.9	2.0	8.1	10.0	2.3	33.3	5.5
Medium-yielding	76	127	55.4	4.9	3.1	38.6	60.4	2.9	24.8	26.7
High-yielding	85	125	60.0	4.5	2.7	37.8	65.0	3.0	52.9	42.9
Low-branching	85	161	77.0	1.9	2.0	7.6	9.7	2.3	33.3	5.4
Medium-branching	82	142	57.2	3.8	2.9	25.6	41.1	2.7	28.6	22.7
High-branching	77	123	54.4	5.5	3.0	41.5	65.9	2.9	35.2	28.1

CLASSIFICATION OF BROAD BEAN LINES

TABLE 3

Index and mean values of high-yielding lines for various characters

Characters	VH-5		Hissar Local	
	Index value	Mean	Index value	Mean
Days to flower	1	79.0	0	91.0
Days to maturity	2	123.0	2	127.0
Plant height (cm)	2	57.6	2	62.4
Branches per plant	2	6.0	1	3.0
Internode length (cm)	1	2.6	1	2.8
Clusters per plant	2	41.7	2	34.0
Pods per plant	2	64.7	2	65.8
Seeds per pod	2	3.0	2	3.0
100-seed weight (g)	2	78.9	0	36.8
Seed yield (g)	2	36.0	2	49.9
Index score	18	—	14	—

lysis can be obtained when maximum variability exists for two characters selected to represent x- and y- ordinates. Additional information gained from the metroglyph analysis was that the hybridization between exotic and indigenous genotypes could ensure the genetic divergence for several characters needing improvement. The lines within medium- and high-yielding groups showed variation for important yield component attributes such as days to flowering, number of branches, pods per plant and seeds per pod. When breeding objectives aim at improving these characters, the hybridization between lines within medium- and high-yielding groups may also be useful. Clearly, the index score

reflected the mean performance of strains for seed yield. Generally high index scores were high yielders. Evidently all the characters scored in present study appeared to be contributing to seed yield.

In conclusion, the results indicated that metroglyph and index score analysis could be utilized in the preliminary classification of a large number of germplasm lines. Such classification aids in careful choice of parents with wide genetic basis for successful hybridization programme. However, the cultivars included in present trial were by no means exhaustive and future work could attend to collect wider range of cultivars.

REFERENCES

- Anderson, E. 1957. A semi-graphical method for analysis of complex problems. *Nat. Acad. Sci.* 43 : 923-27.
- Jain, P. P., Singh, R. K. and Sharma, S. C. 1978. A comparative study of measures of divergence in wheat. 5th Intern. Wheat Genet. Symp., New Delhi.
- Mahmoud, S. A., El-Hyakemy, Y. and El-Rayes, F. M. 1978. Correlation and path-coefficient analysis of yield components and chemical composition in broad bean, *Vicia faba*. *Agric. Res. Rev.* 56 : 117-26.

FINE SAND MINERALOGY UNDER DIFFERENT LANDFORMS OF A PART OF SOUTHERN HARYANA

V. P. GOYAL, V. N. GARALAPURI and MAHENDRA SINGH

Department of Soils

Haryana Agricultural University, Hisar

(Received : February 4, 1984; Revised : October 8, 1984)

ABSTRACT

Ten representative soil profiles were exposed on different landforms of a part of southern Haryana to study the fine sand mineralogical composition. The light mineral fraction which constituted more than 95% of the total, showed the predominance of quartz followed by muscovite. The other light minerals (sp. gr. < 2.86) present were orthoclase, microcline, albite, oligoclase, saussuritized sericite and calcite. The heavy minerals (sp. gr. > 2.86) present were hornblende, chlorite, biotite, tourmaline, epidote, apatite, zircon, garnet, sphene/rutile and opaque minerals.

Level and slightly slopy plains showed better sorted grains with more weathering than of slightly undulating plains but as a whole the soils were still immature. In Sahibi flood plain weathering and alteration were negligible and confined to seasonal sedimentation conditions only.

The nature and quantity of minerals present in the fine sand fraction of soils can be used to detect stratification of parent material, evaluating initial pedogenesis and recognising differences in provenance of sediments. Although several workers (Roonwal *et al.*, 1967; Garalapuri and Goyal, 1974; Manchanda *et al.*, 1982; Kuhad *et al.*, 1983) have studied the fine sand mineralogy of some parts of Haryana but no systematic study on the mineralogical composition of soils on different landforms had been conducted. The present study was undertaken to know the mineralogical and morphological characteristics of the fine sand fraction of soils of southern Haryana.

MATERIAL AND METHODS

The southern part of Haryana state includes parts of Rohtak, Sonapat, Bhiwani, Gurgaon and Mahendragarh districts. The area lies between 27° 57' 50" to 28° 55' 57" N latitude and 76° 20' 52" to 76° 52' 50" E longitude and covers 4721 sq km.

The area has been broadly divided into three geomorphic landforms : (i) Pre-Cambrian Aravali Delhi Rocky Hills and their pedimental extension in the south, (ii) Older Alluvial Plain—a part of the Indo-Gangetic Plain with sediments derived mostly from the Himalayan rivers, and (iii) Sahibi Flood Plain with active

FINE SAND MINERALOGY

channels, relict channels, levees and point bar complex in association with lower flood plain and basins away from its close proximity. The study was confined to the Older Alluvial Plain and the Sahibi Flood Plain.

By using aerial photographs of scale 1:25000, landsat imageries and Survey of

India toposheets as well as field observations, major and sub-landforms were delineated. Ten representative pedons were exposed in different landforms (Fig. 1). Landform and soil taxonomic unit of each pedon are given in Table 1. Soil profiles were described according to F. A. O. (1966). Representative soil samples from each horizon were

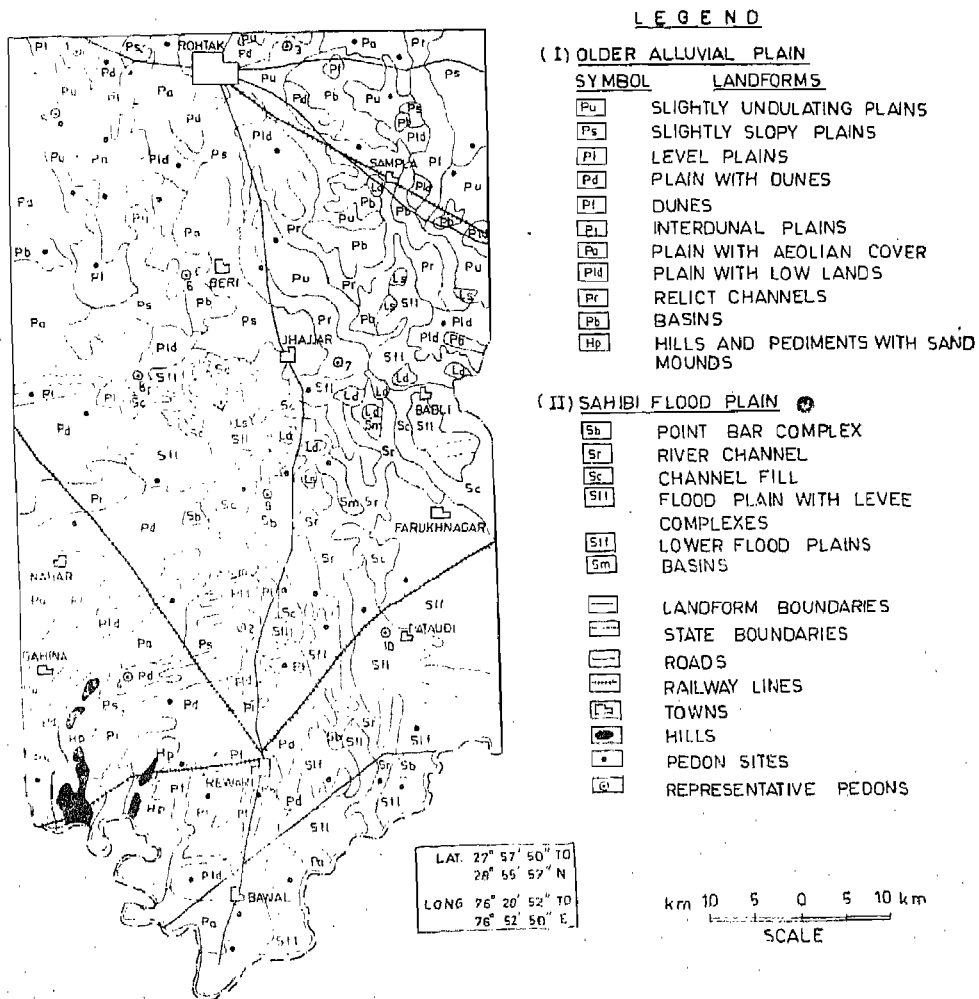


Fig. 1. Delineated landforms of the study area (Haryana).

collected. Fine sand was separated from the soil samples by using the principle of International Pipette Method for mechanical analysis (Piper, 1966).

For preparation of a specimen, the steps involved were : (i) crushing, (ii) disaggregation, (iii) sizing, (iv) cleaning, (v) separation, and (vi) mounting (Krumbein and Pettijohn, 1938). Crushing and disaggregation were achieved through mechanical analysis. Sand grains between 100 and 120 mesh size, separated by sieving, were boiled in 50% HCl mixed with some stannous chloride to remove coatings of ferruginous and other material. Light and heavy minerals separated by bromoform (sp. gr. > 2.86) were washed with acetone and dried. Permanent slides were prepared separately for light and heavy minerals with canada balsam. The slides were studied under a polarizing microscope for mineral identification. Relative abundance of minerals was recorded (Brewer, 1964). Electrical conductivity, pH and clay content were determined by standard procedures.

RESULTS AND DISCUSSION

Petrographic examination of light and heavy mineral suits of the fine sand fraction was conducted. Type of minerals present with their relative abundance in each of the pedon are given in Table 1 and are discussed below :

Older Alluvial Plain

Plains. This was most likely an area of down sinking in the geological past forming a part of the Indo-Gangetic alluvial plain north of the buried Pre-

Cambrian pedimental extension (Krishnan, 1968). This plain was further differentiated into level plain, slightly slopy plain and slightly undulating plain. These occupied mostly the northern part of the study area (Fig. 1). In the pedons (P_1 to P_3) of these sub-landforms, quartz was the dominant mineral. Other minerals present were muscovite, orthoclase/microcline, albite/oligoclase, saussuritised sericite and calcite. In pedon 2 albite/oligoclase was absent, whereas in pedon 3 saussuritised sericite was absent. In heavy fraction the dominant mineral was hornblende followed by opaque minerals, tourmaline and chlorite except in pedon 1 where opaque minerals were dominant. Zircon was more in the lower horizons. Small amounts of biotite, epidote, apatite, garnet and sphene/rutile were also recorded in some horizons. Pedon 3 was situated on the higher elevation with mostly unsorted admixture of fluvio-aeolian origin with negligible weathering. The provenance seemed to be of acid intrusive and igneous rocks of the Archaean complex.

Level plain (P_1) and slightly slopy plain (P_2) showed increasingly better sorted grains with better weathering conditions than that of slightly undulating plain (P_3). The morphology of the mineral grains, i.e. scar marks, crenulated borders and broken overgrowths, showed these to be of fluvial origin manifested by aeolian agencies. The provenance was mainly an igneous terrain away from the present site. The soils were medium textured, non-saline but alkaline (Table 2).

Plains with aeolian activity. Plains with aeolian activity dominated in the

TABLE 1
Mineralogical composition of the fine sand fraction

Heavy minerals (Sp. gravity > 2.86)																	
Light minerals (Sp. gravity < 2.86)																	
Pelon No.	Depth (cm)	Quartz	Orthoclase/ microcline	Albite/oligoclase	Muscovite	Saundersite	Calcite	Hornblende	Biotite	Chlorite	Epidote	Tourmaline	Zircon	Apatite	Garnet	Sphene/Rutile	Opaque minerals
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
OLDER ALLUVIAL PLAIN																	
Plains																	
Level plain (Fine loamy, Fluventic Udic Ustochrepts)																	
P ₁	0-20	A	P	C	P	R	—	P	—	R	T	R	T	—	T	R	P
	20-48	A	R	P	P	P	—	P ⁺	T	T	—	P	T	—	T	R	P
	48-76	A	R	R	P	P	T	R	—	P	R	C	P	T	—	P	C
	76-115	A	P	C	R	R	T	R	T	P	R	C	P	—	T	R	P
	115-175	A	R	P	R	R	T	R	—	P	R	P	R	T	T	P	R
Slightly slopy plain (Coarse loamy, calcareous, Ustic Torriorthents)																	
P ₂	0-23	A	R	—	C	—	—	P	R	R	—	P	T	T	—	—	P
	23-82	A	R	—	C	—	—	P	T	P	T	P	T	—	—	T	P ⁺
	82-130	A	T	—	C	T	—	C	—	P	R	P	R	—	—	T	P
	130-180	A	—	—	P	—	T	T	—	R	T	P	T	—	—	T	P
Slightly undulating plain (Coarse loamy, Typic Ustorthents)																	
P ₃	0-16	A	R	T	P	—	—	P	R	P	—	P	T	T	T	T	P
	16-48	A	R	T	P	—	—	P	T	P	T	P	T	—	—	T	P
	48-87	A	R	—	C	—	—	C	—	P	T	P	R	—	—	T	P
	87-124	A	R	—	P	—	—	C	—	R	—	R	T	—	—	—	P
	124-178	A	R	—	C	—	T	C	—	P	T	P	T	—	—	—	P

contd.

contd.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	18	17	18
Plains with aeolian activity																	
Plain with dunes and dunes (Typic Ustipsamments)																	
P ₄	0-21	A	P ⁻	P ⁺	P	T	—	P ⁻	R	P ⁻	T	P	T	R	—	—	P ⁻
	21-77	A	P	R	P ⁻	—	—	T	—	R	R	P	—	—	—	—	P ⁻
	77-140	A	P ⁻	P ⁺	P	T	T	P	R	P	R	P	R	T	T	T	P
	140-190	C	P ⁻	P	C	R	T	P ⁺	T	P ⁺	P	P	R	—	T	T	P ⁺
Plain with aeolian cover (Coarse loamy, Udic Ustochrepts)																	
P ₅	0-21	A	R	R	R	P	—	C	T	P	R	P	T	—	—	T	C
	21-43	A	R	R	P	R	—	P	—	C	R	P	T	—	T	T	P
	43-86	A	R	T	P	—	—	P	—	C	R	C	R	T	T	T	P
	86-120	A	T	T	C	—	—	R	T	C	R	C	P	—	—	—	P
	120-162	A	T	—	C	—	T	R	P	P	—	—	—	—	—	—	P
	162-180	A	P	P	P	T	R	P	P	P	—	—	—	T	T	T	P
Low lands																	
Basins (Fine loamy, calcareous, Typic Ustochrepts)																	
P ₆	0-19	A	R	T	P	—	—	P	T	R	—	P	T	—	—	—	P
	19-70	A	R	T	C	—	—	P	—	R	—	P	T	—	—	—	P ⁻
	70-122	A	P	R	C ⁺	—	—	P	—	P	T	P	T	—	—	T	P
	122-175	A	R	—	C	—	—	P	—	P	T	P	T	—	T	T	P
	175-215	A	R	—	P	T	—	P	—	P	R	P	T	—	T	T	P
Relict channels (Coarse loamy, Udic Ustochrepts)																	
P ₇	0-20	A	R	—	P	—	—	R	T	R	—	P	T	—	—	—	R
	20-78	A	R	R	C	T	—	R	—	P	T	P	—	—	—	T	P
	78-92	A	R	T	C	T	—	R	—	P	T	P	—	—	—	T	P
	92-178	A	R	—	C	—	—	P	—	P ⁻	T	P	T	—	T	T	P ⁻
Plain with low lands (Fine loamy, calcareous, Aeric Ochraqualfs)																	
P ₈	0-22	A	R	P	P	R	—	P	R	R	T	P	R	T	—	T	P ⁺
	22-65	A	R	T	P	T	—	P	T	P	T	P	T	—	—	T	P
	65-106	A	T	—	P	—	—	C	—	P	R	C	P	T	T	T	P ⁺
	106-175	A	—	—	P	—	Y	P	—	P	T	P ⁻	R ⁻	—	—	T	P ⁻

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
SAHIBI FLOOD PLAIN																	
Active fluvial plain—Point bar complex (Typic Ustipsammits)																	
P _a	0-20	A	R	T	P	R	—	P	R	P	R	P	T	T	—	—	P
	20-71	A	T	—	C	—	—	P	—	R	—	R	—	—	—	—	P ⁻
	71-115	C	P	P	P	—	—	C	—	P	R	P	R	R	—	R	P ⁻
	115-180	A	R	T	C	—	—	P	—	R	T	P	T	—	—	T	P
Associated fluvial low lands—Flood plain with levee complexes (coarse loamy, calcareous, Fluvantic Ustochrepts)																	
P _{1a}	0-22	A	R	—	P	—	—	P	T	R	—	P	T	R	—	—	P
	22-36	A	R	T	C	T	—	P	—	R	T	P	—	T	—	—	P
	36-55	A	R	T	P	—	—	P	T	R	T	P	R	R	—	—	P
	55-105	A	R	—	C	—	T	P	—	R	T	P	—	T	—	—	P ⁻
	105-181	A	R	—	P	—	T	P	—	P	R	R	T	—	—	—	P ⁻

A=Abundant (>60%), C=Common (16-60%), P⁺=Present (11-15%), P⁻=Present (5-10%), R=Rare (2-5%), T=Traces (1 or less than 1%), —=Nil.

TABLE 2

Physico-chemical characteristics of the soils

Pedon No.	Depth (cm)	Horizon	1:2 soil water suspension		Clay (%)	Texture
			pH	EC (mmhos/cm)		
P ₁	0-20	A _p	8.2	0.20	12.8	Loam
	20-48	B ₁	8.1	0.17	14.3	Loam
	48-76	B ₂₁	7.9	0.15	18.9	Loam
	76-115	B ₂₂	7.8	0.13	22.5	Silty loam
	115-175	B ₂₃	7.9	0.10	23.8	Silty loam
P ₂	0-23	A _p	8.2	0.41	11.7	Sandy loam
	23-82	C ₁	8.2	0.37	9.2	Sandy loam
	82-130	C ₂	8.3	0.43	11.8	Sandy loam
	130-180	IIC ₃	8.5	0.45	10.2	Sandy loam
P ₃	0-16	A _p	7.8	0.39	10.6	Sandy loam
	16-48	C ₁	8.0	0.21	13.1	Loam
	48-87	C ₂	7.9	0.20	13.5	Loam
	87-124	C ₃	7.9	0.22	13.2	Loam
	124-178	C ₄	8.1	0.21	13.7	Loam
P ₄	0-21	A _p	8.2	0.08	7.1	Loamy sand
	21-77	C ₁	8.0	0.10	7.2	Loamy sand
	77-140	C ₂	8.0	0.07	7.4	Loamy sand
	140-190	IIC ₂	8.2	0.43	6.3	Loamy sand
P ₅	0-21	A _p	8.0	0.18	7.6	Loamy sand
	21-43	B ₁	7.9	0.13	12.8	Loam
	43-86	B ₂₁	7.9	0.12	14.4	Loam
	86-120	B ₂₂	8.0	0.15	16.5	Loam
	120-162	B ₂₃	8.0	0.16	16.5	Loam
	162-180	B ₂	7.9	0.17	14.6	Loam
P ₆	0-19	A _p	7.9	0.35	18.1	Loam
	19-70	B ₁	8.1	0.35	20.7	Loam
	70-122	IIC _{1Ca}	8.3	0.27	17.4	Silty loam
	122-175	IIC _{2Ca}	8.4	0.28	10.0	Silty loam
	175-215	IIC _{3Ca}	8.5	0.29	8.6	Silty loam
P ₇	0-20	A _p	7.5	0.20	10.4	Loamy sand
	20-78	B ₁	7.7	0.12	13.6	Silty loam
	78-92	B ₂₁	7.8	0.15	17.4	Silty loam
	92-178	B ₂₂	7.8	0.21	18.9	Loam
P ₈	0-22	A _p	8.3	0.29	13.0	Sandy loam
	22-65	B _{21t}	8.0	0.35	22.7	Loam
	65-106	B _{22t}	7.9	0.43	26.8	Clay loam
	106-175	B _{23t}	7.9	0.50	31.7	Silty clay loam
P ₉	0-20	A _p	8.2	0.56	7.2	Loamy sand
	20-71	IIC ₁	8.1	0.44	7.2	Loamy sand
	71-115	IIC ₂	8.3	0.34	6.2	Loamy sand
	115-180	IIC ₃	8.4	0.23	5.6	Sand
P ₁₀	0-22	A _p	8.4	0.15	6.81	Sand
	22-36	B ₂₁	8.3	0.29	13.46	Sandy loam
	36-55	B ₂₂	8.2	0.32	16.40	Loam
	55-105	B ₂₃	8.2	0.24	19.10	Loam
	105-181	IIC	8.4	0.12	6.72	Sand

western and south-western part of the study area (Fig. 1). This area was further divided into four distinct sub-units, i.e., plain with dunes, dunes, interdunal plains and plains with aeolian cover. Two representative pedons (P_4 and P_5) were studied in these landforms. Quartz was the dominant light mineral in both the pedons followed by muscovite and orthoclase/microcline in pedon 5, and muscovite followed by albite/oligoclase in pedon 4. Saussuritized sericite and calcite were also present in small amounts in a few horizons. The heavy mineral fraction in pedon 5 consisted of opaque minerals followed by chlorite, tourmaline and hornblende, whereas in pedon 4 opaque minerals were followed by hornblende, tourmaline and chlorite. In most of the horizons zircon, epidote, biotite, apatite, garnet, sphene/rutile were also observed in small amounts (Table 1).

The characteristics of the mineral grains were similar to those of plains (without aeolian activity) in all aspects except that mineral grain had scar marks and attrition of grains causing more angularity and shattering effects. Dunes and older plains with aeolian cover showed saussuritisation because of the time available and stability to cause it. Due to deflation and winnowing at times, the micas are scarce and crenulated. The soils were light to medium in texture, non-saline and alkaline (Table 2).

Low lands. The post-Pleistocene age sediments, very deep and fine textured which filled the basins were mostly derived from the Himalayan rivers from the north. Plain with lowlands, relict channels and basins were the three

distinct sub-units of this landform which occupied north-eastern and north-central part of the study area (Fig. 1).

Three representative pedons (P_6 , P_7 and P_8) were studied in this landform. In the light fraction the minerals identified were quartz, followed by muscovite, orthoclase/microcline, albite/oligoclase and saussuritized sericite. The heavy fraction consisted of hornblende, opaques, tourmaline and chlorite. Their abundance varied in different horizons. Zircon and epidote were generally more in the lower horizons. Biotite, apatite, garnet and sphene/rutile were also present in small amounts in a few horizons, whereas apatite was absent in pedons 6 and 7 (Table 1). Similar results were also reported by Manchanda *et al.* (1982) and Kuhad *et al.* (1983) in a part of Indo-Gangetic Plain in Haryana.

The low lands of older alluvial plain showed predominance of finer admixture with moderately better sorted grains that resulted from distant fluvial transport. Weathering was more pronounced and progressively differentiated with depth. The plagioclase feldspars and other ferromagnesian minerals had weathered to give rise to dissociated ions. Crenulation of mica, and pitted and corroded nature of other grains showed a better environment of pedo-chemical weathering. Soils were medium to heavy textured, non-saline and alkaline (Table 2).

Sahibi Flood Plain

The Sahibi river enters the study area from the south and is very active upto

the central part but its extension which took a turn towards east was represented by broken lakes and buried up channel belts. The two sub-units of this landform are as under :

Active fluvial plain. The active fluvial plain was comprised the following three distinct sub-units, i.e. river channel, point bar complex and the channel fills which occupied the central and east-central part of the study area (Fig. 1). In this landform one representative pedon (P_9) was studied. Quartz as dominant mineral followed by muscovite, orthoclase/microcline and albite/oligoclase were the light minerals, whereas the heavy minerals consisted of hornblende followed by opaques, tourmaline and chlorite. Small amounts of zircon, apatite, epidote, biotite and sphene/rutile were also observed.

The active fluvial plain sediments were mainly composed of stratified layers deposited by fluvio-aeolian agencies at different times. Thus, these immature soils showed stratification with well sorted and moderately sorted sand size grains alternatively. Alteration and weathering were negligible and confined to seasonal conditions. Provenance seemed to be of quartzites and parametamorphics of the Delhi stage rock types mainly. The surfaces were also showing the admixture of annual aeolian material with alternate layered strata. The soils were sand to loamy sand in texture, alkaline and without any salinity hazard (Table 2).

Associated fluvial low lands. Flood plain with levee complexes, lower flood plain and basins were the three distinct sub-units of this landform which occupied mostly the south-eastern part of the study area (Fig. 1). One pedon (P_{10}) was studied in this landform. Quartz was the dominant mineral followed by muscovite, orthoclase/microcline, albite/oligoclase and saussuritised sericite. Calcite was also observed in traces in the lower horizons. The heavy fraction mainly consisted of opaque minerals, hornblende, tourmaline and chlorite. Zircon, epidote, biotite, apatite and sphene/rutile were also present in small amounts in some of the horizons (Table 1).

In flood plain with levee complexes (P_{10}) because of reasonable equilibrium conditions with not much of an influx of fluvial deposition, the soils were moderately developed with moderate degree of pedochemical weathering.

The poor native nutrient reserve of these soils may be attributed to the low status of easily weatherable minerals in these soils.

From mineralogical study of the fine sand fraction it can be concluded that the sediments of the southern Haryana are mainly brought down by the rivers or ephemeral streams during Pleistocene to Recent times along with modifications due to wind blown sand dunes and loess blanket brought down by cyclic storms and deposited under semiarid conditions with scanty rain.

REFERENCES

- Brewer, R. 1964. *Fabric and Mineral Analysis of Soils*. Wiley New York, U.S.A.
- F. A. O. 1966. *Guidlines for Soil Profile Description*. FAO Rome.
- Garalapuri, V. N. and Goyal, V. P. 1974. Mineralogical study of the fine sands from the western fringe of Haryana. *Indian J. agric. Res.* 8 : 227-32.
- Krishnan, M. S. 1968. *Geology of India and Burma*. Higginbothams Pvt. Ltd., Madras.
- Krumbein, W. C. and Pettijohn, F. J. 1938. *Manual of Sedimentary Petrography*. D. Appleton-Century Co., New York.
- Kuhad, M. S., Khanna, S. S. and Garalapuri, V. N. 1983. Mineralogy of fine sand fraction of soils of Haryana. *Haryana agric. Univ. J. Res.* 13 : 87-95.
- Manchanda, M. L., Garalapuri, V. N. and Khanna, S. S. 1982. Mineralogy of fine sand fraction in relation to different landforms in a part of Indo-Gangetic plain in Haryana. *Haryana agric. Univ. J. Res.* 12 : 475-86.
- Piper, C. S. 1966. *Soil and Plant Analysis*. Hans Publishers, Bombay.
- Roonwal, G. S., Khanna, S. S. and Prakesh, A. 1967. Mineralogy of sand fraction in certain profiles of Hisar district (Haryana). *J. Res. Punjab agric. Univ.* 4 : 168-73.

PERFORMANCE OF PEARL MILLET HYBRIDS/SYNTHETIC VARIETIES UNDER VARYING PLANT POPULATIONS AND DATE OF PLANTING

P. S. GILL and S. L. SAINI

Department of Agronomy

Haryana Agricultural University, Hisar

(Received : February 10, 1984; Revised : December 11, 1984)

ABSTRACT

Maximum grain yield was obtained in earlier planting (on the onset of monsoon) which decreased significantly when the sowing was delayed by 10 or 20 days. Among the varieties, both the hybrids viz., BJ-104 and CM-46, which were at par, outyielded both the populations, i.e. WC-C×75 and HS-1 by a significant margin during both the years. Various plant populations, however, could not influence neither the grain yield nor the stover yield in bajra.

Pearl millet (*Pennisetum americanum* (L.) K. Schum) commonly known as bajra is considered to be a major dual purpose crop in India. In Haryana, it is the most important kharif grain crop, particularly in semi-arid areas. In spite of the fact that with the introduction of hybrids during 1965 a quantum jump in the production of bajra was achieved; but the average yield per unit area in the country as a whole is much below the potential yields of the hybrids. This could be due to the fact that the replacement of area under hybrids is hardly 25-30 per cent. In the recent years, scientists have started developing synthetic or composite varieties which do not require replacement of seed every year. But the information on their yield potential against hybrids under different dates of sowing and plant population is very meagre, which has necessitated the present studies.

MATERIAL AND METHODS

Field studies were conducted during kharif seasons of 1979 and 1980, at Haryana Agricultural University, Hisar. The soil of the experimental field was sandy loam in texture, low in organic carbon (0.18%), low in P (4 kg P/ha) and high in K (317 kg/ha) and it was slightly alkaline (pH 8.2) in reaction. Treatments included three dates of sowing (July 15, July 25 and August 9) during 1979 and (July 12, July 23 and August 5) 1980; three plant to plant spacings viz., 10, 12.5, and 15 cm and four varieties viz., BJ-104, CM-46, HS-1 and WC-C×75. A uniform row spacing of 45 cm was kept. The experiment was laid out in split plot design with dates of sowing and plant to plant spacing in main plots and varieties in sub-plots, replicated three times. A uniform dose of fertilizer i.e. 80 kg N/ha + 20 kg P₂O₅/ha was applied.

SOWING TIME AND PLANT POPULATION IN BAJRA

Phosphorus was applied as basal dose, whereas nitrogen was applied in two splits, i.e. half at sowing and second half after about 21 days of sowing. Plant to plant distance was maintained as per treatment by thinning and transplanting in between the plots after about 15-20 days of each sowing on any rainy day.

RESULTS AND DISCUSSION

Sowing Dates

The grain yield of bajra was significantly influenced by dates of sowing during both the years (Table 2). Highest

grain yield was recorded with D₁ (onset of monsoon), which differed significantly from D₂ (20 days late) but was at par with D₃ (10 days late). The grain yield under D₃ was also significantly higher over the late sowing done 20 days after first date of sowing during both the years. The higher grain yield with early sowing may be ascribed to significantly higher yield per plant, more number of ear heads per plant and higher test weight (Table 1). Singh and Singh (1969), and Bhardwaj *et al.* (1971) observed mid July to be the optimum time of sowing of bajra. Tomer *et al.* (1974) while working

TABLE 1

Effect of sowing date and intra-row spacing on the yield contributing characters of bajra hybrids/varieties

Treatments	Yield (g/plant)				No. of ear bearing		100-grain weight	
	Grain		Stover		shoots per plant		(g)	
	1979	1980	1979	1980	1979	1980	1979	1980
Sowing date								
D ₁ (onset of monsoon)	22.8	20.5	63.7	72.5	1.7	1.6	6.7	7.1
D ₂ (10 days late)	21.8	20.7	63.2	63.8	1.5	1.8	7.8	7.7
D ₃ (20 days late)	13.7	14.7	21.3	44.2	1.2	1.3	7.4	6.6
S. Em±	0.7	1.1	4.8	2.8	0.1	0.1	0.2	0.3
C.D. at 5%	2.1	3.2	14.8	8.3	0.2	0.2	0.6	1.0
Varieties								
BJ-104	20.1	21.3	39.3	56.5	1.5	1.7	7.3	7.4
WC-C × 75	19.1	16.8	73.4	70.5	1.3	1.3	8.2	8.1
CM-46	23.4	19.8	45.5	50.8	2.0	1.8	7.1	6.7
HS-1	15.2	17.1	37.8	63.2	1.3	1.4	6.5	6.3
S. Em±	1.0	0.9	0.8	2.8	0.05	0.04	0.3	0.4
C.D. at 5%	2.7	2.5	2.2	7.9	0.13	0.11	1.0	1.3
Spacings								
S ₁ (45 × 10 cm)	18.1	19.6	48.4	60.6	1.5	1.5	7.0	7.1
S ₂ (45 × 12.5 cm)	18.4	17.3	49.0	59.3	1.5	1.5	7.4	7.1
S ₃ (45 × 15 cm)	21.8	19.4	50.7	60.5	1.5	1.6	7.5	7.2
S. Em±	1.0	1.1	4.8	2.8	0.09	0.07	0.2	0.3
C.D. at 5%	2.7	NS	NS	NS	NS	NS	NS	NS

at Hisar also observed 3.6 to 89.8 per cent decrease in grain yield of bajra due to delay in sowing. Stover yield followed a trend almost similar to that of grain yield.

Varieties

Pearl millet hybrids viz., BJ-104 and CM-46, which were at par with each other, produced significantly higher grain yield (Table 2) during both the years over the two synthetic varieties viz. WC-C $\times$ 75 and HS-1. During 1979, WC-C $\times$ 75 gave a significantly higher grain yield over HS-1, whereas during

1980 the results were just reverse i.e. HS-1 gave significantly higher grain yield over WC-C $\times$ 75. In respect of stover yield, variety WC-C $\times$ 75 recorded significantly higher yield over all the remaining hybrids/varieties during both the years. The remaining varieties were at par with each other during first year, whereas during second year the difference in stover yield amongst all the varieties was found to be significant; maximum being with HS-1 followed by BJ-104 and CM-46. The increase in grain yield by hybrids may be due to higher yield per plant and more number of ear bearing

TABLE 2
Effect of sowing date and intra-row spacing on the grain and stover yield of bajra hybrids/varieties

Treatments	Yield (q/ha)					
	Grain			Stover		
	1979	1980	Mean	1979	1980	Mean
Sowing date						
D ₁ (onset of monsoon)	27.09	32.57	29.83	75.80	114.20	95.00
D ₂ (10 days late)	24.51	31.33	27.92	70.20	99.50	84.80
D ₃ (20 days late)	16.43	25.77	21.10	45.30	78.70	62.00
S. Em $\pm$	0.89	1.47	—	2.46	3.05	—
C.D. at 5%	2.63	4.39	—	7.34	9.26	—
Varieties						
BJ-104	25.02	34.61	29.81	50.50	93.90	72.20
WC-C $\times$ 75	21.20	24.65	22.92	80.70	110.90	95.80
CM-46	25.02	32.50	28.76	47.60	82.10	64.80
HS-1	19.52	27.81	23.66	49.60	103.50	76.60
S. Em $\pm$	0.61	0.85	—	10.85	2.78	—
C.D. at 5%	1.68	2.38	—	29.45	7.73	—
Spacings						
S ₁ (45 $\times$ 10 cm)	22.83	31.02	26.92	60.10	96.30	78.20
S ₂ (45 $\times$ 12.5 cm)	21.93	28.45	25.19	56.40	97.40	76.90
S ₃ (45 $\times$ 15.0 cm)	25.02	30.22	27.62	54.80	92.20	73.50
S. Em $\pm$	0.89	1.47	—	2.46	3.05	—
C.D. at 5%	NS	NS	—	NS	NS	—

SOWING TIME AND PLANT POPULATION IN BAJRA

tillers per plant (Table 1). Test weight of BJ-104 and CM-46 was also higher than that of HS-1. Similar results were also obtained by Singh and Singh (1969) and Shekhawat *et al.* (1970).

Interaction of dates of sowing and varieties was found to be significant during 1979 (Table 3). It is evident from the data in Table 3 that hybrid BJ-104 produced highest grain yield under D₁ which differed significantly from HS-1, but was at par with CM-46 and WC-C×75. On the other hand under D₂, hybrid CM-46 produced highest grain yield which differed significantly from HS-1 but was at par with BJ-104 and WC-C×75. However, under delayed planting date (D₃) also hybrid CM-46 produced highest grain yield which differed significantly from WC-C×75 but was at par with BJ-104 and HS-1.

Delayed sowing beyond D₂ (25 July) caused a significant reduction in grain yield irrespective of genotype used. Tomer *et al.* (1974) while working at Hisar also observed 3.6 to 89.8 per cent reduction in grain yield of pearl millet

due to delay in sowing from mid July to end of August.

Plant to Plant Spacing

The data given in Table 2 indicate that various plant to plant spacings could neither influence the grain nor stover yield in pearl millet. The various yield contributing characters (Table 1) also remained unaffected due to various plant spacings. Similarly, Nirwal and Upadhyay (1979) did not observe any difference in yield of bajra within the intra-row spacing of 7.5, 15 and 22.5 cm.

Thus, the two year data gave a sufficient indication that hybrid bajra sown in the middle of July with a spacing of 45×15 cm is the best combination for obtaining the highest yield.

ACKNOWLEDGEMENTS

Authors are grateful to the Director of Research, Haryana Agricultural University, Hisar, for providing the facilities. Help rendered by Professor and Head, Department of Plant Breeding is also gratefully acknowledged.

TABLE 3

Effect of sowing date and varieties on the grain yield of bajra during 1979

Sowing date	BJ-104	WC-C×75	CM-46	HS-1	Mean
July 15, 1979	30.12	27.65	27.88	22.72	27.09
July 25, 1979	25.63	24.06	27.37	21.03	24.51
August 9, 1979	19.29	11.38	19.85	14.69	16.43
Mean	25.02	21.20	25.02	19.62	

C. D. for comparing two varieties } = 5.16
with constant date of sowing

C. D. for comparing two dates of sowing } = 4.87
with constant variety

REFERENCES

- Bhardwaj, R. B. L., Gautam, R. C. and Singh, A. 1971. New practices for hybrid bajra. *Indian Farm.* **20**(11) : 18-20.
- Nirwal, B. G. and Upadhyay, U. C. 1979. Growth and yield of hybrid pearl millet (HB-1) as influenced by inter and intra-row spacing and varying levels of nitrogen. *Indian J. Agron.* **24** : 17-20.
- Shekhawat, G. S., Chundawat, G. S. and Shrotriya, G. C. 1970. On the response of bajra varieties to level of nitrogen on sandy soil of Rajasthan. *Indian J. Agron.* **15** : 193-94.
- Singh, R. and Singh, S. N. 1969. A note on the effects of different dates of sowing HB-1 on grain yield and incidence of ergot (*Claveiceps microcephale*). *Madras agric. J.* **56** : 140.
- Tomar, P. S., Singh, R. C. and Saini, S. L. 1974. Effect of direct seeding and transplanting on the growth and yield of (Hybrid Bajra-3) pearl millet grown at different nitrogen levels under late sown conditions. *Indian J. agric. Sci.* **44** : 317.

NUMERICAL APPROXIMATION OF STEADY STATE MOVEMENT OF Na^+ IN Ca^{2+} SATURATED SOIL COLUMNS

RAJ PAL, A. K. KAPOOR and S. JOSHI
Department of Soils
Haryana Agricultural University, Hisar

(Received : May 11, 1984; Revised : September 6, 1984)

ABSTRACT

The transport of Na^+ in Ca^{2+} saturated sandy loam and loam soil columns was studied under steady state saturated flow conditions at two different pore volumes. The cation exchange process was modelled using non-linear convective-dispersive partial differential equation that describes the miscible displacement of cations in soils. The numerical model utilized a constant slope corresponding to the linear part of the normalized exchange isotherm of Na^+ . The normalized exchange isotherms of the exchanging cation for higher pore volumes of solutions were different and gave higher values than those for lower pore volumes. The observed normalized concentration profiles of Na^+ differed considerably from those predicted using numerical solution of the transport equation. The predicted cation concentration values could be improved if variable slopes corresponding to different points on the exchange isotherm were taken instead of taking a constant slope pertaining to linear part of the exchange isotherm.

The various predictive approaches for solute transport in soils have been reviewed recently by Pal and Poonia (1982). Lai and Jurinak (1972a) studied the transport of Na^+ and Mg^{2+} in Ca^{2+} saturated soil columns under steady state flow of different pore velocities. They applied the analytical solution of the transport equation as deduced by Lindstrom *et al.* (1967) to predict the observed results using among other parameters, the linear part of the normalized exchange isotherm of Na^+ for Na^+ break-through curves (BTCs) and a straight line exchange isotherm for Mg^{2+} BTCs. Similarly, Lai *et al.* (1978) applied the same analytical treatment to predict the movement of Na^+ and Mg^{2+} in $\text{Na}^+-\text{Ca}^{2+}-\text{Mg}^{2+}$ system rather than that

of Na^+ in $\text{Na}^+-\text{Ca}^{2+}$, and that of Mg^{2+} in $\text{Ca}^{2+}-\text{Mg}^{2+}$ system as done by Lai and Jurinak (1972). Lai *et al.* (1978) also used slope of the linear part of the normalized exchange isotherms of Na^+ to calculate the retention factor used in their theoretical analysis. Lai and Jurinak (1971, 1972b) solved the relevant partial differential equation, describing dynamics of ions in soils, numerically to predict the movement of Na^+ and Mg^{2+} in Ca^{2+} saturated soil columns using linear and non-linear exchange functions. They found a fair agreement between the experimental and the calculated results. But such a study on soils from the arid and semi-arid regions such as that of Haryana remains to be done. Needless to mention that this fundamental work has

a great relevance to practical problems associated with the use of poor quality water for irrigation, and reclamation of salt affected soils.

The Parabolic partial differential equation that describes one dimensional flow of cations through soils, is

$$R \frac{\partial x}{\partial t} = D \frac{\partial^2 x}{\partial z^2} - \bar{v} \frac{\partial x}{\partial z} \quad \dots 1$$

where $x [=C/C_0]$, with C as the concentration of the exchanging cation solution (meq cm^{-3}) and C_0 the total concentration of the cations in the solution phase (meq cm^{-3})] is the reduced concentration of the exchanging cation, D is the dispersion coefficient ($\text{cm}^2 \text{h}^{-1}$), $\bar{v}$ is the average pore velocity (cm h^{-1}), z is the distance along the direction of flow (cm), t is time (h), R is the retention factor given by

$$R=1+R_D \quad \dots 2$$

where $R_D [=pQ/\psi C_0]$, with p as the bulk density (g cm^{-3}), Q the cation exchange capacity (meq g^{-1}), and ψ the pore fraction] is called the distribution ratio, f is the slope of the normalized exchange isotherm.

The initial and boundary conditions for the cation movement are

$$\begin{aligned} X(Z, 0) &= 0 & 0 \leq Z \leq L \\ X(0, t) &= 1 & t > 0 \\ \frac{\partial x}{\partial z}(L, t) &= 0 & t > 0 \end{aligned} \quad \dots 3$$

where L is the length of the soil column. After approximating terms in equation (1) by their finite differences and rearranging terms, the following algorithm is obtained for the numerical computation after applying equation (3):

$$\begin{aligned} X_{i, j+1} &= \Delta t \left[\frac{D_0(X_{i,j})}{\Delta Z^2} - \frac{V_0(X_{i,j})}{2\Delta Z} \right] X_{i+1,j} \\ &- \left[\frac{2D_0(X_{i,j})}{\Delta Z^2} - \frac{1}{\Delta t} \right] X_{i,j} \\ &+ \left[\frac{D_0(X_{i,j})}{\Delta Z^2} + \frac{V_0(X_{i,j})}{2\Delta Z} \right] X_{i-1,j} \end{aligned} \quad \dots 4$$

$$\text{where } D_0 = \frac{D}{R}$$

$$\text{and } V_0 = \frac{\bar{v}}{R}$$

D_0 is apparent dispersion coefficient and V_0 is apparent pore velocity, Δt and ΔZ are, respectively, the time and depth increments, i is the depth pivotal point and j is the time pivotal point. Δt and ΔZ were chosen such that $0 < \Delta t / (\Delta z)^2 < \frac{1}{2}$.

The computer programme was written in BASIC 80 and run on Apple II Plus microprocessor.

MATERIAL AND METHODS

Surface soil samples (0-15 cm) with textures of sandy loam collected from Research Farm, Haryana Agricultural University, Hisar and loam from Research Farm, Haryana Agricultural University, Sirsa, were air dried and passed through a 2 mm sieve. Some of the physico-chemical characteristics of these soil samples are given in Table 1.

The plexiglass columns used in this study were of 5 cm inside diameter for loam and 5.6 for sandy loam soil. The columns were packed as uniformly as possible with soil samples to a depth of 25 cm. The uniformity of B.D. was maintained by adding about 100 g soil at a

TABLE 1

Physico-chemical characteristics of the soils and pertinent column parameters

Characteristics/parameters	Sandy loam	Loam
Sand (%)	69	57
Silt (%)	14	25
Clay (%)	17	18
Dispersion coefficient (cm ² /h)	0.97	0.15
Bulk density (g/cm ³)	1.49	1.45
Cation adsorption capacity (meq/g)	0.077	0.125
Pore velocity (cm/h)	1.91	0.60
Pore fraction	0.44	0.47
Total concentration (meq/ml)	0.1	0.1
Column diameter (cm)	5.6	5.0
Column length (cm)	25	25
Total time (h)	16, 24	43, 86
Pore volume (ml)	272, 408	232, 464
Total input volume (pore volume)	1, 1.5	1, 2
Time increment, Δt (h)	.1	.1
Depth increment, Δz (cm)	.5	.5

time, followed by a number (20) of pre-determined tappings with a wooden roller fitted with nails at the bottom. They were saturated with Ca²⁺, by leaching them with 0.1 N Ca (CH₃COO)₂ until steady state was reached both with respect to Ca²⁺ ion and fluid flow rate. This was followed by leaching with 0.1 N CaCl₂, and the effluent was collected at regular intervals. The solution samples so collected were analysed for Cl⁻. The break-through curves (BTCs) representing reduced concentration of Cl⁻ against pore volume of solution collected were used to calculate

dispersion coefficient (D₀) from the following formula

$$D_0 = \frac{V_0 L}{4\pi S^2 V_0^2}$$

where S is the slope corresponding to reduced concentration=0.5, and V₀ is the apparent pore volume. Finally a pre-determined amount (i. e. 1 and 1.5, and 1 and 2 pore volume in sandy loam and loam, respectively) of exchanging solution 0.1 N NaCl was added to the columns. After the solution had infiltrated the columns were sectioned into 10 portions of 2.5 cm each. The soil solution in each section was extracted. The cations in the extracts and the exchangeable cations of the soil samples were determined for each section following standard procedures (Richards, 1954). Some of the pertinent column parameters are given in Table 1.

RESULTS AND DISCUSSION

The normalized exchange isotherms for Na⁺, depicting the relationship between the equivalent ion fractions of Na⁺ in the equilibrium solution (C_{Na}/C₀, with C_{Na} as the concentration of Na⁺ in meq l⁻¹ and C₀ as the total concentration of cations in solution in meq l⁻¹) and of the exchange complex (q_{Na}/Q, with q_{Na} as exchangeable Na⁺ in meq g⁻¹ and Q as the cation exchange capacity in meq g⁻¹), were drawn (Figs. 1 and 2). The isotherms showed that the values of q_{Na}/Q at a given C_{Na}/C₀ increased with the increase in pore volume of solution added. These data suggest that at a given C_{Na}/C₀, the ESP (exchangeable sodium percentage) build-up of soil increased with the increase in

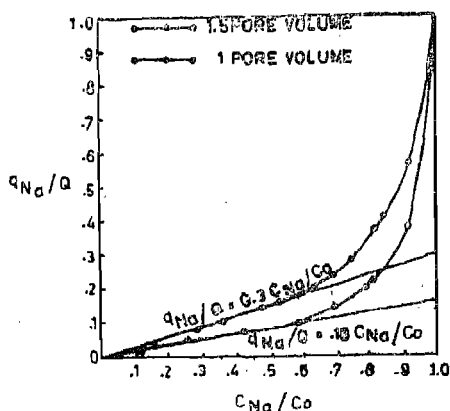


Fig. 1. Normalized exchange isotherms of Na^+ for different pore volumes in sandy loam soil.

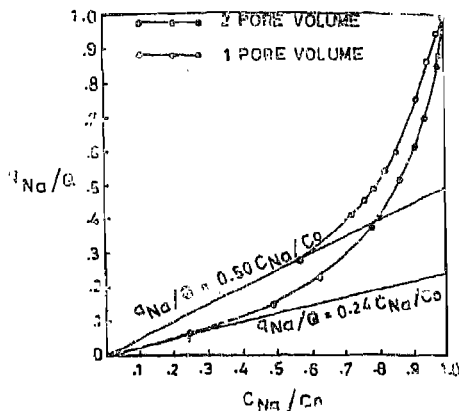


Fig. 2. Normalized exchange isotherms of Na^+ for different pore volumes in loam soil.

pore volume of solution containing the exchanging cation introduced into the soil columns. This is due to the fact that the greater the pore volumes of the exchanging cation solution introduced into the column, the greater would be the time the exchanging cation (Na^+) will get to replace the already present cation (Ca^{2+}) from the exchange complex.

The observed and predicted reduced solution concentrations of Na^+ (C_{Na}/C_0) at different depths for both the soil samples studied are shown in Figs. 3 and 4. The reduced concentration profiles were calculated using constant slopes corresponding to the linear parts near the origin of the normalized exchange isotherms shown in Figs. 1 and 2. There is a large discrepancy between the experimental and the calculated results. The main reasons being that the so called linear part of the normalized exchange isotherms of Na^+ , the slope of which is considered for the calculation of Na^+ reduced concentration vs soil

depth profiles, covers only a small portion of the exchange isotherm.

This approximation of considering the isotherm as linear is valid only either if a trace of the exchanging cation is introduced into the column such that its concentration does not exceed a small fraction of the total concentration, or the soil exchange complex does not exhibit any preference for either of the cations involved in exchange. But, in the present study, neither of the above conditions were fulfilled. The cations participating in the exchange reaction were Na^+ and Ca^{2+} , and the soil exchange complex is known to exhibit higher preference for the divalent cation (Figs. 1 and 2). Further, the solution concentration of the exchanging cation was large enough to cover almost whole of the exchange isotherm.

As is evident from equation (2), the retention of the exchanging cation by the soil exchange complex increases by

TRANSPORT OF SODIUM IN CALCIUM SATURATED SOILS

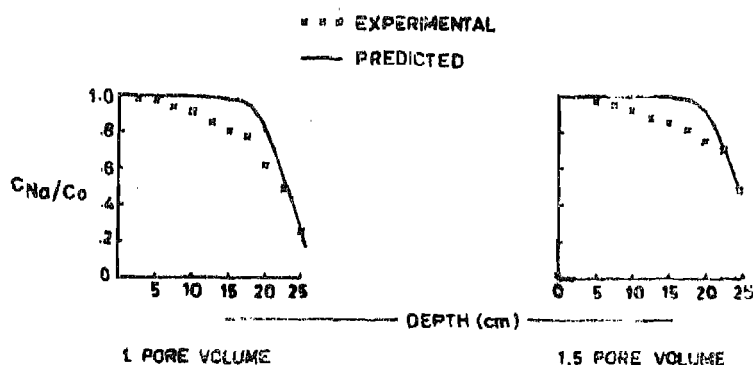


Fig. 3. Experimental and predicted reduced concentration of Na^+ vs soil column depth for different pore volumes in sandy loam soil.

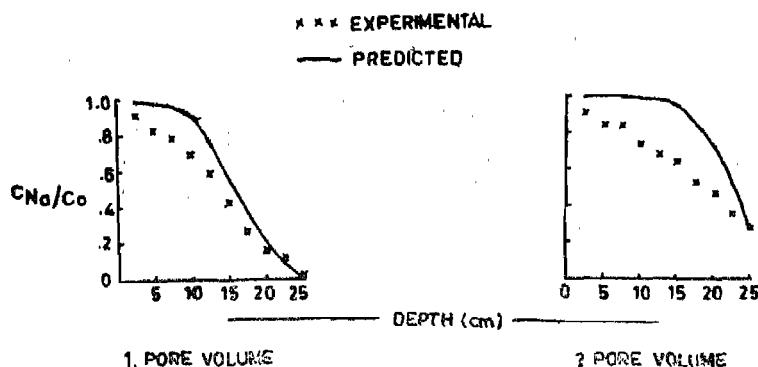


Fig. 4. Experimental and predicted reduced concentration of Na^+ vs soil column depth for different pore volumes in loam soil.

increasing the slope (f), thus, reducing its concentration in the equilibrium solution, and the value of C_{Na}/C_0 . The concave upward part of the exchange isotherms (Figs. 1 and 2) showing less preference of Na^+ as compared to Ca^{2+} by the soil exchange complex, would give higher values of slope with the increase in C_{Na}/C_0 , than the constant value corresponding to the linear part of the isotherm. Therefore, the predicted reduced concentration vs depth profiles of Na^+ lay above the experimental pro-

files, because of the constant slope considered for calculations. The constant slope was much smaller than the actual slopes corresponding to higher C_{Na}/C_0 values. One, however, notices agreement between the experimental and predicted reduced concentration profiles near smaller values of C_{Na}/C_0 , which is self explanatory in view of the fact that for calculation purposes, slope of the linear part of the normalized exchange isotherm of Na^+ was considered.

In conclusion it may be stated that it is a gross over simplification if a constant value of slope pertaining to only the linear part of the exchange isotherm is taken for computation of concentration of the exchanging cation in solution, when the experimental values of C_{Na}/C_0

are large. In such cases variable slopes corresponding to different points on the exchange isotherm should be taken to match the observed and the predicted cation concentrations better. This part is difficult to be included in the computer programme for the time being.

REFERENCES

- Lai, S. and Jurinak, J. J. 1971. Numerical approximation of cation exchange in miscible displacement through soil columns. *Soil Sci. Soc. Am. Proc.* **35** : 894-99.
- Lai, S. and Jurinak, J. J. 1972a. Cation adsorption in one dimensional flow through soils. A numerical solution. *Water Resour. Res.* **8** : 99-107.
- Lai, S. and Jurinak, J. J. 1972b. The transport of cations in soil columns at different pore velocities. *Soil Sci. Soc. Am. Proc.* **36** : 730-33.
- Lai, S., Jurinak, J. J. and Waganet, R. J. 1978. Multicomponent cation adsorption during convective-dispersive flow through soils: experimental study. *Soil Sci. Soc. Am. J.* **42** : 240-43.
- Lindstrom, F. T., Haque, R., Freed, V. H. and Boersma, L. 1967. Theory on the movement of some herbicides in soils, linear diffusion and convection of chemicals in soils. *Environ. Sci. Technol.* **1** : 661-65.
- Pal, R. and Poonia, S. R. 1982. Predictive approaches for solute transport in soils. *J. Scient. Ind. Res.* **41** : 117-30.
- Richards, L. A. 1954. Diagnosis and improvement of saline and alkali soils. USDA Hand Book No. 60.

COMPARATIVE EFFICACY OF SOME SYSTEMIC INSECTICIDES AGAINST SUGARCANE WHITEFLY, *ALEUROLOBUS BARODENSIS* MASK. (HOMOPTERA : ALEURODIDAE)

J. P. CHAUDHARY, S. R. YADAV and J. N. GUPTA

Department of Entomology

Haryana Agricultural University, Hisar

(Received : December 11, 1982; Revised : June 12, 1985)

ABSTRACT

Comparative efficacy of six systemic insecticides, viz. methyl demeton (Metasystox 25 EC), phosphamidon (Dimecron 100 EC), monocrotophos (Nuvacron 40 EC), thiometon (Ekatin 25 EC), formothion (Anthio 25 EC) and dimethoate (Rogor 30 EC) each @ 0.25 and 0.50 kg. a.i./ha alongwith malathion (Cythion 50 EC), a recommended contact insecticide @ 0.5 and 1.0 kg a.i./ha was tested against sugarcane whitefly, *Aleurolobus barodensis* Mask. during October, 1981. The spray material was used @ 1000 l/ha and efficacy of insecticides was evaluated at 4 and 7 days after spraying. In both the trials, spraying of dimethoate and methyl demeton @ 0.5 kg a.i./ha and malathion @ 1.0 kg a.i./ha, gave very high mortality of nymphs and puparia on 7th day.

The sugarcane whitefly, *Aleurolobus barodensis* Mask. is a sporadic pest of sugarcane and occurs from September to November in neglected ratoon crops, taken in water logged fields or under nitrogen deficient conditions. The losses by this pest to the tune of 15-20 per cent in cane yield and 1-2 units in sugar recovery have been reported by Gupta and Nagar (1951). Studies on its chemical control have been in progress since 1954 (Rao, 1954). Two to three sprayings of several contact insecticides viz., BHC, lindane, toxaphene, chlordane, endrin, dieldrin, parathion, malathion and diazinon in their different concentrations have been recommended for the control of this pest by different workers (Basheer, 1956; Khan and Krishnamurthy Rao, 1956; Singh *et al.*, 1956; Siddiqi and Agarwal, 1957; Siddiqi and Saxena,

1960; Sandhu and Singh, 1964). However, information on the efficacy of systemic insecticides which could be more effective than contact insecticides, this being a sucking insect, is scarce. Therefore, during October, 1981 when *A. barodensis* appeared in very serious form in about 3-4 thousand hectares of ratoon crop in Rohtak Sugar Mill Zone, effectiveness of some commonly available systemic insecticides was tested against this pest.

MATERIAL AND METHODS

Efficacy of systemic insecticides (Tables 1 and 2) was evaluated each @ 0.25 and 0.50 kg a.i./ha (0.025 and 0.05 per cent concentration) alongwith malathion, a recommended insecticide @ 0.5 and 1.0 kg a.i./ha (0.05 and 0.1

per cent concentration) against *A. barodensis*, as compared with unsprayed control plots. Two experiments were conducted in sugarcane fields heavily infested with whitefly in Sugar Mill Zone of Rohtak, during October, 1981. In all, there were 15 treatments including control (Table 1), each replicated thrice, in plots of 50 × 4 m size, in each of the two experimental fields. The spray material was used @ 1000 l/ha. The effectiveness of the insecticides was evaluated by counting second stage nymphs to the puparial stage of whitefly, a day before and 4 and 7 days after spraying of the insecticides. From each plot 10 leaves were taken, one each from 10 randomly selected plants. From each selected plant, the 5th opened leaf from the top which had maximum nymphs and puparia, was taken for this purpose. On each leaf, observations were taken from 3 different places, i.e. from lower, middle and top portions of leaf by counting only the living nymphs and puparia from 4 sq. cm leaf area at one place, with the help of 2 × 2 cm square windows cut in paper strips. All the living nymphs from second stage onward to the puparial stage available on these portions were then counted. The viability of nymphs and puparia was judged by pinprick method (Siddiqi and Saxena, 1960) i.e. all those nymphs and puparia which gave yellowish fluid on pricking by the needle were only considered as living. The percentage reduction in population of living nymphs and puparia was assessed by comparing reduction in population 4 and 7 days after spraying, with the original population recorded before spraying of the insecticides.

RESULTS AND DISCUSSION

The data presented in Table 1 show that in both the experimental fields, there was heavy incidence of whitefly as the average number of living nymphs and puparia in the first and second fields varied from 31.3 to 69.3 and 96.0 to 125.3 per 40 sq. cm leaf area, respectively. The differences in population of nymphs and puparia in different treatments before the spraying of insecticides were non-significant, indicating that the population of the pest was homogenous in both the fields.

Reduction in the Population of Nymphs and Puparia within 4 Days of Spraying

In the first experiment (Table 1), the highest reduction in population of living puparia (89.5%) was recorded in dimethoate 0.5 kg a.i./ha which was significantly higher than all the remaining treatments within 4 days of its spraying. The other effective treatments were dimethoate @ 0.25 kg a.i./ha, malathion @ 1.0 kg a.i./ha, and methyl demeton, phosphamidon and formothion each @ 0.5 kg a.i./ha, giving 78.9 to 83.4 per cent reduction in the pest population. In the remaining eight insecticidal treatments, the reduction in the pest population was low (22.2 to 72.7%), the lowest being in monocrotophos @ 0.25 kg a.i./ha.

In the second trial also (Table 1) the highest reduction (95.0%) in insect population was recorded in dimethoate when applied @ 0.5 kg a.i./ha, followed by malathion @ 1.0 kg a.i./ha (94.3%),

EFFICACY OF INSECTICIDES AGAINST SUGARCANE WHITEFLY

TABLE 1
Comparative efficacy of different insecticides against *A. barodensis*

Treatments	Dose (kg a.i./ha)	First experiment		Second experiment	
		Initial population (Nymphs & puparia/ 40 cm ² leaf area)	Per cent reduction in population (days after spraying)	Initial population (Nymphs & puparia/ 40 cm ² leaf area)	Per cent reduction in population (days after spraying)
		4	7	4	7
1. Methyl demeton	0.25	63.3	70.4(57.13)	98.3	83.5(66.07)
2. Methyl demeton	0.50	55.0	84.3(68.77)	106.3	90.0(72.07)
3. Phosphamidon	0.25	49.0	63.5(52.85)	120.7	78.6(62.46)
4. Phosphamidon	0.50	57.7	79.0(62.73)	119.0	83.2(65.84)
5. Monocrotophos	0.25	33.0	22.2(28.12)	110.0	47.6(43.62)
6. Monocrotophos	0.50	37.3	44.4(41.76)	114.3	69.5(56.48)
7. Thiometon	0.25	44.7	69.8(56.68)	118.3	85.9(69.00)
8. Thiometon	0.50	35.3	71.2(57.78)	116.3	88.7(70.41)
9. Formothion	0.25	69.3	72.7(58.54)	117.3	84.9(67.21)
10. Formothion	0.50	53.3	78.9(62.74)	119.3	87.8(69.61)
11. Dimethoate	0.25	47.0	83.8(66.28)	103.0	89.7(71.35)
12. Dimethoate	0.50	52.3	89.5(71.21)	125.3	95.0(77.15)
13. Malathion	0.50	31.3	68.9(56.72)	115.3	88.7(70.43)
14. Malathion	1.00	36.0	83.7(66.24)	103.0	94.3(76.34)
15. Control	—	36.3	9.4(17.78)	96.0	13.6(21.63)
C.D. at 5%		NS	(4.90)	NS	(3.31)
			(2.87)		(3.24)

Values in parentheses are means of angular transformation.

and mortality in these two treatments was significantly higher than in all the other treatments. The next group of effective treatments with high mortality ratios comprised methyl demeton, dimethoate, malathion, thiometon, formothion each @ 0.5 kg a.i./ha and formothion @ 0.25 kg a.i./ha giving 85.9 to 90.0 per cent mortality as compared to only 13.6 per cent in control (Table 1). The mortality was lowest in monocrotophos treated plots.

When efficacy of different treatments was evaluated on the basis of pooled data of both the experiments (Table 2), the highest mortality of 92.2% was recorded in dimethoate @ 0.5 kg a.i./ha which was significantly superior to all the remaining treatments except malathion @ 1.0 kg a.i./ha in which average mortality was 89.1 per cent. The next effective treatments on the basis of pooled data were methyl demeton and formothion each @ 0.5 kg a.i./ha and dimethoate @ 0.25 kg a.i./ha giving average mortality from 83.4 to 87.4 per cent.

Reduction in the Population of Nymphs and Puparia within 7 Days of Spraying

When efficacy of these insecticidal treatments was adjudged 7 days after spraying of insecticides, the highest reduction in living nymphal and puparial population (94.3%) in the first experiment was in dimethoate @ 0.5 kg a.i./ha which was significantly higher than all other treatments (Table 1). The other best treatments were methyl demeton @ 0.5 kg a.i./ha, malathion @ 1.0 kg a.i./ha and dimethoate @ 0.25 kg a.i./ha. These treatments were significantly

superior to other 11 treatments including control except formothion 0.5 kg a.i./ha which was at par with dimethoate @ 0.25 kg a.i./ha.

In the second experiment (Table 1), malathion @ 1.0 a.i./ha and dimethoate @ 0.5 kg a.i./ha proved to be equally effective and best treatments, giving 96.4 and 96.0 per cent kill of the insect, respectively. The next best treatments in this experiment were methyl demeton, malathion and thiometon each @ 0.5 kg a.i./ha and dimethoate @ 0.25 kg a.i./ha and were superior to remaining eight insecticidal treatments. Mortality in both the doses of formothion, thiometon @ 0.5 kg a.i./ha and methyl demeton @ 0.25 kg a.i./ha was also high.

When all these treatments were evaluated on the basis of pooled data of both the experiments (Table 2), the reduction of nymphal and puparial population in dimethoate @ 0.5 kg a.i./ha and malathion @ 1.0 kg a.i./ha was found to be maximum followed by methyl demeton @ 0.5 kg a.i./ha and dimethoate @ 0.25 kg a.i./ha. In all the above four treatments, the pooled mortality was above 90 per cent. In both the doses of monocrotophos, the mortality was very low (42.1 and 65.9 per cent).

Comparing overall efficacy of different treatments, dimethoate and methyl demeton each @ 0.5 kg a.i./ha and malathion @ 1.0 kg a.i./ha not only gave effective mortality (87.4 to 92.2%) within 4 days but also gave highest pooled mortality (92.1 to 95.2%) within 7 days of their spraying. Higher doses of the insecticides gave better mortality than their

EFFICACY OF INSECTICIDES AGAINST SUGARCANE WHITEFLY

TABLE 2

Comparative efficacy* of different insecticides against *A. barodensis*

Treatments	Dose (kg a.i./ha)	Per cent reduction in population (days after spraying)		Cost of insecticide (Rs./ha)
		4	7	
Methyl demeton	0.25	77.0(61.40)	82.5(65.30)	87.0
Methyl demeton	0.50	87.1(69.29)	92.1(73.79)	174.0
Phosphamidon	0.25	71.1(57.46)	77.1(61.43)	47.5
Phosphamidon	0.50	81.1(64.24)	85.2(67.41)	95.0
Monocrotophos	0.25	34.9(36.23)	42.1(40.45)	112.5
Monocrotophos	0.50	57.3(49.20)	65.9(54.25)	225.0
Thiometon	0.25	77.9(61.96)	83.2(65.81)	82.0
Thiometon	0.50	80.0(63.55)	85.0(67.18)	164.0
Formothion	0.25	78.8(62.63)	85.7(67.82)	92.8
Formothion	0.50	83.4(66.01)	87.5(69.39)	185.6
Dimethoate	0.25	86.8(68.71)	90.2(71.82)	72.5
Dimethoate	0.50	92.2(73.92)	95.2(77.52)	145.0
Malathion	0.50	78.8(62.59)	86.5(68.50)	86.0
Malathion	1.00	89.1(70.00)	92.8(75.77)	172.0
Control	—	11.5(19.80)	14.3(22.19)	—
C.D. at 5%	—	(3.40)	(2.58)	—

*Based on pooled data of two experiments.

lower doses in almost all the treatments. Both the doses of monocrotophos proved ineffective in reducing population of the whitefly. Malathion, a less hazardous contact insecticide, which was earlier recommended for the control of this pest (Singh *et al.*, 1956; Siddiqi and Saxena, 1960), gave very effective control in these experiments also.

Considering overall effectiveness and the cost of various treatments, dimethoate @0.5 kg a.i./ha (Rs. 145/ha), and methyl demeton @ 0.5 kg a.i./ha (Rs. 174/ha)

were found as effective as malathion @ 1.0 kg a.i./ha (Rs. 172/ha) and can also be recommended for the control of this pest.

ACKNOWLEDGEMENTS

The authors are highly grateful to Dr. S. S. Verma, Chief Scientist (Sugarcane) and Dr. R. S. Hooda, Cane Development Officer, Haryana Cooperative Sugar Mills Ltd., Rohtak, for providing facilities.

REFERENCES

- Basheer, M. 1956. Note on the whitefly (*Aleurolobus barodensis* Mask.) and its control in Madras State. *Madras agric. J.* **43** : 117-20.
- Gupta, B. D. and Nagar, D. S. 1951. A note on the effect of whitefly (*Aleurolobus barodensis* M.) infestation on the quality and yield of plant and ratoon crop of sugarcane. *Agric. Anim. Husb. J. U. P.* **1**(2) : 27-32.
- Khan, M. Q. and Krishnamurthy Rao, B. H. 1956. Trials with endrin, folidol, DDT and BHC for the control of *Aleurolobus barodensis* M. (Sugarcane whitefly) in Hyderabad State. *Indian Sug.* **6** : 509-12.
- Rao, G. N. 1954. Preliminary experiments with certain insecticides in the control of sugarcane whitefly, *Aleurolobus barodensis* Mask. Proc. 2nd Bien. Conf. Sug. Res. Dev. Workers India. pp. 188-93.
- Sandhu, J. S. and Singh, Sardar. 1964. Studies on the control of sugarcane whitefly, *Aleurolobus barodensis* M. in Punjab. *Indian J. Sugarcane Res. Dev.* **8** : 361-66.
- Siddiqi, Z. A. and Agarwal, R. A. 1957. Trial of some organic insecticides on sugarcane whitefly in UP. Proc. 3rd All India Conf. Sug. Res. Dev. Workers. **2** : 300-11.
- Siddiqi, Z. A. and Saxena, A. P. 1960. Studies on the control of sugarcane whitefly and the effect of its infestation on juice quality. *Indian J. Ent.* **22** : 99-104.
- Singh, H., Kalra, A. N. and Sandhu, J. S. 1956. Sugarcane whitefly, *Aleurolobus barodensis* Mask. and its control. *Indian Sug.* **5** : 689-96.

RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XV, No. 4, pp. 463—464 (December 1985)

PREVALENCE OF PIGEON-PEA CYST NEMATODE, *HETERODERA CAJANI* KOSHY, 1967 IN BHIWANI DISTRICT (HARYANA) ALONGWITH A NEW HOST RECORD

R. K. WALIA, HARISH K. BAJAJ and D. C. GUPTA

Department of Nematology

Haryana Agricultural University, Hisar

(Received : January 2, 1984; Revised : July 12, 1984)

Pigeon-pea cyst nematode, *Heterodera cajani* Koshy, 1967 is known to attack mostly the leguminous crops. Koshy (1967) reported *Cajanus cajan*, *Glycine max*, *Phaseolus calcaratus*, *Pisum sativum*, *Vicia sativa*, *Vigna aconitifolia*, *V. mungo*, *V. radiata* and *V. sinensis* as susceptible to *H. cajani*. Koshy and Swarup (1972) added *Cicer arietinum*, *Dolichos biflorus*, *D. lablab*, *Phaseolus lathyroides*, *Sesamum indicum* and *Vicia narbodensis* to the list of its hosts. Since then, guar (*Cyamopsis tetragonoloba*) and Dhaincha (*Sesbania aculeata*) have been reported as hosts of this nematode from Haryana (Bhatti and Gupta, 1973; Dalal and Bhatti, 1983).

During an intensive survey of Bhiwani district for cyst nematodes associated with various crops, sunhemp (*Crotalaria juncea* L.) was found to be infested with *Heterodera cajani* on roots as well as in

soil. Sixteen cysts full of eggs and egg masses were recovered per 250 cc soil. This is a new record for this nematode. Koshy and Swarup (1972) had reported sunhemp (var. IC 7547 and IC 45) as non-host. The present observations may be due to varietal differences.

Besides sunhemp, *H. cajani* cysts were recorded on other leguminous crops also including guar (*Cyamopsis tetragonoloba*), green gram (*Vigna radiata*), black gram (*V. mungo*) and arhar (*Cajanus cajan*). Guar which is the main kharif crop in this area showed the highest incidence (41%) of this nematode. The number of cysts amounted to as high as 60 per 250 cc soil. The presence of such high populations on guar indicates that it is a very good host for this nematode and warrants further investigations.

REFERENCES

- Bhatti, D. S. and Gupta, D. C. 1973. Guar an additional host of *Heterodera cajani*. *Indian J. Nematol.* **3** : 160.
Dalal, M. R. and Bhatti, D. S. 1983. Dhaincha (*Sesbania aculeata*) an additional host of

- Heterodera cajani* Koshy, 1967. (Abstr.). Third All India Nematology Symposium held at Himachal Pradesh Krishi Vishva Vidyalaya, Solan, May 24-26, 1983. p. 10.

WALIA ET AL.

- Koshy, P. K. 1967. A new species of *Heterodera* from India. *Indian Phytopath.* **20**: 272-74.
- Koshy, P. K. and Swarup, G. 1972. Susceptibility of plants to pigeon pea cyst nematode, *Heterodera cajani*. *Indian J. Nematol.* **2**: 1-6.

RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XV, No. 4, pp. 465—466 (December 1985)

REACTION OF POTATO VARIETIES AND HYBRIDS TO EARLY BLIGHT DISEASE

M. S. CHAUHAN

Department of Plant Pathology
Haryana Agricultural University, Hisar

(Received : January 31, 1984; Revised : March 6, 1985)

Early blight of potato caused by *Alternaria solani* (Ell. and Mart.) Jones and Grouet is a widespread and economically important foliage disease of potato crop in the hills and plains of India. The most effective control of the disease lies in the cultivation of resistant varieties. Field resistant varieties, mostly of foreign origin, were first identified by Stuart (1914). Previously, the method most commonly employed in assessing the reaction of potato varieties involved inoculation of the whole plant either in the field or in the greenhouse (Gerhold, 1957; Hooker and Fronek, 1960; Prasad and Dutt, 1971; Frank *et al.*, 1979). Keeping in view, the intensity of the problem, a field screening project was initiated to identify the resistance source(s).

The experiment was carried out at the Experimental Research Area, Haryana Agricultural University, Hisar, during 1973-75. Thirty cultivars/hybrids were sown in the first week of October in randomized block design with four replications. As far as possible identical agronomical conditions were maintained during the conduct of the experiment.

Ten plants from each replication were randomly tagged for observations.

In order to obtain uniform and comparable results, the leaves of each cultivar/hybrid were inoculated with a spore suspension counting 400-500 spores/ml of water after 15 days of sowing (Douglas and Pavek, 1972). Three observations (first at the just initiation of the disease, second at 20 days interval and third just before harvesting) were recorded on the disease incidence. The development and severity of infection were studied on the basis of per cent infected leaves, number and size of the lesions. The size of the lesion was determined by measuring the diameter of the individual spots by using the modified Horsfall-Barratt (1945) scale.

The data presented in Table 1 revealed that out of thirty cultivars/hybrids screened against *A. solani*, none was found immune while only 10 viz., A 2349, C 3721, E 4451, E 7349, E 4960, F 2426, JC 7241, JE 236, UB 8 and 5 (a) were found resistant. Prasad and Dutt (1971) have also assessed the reaction of potato varieties against this disease and found

TABLE 1
Reaction of potato varieties/hybrids to *Alternaria solani**

Disease reaction	Varieties/Hybrids
Immune (0)	Nil
Resistant (0.1—10%)	A 2349, C 3721, E 4451, E 7349, E 4960, F 2426, JC 7241, JE 236, UB 8 and 5 (a)
Moderately susceptible (10.1—30%)	B 54, B 5765, C 697 (5a), C 990, G 2703, Kufri Chandermukhi and Kufriflankar
Susceptible (30.1—50%)	CE 91, E 3349, PM/B 39, EM/B 59, EM/C 1242, JE 431, JE 808, Kufri Sheetman and Kufri Sindhuri
Highly susceptible (above 50%)	A 7416, E 3795 (5a), EM/BPI and EM/D 859

*Average of two year (1973-75) observations.

Kufri Sindhuri as moderately resistant while in the trial conducted here, this variety falls under susceptible category, whereas C 990 was in the same category at both the places. There are many factors which play a vital role in the disease development and it is possible that due to these factors this variety showed different reactions. Moreover, these varieties have been tested at two entirely different agro-climatic locations.

Resistance of some of the genetic stock can also be utilized as a source of resistance for breeding resistant varieties/

hybrids of *A. solani*. The susceptible varieties/hybrids, on the other hand can also be indirectly helpful in creating the natural epidemics in the field by increasing the inoculum potential.

ACKNOWLEDGEMENTS

Thanks are due to Dr. R. K. Grover and Dr. Kirti Singh, former Prof's and Head, Department of Plant Pathology and Department of Vegetable Crops, respectively for providing necessary facilities, guidance and keen interest during the present study.

REFERENCES

- Douglas, D. R. and Pavsek, J. I. 1972. Screening potatoes for field resistance to early blight. *Am. Potato J.* **49** : 1-6.
- Frank, J. A., Webb, R. E. and Douglas, D. R. 1979. Evaluation of several USDA potato clones for resistance to early blight. *Plant Dis. Rep.* **63** : 392-94.
- Gerhold, N. R. 1957. Artificial field inoculation of potato with *Alternaria solani*. *Plant Dis. Rep.* **41** : 135.
- Hooker, W. J. and Fronek, F. R. 1960. The influence of virus Y infection on early blight susceptibility in potato. *Proc. 4th Int. Conf. Potato Virus Diseases* **12** : 175.
- Horsfall, J. G. and Barratt, R. W. 1945. An improved grading system for measuring potato disease. *Phytopathology* **35** : 655 (Abstr.).
- Prasad, B. and Dutt, B. L. 1971. Laboratory assessment of the reaction of potato varieties to *Alternaria solani*. *Indian J. Microbiol.* **11** : 91-96.
- Stuart, W. 1914. Disease resistance of potato. Third Report. *Vermont Agric. Exp. Stn. Bull.* **169** : 147-83.

RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XV, No. 4, pp. 467—470 (December 1985)

COMBINING ABILITY AND GENETIC ARCHITECTURE OF OIL CONTENT IN INDIAN MUSTARD

S. K. GUPTA, S. K. THAKRAL, T. P. YADAVA and PARKASH KUMAR

Department of Plant Breeding

Haryana Agricultural University, Hisar

(Received : March 6, 1984; Revised : November 9, 1984)

In Indian mustard, very limited efforts have been made to know the genetic architecture of oil content. Therefore, the present study was initiated to estimate the combining ability of parents alongwith the nature and magnitude of genetic variances involved in the inheritance of oil content.

The material comprising nine genotypes viz., RH-30, Prakash, Yellow Rai K-1, RH-785, RC-1426, RC-1425, RH-780, RC-423 and RC-781 were hybridized in a half diallelic fashion. The observed progenies including parents and F_1 's were sown in a randomised block design with three replications. At the time of harvest, bulk seed of five randomly selected plants was utilised to estimate the oil content as per specifications outlined in AOAC (1961). In order to know the existence and magnitude of additive and non-additive genetic components, the data were analysed as per models suggested by Griffing (1956) method 2 model I, and Hayman (1954).

The analysis of variance for combining ability (Table 1) indicated that mean squares due to general and specific combining ability were significant for oil

TABLE 1

Analysis of variance for combining ability for oil content in Indian mustard

Source	df.	Mean sum of squares
General combining ability	8	12.81**
Specific combining ability	35	4.03**
Error	88	0.092
σ^2_g	1.16	
σ^2_s	3.94	
σ^2_{s/σ^2_g}	3.39	

**Significant at $P=0.01$.

content. The ratio σ^2_s/σ^2_g estimated to be 3.39 revealed the preponderance of non-additive genetic variances for the inheritance of oil content in Indian mustard. In spite of higher magnitude of non-additive genetic components, the possibility of presence of additive genetic variance cannot be ruled out though in lower magnitude. Yadava and Gupta (1975) also revealed the importance of both fixable and non-fixable components of genetic variances for the inheritance of oil content in Indian mustard. But contrary to the present and that of Yadava and Gupta (1975) findings, Grami and Stefansson (1977) concluded that oil content is exclusively under the control

of additive genetic component in summer rape.

The genetic component analysis indicated that D—the additive component, and H_1 —the dominance component were significant suggesting thereby the presence of both the components (Table 2). But, the magnitude of dominance component was much higher which was further confirmed when the ratio $(H_1/D)^{\frac{1}{2}}$ measuring the average degree of dominance falls in the range of over dominance as it attained the value 1.68. The ratio $H_2/4H_1$, measuring the symmetry of positive and negative genes exhibited the value 0.18, which showed its deviation from the theoretical value of 0.25 indicating thereby the asymmetry of genes among parents for the character under study. Further, the statistics $(4DH_1)^{\frac{1}{2}} + F/(4DH_1)^{\frac{1}{2}} - F$ showed that for every one recessive gene affecting oil content in Indian mustard there were minimum two dominant genes. The ratio h^2/H_2 was observed to be underestimated mainly because of the presence of

complementary genes. The heritability in narrow sense was 34.72 which indicated the possibility of utilizing conventional breeding methodologies for the exploitation of additive genetic variance.

The perusal of data presented in Table 3 indicated that a parent RH-785 possessed highest gca effects and was, therefore, categorised as best. It was further followed by other parents viz., RC-781, RH-780 and Prakash in descending order. These parents can effectively be utilized in future breeding programmes aiming at the improvement of oil content in Indian mustard. Further, the results with respect to specific combining ability effects revealed that 15 crosses exhibited positive sca effects. Out of these, 11 crosses (Table 3) resulted from one good combining parent, whereas the other three crosses possessed both the good combining parents. The remaining one cross RC-1426 × RC-1425 was the resultant of poor general combiners. The high sca effects of this cross might have arisen purely due to the presence of genic interactions. The high or low sca effect of a particular cross combination depends upon whether the parental performance is low or high.

TABLE 2
Estimates of genetic components and their ratios for oil content in Indian mustard

	Components	Ratios	
D	$6.74^* \pm 1.50$	$(H_1/D)^{\frac{1}{2}}$	1.68
H_1	$18.98^* \pm 3.30$	$H_2/4H_1$	0.18
H_2	13.96 ± 2.84	$(4DH_1)^{\frac{1}{2}} + F$	1.84
h^2	0.92 ± 1.90	$(4DH_1)^{\frac{1}{2}} - F$	
F	6.66 ± 3.49	h^2/H_2	0.07
E	0.092 ± 0.473	$h^2(n.s.)$	34.72

*Significant at $P=0.05$.

It is very interesting to conclude that all the genetical analysis i. e. combining ability and component analysis have laid out the importance of both the genetic components though the magnitude of non-additive genetic variance is higher as compared to additive genetic variance. Therefore, a breeding procedure which takes into consideration both the genetic components (i. e. additive and non-additive), would be suited for their

TABLE 3
Estimates of general (diagonal) and specific (above diagonal) combining ability effects for oil content in Indian mustard

Parents	RH-30	Prakash	Yellow Rai K-1	RH-785	RC-1426	RC-1425	RH-780	RC-423	RC-781
RH-30	—0.075	—1.623	—0.502	0.848*	—0.264	—1.062*	—0.488	—1.276*	2.316*
Prakash		0.337*	1.357*	—1.041*	2.751*	1.937*	1.363*	—4.128*	—1.822*
Yellow Rai K-1			—2.618*	1.671*	3.595*	—0.562	—2.292*	—2.266*	—1.118*
RH-785				1.113*	—3.929*	—1.929*	1.070*	1.543*	0.442
RC-1426					—0.105*	0.972*	2.408*	—0.302	1.636*
RC-1425						0.065	0.771	0.020	—0.531
RH-780							0.522*	1.167*	1.552*
RC-423								—0.130	1.771*
RC-781									0.891
	S.E.(gt) = .085			S.E.(sj) = 0.13			S.E.(sij-sik) = 0.41		

*Significant at $P=0.05$.

simultaneous exploitation. It appears content by breaking the undesirable that biparental mating of selects is likely linkage of seed yield and oil content. to bring improvement for yield and oil

REFERENCES

- AOAC. 1961. Official Methods of Analysis. Association of Official Agricultural Chemists, Washington, DC.
- Grami, B. and Stefansson, B. R. 1977. Gene action for protein and oil content in summer rape. *Can. J. Plant Sci.* **57** : 625-31.
- Griffing, B. 1956. Concept of general and specific combining ability in relation to diallel crossing system. *Aust. J. biol. Sci.* **9** : 463-93.
- Hayman, B. I. 1964. The theory and analysis of diallel crosses. *Genetics* **39** : 789-809.
- Yadava, T. P. and Gupta, V. P. 1975. Heterosis and genetic architecture for oil content in mustard. *Indian J. Genet.* **35** : 143-55.

RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XV, No. 4, pp. 471—472 (December 1985)

CARCELIA SP. PARASITISING *SPILOSOMA OBLIQUA* (WALKER)

V. K. KALRA

Department of Plant Breeding (Oilseeds Section)
Haryana Agricultural University, Hisar

(Received : March 7, 1984; Revised : July 20, 1984)

During **kharif** 1980 and 1981, sesame (*Sesamum indicum*) crop was heavily damaged by the hairy caterpillar, *Spilosoma* (*Diacrisia*) *obliqua* (Walker). The caterpillars of this pest were collected from fields and reared in the laboratory. Some of these larvae were found parasitised. The flies of a parasite, which emerged in the rearing cages, were got identified to be *Carcelia* sp. (Tachinidae : Diptera).

These studies were extended with a view to estimate the extent of parasitisation. Eight batches of 50 larvae each were collected from field during August to December and reared in laboratory. The extent of parasitisation was found to be 16 per cent. However, the parasitoid emerged only from the larvae collected during October to December. In most cases only one parasitoid emerged from a caterpillar (Fig. 1), but in some cases two maggots in single caterpillar were also noticed.

It was observed that the first and second instar caterpillars of *S. obliqua* served as the most suited stage to the parasitoid. In later stages of the host caterpillar, the parasitoid either died premature or could not complete the life cycle.

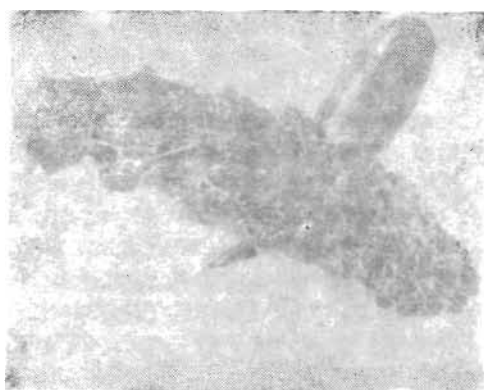


Fig. 1. Caterpillar of *Spilosoma* (*Diacrisia*) *obliqua* parasitised by *Carcelia* sp.

Earlier, the parasitisation of *D. obliqua* by *Carcelia* sp. has been reported by Battu and Dhaliwal (1976). This parasitoid may prove a potential factor in suppressing the population of this polyphagous pest, if manipulated.

ACKNOWLEDGEMENTS

The author is thankful to the Project Leader and Head, Department of Plant Breeding for providing the facilities and Mr. K. M. Harris of the Commonwealth Institute of Entomology, London, for identifying the insect.

KALRA

REFERENCE

- Battu, G. S. and Dhaliwal, G. S. 1976. *Carcelia* sp. (Tachinidae : Diptera) as a parasite of *Diocrisia obliqua* (Walker) in Punjab. *Curr. Res.* **5** : 122-23.

RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XV, No. 4, pp. 473—474 (December 1985)

RECORD OF ISABGOL WILT FROM HARYANA

NARESH MEHTA, R. L. MADAAN and D. P. THAKUR

Department of Plant Pathology
Haryana Agricultural University, Hisar

(Received : August 8, 1984; Revised : January 24, 1985)

Isabgol (*Plantago ovata* Forsk.) is a medicinally important crop grown in arid regions of India. Isabgol is a good source of mucilage for pharmaceuticals such as stabilizers and laxatives. A serious wilt disease was observed from Haryana Agricultural University Research Area of Medicinal and Industrial Plants Section, Hisar, during 1982-83 crop season. Although wilt disease of Isabgol incited by *Pythium ultimum* and *Fusarium oxysporum* has been reported earlier from U. S. A. (Russell, 1975; Chastagner *et al.*, 1978) this has been reported for the first time from Haryana.

The first symptom of wilt occurs on the outer leaves by change in leaf colour from green to silver and sudden death of the plants takes place. Affected leaves become prostrate within 2-3 days after incipient wilting. Roots of the wilted plants showed a black discolouration which gradually progressed from the root tip towards the collar region. Such roots on split out showed internal black to brown discolouration. Present study embodies the characters and identification of fungi found responsible for the cause of the disease.

Isolations were made from naturally infected plants grown in the field for

breeding programme on Czapek's medium. The culture tubes were placed in incubator at $25 \pm 1^\circ\text{C}$ for 5 days and the fungus was purified by single spore technique. The two fungi were isolated from the infected roots and for identification, the culture tubes were sent to the CMI, England and have been identified as *Fusarium solani* (Mart.) Sacc (IMI 277584) and *Fusarium oxysporum* schlecht. (IMI 277585).

F. solani produces extensive cottony mycelial growth with light pinkish pigmentation, micro conidia unicellular, hyaline produced from long lateral phialides measuring 136.5μ . Conidia are 1-3 septae, hyaline, sickle shaped measuring $7.5-37.5 \times 3.7-7.5 \mu$ in size.

F. oxysporum produces cottony mycelial growth with light yellow pigmentation, micro conidia unicellular, hyaline, measuring $2.7-12.0 \times 2.7-3.5 \mu$ in size, whereas macro-conidia are 1-3 septae, spindle, sickle and oval shaped measuring $10.7-42.5 \times 2.7-4.5 \mu$ in size.

Pathogenicity of both the fungi was tested separately in pots in greenhouse. Ten days old culture (500 mg) grown on Czapek's broth medium was added in the

plastic pot containing 1.5 kg sterilized soil. The sowing was done after 24 h of inoculation of fungus in the pot. The earliest symptom was observed after 10 days of sowing and complete wilting of the plants occurred within two weeks. The pathogen reisolated from the wilted plants resembled the test fungus separately. Rotting developed at the collar region of roots revealing the chara-

cteristic feature of *Fusarium* to infect the hypocotyl region.

ACKNOWLEDGEMENTS

The authors are thankful to Dr. C. Booth, CMI, Kew, for identifying the fungi and also to the Prof. & Head, Department of Plant Pathology, for providing necessary facilities.

REFERENCES

- Chastagner, G. A., Ogawa, J. M. and Sammetak, P. V. 1978. Causes and control of damping off of *Plantago ovata*. *Plant Dis. Rep.* **62** : 929-32.
- Russell, T. E. 1975. *Plantago* wilt. *Phytopathology* **65** : 359-60.

ATTITUDE OF MEDICAL PRACTITIONERS TOWARDS NUTRITION

NEERAJ SUNEJA and C. M. BHAT

Department of Foods and Nutrition

Haryana Agricultural University, Hisar

(Received : April 16, 1984; Revised : July 4, 1985)

ABSTRACT

The study was conducted on both government and private doctors of Hisar district using the questionnaire-cum-interview method. Majority of doctors had a strongly favourable attitude towards nutrition teaching in medical schools and necessity for nutrition education for good health, considering nutritional advice as important as prescribing a medicine. Doctors lacked confidence in their nutrition knowledge and were uncertain about their ability to advise patients on nutritional care. Therefore, nutrition education component be strengthened in the medical curriculum to enable doctors to achieve good nutrition and health for the communities being served by them.

The responsibilities of the medical doctors as an informal nutrition educator and the place of nutrition education in the medical curriculum are the topics of great interest to the nutritionists and other health professionals. The ability of physicians to advise and treat their patients with nutritional problems has been subjected to increasing criticism from within the medical profession (Wen *et al.*, 1973; Butterworth, 1974; Coursin, 1974). As under-nutrition and mal-nutrition are the most serious human health and social problems that affect vast areas of the world, it is imperative that our doctors are well versed in human nutrition to be able to impart sound nutrition knowledge to their patients and the communities served by them.

Lack of sufficient nutrition courses in medical curriculum on one hand and the increasing demand of doctors to serve as nutrition educators on the other hand

are causing great concern. As the doctors are in a privileged position to impart nutrition education, there is an urgent need to ensure that medical doctors have sufficient knowledge of nutrition and that they have a positive attitude towards nutrition in relation to health.

In a study conducted by Vickstrom and Fox (1976) it was observed that in general the nurses had a favourable attitude towards nutrition. Although their knowledge was adequate, they lacked confidence in that knowledge. Older nurses had a more favourable attitude but were less knowledgeable than younger ones. The more knowledgeable nurses had more positive attitude towards their own role in nutrition education. However, there are no data on the attitude of physicians towards nutrition. The present investigation was, therefore, undertaken to study the attitude of medical doctors towards nutrition and their role in nutrition education.

MATERIAL AND METHODS

The questionnaire included statements regarding the role of nutrition in health and disease, inclusion of nutrition education in medical curriculum, ability of the doctors to treat patients for their nutritional problems and role of medical doctors in nutrition education. The statements were framed using Edward's (1957) informal criteria for attitude item construction. The statements were pre-tested on a group of ten medical doctors. The questionnaire was sent by mail to all the medical practitioners of Hisar district with M.B.B.S. as their basic qualification, followed by a personal interview and discussion. Necessary modifications were made in the schedule and a final questionnaire containing 15 statements was prepared. A five category continuum from strongly agree to strongly disagree was chosen. Majority of attitude statements were framed in a favourable direction anticipating that most of the doctors would agree with the statements. A few attitude statements were written in an unfavourable direction and the respondents were expected to disagree with them. A total of 70 government and 50 private medical practitioners responded to the questionnaire. The responses to the questionnaire were scored using rank correlation by split-half method.

RESULTS AND DISCUSSION

Personal Variable Matrix of Respondents

Majority of doctors who responded to the questionnaire were M. B. B. S., employed in hospitals and were in the

age group of 30-39 years having 5-9 years of working experience to their credit. Eightyseven per cent of government and 94% of private doctors had medical practice as a career in their first choice. No doctor was a member of Nutrition Society of India, although majority of both government and private doctors were interested to become active members. Most of the doctors in the study had no publication of their own but used 'interaction with medical representatives' and 'reading latest books and journals' as the most common mode of keeping abreast of the latest developments in the field of nutrition.

Regarding the extent of nutrition education given to the medical practitioners in their medical training, it was found that relevant topics of Foods and Nutrition were covered under related topics in Biochemistry, Physiology, Paediatrics, Social and Preventive Medicine. For example the topics of digestion and absorption of nutrients, deficiency diseases and nutritional disorders such as diabetes, phenylketoneuria, lactose intolerance, etc. are covered under relevant topics of Physiology. Similarly, metabolism of nutrients, metabolic disorders and their treatments are discussed in Biochemistry. Maternal and child nutrition are covered under Paediatrics. Certainly this approach, although integrated in nature does not allow the desired emphasis on nutrition as a subject and thus the information delivered is more as a bird's eye view and lacks the knowledge in depth. The therapeutic nutrition is badly neglected as it is covered very inadequately and the doctors are not exposed to the dietary management of various disorders even in hospitals

ATTITUDE OF MEDICAL PRACTITIONERS TOWARDS NUTRITION

which have got well managed dietary departments.

Attitude of Respondents towards Nutrition

Data presented in Table 1 indicate mean score for attitude statements.

Majority of both government and private doctors had strongly favourable attitude towards teaching of nutrition in medical schools (83 and 80 per cent). Sixty per cent of government doctors and 80% of private practitioners had favourable attitude regarding doctors having up-to-

TABLE 1

Mean attitude scores of medical practitioners towards nutrition

S. No.	Attitude statement	Government medical doctors	Private practitioners
1.	Nutrition teaching is relevant to medical education and should be included in curriculum as a regular course	1.21±0.05	1.24±0.06
2.	A medical graduate must have an up-to-date knowledge in elementary human nutrition	1.35±0.06	1.28±0.06
3.	It is not at all necessary for a doctor to have knowledge of human nutrition	4.48±0.06	4.40±0.11
4.	Nutrition education is necessary for good health	1.37±0.05	1.46±0.07
5.	Good nutrition is necessary for treating certain diseases	1.35±0.06	1.42±0.07
6.	Doctors should treat nutritional advice as important as prescribing medicine	1.54±0.08	1.54±0.08
7.	Good nutrition is a pre-requisite to successful surgery	1.77±0.11	1.86±0.13
8.	Doctors need more knowledge in nutrition and would be better equipped to advise patients for proper diet intake	1.92±0.13	1.82±0.13
9.	Doctors use nutrition knowledge in their own day to day meals	2.65±0.14	2.74±0.17
10.	Doctors are contented with the level of nutrition information being taught to them in their medical training	2.84±0.13	2.98±0.16
11.	Doctors keep themselves abreast of recent developments in the field of human nutrition	2.82±0.14	2.92±0.15
12.	Doctors are aware of different fields of medical sciences and somewhat of nutrition too	2.02±0.07	2.20±0.09
13.	Doctors are aware of different agencies working in the field of human nutrition	3.31±0.11	3.62±0.15
14.	Doctors are fully equipped to advise patients for their diets independently	2.90±0.14	3.10±0.06
15.	Doctors have enough knowledge of foods and nutrition to supervise the management of dietary department of a hospital	3.00±0.15	3.26±0.15

Score key

Strongly agree	-1
Agree	-2
Undecided	-3
Disagree	-4
Strongly disagree	-5

Chi-square non-significant at 5% level

Rank correlation values (i) Govt. doctors =0.99*
(ii) Private practitioners =0.96*

*Significant at 5% level.

date knowledge in elementary human nutrition. Similarly, a large number of doctors had favourable attitude regarding necessity for nutrition education for good health (66 and 56 per cent), and need for good nutrition as a pre-requisite to successful surgery (67 and 70 per cent).

The doctors favourably admitted that they need more knowledge in nutrition to advise patients for proper diet intakes and their awareness is more towards different fields of medical sciences and somewhat of nutrition too. The doctors expressed the need for inclusion of more nutrition information in medical curricula so that they can guide their patients on nutritional care more effectively. Fortytwo per cent of government and 44% of private doctors showed uncertainty about the use of nutrition knowledge in doctors own day to day meals, doctors keeping abreast of recent development in the field of human nutrition (44 and 48 per cent), their contentment with the level of nutrition knowledge being imparted to them in their medical training (42 and 46 per cent). Doctors' inability to advise their patients independently and their lack

of knowledge of foods and nutrition to supervise the management of dietary department of the hospital clearly show the lack of confidence in their nutrition knowledge and their inability to advise the patients on nutritional care. Doctors had unfavourable attitude towards the statement that it is not at all necessary for a doctor to have knowledge of human nutrition (57 and 58 per cent).

The results of rank correlations by split half method revealed that doctors were consistent in their views. Chi-square, which was applied to test the difference in attitude of government medical doctors and private practitioners towards nutrition showed that there was no significant difference in the attitude of government medical doctors and private practitioners at 5% level of significance.

The findings of the present study reveal that the medical doctors on the whole have a favourable attitude towards nutrition and are in agreement with the reports of Vickstrom and Fox (1976) who observed that in general the nurses had a favourable attitude towards nutrition.

REFERENCES

Butterworth, C. E. 1974. The skeleton in hospital closet. <i>Nutr. Today</i> 9 : 4-8. Coursin, D. B. 1974. Towards accreditation of nutrition as medical sub speciality. <i>Am. J. Clin. Nutr.</i> 27 : 1195-98. Edward, A. I. 1957. <i>Techniques of Attitude Scale Construction</i>. Appleton - Century - Crofts, N. Y.	Vickstrom, J. A. and Fox, H. M. 1976. Nutrition knowledge and attitude of registered nurses. <i>J. Am. Dietet. Assoc.</i> 68 : 453-56. Wen, C., Weerasinghe, H. D. and Dwyer, J. T. 1973. Nutrition education in US medical schools. <i>J. Am. Dietet. Assoc.</i> 63 : 408-10.

DIFFERENTIAL KNOWLEDGE AND SOURCE UTILIZATION PATTERN OF RURAL AND URBAN MOTHERS REGARDING CHILD REARING PRACTICES

T. VERMA and S. AGARWAL
College of Home Science
Haryana Agricultural University, Hisar

(Received : July 28, 1984; Revised : August 16, 1985)

ABSTRACT

The study was conducted on 200 mothers of rural and urban of high and low income groups. Kolmogorov-Smirnov two-sample test was used to find out the differences regarding child rearing practices among rural and urban mothers of high and low income groups. Correlation coefficient was used to see the relationship. Significant differences between urban high with urban low and also with rural high and low income groups, in their knowledge and source utilization were found.

Every moment of a child's life is spent in contact with his parent which leaves some effect on his behaviour and potentialities for future action. The importance of many of these moments is very small but those that provide repetitions of common and consistent experience add up, over the years, to the production of consistent ways of behaviour.

There are dramatic differences among culture in the way young children are reared (Shroff, 1970; Saled, 1975). Furthermore, societies differ from one another in the degree to which children are indulged during the period of training hence the variations are bound to exist between the parents of different socio-economic groups regarding the severity of the discipline imposed during the socialization period (Desai, 1965).

Thus, it is assumed that infants in every society would initially develop

different habits which continue to be relevant in adult life. Therefore, different approaches have to be followed, otherwise dissemination of knowledge will suffer serious setback. This pin points to the fact that knowledge-transfer mechanisms have to be formulated separately for different social systems which have led to the formulation of the study with the following objectives :

- (i) To find out the existing child rearing practices
- (ii) To assess the knowledge regarding child rearing practices
- (iii) To find out the source utilization pattern regarding child rearing practices
- (iv) To determine the relationship between the source utilization pattern and level of knowledge.

MATERIAL AND METHODS

The study confined to Hisar city and Satroad village of Hisar Block-I to represent the sample of urban and rural areas, respectively. Mothers of high and low income groups (50 each), who atleast had one child within the age group of 2-3 years, from both the areas were drawn separately by simple random sampling procedure. Thus, 200 mothers constituted the sample and interviewed personally. The obtained data on structured interview schedule were analysed statistically by using Kolmogorov-Smirnov two-sample test of significance and correlation coefficient.

Assessment of Existing Child Rearing Practices

The information collected was on the general pattern of child rearing prevalent in the sampled households. This included—feeding and weaning, toilet training, dependence-independence training, aggression training, and restriction and demand for disciplining the child.

As regards feeding and weaning practices, responses were obtained under feeding interval, quantity of milk given to the child, age at which weaning was started and the pattern of weaning foods introduced.

The toilet training practice response categories were procedure used to train the child, type of discipline adopted and the facilities provided to the child.

As regards the development of independent behaviour in the child, the response categories were perceived deve-

lopmental age for independent behaviour among children, method used to help the child to be independent and whether the child is dependent or independent in respect of eating, bathing, dressing, in taking care of his/her needs of bowel movements (toileting), sleeping, playing, etc.

As regards aggression, the response categories were approaches adopted to control the child's aggression, the expression of aggression and whether the child is aggressive or non-aggressive.

The pattern of imposing restriction and fulfilling the demand of the child was studied under the method of disciplining the children. The response categories were method of dealing with the child's demands, way of imposing the restrictions on the child and whether the balance is maintained between the two.

The aggregate scores for all the five practices were calculated separately based on their response categories. The dichotomous responses with affirmative reply were given the score of one and the non-affirmative zero. The total scores of each practice were divided into three categories viz. appropriate, somewhat appropriate and least appropriate. Respondents with zero scores were categorised under not followed at all category.

Knowledge-Inventory

Knowledge-inventory for each practice was prepared and recorded information was assigned scores, with which aggregate scores were obtained. These were equally distributed into three categories,

CHILD REARING PRACTICES

viz. least sufficient, somewhat sufficient and sufficient knowledge.

RESULTS AND DISCUSSION

The data pertaining to the existing child rearing practices reveal that in majority of the cases feeding and weaning, toilet training, and dependence-independence were followed to somewhat appropriate extent, however aggression and discipline were least appropriately followed (Table 1).

A significant difference existed between urban high and urban low income groups in following all the five practices of child rearing, viz. feeding and weaning, toilet training, aggression training, dependence-independence training and disciplining the child (Table 2). However, for the disciplining the child significant difference was observed only in case of rural high and rural low income groups. Regarding urban high and rural high, these two income groups were found significantly different with each

TABLE 1

Extent of existing child rearing practices among urban and rural mothers of high and low income groups

S. No.	Practices	Extent of appropriateness of existing practices followed	Urban		Rural		Total (n=200)
			High (n=50)	Low (n=50)	High (n=50)	Low (n=50)	
1.	Feeding and weaning	Appropriate	39(78)	9(18)	7(14)	3(6)	58(29)
		Somewhat appropriate	10(20)	28(56)	21(42)	20(40)	79(39.5)
		Least appropriate	1(2)	13(26)	22(44)	27(54)	63(31.5)
2.	Toilet training	Appropriate	2(4)	0	0	0	2(1)
		Somewhat appropriate	47(94)	12(24)	10(20)	8(16)	77(38.5)
		Least appropriate	1(2)	25(50)	14(28)	20(40)	60(30)
3.	Dependence-independence	Not followed at all	0	13(26)	26(52)	22(44)	61(30.5)
		Appropriate	46(92)	13(26)	12(24)	7(14)	78(39)
		Somewhat appropriate	3(6)	35(70)	37(74)	39(78)	114(57)
4.	Aggression	Least appropriate	1(2)	2(4)	1(2)	4(8)	8(4)
		Appropriate	40(80)	8(16)	2(4)	3(6)	53(26.5)
		Somewhat appropriate	9(18)	16(32)	21(42)	8(16)	54(27)
5.	Disciplining the child	Least appropriate	1(2)	26(52)	27(54)	39(78)	93(46.5)
		Appropriate	48(96)	6(12)	7(14)	4(8)	65(32.5)
		Somewhat appropriate	0	21(42)	30(60)	7(14)	58(29)
		Least appropriate	2(4)	23(46)	13(26)	39(78)	77(38.5)

Values in parentheses are percentages.

TABLE 2

Level of difference in child rearing practices followed by urban and rural mothers of high and low income groups (χ^2 values)

S. No.	Practices	UH+UL	RH+RL	UH+RH	UL+RL
1.	Feeding and weaning	36.00**	1.00	40.96**	7.84*
2.	Toilet training	54.76**	1.44	60.84**	3.24
3.	Dependence-independence	43.56**	1.00	46.24**	1.44
4.	Aggression	40.96**	5.76	57.76**	6.76*
5.	Disciplining the child	70.56**	27.04*	67.24**	10.24**

UH=Urban high UL=Urban low RH=Rural high RL=Rural low

*Significant at 0.05 level of probability with 2 d.f. (Tab. value=5.99)

**Significant at 0.01 level of probability with 2 d.f. (Tab. value=9.21)

other for all the five practices of child rearing. As regards feeding and weaning, aggression training and disciplining the child, significant differences were observed between urban low and rural low income groups.

The precision with which these practices have been followed by urban and rural mothers was by and large could be ascertained by their level of knowledge.

It is evident from the data in Table 3 that in majority of the cases mother respondents had insufficient knowledge for all the five selected practices. The data in Table 4 reveal that knowledge of urban high and urban low income group mothers differed significantly in respect of all the five practices of child rearing. However, no significant differences were observed in the knowledge of different practices of rural high and rural low income groups except for disciplining the child. Regarding urban high and rural high income group mothers a significant difference was found in regard to knowledge of all the five practices, whereas urban low and

rural low income group mothers differed significantly in respect of feeding and weaning, aggression and disciplining the child.

The knowledge regarding any practice has much to do with the sources through which the information has been received. Therefore, source utilization pattern of mothers for these practices was studied. The multiple choice data in Table 5 reveal that irrespective of the categories, all the mothers (100%) had been using localite sources for all the five practices. However, in case of urban high, mass media (84%) and cosmopolite sources (74%) were utilized in combination, whereas very negligible proportion of urban low, rural high and rural low income group mothers had utilized cosmopolite and mass media sources.

The test of significance indicated difference among urban high and urban low; and urban high and rural high groups ($\chi^2=11.30^{**}$ and 32.43^{**} , respectively). Whereas for rural high and rural

CHILD REARING PRACTICES

TABLE 3

Extent of knowledge regarding child rearing practices of urban and rural mothers of high and low income groups

S. No.	Practices	Level of knowledge	Urban		Rural		Total (n=200)
			High (n=50)	Low (n=50)	High (n=50)	Low (n=50)	
1.	Feeding and weaning	Sufficient	32(64)	0	0	0	32(16)
		Somewhat sufficient	18(36)	25(50)	11(22)	8(16)	64(32)
		Insufficient	0	25(50)	39(78)	42(84)	106(53)
2.	Toilet training	Sufficient	24(48)	0	0	0	24(12)
		Somewhat sufficient	26(52)	13(26)	22(44)	10(20)	71(35.5)
		Insufficient	0	37(74)	28(56)	40(80)	105(52.5)
3.	Dependence-independence	Sufficient	30(60)	3(6)	1(2)	3(6)	37(18.5)
		Somewhat sufficient	19(38)	13(26)	17(34)	11(22)	60(30)
		Insufficient	1(2)	34(68)	32(64)	36(72)	113(56.5)
4.	Aggression	Sufficient	0	0	0	0	0
		Somewhat sufficient	36(72)	20(40)	7(14)	4(8)	67(33.5)
		Insufficient	14(28)	30(60)	43(86)	46(92)	133(66.5)
5.	Disciplining the child	Sufficient	4(8)	0	1(2)	0	5(2.5)
		Somewhat sufficient	43(86)	22(44)	21(42)	7(14)	93(46.5)
		Insufficient	3(6)	28(56)	28(56)	43(86)	102(51)

Values in parentheses are percentages.

TABLE 4

Level of difference in knowledge regarding child rearing practices of urban and rural mothers of high and low income groups (χ^2 values)

S. No.	Practices	UH + UL	RH + RL	UH + RH	UL + RL
1.	Feeding and weaning	40.96**	0.36	60.84**	21.16**
2.	Toilet training	54.76**	5.76	31.36**	00.96
3.	Dependence-independence	43.56**	1.44	38.44**	00.56
4.	Aggression	10.24**	0.96	33.64**	10.24**
5.	Disciplining the child	25.00**	9.00*	25.00**	9.00*

UH=Urban high

UL=Urban low

RH=Rural high

RL=Rural low

Significant at 0.01 level of probability with 2 d.f. (Tab. value=9.21)

low; and low urban and low rural income groups no difference was recorded. It may be inferred that except for urban high, in all other combinations the pattern of utilization of sources was found similar i.e. heavy dependence on localite sources.

The sources of information play a crucial role in providing the information, therefore, the differential pattern of source utilization of rural and urban mothers was further studied in relation to their knowledge of all the five areas of child

TABLE 5

Utilization of source of information for child rearing practices among urban and rural mothers of high and low income groups

S. No.	Source of information	Urban		Rural		Total (n=200)	X ² value
		High (n=50)	Low (n=50)	High (n=50)	Low (n=50)		
1.	Localite sources	50(100)	50(100)	50(100)	50(100)	200(100)	Urban (high+low) 11.30**
2.	Cosmopolite sources	37(74)	9(18)	7(14)	2(4)	55(27.5)	Rural (high+low) 1.35
3.	Mass-media sources	42(84)	4(8)	3(6)	1(2)	50(25)	High (rural+urban) 32.43** Low (rural+urban) 2.56

(Multiple responses for sources)

Values in parentheses are percentages.

X² Tabulated (Kolmogorov-Smirnov two-sample test) at 0.05 level of probability with 2 d.f.=5.99 and 0.01 level=9.21.

TABLE 6

Relationship between information source utilization and level of knowledge of child rearing practices

S. No.	Child rearing practices	Sources of information (r=values)	
		Urban (n=100)	Rural (n=100)
1.	Feeding and weaning	0.5521*	0.4310*
2.	Toilet training	0.4947*	0.3077*
3.	Dependence-independence	0.2704*	0.3900*
4.	Aggression	0.3690*	0.4635*
5.	Disciplining the child	0.4582*	0.4367*

*Significant at 0.05 level of probability with 98 d.f. (Tabular value=0.194).

rearing practices. The zero order correlation coefficient was applied to explore the relationship (Table 6). The source utilization pattern and level of knowledge of urban mothers were found to be positively significant for feeding and weaning, toilet training, dependence-independence training, aggression training and disciplining the child ($r=0.5521^*$, 0.4947^* , 0.2704^* , 0.3690^* , and 0.4582^* , respec-

tively). However, in case of rural mothers also similar results have been obtained ($r=0.4310^*$, 0.3077^* , 0.3900^* , 0.4635^* , and 0.4367^* , respectively).

Thus, the significant relationship under both categories may be inferred as mothers with sufficient knowledge regarding child rearing practices were found using cosmopolite and mass media

CHILD REARING PRACTICES

sources, however those with insufficient knowledge confined to localite sources. Urban mothers especially of high income groups had sufficient knowledge regarding these practices who were found utilizing mass-media and cosmopolite sources, whereas rural mothers (irrespective of their income categories) and urban low income group mothers had mostly used localite sources with negligible combination of other sources. Therefore, their knowledge regarding these practices significantly differed from

that of urban high group mothers who followed these practices appropriately. Limited exposure through localite sources was confirmed to be the determinant of insufficient knowledge. Therefore, transmitting agencies should give serious thought on this aspect for improving the status of children, and ensure variety of exposure media for imparting technical know-how of child rearing practices in a more planned and systematic manner.

REFERENCES

- Desai, M. 1965. A study of child rearing practices with reference to feeding and toilet training in higher and lower socio economic groups. M. Sc. dissertation, M. S. University, Baroda.
- Saied, S. 1975. Child rearing practices among the Hindus, Muslims and Christians in the city of Madras. M.Sc. dissertation, University of Madras, Madras.
- Shroff, N. C. 1970. A study of child rearing practices in Ismaili community in Ahmedabad city. M.Sc. dissertation, M. S. University, Baroda.

EFFECT OF REGIONAL ADVANCEMENT ON THE SOCIAL MOBILITY PATTERN—A STUDY OF RURAL HARYANA

SAVITA MEHRA, M. L. SHARMA and T. M. DAK

Department of Sociology

Haryana Agricultural University, Hisar

(Received : December 5, 1983; Revised : November 16, 1984)

ABSTRACT

The study conducted in one most advanced and one least developed districts of Haryana with 404 respondents from eight villages, assessed the patterns of social mobility in the countryside and examined the role of development of a region in affecting the mobility pattern. Four forms of mobility viz. intergenerational, intragenerational, return and spatial were studied. Status improvement pattern among scheduled and lower castes was also examined in the context of regional development.

The study showed that mobility was more pronounced in the present generation than in the previous generations. Service and labour class occupations were fast expanding, while those of farming and artisanary had tended to sequeeze over generations. Urban-ward mobility was also assuming a significant proportion in view of the pressure on agriculture and technological development. Adoption of caste-free occupations, acquisition of education and land emerged as main channels for upward mobility among scheduled and lower castes. Whatever form of social mobility was examined, it was invariably influenced by level of the development of a region in favour of developed regions.

The under-development of a society is characterized by the prevalence of hereditary occupational roles, ascriptive status, predominance of agriculture, immobile work force and the like. In such societies, the control imposed by the group restricts individuals to introduce innovations, achieve status, seek change in occupational roles and abandon narrow loyalties based on kith and kin. As the society develops, the role of primary sector declines, population becomes mobile and change oriented, importance of hereditary and traditional occupations reduces, individual choice

and achievement are more stressed and feudal mode of relationships give way to new relationships based on equality and achievement (Gouldner, 1958).

The question, whether the aforesaid changes have accompanied the socio-economic development in India also, has been the subject of speculation for a long time. Most theorists assume close interdependence of elements in a social system and argue that substantial change in one component would lead to definite and congruent change in others (Moore, 1968). How far such a structural

REGIONAL ADVANCEMENT AND SOCIAL MOBILITY

congruity applied to development in India remains a focus of the present paper. However, the existing literature hardly throw any light on different aspects of change and mobility attendant upon development of a region. Such studies are conspicuously absent in case of Haryana. Based on data from Haryana, an attempt has been made here to rank area in terms of development level and to find out if it is associated with corresponding change in their mobility patterns.

METHODOLOGY

The present study was conducted in two districts of Haryana state. Based on the selected indices of advancement*, two districts, one most advanced (Karnal) and the other least advanced (Bhiwani) were selected. From each selected district one block was randomly selected—Nilokheri block from Karnal and Dadri from Bhiwani district. From each block, all villages were ranked in terms of selected indicators of development based on village records. Two villages from the upper five per cent and two from the lower five per cent of the villages were randomly selected representing different levels of development. Thus, eight villages from two blocks formed the sample. The eight villages were arranged in order of their advancement which were grouped as most developed, developed, less developed and least developed. The villages thus selected from

Karnal district were Amine, Shamgarh, Sandhir and Takhana; and the villages selected from Bhiwani were Samaspur, Charkhi, Bursana and Narsingwas.

The respondents were stratified on the basis of caste and 10% of them were randomly drawn to make a total of 404. The distribution of sampled villages and respondents has been shown in Table 1.

Heads of the families within age group of 20-60 years were the subjects of present study. Data were collected through pretested schedule.

RESULTS AND DISCUSSION

Four dimensions of social mobility, viz. intergenerational mobility, intra-generational or career mobility, return mobility and spatial mobility were identified for the purpose of study. Status improvement pattern among scheduled and lower castes was also examined in the context of regional development.

Intergenerational Occupational Mobility

The process whereby an individual deviates from his father's occupation and pursues an occupation different from his father's is termed here as intergenerational mobility.

Pattern of change. To delineate the pattern of intergenerational occupational

* Following indices were used for the purpose :

Area under high yielding varieties as percentage to total cropped area; percentage of gross area irrigated to total cropped area; amount of fertilizer used per unit of irrigated area; farm mechanisation i.e. number of tractors and tube-wells/pumping sets; percentage of agricultural labourers to total agricultural workers; literacy rate; proportion of scheduled caste population to total population; value productivity per hectare and soil rating index.

TABLE 1
Distribution of sampled villages and respondents

Development level	District	Village	Total population	Sample size	Total sample size of a region
Most developed	Karnal	1. Amine	856	85	155
		2. Shamgarh	704	70	
Developed	Bhiwani	1. Samaspur	642	64	134
		2. Charkhi	705	70	
Less developed	Karnal	1. Sandhir	306	30	60
		2. Takhana	296	30	
Least developed	Bhiwani	1. Bursana	301	30	55
		2. Narsingwas	254	25	

TABLE 2
Intergenerational occupational mobility between respondents and their fathers

Father's occupation	Respondent's occupation				
	Farming	Artisanary	Labour	Service	Total
Farming	130 (69.3)	7 (3.7)	11 (5.8)	40 (21.3)	188 (46.5)
Artisanary	11 (14.9)	33 (41.8)	20 (25.3)	15 (19.0)	79 (19.6)
Labour	4 (5.2)	8 (10.4)	47 (61.0)	18 (23.4)	77 (19.1)
Service	25 (41.7)	3 (5.0)	1 (1.6)	31 (51.7)	60 (14.8)
Total	170 (42.1)	51 (12.6)	79 (19.6)	104 (25.7)	404 (100.0)

$$\chi^2=264.65, df=9, P=.01, C=0.63$$

mobility, an effort was made to find out relationship between respondent's occupation and respondent's father's occupation (Table 2). This analysis of intergenerational occupational mobility between respondents and their fathers in diagonal cells shows that the highest percentage (69.3%) of subjects, who were in their fathers' occupational cate-

gory, belonged to farming followed by labourers (61.0%), servicemen (51.7%) and artisans (41.8%).

The least amount of inheritance among artisans shows higher degree of movement from this occupational category; more than half of the respondents (58.2%) have deviated from their parental

REGIONAL ADVANCEMENT AND SOCIAL MOBILITY

occupation. The growth of industries, competition with machine-made goods and change in the likings of the people have compelled artisans to adopt occupations other than their parental ones. The attachment with land, feeling of security and the law of inheritance seem to be the main reasons for relatively lower intergenerational mobility among the farming group. The value of chi-square and coefficient of contingency indicated a significant and strong association between father's occupation and son's occupation. Jorapur (1971), Sharda (1977) and Rajagopalan (1978) also supported the above findings.

Mobility through generations. In order to assess the change in occupational structure, occupations of three different generations were compared i. e. of respondents (G_1), their fathers (G_2), and grandfathers (G_3).

Data in Table 3 show that with the passage of time, occupational structure

is undergoing a significant change i. e. there is a decreasing concentration of rural people towards farming and artisanary occupations from G_3 to G_1 generations and increasing concentration towards service and labour jobs. It reveals that people who are discarding farming or artisanary occupations are moving towards service sector or are becoming labourers. Increase in family size over the years, continuing fragmentation of holdings and growing opportunities for urban and non-farm jobs seem to have influenced the change in occupational structure.

Effect of region's development. Intergenerational occupational mobility pattern was analysed according to level of development also. For this purpose father's occupation was compared with that of grandfather and respondent's occupation with that of father. Data in Table 4 indicate that in both pairs of generations proportion of people deviating from parental occupations

TABLE 3
Shift in occupations through generations

Occupational categories	Grandfather (G_3)	Father (G_2)	Respondent (G_1)
Farming	219 (54.2)	188 (46.5)	174 (42.1)
Artisanary	122 (30.3)	79 (19.6)	51 (12.6)
Labour	58 (14.4)	77 (19.1)	79 (19.6)
Service	5 (1.2)	60 (14.8)	104 (25.7)
Total	404 (100.0)	494 (100.0)	494 (100.0)

Figures in parentheses are percentages.

TABLE 4
Development level and intergenerational occupational mobility among different pairs of generations

Development level	Respondents whose occupation is different from their father	Respondent's fathers' occupation different from grand-father
Most developed	74 (47.8)	44 (28.3)
Developed	57 (42.5)	34 (26.1)
Less developed	21 (35.0)	11 (18.3)
Least developed	11 (20.0)	8 (14.5)
All regions	163 (40.4)	97 (26.6)

increases with the increase in the level of development of a region and this holds good for both the pairs compared. Ranga Rao (1966), and Aggarwal and Deb (1973) also confirm the above findings.

It is due to the fact that with the development of industries, education, techniques of production and communication, several new opportunities for change in occupations tended to emerge. It may also be noted that deviation from parental occupation was more pronounced in the present generation (40.4%) than in that of the father's (26.6%). Jain (1968), Singh (1976) and Malik (1979) also reported similar findings.

Return Mobility

The return mobility is viewed here as the process where respondents in their career take occupations different from their fathers' but after some period they

again return to their parental occupations (Sharda, 1977). The change from parental occupation is not always final. The need for security, age consideration, working conditions and host of other factors compel respondents to return to the parents' occupation.

Data reveal that of the total 404 respondents 11.6% returned to their parental occupations. Rao (1970) and Sharda (1977) also reported the trend of return mobility. There was a higher return mobility amongst respondents of higher age, having agricultural background and literates. It is due to the fact that educated people, who remained in service or army, prefer to settle down in their respective villages and pursue parental occupations after retirement. This is necessary in view of their inability to take a risk in new enterprise in absence of relevant skills. Since land is inherited and farming remains a main occupation, those with agricultural background prefer to return to the father's occupations. When analysed region-wise, return mobility pattern did not show a specific trend.

Intragenerational Occupational Mobility

Individual's placement in occupational structure is based also upon the occupation with which he begins his career. The process wherein an individual deviates from his first occupation and pursues a different occupation is termed here as intragenerational mobility.

It is evident from Table 5 that of the total respondents, 33.2% had changed their occupations i.e. their present occu-

REGIONAL ADVANCEMENT AND SOCIAL MOBILITY

TABLE 5

Intragenerational occupational mobility or career mobility

Respondent's first occupation	Respondent's present occupation				
	Farming	Artisanary	Labour	Service	Total
Farming	110 (85.3)	8 (6.2)	4 (3.1)	7 (5.4)	129 (31.9)
Artisanary	5 (14.6)	26 (55.3)	9 (19.2)	7 (14.9)	47 (11.6)
Labour	10 (10.9)	8 (8.7)	59 (64.1)	15 (16.3)	92 (22.8)
Service	45 (33.1)	9 (6.6)	7 (5.2)	75 (55.1)	136 (33.7)
Total	170 (42.1)	51 (12.6)	79 (19.6)	104 (25.7)	404 (100.0)

pation was different from the first one. Bultena (1969) also reported similar trend. The respondents with farming occupation were least mobile i. e. 85.3% were performing the same occupation and only a small proportion (14.7%) had moved up or down in the occupational hierarchy. In contrast, servicemen and artisans were found to be most mobile as over 44% of them had changed their first occupation. Labour class people were found to be more mobile than farming class.

The reasons for differential mobility rates among different occupational groups are obvious. Lack of security of income, and possibility of higher wages and positions are the main reasons for greater mobility of servicemen and artisans. As farming provides greater security of livelihood and income and as assured alternatives are not easily available particularly where people are not well educated, an overwhelming proportion of the respondents tends to remain in the same occupation throughout their life.

Effect of region's development.
As in case of intergenerational occupational mobility, intragenerational mobility is also greatly influenced by the level of development of a region. Data in Table 6 reveal that the proportion of those deviated from their first occupation correspondingly increased with the level of development of the region, the highest being in case of most developed region (35.5%) and the lowest in least developed one (29.1%).

Urbanward Mobility

While analysing intergenerational and intragenerational occupational mobilities, it was found that persons are occupationally mobile in two ways: firstly, they adopt the occupation which exists in the village itself i. e. they take up occupations associated with other castes and secondly, they turn to urban market for getting better employment. Everyday they attend to their work in a town or city and return back to their native place. Analysis of data on this aspect revealed that out of total respondents, 25.7%

TABLE 6

Intragenerational occupational mobility or career mobility as per development level

Development level	Same occupation	Different occupation	Total
Most developed	100 (64.5)	55 (35.5)	155 (38.4)
Developed	91 (67.9)	43 (32.1)	134 (33.1)
Less developed	42 (70.0)	18 (30.0)	60 (14.9)
Least developed	39 (70.9)	16 (29.1)	55 (13.6)
Total	270 (66.8)	134 (33.2)	404 (100.0)

TABLE 7

Distribution of urban occupations of respondents as per their caste

Caste	Professional	Clerical	Skilled/ semi-skilled	Unskilled	Total
Upper	11 (44.0)	4 (16.0)	10 (40.0)	—	25 (24.1)
Intermediate	2 (6.4)	6 (19.4)	23 (74.2)	—	31 (29.8)
Lower	—	1 (9.1)	7 (63.6)	3 (27.3)	11 (10.5)
Untouchable	2 (5.5)	12 (32.4)	15 (40.5)	8 (21.6)	37 (35.6)
Total	16 (15.4)	26 (25.0)	54 (51.9)	8 (7.7)	104 (100.0)

were found to be mobile. Chekki (1971) and Sharma (1974) also noticed the attraction of rural people towards urban occupations.

In order to assess the occupational distribution of mobile respondents, data were further analysed. Data in Table 7 show that out of total respondents working in urban areas, 51.9% were engaged in skilled occupations, 25.0%

in clerical occupations, 15.4% in professions and 7.7% in unskilled occupations. Caste-wise analysis of respondents revealed that 44% of them hailing from upper castes were professionals, while only 6.4 and 5.4 per cent of respondents from intermediate and untouchable caste groups, respectively were so classified. There was none working as professional from the lower castes.

Further, 74.2% of the respondents of the intermediate castes followed by 63.6 and 40.5 per cent of the lower and untouchable caste groups, respectively were engaged in skilled occupations. Not even a single respondent from upper and intermediate caste groups was working as unskilled worker, while the corresponding proportion from lower and untouchable caste groups was 27.3 and 21.6 per cent, respectively. This leads to the conclusion that upper caste still enjoys monopoly over high prestigious urban occupations. It was mainly because of their privileged position. On the other hand, lower and untouchable castes were still engaged in manual and unskilled occupations in urban areas mainly due to lack of education, skill, etc.

Effect of developments. As the population acquires education and as the society develops technologically and industrially, people in increasing numbers tend to shift towards new and urban occupations. The tendency to shift from rural to urban areas, therefore, is more pronounced in the developed areas than in underdeveloped ones. The support for such an assumption comes from data presented in Table 8. As can be seen, most advanced and advanced regions contained a larger proportion of urbanward mobile persons i. e. 31.0 and 27.6 per cent, respectively as compared to less developed and least developed regions i. e. 18.3 and 14.4 per cent, respectively. As the region's development increased, percentage of spatially mobile population also correspondingly increased. Obviously, developed regions, by virtue of their greater occupational diversification could attract people from rural areas to seek better employment.

Status Emulation among Lower Castes

A closely related question which is often asked is concerned with the status of scheduled castes who in the past remained socially and economically disadvantaged. The occupations they performed were generally considered degrading and the life style polluting. While constitutional and legislative efforts helped in improving their conditions, role of development is significant in this regard. While industrial development and technological improvement have transferred 'lower' tasks to machines and provided flexibility to the rigid occupational structure through caste-free occupations, educational and employment opportunities offered by the government helped them to acquire new knowledge and skills for movement towards new and highly valued social roles and abandon occupations considered degrading or polluting. The chances for these changes are likely to be greater in developed regions than in backward ones.

Data presented in Table 9 pertain to the respondents of lower and untouchable castes and reveal the channels used by them for improving their status in different regions. It is evident that acquisition of education by the sons (51.2%) or themselves (45.7%) and change in occupation were used as main channels for improving the status. Among other important means used by scheduled castes were acquisition of land (24.7%), and adoption of customs of higher castes (15.4%). It may be noted that the proportion of people who sought improvement in their status by different channels increases with the

TABLE 8

Spatial mobility as per development

Development level	Spatially non-mobile	Spatially mobile	Total
Most developed	107 (69.0)	48 (31.0)	155 (38.4)
Developed	97 (72.4)	37 (27.6)	134 (33.1)
Less developed	49 (81.7)	11 (18.3)	60 (14.9)
Least developed	47 (85.6)	8 (14.4)	55 (13.6)
Total	300 (74.3)	104 (25.7)	404 (100.0)

TABLE 9

Status improvement among lower castes by region's development

Channels	Most developed	Developed	Less developed	Least developed	Total
1. Adopting new and higher caste occupations	25 (39.7)	14 (34.1)	7 (16.7)	2 (12.5)	48 (29.6)
2. Self education	35 (55.6)	21 (51.2)	14 (33.3)	4 (25.0)	74 (45.7)
3. Children's education	41 (65.1)	27 (65.2)	12 (28.6)	3 (18.7)	83 (51.2)
4. Land acquisition	17 (26.9)	12 (29.2)	7 (16.7)	4 (25.0)	40 (24.7)
5. Adopting higher caste customs	15 (23.8)	5 (12.2)	3 (7.1)	1 (6.2)	25 (15.4)
6. Made no efforts	1 (1.6)	3 (7.3)	5 (11.9)	6 (37.5)	15 (9.3)

(Responses were multiple)

increase in development level of the region, but of those who did not make any such attempt correspondingly decreased. Clearly, lower and scheduled castes, found greater opportunities for improving their socio-economic status in advanced regions than in backward ones. It is so because developed regions offer more

changes for social mobility and change in hereditary occupational roles through greater educational opportunities, more advanced knowledge and skills and technological and industrial opportunities.

The study has made an attempt to examine mobility patterns between and

REGIONAL ADVANCEMENT AND SOCIAL MOBILITY

within generations particularly in the context of development of the region. Interesting trends have been discerned. Obviously, the present generation was found more mobile as compared to previous ones. It is so mainly because of the intensification of the process of development in the field of technology, culture, education, transport and means of communication in recent decades.

Intergenerational mobility analysis revealed a striking change in the occupational pattern. Accordingly, service and labour class occupations are fast expanding, while those of farming and artisanary have tended to squeeze over generations. Disliking for caste occupations, prestige attached to caste occupations, continuing fragmentation of holdings and growing opportunities for urban and non-farm jobs due to industrial growth, and the expansion of education and the like may be the main reasons.

Urban-ward mobility is assuming a significant proportion in view of the pressure on agriculture, non-availability of non-farm jobs and scores of similar factors.

It was interesting that the migrants have more or less maintained their occupational hierarchy in cities also partly

because of difference in their education, occupational skills, training, and the resources and the like.

Whatever way social mobility was examined, it was invariably influenced by level of the development of the region in such a way that developed regions exhibited greater mobility than the less developed.

The study suggests that the process of social, occupational and geographical mobility, which is important for the emergence of an industrialized society can be intensified by an integrated approach involving rapid development of the region, increased occupational opportunities, promotion of educational and training facilities in the countryside and improvement of transport and communication facilities. These will facilitate individuals in getting better training and education needed for skilled and caste free urban occupations and thereby in upward social mobility. Further non-farm jobs should be increased by establishing small scale industries in rural areas, by the removal of constraints of finance, management and resources and marketing, etc. Greater stress should be given for improving the status of lower castes or weaker sections as they were found to be working on low paid jobs.

REFERENCES

- Aggarwal, B. K. and Deb, P. C. 1973. Intergenerational occupational mobility in Ludhiana. *J. Res. Punjab agric. Univ.* 10 : 120-25.
- Bultena, G. L. 1969. Career mobility of low income farm operators. *Rural Sociology* 34 : 563-68.
- Chekki, Dan A. 1971. Social stratification and trends of social mobility in modern India. *Indian J. Social Work* 31 : 367-80.
- Gouldner, H. B. 1958. Industrial sociology. In : *Sociology*. Broom, L. and Solznick, P. (eds.). Row Paterson and Co., New York.

- Jain, S. P. 1968. Social mobility in a town--An intergenerational analysis. *Economic and Political Weekly* 5 : 1703-10.
- Jorapur, P. B. 1971. Intergenerational occupational mobility. *Indian J. Social Work* 31 : 461-67.
- Malik, S. 1979. *Social Integration of Scheduled Castes*. Abhinav Publication, Delhi.
- Moore, W. F. 1968. Industrialization : Social aspects. In : *Encyclopedia of Social Science*, Sills, D. L. (ed.). Mac Millan Co. and Free Press, New York.
- Rajagopalan, C. 1978. Social mobility among scheduled castes. Ph.D. thesis, Bangalore University, Bangalore.
- Ranga Rao, K. 1966. Intergenerational occupational mobility. *Indian J. Social Res.* 68 : 122-23.
- Rao, M. S. A. 1970. *Urbanisation and Social Change*. Orient Longman, New Delhi.
- Sharda, B. D. 1977. *Status Attainment in Rural India*. Ajanta Publication, New Delhi.
- Sharma, K. L. 1974. *Changing Rural Stratification System. A Comparative Study in Six Villages in Rajasthan*. Orient Publications Delhi.
- Singh, S. 1976. Occupational mobility among scheduled castes. *Indian J. Social Work* 37 : 267-78.

RESEARCH NOTE

Haryana agric. Univ. J. Res., Vol. XV, No. 4, pp. 497—501 (December 1985)

STUDY OF PATTERNS OF SOCIAL INTERACTION AMONG PREADOLESCENTS

PRAVEEN KAUR and M. L. SHARMA

Department of Sociology

Haryana Agricultural University, Hisar

(Received : January 23, 1984; Revised : December 31, 1984)

Adolescence is pre-eminently a period of social developments and adjustments. The social relations begin to change from an excessive emotionalized interest to a stable and enduring friendship. Thus, preadolescence which is a junction between childhood and adolescence is the age when adulthood pattern of human relationships is explored and exercised. Friendship at this age acquires a special significance because children are being weaned away from parental dependence and exert their freedom in forming a group and making friends. Friendship performs many other functions, too. It might help in transmitting culture, providing testing ground for behaviour, passing on knowledge, teachings, rules and logical consequences. Thus, a study of patterns of group relations among preadolescents would be useful in providing insight into the personality development and also in identifying the factors that contribute to social relationships of this age. The area of interactional processes in preadolescents has remained almost neglected in our country. Thus, patterns of social interaction among the preadolescents and the role of various socio-economic and personal variables in their friendship and group popularity

were studied. Respondents were required to give the following information :

- (i) two choices of most intimate friends of their own class,
- (ii) activities or situations they wanted to share with their friends, and
- (iii) qualities they perceive in their friends.

Respondents were asked to select the five most important activities out of the listed eight, which they wanted to share with their friends. They were also required to select 10 most important qualities of their intimate friends out of the listed 20. Our visits to their classrooms and play-grounds also gave supportive information.

Sex Cleavage

The sociogram shows a complete lack of communication between girls and boys (Fig. 1). Not even a single choice has been given to the members of the opposite sex either by the girls or by the boys. They maintain least possible relationship, and confine their all sorts of activities to the members of their own

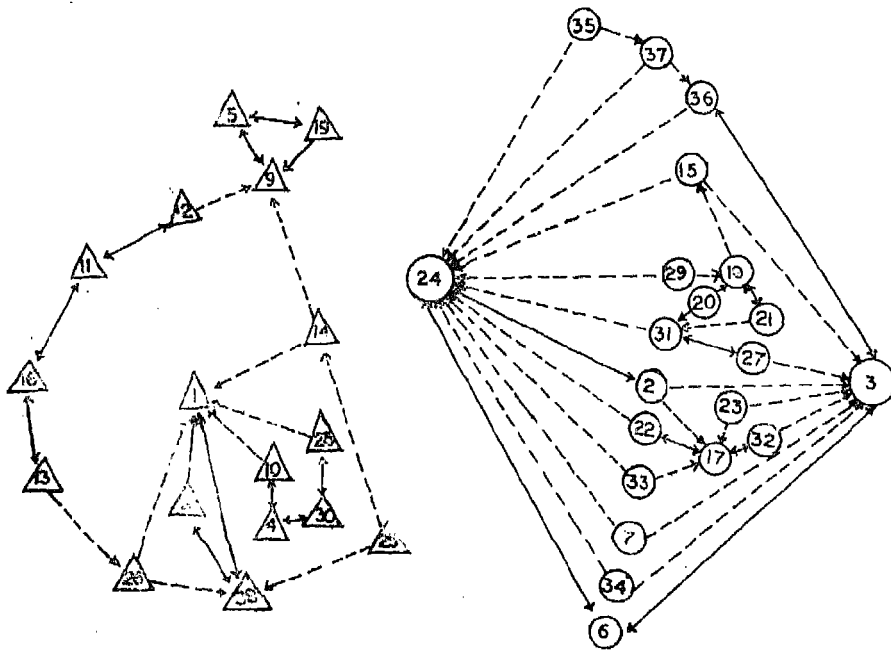


Fig. 1. Choice of friends.

sex. This tendency of preferring persons of own sex becomes more pronounced each year, and reaches its peak just before and during puberty (Hurlock, 1955). Girls invariably complained about the childish behaviour of boys and got irritated when they found boys taking things not seriously. On the other hand, boys complained that the girls in general lacked tolerance, patience and humour. They also get irritated and loose temper very soon. The temperamental differences in boys and girls could be accounted to the difference in rate of physical and mental development in boys and girls. Girls mature much earlier than the boys and hence, a girl of thirteen may find a boy of her own age as immature and idiot which might lead to antagonism (Gessell, 1956). The differences in

temperament could also be due to differential child-rearing practices directed at girls and boys. Because of the more restrictions on girls, they identify with their mothers soon and thus advance on adult patterns of maturity much earlier than the boys who achieve this stage a little late because of parents' permissible attitude towards them. Further, due to differential sex-role expectations adolescents find themselves under the constant pressure to be different and their this effort to define more clearly their appropriate sex-roles bind them together within their own sex (Williams and Stith, 1974). Hence, they need friends of their own type to share their experiences, learn and practise what is expected and acceptable behaviour in society. The sex-cleavage in adolescence is a univer-

PREADOLESCENTS' PATTERNS OF SOCIAL INTERACTION

sal phenomenon and has been reported by Ghosh (1953), Hurlock (1955), Gessell (1956), Khanna (1960), Williams and Stith (1974) and many others. But results reveal that the tendency of sex segregation and antagonism for opposite sex is present in preadolescents also.

Activities and Qualities

There is a considerable difference between boys and girls in their relationships with their own sex. The sociogram also reveals the difference in the size of the groups of boys and girls. Boys prefer a wider circle of friendship, whereas girls maintain their friendship within a group of two or three based upon reciprocal choices. Girls need some one to confide in, to tell the secrets and also to share the experiences of relevance (Probably arising due to the onset of puberty). Boys generally prefer a friend who is a good player (Table 1). Boys are more often concerned in doing things with their friends, and they group along activity lines. But friendship seems to be more meaningful to a thirteen year old girl.

Girls give importance to supportive-ness, sympathy, and moderate self-confidence, whereas boys give importance to sports skill, humour, cheerful nature, permissiveness and interest in extra curricular activities (Table 2). Choice of friends in girls is more based upon similarity in interests, hobbies, activities, academic performance, temperament and attitude. One clique of girls was good in swimming and other in dancing. They were described as more social, talkative, active and initiative than the girls of mutual choices who were less active. Isolated girls were described as less social, shy, passive with no initiative and lazy type.

Cliques and Reciprocal Choices

Girls have a distinctive tendency of having limited number of friends. The sociogram shows that out of 17 girls, there were two cliques and six other mutual choices. Boys had eight mutual choices but no clique. Caste, class and close vicinity, parental occupation and family relations do not appear significant in the choice of a friend. Girls seem to

TABLE 1
Frequency of activities the most intimate friends like to share

S. No.	Activities	Girls	Boys
1.	Share personal experiences	16(1)	7(7.5)
2.	Talk together	15(2)	17(2.5)
3.	Sit together	14(3.5)	14(5)
4.	Spend leisure time together	14(3.5)	17(2.5)
5.	Play together	12(5)	19(1)
6.	Study together	6(8)	7(7.5)
7.	Have lunch together	4(7.5)	8(6)
8.	Walk together	4(7.5)	16(4)

Figures in parentheses are rank orders.

TABLE 2

Frequencies of the qualities as indicated by the respondents

S. No.	Qualities	Girls	Boys
1.	Supportiveness	15(1)	6
2.	Sympathetic	14(2)	5
3.	Moderate self-confidence	13(3)	14(7)
4.	Talkativeness	12(4.5)	5
5.	Interest in extra curricular activities	12(4.5)	16(5)
6.	Emotional control	11(6.5)	11(9)
7.	Good appearance	11(6.5)	4
8.	Responsible	10(8)	10(10)
9.	Encouraging	8(9.5)	12(8)
10.	Good in studies	8(9.5)	6
11.	Cheerful nature	7	19(2.5)
12.	Truthfulness	7	6
13.	Adjustability	7	9
14.	Intelligence	6	6
15.	Liberal and open-mindedness	6	17(4)
16.	Cooperative	5	15(6)
17.	Clarity in ideas	5	4
18.	Boldness	5	6
19.	Good players	4	20
20.	Humour	4	19(25)

Figures in parentheses are rank orders.

be slightly affected by family status but boys not at all. Since boys have wider group of interaction, the maximum choices were also obtained by them, whereas among girls the popular girl had only six choices. Active participation in extra curricular activities, emotional control, sociability, helpful attitude and athletic skill are the main factors responsible for the group popularity which are more in favour of boys and less in girls.

Parents and teachers have to realize that sex cleavage and even antagonism

among both sexes are inevitable in pre-adolescents for which they should not be punished unnecessarily. It is actually, an indicative of the process of their successful preparation for adopting the differential sex roles. The presence of opposite sex peers as in co-educational schools provide differential re-inforcement for sex-typed play. Formation of cliques is also an inevitable process of interaction among girls at this age. Its persistence for longer time may not be a healthy sign of emotional and social adjustments. Boys seldom move in cliques.

PREADOLESCENTS' PATTERNS OF SOCIAL INTERACTION

REFERENCES

- Gessell, A. 1956. *Youth (10-16 years)*. Harper and Brothers, New York.
- Ghosh, I. 1953. The nature and causes as stated by the pupil themselves of formation of friendship among adolescents of class X of two girls schools of Delhi. M.Ed. thesis, University of Delhi, Delhi.
- Hurlock, E. B. 1955. *Child Development*. McGraw Hill Kogakusha Ltd
- Khanna, A. 1960. A study of friendship in adolescent boys and girls. *Manas* 7: 3-18.
- Williams, J. W. and Stith, M. 1974. *Middle Childhood : Behaviour and Development*. MacMillan Publishing Co., Inc. New York.

TITLE INDEX

Animal and Veterinary Sciences

- Performance of starting commercial pullets on different protein and energy levels in Haryana, 1
- Efficacy of certain antibacterial intrauterine infusions on the reproductive efficiency in postpartum cows, 7
- Effect of light colour on the reproductive performance of Japanese quail, 10
- Calcium, phosphorus, manganese and zinc retention in broilers given maize and sorghum based diets with different energy and protein levels, 125
- An appraisal of edible and non-edible organs of Nali and its crossbred lambs, 133
- Effect of physical exercise on peripheral cortisol levels in buffalo calves, 138
- Physiological changes during electroanaesthesia, 241
- Relative efficiency of selection on part and annual records, 248
- Utilization of agro-industrial byproducts by livestock and poultry. VI. Nutritive value of gram (*Cicer arietinum*) chuni for cattle, 257
- Effect of early protein restriction on body weight, physical measurements, cooking loss and chemical composition of sexed birds, 381
- Histomorphological studies on the endometrial epithelium of buffalo during estrous cycle, 395

Basic Sciences

- Variability in protein, tryptophan and methionine contents in *Phaseolus* and *Vigna* spp., 15
- Variation in the level of essential oil in *Cymbopogon martini* var. *motia* at different harvestings and growth stages, in various plant parts and on ageing the harvested crop, 21
- Kinetics of soluble and immobilised amyloglucosidase, 26
- Effect of artificial aging on the levels of protease, lipase, ribonuclease, total lipid and free fatty acids from soybean seeds differing in storage potential, 141
- Ureides and enzymes of their metabolism in nodules of mungbean as influenced by plant genotype and rhizobial strain, 148
- Cytogenetic effects of food additives in barley. 1. Food dyes, 153
- Effect of accelerated aging of soybean seeds of differential storage potential on phospho- and glycolipids, 260
- Studies on multiple antibiotic resistance pattern and plasmid curing in *Rhizobium trifolii*, 265

Cytogenetic effects of food additives in barley. 2. Citric acid, acetic acid and potassium metabisulphite, 271

Damage reduction with gibberellic acid post-treatment in gamma irradiated caryopses of *Avena fatua* L., 399

Production of hydrolytic enzymes in wild-type and non-nodulating strains of *Rhizobium trifolii*, 403

Crop Sciences

Yield, total productivity, water-use efficiency and returns as affected by intercropping in castor in semi-arid tropics, 29

Effect of growth regulators on flowering and fruiting of bottle gourd, 36

Seasonal fluctuations in incidence of ber fruitfly *Carpomyia vesuviana* Costa (Diptera : Tephritidae) under agro-climatic conditions of Hisar, 42

Irrigation production functions for Ludhiana conditions, 51

Soils of N. E. S. block Ganaur of district Sonapat, Haryana—their problems and management, 57

Pathological analyses of national and regional pearl millet genepool for major diseases under multiple disease sick-plot, 64

Variation in leaf diffusive resistance in wheat cultivars, 71

Effect of growth regulators on rooting of lemon cuttings with and without leaves, 77

Effect of moisture stress, sowing methods and nitrogen levels on the quality and oil yield of mustard, 82

Response of paddy to nitrogen sources, their application time and nitrification inhibitors, 87

Nutrient status of ber (*Zizyphus mauritiana* L.) orchards in Mahendragarh district of Haryana, 94

Observations on the extent of decline in different cultivars of citrus, 97

A new record of occurrence of *Ephestia cautella* (Wlk) on stored cotton seed in Haryana, 99

Powdery mildew on *Capsicum annum* in Haryana, 100

Nature and extent of damage of *Heliothis armigera* (Hubner) in seed crop of onion, 102

Grain growth of wheat as influenced by time of sowing and nitrogen fertilization, 158

Effect of growth regulators on fruit-set, final retention and fruit quality in sweet lime (*Citrus limettoides* Tanaka.), 164

- Water table decline and quality trend in the vicinity of Lower Ghaggar basin, 170
- Effect of thinning on fruit-drop, ripening, fruit quality and yield in Beauty Seedless grapes, 177
- Productivity and water-use of pearl millet in dryland as affected by crop geometry, 181
- Effect of seeding time, seed-rate and row spacing on seed yield and water-use efficiency of dryland gram in South-West Haryana, 186
- Studies on the significance of dew fall at Hisar region, 191
- Influence of irrigation and phosphorus fertilization on arhar and moong crops, 195
- Effect of long term application of farm yard manure and nitrogen. II. Mineral P fractions, 200
- Tomato fruit quality during storage as influenced by nitrogen doses and irrigation intensities, 206
- Studies on *Meloidogyne javanica* (Treub, 1885) Chitwood, 1949 infecting chickpea in Haryana, 213
- Relationship between fruit weight and seed content in grapes, 216
- Bioefficacy and economics of synthetic pyrethroids in cotton under Haryana conditions, 218
- Studies on cross pollination at various distances in rapeseed and mustard, 221
- Relative efficacy of different fungitoxics against *Claviceps fusiformis* (Loveless) *in vitro* and *in vivo*, 279
- Effect of different pollinizers on fruit set, final retention and quality of fruits in sweet lime, 284
- Effect of seeding time and plant geometry on the seed yield and water-use of taramira in dryland, 289
- Morpho-physiological attributes in relation to seed yield in Indian mustard, 295
- Genetic analysis of heading and maturity in barley (*Hordeum vulgare* L.) in a range of environments, 300
- Potato yield in relation to seed size and plant density, 305
- Efficacy of gramoxone, bolls eye and sodium chlorate as defoliants to improve the yield and quality of cotton H 777, 309
- Effect of different heights of stacks of cotton sticks on the survival of overwintering *Pectinophora gossypiella* (Saunders) larvae, 313
- Incidence, biology and nature of damage by *Nephoterix infusella* Mayrick (= *Phycita infusella* Meyrick) on cotton in Haryana, 317

- Interaction between seed rate, crop stand and sowing machinery in cotton, 323
- Effect of seedling treatment and foliar application of cytozyme on growth and yield of tomato, brinjal and chilli, 329
- Interference of *Amaranthus tricolor* with the growth and development of *Vigna radiata*, 336
- Pollination in relation to seed yield in sunflower, 341
- Effect of culture media, temperature and pH on growth and sporulation of fungal foliar pathogens of cotton, 344
- Effect of carbofuran on paddy infected with rice-root nematode, *Hirschmanniella oryzae*, 350
- Gene effects studies of curd compactness in cauliflower, 406
- Effect of girdling on the storage behaviour of grapes, 410
- Evaluation of aldicarb (Temik 10 G) and malathion sprays against aphids in seed crop of radish, 414
- Functional classification of dry agricultural lands of tehsil Bawanikhera of Bhiwani district (Haryana), 418
- Effect of time of sowing on growth and yield of pigeonpea cultivars, 427
- Preliminary classification of broad bean germplasm lines, 431
- Fine sand mineralogy under different landforms of a part of southern Haryana, 436
- Performance of pearl millet hybrids/synthetic varieties under varying plant populations and date of planting, 446
- Numerical approximation of steady state movement of Na^+ in Ca^{2+} saturated soil columns, 451
- Comparative efficacy of some systemic insecticides against sugarcane whitefly, *Aleurolobus barodensis* Mask. (Homoptera : Aleurodidae), 457
- Prevalence of pigeon-pea cyst nematode, *Heterodera cajani* Koshy, 1967 in Bhiwani district (Haryana) along with a new host record, 463
- Reaction of potato varieties and hybrids to early blight disease, 465
- Combining ability and genetic architecture of oil content in Indian mustard, 467
- Carcelia* sp. parasitising *Spilosoma obliqua* (Walker), 471
- Record of isabgol wilt from Haryana, 473

Home Science

- Extent of child labour and its impact on the height and weight of children in rural Haryana, 223

A study of physically handicapped children, 232

Study of self-disclosure in rural and urban boys, 353

Attitude of medical practitioners towards nutrition, 475

Differential knowledge and source utilization pattern of rural and urban mothers regarding child rearing practices, 479

Social Sciences

Vocational interests of final year high school girls, 105

Planning small farms under varying capital, 110

Factors influencing farm modernization in Haryana, 115

Drop-outs among scheduled castes in Haryana, 119

Comparative profile of the rural women key-communicators and their recipients, 236

Pattern of spatial mobility in Haryana : a sociological analysis, 357

Economic efficiency of subsidised loans disbursed under rural development programmes in Haryana, 364

Agricultural Development Officers' perception of suitability of extension education input in their under-graduate training, 374

Effect of regional advancement on the social mobility pattern—a study of rural Haryana, 486

Study of patterns of social interaction among preadolescents, 497

SUBJECT INDEX

- Acetic acid
 - food additives in barley, 271
- Aging of soybean seeds, 260
- Agricultural Development Officers
 - perception of, 374
- Amaranthus tricolor*
 - development, 336
 - growth, 336
- Annual records
 - relative efficiency of, 248
- Antibacterial intrauterine infusions
 - efficacy of, 7
- Antibiotic resistance pattern
 - in *Rhizobium trifolii*, 265
- Arhar
 - influence of irrigation, 195
 - influence of phosphorus fertilization in, 195
- Artificial aging
 - effect of, 141
- Attitude of medical practitioners, 475
- Avena fatua* L.
 - damage reduction, 399
 - gamma irradiated caryopses of, 399
 - gibberellic acid post-treatment, 399
- Barley
 - acetic acid, 271
 - citric acid, 271
 - cytogenetic effects of food additives in, 153, 271
 - genetic analysis of, 300
 - potassium metabisulphite, 271
- Ber
 - nutrient status of, 14
- Ber fruitfly
 - incidence of, 42
- Bioefficacy
 - of synthetic pyrethroids in cotton, 218
- Biology
 - of *Nephoterix infusella*, 317
- Bottle gourd
 - growth regulators in, 36
- Boys
 - rural, 352
 - urban, 352
- Brinjal
 - foliar application of cytozyme, 329
 - seedling treatment, 329
- Broad bean germplasm lines
 - preliminary classification, 431
- Broilers
 - calcium, 126
 - manganese, 126
 - phosphorus, 126
 - zinc retention, 126
- Buffalo
 - endometrial epithelium of, 395
 - estrous cycle, 395
 - histomorphological studies of, 395
- Buffalo calves
 - exercise on peripheral cortisol levels in, 138
- Calcium
 - in broilers, 126
- Capsicum annum*
 - powdery mildew on, 100
- Carcella* sp.
 - parasitising *Spilosoma obliqua*, 471

Castor

- intercropping in, 29

Cauliflower

- curd compactness in, 406
- gene effects of, 406

Chemical composition of sexed birds, 381

Chemical control of *Claviceps fusiformis*, 279

Chickpea

- Meloidogyne javanica*, 213

Child labour

- impact on height, 223
- impact on weight, 223

Child rearing practices, 479

Chilli

- foliar application, 321
- powdery mildew on, 100
- seedling treatment, 329

Chuni

- nutritive value of, 257

Citric acid

- food additives in barley, 271

Citrus

- decline in, 97

Claviceps fusiformis

- chemical control of, 279
- fungitoxicants, 279

Combining ability of mustard, 467

Commercial pullets

- performance of, 1

Cotton

- defoliants effects of, 309
- Pectinophora gossypiella*, 313
- stacks, 313

Cows

- antibacterial intrauterine infusions, 7
- reproductive efficiency, 7

Crop stand in cotton, 323

Cropland ecosystem, 336

Cross pollination

- in mustard, 221
- in rapeseed, 221

Curd compactness

- in cauliflower, 406

Cymbopogon martini var *motia*

- essential oil in, 21

Cytogenetic effects

- of food additives, 153, 271

Damage by *Nephoterix infusella*, 317

Damage reduction

- of *Avena fatua* L., 399

Date of planting of pearl millet, 446

Decline

- in citrus, 97
- of water table, 170

Defoliants

- effect on cotton in, 309

Dew fall, 191

Diets of broilers, 126

Drop-outs

- scheduled castes, 119

Dry-agricultural lands

- functional classification of, 418

Early blight disease of potato, 465

Economic efficiency of subsidised loans, 364

Edible organs of lambs, 133

- Electroanaesthesia
 - physiological changes, 241
- Endometrial epithelium of buffalo, 395
- Energy levels of pullets, 1
- Ephestia cautella*
 - occurrence of, 99
- Essential oil in *Cymbopogon martini* var. *motia*, 21
- Estrous cycle of buffalo, 395
- Farm modernization
 - influencing of, 115
- Farm yard manure
 - long term application of, 200
- Fine sand mineralogy, 436
- Flowering of bottle gourd, 37
- Foliar application
 - on brinjal, 329
 - on chilli, 329
 - on tomato, 329
- Food additives
 - in barley, 153, 271
- Food dyes
 - in barley, 153
- Free fatty acids, 141
- Fruit drop
 - grapes, 177
- Fruit set
 - in sweet lime, 164, 284
- Fruit weight
 - in grapes, 216
- Fruiting
 - of bottle gourd, 36
- Functional classification
 - of dry agricultural lands, 418
- Fungal foliar pathogens
 - of cotton, 344
- Gamma irradiated caryopses
 - of *Avena fatua* L., 399
- Gene effects
 - in cauliflower, 406
- Genepool
 - pearl millet, 64
- Genetic analysis
 - in barley, 300
- Gibberellic acid post-treatment
 - of *Avena fatua* L., 399
- Girdling of grapes, 410
- Glycolipids
 - seed aging, 260
- Gram
 - row spacing, 186
 - seed rate, 186
 - seed yield, 186
 - seeding time, 186
 - water-use efficiency, 186
- Grapes
 - fruit drop, 177
 - fruit quality, 177
 - fruit ripening, 177
 - fruit weight, 216
 - seed content, 216
 - yield, 177
- Growth
 - of brinjal, 329
 - of chilli, 329
 - of pigeonpea, 427
 - of tomato, 329
- Growth regulators
 - of bottle gourd, 36
 - of sweet lime, 164

- Handicapped children, 232
- Heading in barley, 300
- Heliothis armigera*
 - in seed crop of onion, 102
- Heterodera cajani*
 - prevalence of, 467
- Hirschmanniella oryzae*, 350
- Histomorphological studies
 - of buffalo, 395
- Hydrolytic enzymes
 - of *Rhizobium trifolii*, 403
- Immobilised amyloglucosidase
 - kinetics of, 26
- In vitro*
 - Claviceps fusiformis*, 279
- In vivo*
 - Claviceps fusiformis*, 279
- Incidence of
 - ber fruitfly, 42
 - Nephoterix infusella*, 317
- Insecticides
 - against sugarcane whitefly, 457
- Intercropping in castor, 29
- Irrigation influence
 - on arhar crop, 195
 - on moong crop, 195
 - on tomato, 206
- Irrigation production functions, 51
- Isabgol wilt, 473
- Key communicators
 - rural women, 236
- Kinetics
 - of immobilised amyloglucosidase, 26
 - of soluble amyloglucosidase, 26
- Lambs
 - edible organs, 133
 - non-edible organs, 133
- Leaf diffusive resistance
 - in wheat, 70
- Lemon cuttings
 - rooting of, 77
- Lipase levels of, 141
- Lipid levels of, 141
- Management of soils, 57
- Manganese in broilers, 126
- Maturity in barley, 300
- Medical practitioners
 - attitude towards nutrition, 475
- Methionine content
 - in *Phaseolus*, 15
 - in *Vigna* spp., 15
- Mineral P fractions, 200
- Mineralogy of fine sands, 436
- Moisture stress of mustard, 82
- Moong
 - influence of irrigation, 195
 - phosphorus fertilization, 195
- Morphological attributes
 - in mustard, 295
- Mothers
 - rural, 479
 - urban, 479
- Mungbean
 - nodules of, 148
 - plant genotype, 148
 - rhizobial strain, 148
- Mustard
 - cross pollination, 221
 - moisture stress of, 82

- nitrogen levels of, 82
- oil yield of, 82, 467
- seed yield, 295
- sowing methods of, 82
- Nature of damage**
 - by *Nephoterix infusella*, 317
- Nephoterix infusella*
 - of cotton, 317
- Nitrogen application**
 - long term application, 200
- Nitrogen levels**
 - of mustard, 82
 - of paddy, 87
 - of wheat, 148
- Nodules**
 - of mungbean, 148
- Non-edible organs**
 - of lambs, 133
- Non-nodulating strains**
 - of *Rhizobium trifolii*, 403
- Numerical approximation**
 - of steady state movement, 451
- Nutrient status**
 - of ber, 94
 - of chuni, 257
- Nutrition**
 - attitude of medical practitioners, 475
- Occurrence of *Ephestia cautella*, 99**
- Oil yield**
 - of mustard, 82, 467
- Onion**
 - seed crop of, 102
- Paddy**
 - nitrification inhibitors of, 87
 - nitrogen sources, 87
- Pearl millet**
 - crop geometry, 181
 - gene pool, 64
 - productivity, 181
 - water-use, 181
- Pectinophora gossypiella* larvae
 - of cotton stacks, 313
- Perception**
 - of Agricultural Development Officers, 374
- Peripheral cortisol levels**
 - in buffalo calves, 138
- Phaseolus*
 - methionine content, 15
 - tryptophan content, 15
 - variability in protein, 15
- Phosphorus**
 - in broilers, 126
- Phosphorus fertilization**
 - on arhar, 195
 - on moong, 195
- Physical measurement**
 - of sexed birds, 381
- Physically handicapped children, 232**
- Physiological attributes in mustard, 295**
- Physiological changes**
 - electroanaesthesia, 241
- Pigeonpea**
 - growth, 427
 - sowing, 427
 - yield, 427
- Pigeonpea cyst nematode**
 - prevalence of, 463
- Planning small farms, 110**
- Plant density**
 - of potato, 305

Plant genotype

- of mungbean, 148

Plant geometry

- of taramira, 281

Plant population

- of pearl millet, 446

Plasmid curing

- in *Rhizobium trifolii*, 265

Pollination

- in sunflower, 341

Pollinizers

- in sunflower, 341
- in sweet lime, 284

Potassium metabisulphite

- food additives in barley, 271

Potato

- early blight disease, 465
- plant density, 305
- seed size, 305

Powdery mildew

- on *Capsicum annum*, 100

Pre-adolescents

- social interactions, 497

Preliminary classification

- of broad bean germplasm lines, 431

Problems

- of soils, 57

Productivity

- of castor, 29
- of pearl millet, 181

Protease, 1

- levels of, 141

Protein levels

- of commercial pullets, 1

Protein variability

- in *Phaseolus*, 15
- in *Vigna* spp., 15

Quails

- effect of coloured lights on, 10

Quality

- of mustard, 82
- of sweet lime, 284
- of water, 170

Radish

- aphids in seed crops of, 414

Rape seed

- cross pollination, 221

Regional advancement

- effect on social mobility pattern, 486

Relative efficiency

- of annual records, 248
- selection, 248

Reproductive efficiency

- in postpartum cows, 7

Reproductive performance

- of cows, 10
- of quails, 10

Retention

- in sweet lime, 164

Rhizobial strain

- of mungbean, 148

Rhizobium trifolii

- antibiotic resistance pattern, 265
- hydrolytic enzymes in, 403

Ribonuclease

- levels of, 141

Rice-root nematode

- control of, 380

- Ripening
 - of grapes, 177
- Rooting
 - of lemon cuttings, 77
- Row spacing
 - of gram, 186
- Rural Development Programmes
 - in Haryana, 364
- Rural women
 - key communicators, 236
 - recipients, 236
- Saturated soil columns, 451
- Scheduled castes
 - drop-outs in, 119
- School girls
 - vocational interests of, 105
- Seed content
 - in grapes, 216
- Seed crop of onion
 - Heliothis armigera* in, 102
- Seed crop of radish
 - control of, 14
- Seed rate
 - of cotton, 323
 - of gram, 186
- Seed size
 - of potato, 305
- Seed time
 - of taramira, 289
- Seed yield
 - of gram, 186
 - of mustard, 295
 - of sunflower, 341
 - of taramira, 289
- Seedling treatment
 - of brinjal, 329
 - of chilli, 329
 - of tomato, 329
- Self disclosure
 - in rural boys, 352
 - in urban boys, 352
- Sexed birds
 - chemical composition of, 381
 - cooking loss, 381
 - physical measurement, 381
- Small farms planning, 110
- Social interactions
 - of pre-adolescents, 497
- Social mobility pattern
 - effect of regional advancement, 486
- Sociological analysis
 - of spatial mobility in, 357
- Soils
 - management, 57
 - problems, 57
- Soluble amyloglucosidase
 - kinetics of, 26
- Sowing
 - of wheat, 158
- Sowing machinery
 - in cotton, 323
- Sowing methods
 - of mustard, 82
- Soybean seeds
 - aging, 260
 - glycolipids, 260
 - storage, 141, 260
- Spatial mobility
 - sociological analysis, 357

Storage

- of grapes, 10
- of tomato, 206

Storage potential

- soybean seeds differing in, 141

Subsidised loan disbursement

- economic efficiency of, 364

Sugarcane whitefly

- insecticides against, 457

Sunflower

- pollination in, 341
- seed yield in, 341

Sweet lime

- fruit set, 164
- growth regulators, 164
- pollinizers, 284
- quality, 164

Synthetic pyrethroids in cotton

- bioefficacy of, 218
- economics of, 218

Taramira

- seed yield, 288
- seeding time, 289
- water-use, 289

Tomato

- irrigation intensities, 206
- nitrogen doses, 206
- quality, 206
- seedling treatment, 329
- storage, 206
- yield, 321

Tryptophan content

- in *Phaseolus*, 15
- in *Vigna* spp., 15

Vigna radiata

- development, 336
- growth, 336

***Vigna* spp.**

- methionine content, 15
- tryptophan content, 15
- variability in protein, 15

Vocational interests

- of school girls, 105

Water table

- decline, 170
- quality, 170

Water-use efficiency

- in castor, 29
- of gram, 186
- of pearl millet, 181
- of taramira, 289

Wheat

- grain growth, 158
- leaf diffusive resistance in, 71
- nitrogen fertilization, 158
- sowing, 158

Wild-type strains

- of *Rhizobium trifolii*, 403

Yield

- in brinjal, 321
- in castor, 29
- in chillies, 329
- in grape, 177
- of pigeonpea, 427
- of tomato, 329

Zinc retention

- in broilers, 126

AUTHOR INDEX

- AGARWAL, S., 479
 AGARWAL, S. K., 82, 191
 AGARWAL, S. P., 138
 AGARWAL, V. K., 138
 AGGARWAL, C. K., 10, 381
 AGGARWAL, R. K., 271
 AHLAWAT, V. P., 94, 97, 216
 ANTIL, R. S., 87, 200
 ARORA, R. K., 77, 97, 164, 284
 ARORA, S. K., 36
 ASHOK KUMAR, 26
 BAINIWAL, C. R., 300
 BAJAJ, Harish K., 463
 BANGARWA, B. S., 115
 BANSAL, N. K., 323
 BASWANA, K. S., 36
 BATRA, B. R., 206
 BATRA, M. L., 195
 BHAGWAN SINGH, 15
 BHANOT, J. P., 414
 BHASKAR, Arun, 336
 BHAT, C. M., 475
 BHATNAGAR, D. K., 206
 BHATTI, D. S., 350
 CHAND, J. N., 100
 CHAUDHARY, J. P., 457
 CHAUDHARY, Kamla, 403
 CHAUDHARY, M. K., 381
 CHAUHAN, M. S., 344, 465
 CHAUHAN, V. S., 94, 177
 CHHABRA, Ashok, 431
 CHHIKARA, B. S., 248
 CHHIKARA, O. P., 364
 CHOPRA, S. C., 248
 CHOPRA, S. K., 381
 CHUGH, B. P., 186, 289
 DAK, T. M., 357, 486
 DALEL SINGH, 87
 DAMYANTI, 236
 DAYA RAM, 418
 DHANGAR, D. S., 213
 DHIMAN, S. D., 71, 158
 DHINDSA, K. S., 21
 DHINGRA, K. K., 427
 DIXIT, V. B., 374
 DUGGAL, K. N., 51
 DWARAKNATH, P. K., 138
 GARALAPURI, V. N., 436
 GILL, P. S., 446
 GOYAL, V. P., 436
 GUPTA, D. C., 213, 463
 GUPTA, J. N., 457
 GUPTA, O. P., 410
 GUPTA, R. C., 7
 GUPTA, S. K., 467
 GURMEET SINGH, 427
 HARCHARAN SINGH, 395
 HARI SINGH, 221, 295, 341
 HARIWIR SINGH, 241
 HIRA NAND, 236, 374
 HOODA, R. S., 329
 JAGDEV SINGH, 195
 JAIN, M. L., 323
 JASBIR KAUR, 223
 JATASRA, D. S., 300
 JOGINDER SINGH, 170
 JOSHI, S., 451
 KADIAN, R. S., 115
 KAIRON, M. S., 309
 KALRA, V. K., 471
 KAPOOR, A. K., 451
 KARWASRA, R. R., 300

KARWASRA, S. P. S., 57
 KASHYAP, R. K., 102, 414
 KASHYAP, Saroj, 105
 KHAIRWAL, J. K., 119
 KHAN, G. M., 82
 KHARANGAR, Shanti Devi, 232
 KHEPER, S. D., 51
 KHIRWAR, S. S., 257
 KUHAD, M. S., 57
 KUMAR, K., 105
 LAHARIA, S. N., 223
 LAKRA, R. K., 42
 LAL, S., 305, 414
 LATHER, V. S., 221, 295
 MAAN, R. S., 248
 MADAAN, R. L., 473
 MAHENDRA SINGH, 87, 200, 436
 MAHERCHANDANI, N., 399
 MAKHIJA, V. K., 374
 MALIK, B. S., 195
 MALIK, O. P., 21
 MALIK, V. S., 99
 MALIK, Y. S., 305
 MANJU, T. S., 7
 MAVI, H. S., 427
 MEHRA, Hari Om, 153, 271
 MEHRA, Savita, 357, 486
 MEHTA, N., 64
 MEHTA, Naresh, 473
 MEHTA, Neena, 410
 NAGWEKAR, S. N., 309
 NAIDU, Madupuri R., 431
 NAINAWATEE, H. S., 26, 148
 NANDAL, A. S., 99, 218, 313
 NATH, M., 223, 232
 NEOG, Sabita Jyoti, 406
 PAHIL, V. S., 279
 PAI, S. D., 309
 PALIWAL, V. K., 257
 PANDEY, U. C., 414
 PANDEY, U. K., 364
 PANDITA, M. L., 36, 102, 206, 305, 329, 406
 PANGHAL, B. S., 110
 PARKASH KUMAR, 467
 PARODA, R. S., 21
 PHOGAT, Suraj Bhan, 10
 PHOOL SINGH, 71
 PRAVEEN KAUR, 497
 PRUTHI, S. P., 381
 PUNIA, S., 353
 RAJ PAL, 451
 RAJ SINGH, 115, 119
 RANA, O. P. S., 15
 RANVIR KUMAR, 51, 170
 RAO, A. S., 141, 148, 260
 RAO, V. Umamaheswara, 191
 RUHAL, D. S., 200
 SAINI, Luxmi Chand, 100
 SAINI, R. K., 218, 317
 SAINI, S. L., 446
 SANGWAN, J. P., 57
 SANGWAN, K. S., 133
 SANGWAN, N. K., 21
 SARDANA, P. K., 110
 SAREEN, P. K., 153, 271
 SAXENA, V. P., 1, 125
 SHARMA, B. K., 344
 SHARMA, D. K., 241
 SHARMA, D. N., 323, 395
 SHARMA, G. D., 21
 SHARMA, H. C., 29, 158, 186, 289
 SHARMA, M. L., 357, 486, 497
 SHARMA, S. S., 216
 SHARMA, Suneel, 216, 410
 SHRI RAM, 133

SIDHU, A. S., 329	VASUDEVA, M., 399
SINGH, B. P., 29, 181, 186, 289	VERMA, S. K., 7
SINGH, D., 148	VERMA, T., 479
SINGH, D. P., 71, 158	VERMA, T. R., 353
SINGH, K. P., 305	VINOD KUMAR, 87
SINGH, R., 148	VIRESHWAR SINGH, 309
SINGH, V. P., 71, 431	VYAS, Kalpana G., 336
SINGHAL, B. K., 336	WAGLE, D. S., 141, 260
SINHA, A. K., 7	WALIA, R. K., 350, 463
SUHAG, K. S., 364	YADAV, A. K., 295, 341
SUNEJA, Neeraj, 475	YADAV, A. S., 265, 403
THAKRAL, K. K., 305	YADAV, K. R., 257
THAKRAL, S. K., 467	YADAV, S. R., 457
THAKUR, D. P., 64, 279, 473	YADAVA, T. P., 221, 295, 467
THAKUR, R. S., 1	YAMDAGNI, R., 77, 94, 97, 164, 284,
UMED SINGH, 7	410
VASHISHAT, R. K., 265, 403	ZILE SINGH, 42, 99, 218, 313
VASHISTHA, R. N., 406	