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## GENETIC VARIABILITY FOR SOME QUANTITATIVE CHARACTERS IN WHEAT

JITENDER KUMAR and O. P. LUTHRA

Department of Genetics

CCS Haryana Agricultural University, Hisar - 125 004

(Accepted : November 9, 1994)

### ABSTRACT

Genotypic and phenotypic coefficient of variabilities, heritability, and genetic advance in two crosses of four wheat varieties, have been reported. High heritability was found for all the characters except for 1000-grain weight in cross HD 2009 × Sonalika. Genetic advance was the highest for biological yield in both the crosses. Estimates of both genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were high for yield per plant in cross HD 2329 × Kalyan Sona.

The main aim in wheat breeding is to develop genotypes for the improvement of yield under diverse agro-climatic conditions. Grains per spike and 1000-grain weight are the most important components of yield (Luthra and Maherchandani, 1993). Moreover, the traits should be so selected that an advance in one component is not nullified by another (Sheoran *et al.*, 1986). Therefore, in order to develop high yielding genotypes the most widely used procedure is the hybridization of diverse material having complementary characteristics and the variability present in the material. Keeping this in view, the present study was conducted to find out the genetic variability, heritability, and genetic advance of yield components and some physiological contributors of yield in two crosses of four wheat varieties.

### MATERIAL AND METHODS

The study was carried out at the Research Farm of CCS Haryana Agri-

cultural University, Hisar. The four varieties of wheat, *viz.*, HD 2329, Kalyan Sona, HD 2009 and Sonalika were involved in two crosses, *i. e.* HD 2329 × Kalyan Sona, and HD 2009 × Sonalika, and were utilized for creating different generations. The varieties and their F<sub>1</sub>'s were crossed and selfed to produce F<sub>1</sub>, F<sub>2</sub> and back cross generations. BC<sub>1</sub>'s and BC<sub>2</sub>'s were selfed. The result of these crossings produced nine generations, *viz.* P<sub>1</sub>, P<sub>2</sub>, F<sub>1</sub>, F<sub>2</sub>, F<sub>3</sub>, BC<sub>1</sub>, BC<sub>2</sub>, BC<sub>1</sub>S and BC<sub>2</sub>S generations. The final experiment was conducted in randomized block design with three replications. The plot size was a single row of one metre length with plant to plant and row to row distances of 10 and 30 cm, respectively. The number of plants sampled were 10 for P<sub>1</sub>, P<sub>2</sub>, F<sub>1</sub>, BC<sub>1</sub> and BC<sub>2</sub>; 40 for F<sub>2</sub>; 50 for F<sub>3</sub>, BC<sub>1</sub>S and BC<sub>2</sub>S. Five competitive plants were selected at random from each row for observations on various characters. Observations were recorded for grain yield per plant (g), number of spikes/

plant, number of grains per spike, 1000-grain weight (g), days to ear emergence, peduncle length (cm), biological yield (g) and harvest index (per cent). Genetic advance was estimated by using the formula given by Allard (1960). Genotypic and phenotypic coefficients of variation (GCV and PCV) were obtained according to Burton (1951). Heritability was estimated by the formula given by Warner (1952).

### RESULTS AND DISCUSSION

Analysis of variance indicated considerable amount of variation among parents and their different generations for various quantitative as well as physiological traits (Tables 1 and 2). Peduncle length showed the highest heritability in cross HD 2329×Kalyan Sona, whereas harvest index showed the highest heritability in cross HD 2009×Sonalika. Spike number showed

the lowest heritability in cross HD 2329×Kalyan Sona, whereas it was the lowest for 1000-grain weight in cross HD 2009×Sonalika. In the present study, high heritability was associated with low genetic advance for all the characters in both the crosses except for 1000-grain weight in cross HD 2009×Sonalika, whereas low heritability was associated with low genetic advance. Similar results have been reported by Singh *et al.* (1987). Moderate heritability was associated with low genetic advance in cross HD 2009×Sonalika for number of grains per spike. Since heritability in narrow sense has direct correspondence with the magnitude of additive gene effects, the simple selection would be effective for all the traits because all the traits have high heritability. However, the extent of improvement of character would be dependent not only on heritability alone but also the extent of phenotypic

TABLE 1

Estimates of phenotypic and genotypic coefficients of variability (PCV and GCV), heritability ( $h^2$ ) and genetic advance for yield and some physiological characters in cross HD 2329×Kalyan Sona

Character	PCV (%)	GCV (%)	$h^2$	Genetic advance as percentage of mean
Yield per plant	24.51	18.94	63.93	5.26
Spike number	23.36	15.70	43.69	2.31
Number of grains per spike	7.19	6.81	68.15	2.90
1000-grain weight	8.10	6.70	51.88	3.75
Days to ear emergence	3.73	3.54	58.99	3.37
Flag leaf area	16.64	14.15	72.59	4.41
Grain filling period	9.61	8.83	62.63	3.97
Peduncle length	8.79	8.19	75.60	4.85
Biological yield	23.66	18.26	56.00	5.65
Harvest index	8.17	2.97	51.16	4.00

GENETIC VARIABILITY IN WHEAT

TABLE 2

Estimates of phenotypic and genotypic coefficients of variability (PCV and GCV), heritability ( $h^2$ ), and genetic advance for yield and some physiological characters in cross HD 2009 × Sonalika

Character	PCV (%)	GCV (%)	$h^2$	Genetic advance as percentage of mean
Yield per plant	16.01	10.43	64.93	3.66
Spike number	14.77	9.07	76.76	3.36
Number of grains per spike	14.02	9.22	41.11	5.24
1000-grain weight	10.56	9.19	20.63	1.49
Days to ear emergence	1.87	1.61	74.17	3.65
Flag leaf area	15.83	15.08	66.81	4.05
Grain filling period	9.34	5.55	68.31	3.94
Peduncle length	6.68	5.11	22.07	1.59
Biological yield	20.98	13.65	50.37	6.42
Harvest index	12.26	7.65	77.12	5.10

variation in the population where selection is to be made. Therefore, high heritability in relation to genetic advance should be viewed before deciding the intensity and direction of selection pressure to be exerted. In the present study, high heritability accompanied by low genetic advance figured important in determining the inheritance of characters included in the present study. Genetic advance for these characters would be difficult by simple selection. If a low magnitude of genetic advance is found with high degree of heritability, the amount of phenotypic variance is

also low. This indicated that direct selection on yield *per se* would not be proper for the improvement of such populations and due weightage may be given for different yield components. So it is suggested that the degree of heritability should not be taken as a sole criterion for drawing conclusions about the expected genetic gain. Similar conclusions were also drawn by Johnson *et al.* (1955), who suggested that heritability estimate along with expected genetic advance is usually more helpful than the heritability value alone.

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## GENETIC DIVERGENCE AND HETEROSIS IN PIGEONPEA (*CAJANUS CAJAN* (L.) MILLSP.)

B. P. S. MALIK\*, S. SINGH and V. P. SINGH

Department of Plant Breeding

CCS Haryana Agricultural University, Hisar - 125 004

(Accepted : December 12, 1994)

### ABSTRACT

Fifteen  $F_1$  hybrids and their six parents were evaluated for genetic divergence and heterosis. All the 21 genotypes could be grouped into seven clusters. Cluster I was the largest comprising nine genotypes. Cluster III had most divergent genotypes and showed maximum mean value for grain yield/plant, plant spread, branches/plant, and number of seeds/pod. Genetic divergence was not related to geographic diversity. The cross EE 76  $\times$  UPAS 120 exhibited maximum degree of heterosis. There was a good agreement between the extent of heterosis shown by the  $F_1$  hybrids and the genetic distance between their parents.

The use of the genetically divergent parents in hybridization is considered as a basic step in crop improvement programmes. More the diversity among the parents, the greater are the chances of achieving high heterotic expression in  $F_1$ s. The present study was, therefore, undertaken to determine the extent of heterosis and to measure genetic divergence in pigeonpea.

### MATERIAL AND METHODS

Six pigeonpea genotypes were crossed in all possible combinations excluding reciprocals. Fifteen  $F_1$  hybrids and their six parents were grown in randomized block design with three replications during kharif 1992 at CCSHAU Regional Research Station, Kaul. Each entry was raised in one

row of three metre length with row to row distance of 60 cm and plant to plant distance of 20 cm. Observations were recorded on 11 characters, viz. days to flower initiation, days to maturity, plant height (cm), plant spread (cm), branches/plant, clusters/plant, pods/plant, pods/cluster, seeds/pod, 100-seed weight (g), and grain yield/plant (g). Multivariate analysis using Mahalanobis  $D^2$  statistics (Mahalanobis, 1928) was carried out as described by Rao (1952) to measure the genetic divergence. Heterosis was measured as deviation of  $F_1$  from the better parent.

### RESULTS AND DISCUSSION

Based on  $D_2$  values, the 21 genotypes could be grouped into seven

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\*CCSHAU Regional Research Station, Kaul - 132 021.

clusters (Table 1) suggesting that the genetic divergence was substantial. Cluster I was the largest with nine genotypes followed by clusters II and III with four genotypes each. Each of the remaining four clusters had single genotype. Different parents found place in different clusters except Pant A 3 and H 73-20 which were together in cluster II. Cluster I included single parent H 72-44 and eight F<sub>1</sub> hybrids involving all the six parents. The cluster II had Pant A 3, H 73-20, their F<sub>1</sub> and hybrid UPAS 120×H 72-44. Similarly, cluster III included Prabhat, its cross with UPAS 120 along with two other crosses EE 76×UPAS 120, and EE 76×H 73-20. Rest of the genotypes (EE 76, UPAS 120 and

crosses EE 76×Prabhat, and EE 76×H 72-44) made four separate clusters. These results indicate that parents and their hybrids because of their different gene combinations did not necessarily come in the same cluster. Further, genotypes possessing similar gene combinations but different geographic origins may fall in the same cluster, *i. e.* no relationship between genetic divergence and geographic distance. Other workers (Beniwal and Jatasra, 1980; Malik *et al.*, 1985) have reported that geographic distribution and genetic diversity were not directly related. Singh and Ramanujam (1981) also noted the tendency of hybrids and their parents being distributed in different clusters.

TABLE 1  
Clustering of 21 pigeonpea genotypes

Cluster No.	Number of entries	Genotypes
I	9	4, 1×5, 2×5, 2×6, 3×4, 3×5, 3×6, 4×5, 4×6
II	4	5, 6, 2×4, 5×6
III	4	3, 1×2, 1×6, 2×3
IV	1	1
V	1	2
VI	1	1×3
VII	1	1×4

1—EE 76 (ICRISAT), 2—UPAS 120 (Pantnagar), 3—Prabhat (Kanpur), 4—H 72-44 (Hisar),  
5—Pant A 3 (Pantnagar), 6—H 73-20 (Hisar).

TABLE 2  
Average intra- (diagonal) and inter-cluster D<sup>2</sup> values among 21 pigeonpea genotypes

Cluster	I	II	III	IV	V	VI	VII
I	64.52	110.51	144.96	311.06	836.12	371.76	158.99
II		70.14	100.30	199.35	859.66	397.54	184.23
III			72.11	130.45	979.29	462.96	225.45
IV				0.00	1530.42	885.31	497.63
V					0.00	126.83	431.58
VI						0.00	118.88
VII							0.00

GENETIC DIVERGENCE AND HETBROSIS IN PIGEONPEA

TABLE 3

Cluster means for 11 traits in pigeonpea

Cluster	I	II	III	IV	V	VI	VII
Days to flower initiation	91.0	82.0	80.0	58.0	85.0	70.0	90.0
Days to maturity	135.0	130.0	124.0	110.0	130.0	115.0	134.0
Plant height (cm)	186.0	198.3	187.9	138.5	228.7	138.7	172.6
Plant spread (cm)	38.5	47.8	57.2	24.9	52.5	36.4	45.3
Branches/plant	10.2	10.0	13.6	5.6	9.7	9.1	11.3
Clusters/plant	76.4	91.7	164.7	21.5	186.4	67.3	73.1
Pods/plant	257.0	358.5	400.7	79.6	497.6	225.3	335.3
Pods/cluster	3.7	4.0	4.0	3.3	3.5	3.4	4.0
Seeds/pod	3.5	3.3	3.6	3.5	3.5	3.5	3.3
100-seed weight (g)	7.9	6.2	6.7	6.4	6.3	6.8	8.4
Grain yield/plant (g)	72.6	81.2	118.3	25.7	63.1	80.8	91.5

TABLE 4

Genetic distance between parents and degree of heterosis in 15 hybrids of pigeonpea

Cross	Genetic distance	Heterosis over better parent	Per cent over check
EE 76 × UPAS 120	39.12	153.6	153.6
EE 76 × Prabhat	11.42	68.7	28.3
EE 76 × H 72-44	12.00	87.1	45.0
EE 76 × Pant A 3	10.50	52.5	39.0
EE 76 × H 73-20	10.50	109.2	108.9
UPAS 120 × Prabhat	31.30	111.9	111.9
UPAS 120 × H 72-44	28.90	108.7	108.7
UPAS 120 × Pant A 3	29.32	49.3	49.3
UPAS 120 × H 73-20	29.32	-0.6	-0.6
Prabhat × H 72-44	12.00	132.3	50.9
Prabhat × Pant A 3	10.00	-0.4	-9.4
Prabhat × H 73-20	10.00	-12.9	-13.0
H 72-44 × Pant A 3	10.50	50.9	37.6
H 72-44 × H 73-20	10.50	4.8	4.6
Pant A 3 × H 73-20	0.00	14.8	14.6

Average intra- and inter-cluster  $D^2$  values have been presented in Table 2. The intra-cluster  $D^2$  value was maximum in cluster III followed by cluster II. The inter-cluster  $D^2$  value was maximum between clusters IV and V followed by between clusters III and V. This value was also high between clusters IV and VI, between II and V and between clusters I and V. This indicates that the genotypes falling in these clusters were highly divergent from each other. The minimum  $D^2$  value was observed between clusters II and III indicating that the genotypes falling in these clusters were least divergent.

The cluster means for 11 characters are given in Table 3. Considerable differences in the cluster means were found for most of the characters. The cluster III with four genotypes had maximum plant spread, grain yield/plant, branches/plant, and seeds/pod. This cluster also had fairly high number of clusters/plant, pods/plant and pods/cluster. However, maximum mean values for number of clusters/plant and pods/plant were observed in cluster V with only one genotype (UPAS 120). The cross EE 76×H 72-44 falling in cluster VII showed maximum seed weight. The minimum values for grain yield, plant spread, branches per plant, clusters/plant, pods/plant and pods/cluster were found in cluster IV. These results indicate that the genotypes falling in clusters III and V were most divergent for grain yield and its important component characters. These

genotypes (Prabhat, UPAS 120, EE 76×UPAS 120, EE 76×H 73-20, UPAS 120×Prabhat) may be exploited in pigeonpea breeding programmes for creating desirable genetic variability and involving superior varieties.

Genetic distances between the parents of 15 hybrids and the degree of heterosis over better parent and over check variety are presented in Table 4. The data reveal that there was good agreement between the genetic distance and the extent of heterosis shown by some  $F_1$  hybrids. For example, the  $F_1$  of the cross EE 76×UPAS 120, involving most divergent parents, also exhibited highest degree of heterosis. A similar situation was found for the hybrids UPAS 120×Prabhat, and UPAS 120×H 72-44. The cross combinations involving less divergent parents generally showed low heterosis. However, the cross UPAS 120×H 73-20 though involved divergent parents, exhibited no heterosis. Similar results were reported by other workers (Anand and Murty, 1968; Singh and Ramanujam, 1981). Such a situation may arise when majority of the dominant alleles are present in one parent and majority of the recessive alleles in the other parent and there is no overdominance.

The cross EE 76×UPAS 120 showing highest heterotic response was subjected to an intensive selection for six generations. Two similar lines produced from this cross performed significantly better than the checks UPAS 120 and Manak.

## GENETIC DIVERGENCE AND HETEROSIS IN PIGEONPEA

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## RESPONSE OF CHICKPEA TO WATER DEFICITS AND DROUGHT STRESS

S. N. GUPTA, B. S. DAHIYA, B. P. S. MALIK and N. R. BISHNOI

Department of Plant Breeding

CCS Haryana Agricultural University, Hisar - 125 004

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### ABSTRACT

The study was conducted to identify some characters other than yield that may be advantageous under drought stress. For this 33 chickpea genotypes were grown in polythene bags filled with sand under irrigated and non-irrigated (pre-sown irrigation only) environments. There was considerable amount of genetic variability for all the characters under both the environments. There was an increase in number of leaflets per leaf with decrease in leaf area as a consequence of increased soil moisture stress. The correlation study indicated that under severe prolonged water stress condition, water consuming activities like increase in height, leaf area and leaf dry weight should be decreased and in their place number of small leaves and branches per plant should be increased to delay the anthesis.

In recent years, considerable attention has been given to physiological characters rather than yield for selection of variety that may be advantageous under drought. Morgan (1984) reported that physiological or morphological characters can be identified and shown to improve the drought resistance of the crop and if the character and yield are separately inherited, incorporation of such character into a high yielding line should improve the crop's yield under drought. Thus, present investigation was conducted to identify some characters as well as to understand characters related to drought.

### MATERIAL AND METHODS

In greenhouse, 33 diverse chickpea genotypes were grown in polythene

bags (64 cm × 21 cm) filled with sand under two environments, *i. e.* irrigated (E<sub>1</sub>) and non-irrigated (E<sub>2</sub>, only pre-sowing irrigation). Complete randomized block design was adopted with three replications. Each experimental plot comprised nine plants in three polythene bags. Observations were recorded for 10 morpho-physiological characters (Table 1). Out of these 10 characters, four characters, *viz.* plant height, leaflets number, leaf area, and leaf dry weight of 4th and 5th leaf from the top were recorded at three stages, *viz.* 50 days (S<sub>1</sub>), 65 days (S<sub>2</sub>) and 80 days (S<sub>3</sub>). Remaining characters were recorded at the termination of the experiment (90 days).

### RESULTS AND DISCUSSION

The analysis of variance for all the morpho-physiological characters

**TABLE 1**  
**Mean squares for various morpho-physiological characters among 33 chickpea genotypes grown in E<sub>1</sub> and E<sub>2</sub> environments**

Character	Stage	Replication (2) <sup>†</sup>			Genotype (32) <sup>†</sup>			Error (64) <sup>†</sup>		
		E <sub>1</sub>	E <sub>2</sub>	E <sub>3</sub>	E <sub>1</sub>	E <sub>2</sub>	E <sub>3</sub>	E <sub>1</sub>	E <sub>2</sub>	E <sub>3</sub>
Plant height (cm)	S <sub>1</sub>	0.293	0.196	0.196	108.825**	118.271**	0.993	1.134	0.993	1.134
	S <sub>2</sub>	3.866	6.538	6.538	160.840**	120.328**	2.191	1.219	2.191	1.219
	S <sub>3</sub>	7.580	0.345	0.345	141.186**	112.302**	3.046	1.977	3.046	1.977
Leaflets number/leaf	S <sub>1</sub>	0.394	0.132	0.132	2.080**	3.395**	0.238	0.267	0.238	0.267
	S <sub>2</sub>	0.283	0.676	0.676	1.940**	3.445**	0.241	0.242	0.241	0.242
	S <sub>3</sub>	0.041	0.192	0.192	3.397**	2.343**	0.592	0.338	0.592	0.338
Leaf area (cm <sup>2</sup> )	S <sub>1</sub>	0.098	0.011	0.011	5.685**	1.491**	0.165	0.021	0.165	0.021
	S <sub>2</sub>	0.003	0.012	0.012	5.627**	1.306**	0.051	0.003	0.051	0.003
	S <sub>3</sub>	0.002	0.006	0.006	1.823**	0.433**	0.011	0.004	0.011	0.004
Leaf dry weight (mg)	S <sub>1</sub>	0.038	0.026	0.026	113.338**	35.984**	0.092	0.018	0.092	0.018
	S <sub>2</sub>	0.131	0.137	0.137	183.095**	77.490**	0.223	1.640	0.223	1.640
	S <sub>3</sub>	0.035	0.086	0.086	42.065**	18.259**	0.025	0.036	0.025	0.036
Leaves/plant	90 days	263.350	89.815	89.815	4322.120**	1700.508**	200.864	118.360	200.864	118.360
Branches/plant	90 days	0.071	0.253	0.253	56.544**	13.035**	0.560	0.586	0.560	0.586
Root dry weight/plant (mg)	90 days	12230.000	38.500	38.500	472972.500**	74958.250**	6048.120	30.250	6048.120	30.250
Shoot dry weight/plant (mg)	90 days	36750.000	5875.000	5875.000	4419412.500**	319142.500**	81295.312	5468.594	81295.312	5468.594
Root/shoot weight ratio	90 days	0.002	0.001	0.001	0.029**	0.013**	0.001	0.001	0.001	0.001
Days to first bloom		8.525	1.730	1.730	573.353**	293.835**	2.369	0.456	2.369	0.456

<sup>†</sup>represents d. f.

\*Significant at p=0.05;

\*\*Significant at p=0.01.

recorded under  $E_1$  and  $E_2$  environments is presented in Table 1. Under both the environments, the mean squares due to genotypes for all the observations were highly significant. Of the two environments, the values of mean squares for  $E_1$  were, in general, higher than  $E_2$  environment.

The phenotypic and genotypic correlation coefficients between different morpho-physiological characters for two environments  $E_1$  and  $E_2$  (Tables 2 and 3) revealed that genotypic correlation coefficients were higher than their corresponding phenotypic correlation coefficients. The correlation coefficients among four characters, *viz.* plant height, number of leaflets/leaf, leaf area, and leaf dry weight studied at  $S_1$ ,  $S_2$  and  $S_3$  stages further revealed that magnitude of correlations, in general, was high for  $S_1$  and  $S_2$  stages under both the environments.

The correlation coefficients between different morpho-physiological characters were worked out to see their relative importance under irrigated and non-irrigated conditions. Under adequate moisture supply, the growth and development of above as well as underground plant parts seemed to be important as the correlation coefficients, both within and between the characters studied were positive. Negative correlations of days to first bloom with plant height, leaf area and leaf dry weight at all the stages under irrigated environment implied early flowering to be associated with fast growth of the genotypes. But earliness is undesirable when water

supply is adequate as yield is often positively correlated with maturity date (Goldsworthy and Colegrove, 1974). The reason for negative association in the present study could be ascribed to the presence of more number of fast growing genotypes in the material.

Earlier the drought escape feature was almost exclusively used in describing a systematic approach to varietal selection for drought prone regions in wheat (Fischer and Maurer, 1978) and rice (Krishnamoorthy *et al.*, 1971). Present study also revealed similar results for non-irrigated condition as days to first bloom had negative association with plant height, leaf area and leaf dry weight at all the three stages. But significant positive association of leaves/plant and branches/plant with days to first bloom and significant negative association with plant height, leaf area and leaf dry weight at all the three stages suggested that increase in number of leaves and branches per plant, under the limited moisture conditions, should necessarily be minimized for quick growth and earliness in flowering. In this context, earlier workers' observations such as ability of plants to produce flowers with minimum of vegetative structures would enable them to produce seed on a limited supply of water (Mulroy and Rundel, 1977), leaf area adjustment either through reduction in leaf size or by reduction in the number of leaves (Turk and Hall, 1980), yield is positively correlated with leaf area at flowering (Rawson *et al.*, 1980), appear to agree, in one way or the

TABLE  
Phenotypic (above diagonal) and genotypic (below diagonal)  
among 33 genotypes under

Character	Plant height (cm)			Leaflets/leaf			Leaf area (cm <sup>2</sup> )			
				S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>				
	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	
Plant height (cm)	S <sub>1</sub>	1.000	** 0.946	** 0.823	0.178	0.112	-0.163	** 0.739	** 0.822	0.084
	S <sub>2</sub>	0.986	1.000	** 0.876	0.116	0.110	-0.144	** 0.702	** 0.595	0.132
	S <sub>3</sub>	0.867	0.933	1.000	0.052	0.010	-0.141	** 0.527	* 0.409	0.161
Leaflets/leaf	S <sub>1</sub>	0.210	0.155	0.047	1.000	* 0.356	0.153	0.340	0.329	-0.004
	S <sub>2</sub>	0.128	0.113	-0.004	0.525	1.000	0.319	0.207	* 0.380	0.134
	S <sub>3</sub>	-0.178	-0.227	-0.207	0.140	0.417	1.000	-0.013	0.067	0.194
Leaf area (cm <sup>2</sup> )	S <sub>1</sub>	0.783	0.754	0.581	0.394	0.243	-0.007	1.000	** 0.846	0.141
	S <sub>2</sub>	0.638	0.626	0.426	0.383	0.481	0.093	0.893	1.000	0.257
	S <sub>3</sub>	0.088	0.135	0.163	-0.006	0.151	0.236	0.144	0.264	1.000
Leaf dry weight (mg)	S <sub>1</sub>	0.744	0.697	0.459	0.306	0.213	-0.004	0.822	0.862	0.136
	S <sub>2</sub>	0.601	0.585	0.372	0.344	0.397	0.037	0.875	0.923	0.215
	S <sub>3</sub>	0.433	0.469	0.346	0.255	0.381	0.299	0.544	0.660	0.752
Leaves/plant (90 days)	-0.000	0.070	0.119	-0.244	-0.110	-0.065	0.074	0.069	-0.162	
Branches/plant (90 days)	0.300	0.330	0.205	0.041	0.227	-0.272	0.328	0.328	-0.266	
Root dry weight/plant (90 days)	0.418	0.403	0.266	0.031	-0.133	0.114	0.577	0.520	0.026	
Shoot dry weight/plant (90 days)	0.273	0.319	0.236	0.034	0.134	0.193	0.316	0.430	0.033	
Root/shoot weight ratio (90 days)	0.261	0.202	0.087	-0.006	-0.147	-0.045	0.376	0.204	-0.085	
Days to first bloom	-0.719	-0.645	-0.514	-0.432	-0.289	0.029	-0.572	-0.484	-0.143	

\*Significant at p=0.05; \*\*Significant at p=0.01.

DROUGHT STRESS IN CHICKPEA

2

correlation coefficients of various morpho-physiological characters  
irrigated environment

Leaf dry weight (mg)			Leaves/ plant	Branches/ plant	Root dry weight/ plant (mg)	Shoot dry weight/ plant (mg)	Root/ shoot weight ratio	Days to first bloom
S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>						
90 days								
** 0.734	** 0.594	** 0.427	0.004	0.296	* 0.408	0.263	0.249	** -0.706
** 0.682	** 0.573	** 0.459	0.061	0.317	* 0.384	0.306	0.183	** -0.630
** 0.446	* 0.357	0.334	0.107	0.199	0.251	0.221	0.082	* -0.484
0.262	0.284	0.212	-0.181	0.041	0.019	0.043	-0.030	* -0.356
0.180	0.337	0.299	-0.074	0.179	-0.118	0.100	-0.122	-0.224
-0.001	0.022	0.235	-0.038	-0.207	0.094	0.116	0.000	0.037
** 0.881	** 0.836	** 0.523	0.061	0.301	** 0.554	0.288	0.349	** -0.352
** 0.850	** 0.910	** 0.651	0.060	0.319	** 0.509	* 0.413	0.192	** -0.475
0.133	0.210	** 0.746	-0.147	-0.264	0.026	0.027	-0.078	-0.142
1.000	** 0.854	** 0.545	-0.084	0.313	** 0.492	0.297	0.306	** -0.645
0.857	1.000	** 0.618	0.124	0.400*	** 0.506	0.338	0.299	** -0.612
0.546	0.620	1.000	0.033	0.102	* 0.366	* 0.377	0.047	** -0.504
-0.089	0.137	0.037	1.000	** 0.558	* 0.393	* 0.393	0.117	0.189
0.317	0.406	0.104	0.617	1.000	* 0.401	0.251	* 0.382	-0.231
0.603	0.517	0.372	0.444	0.415	1.000	** 0.532	** 0.523	-0.222
0.305	0.347	0.390	0.444	0.266	0.551	1.000	* -0.361	-0.063
0.329	0.321	0.046	0.147	0.398	0.539	-0.346	1.000	-0.206
-0.651	-0.615	-0.507	0.213	-0.240	-0.227	-0.055	-0.223	1.000

TABLE  
Phenotypic (above diagonal) and genotypic (below diagonal)  
among 33 genotypes under

Character		Plant height (cm)			Leaflets/leaf			Leaf area (cm <sup>2</sup> )		
		S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>
Plant height (cm)	S <sub>1</sub>	1.000	**	**	**	0.133	-0.173	**	**	0.193
	S <sub>2</sub>	0.963	1.000	**	**	0.250	-0.204	**	**	0.294
	S <sub>3</sub>	0.938	0.986	1.000	**	0.325	-0.169	**	**	0.295
Leaflets/leaf	S <sub>1</sub>	0.661	0.637	0.638	1.000	**	0.201	**	**	0.300
	S <sub>2</sub>	0.173	0.296	0.356	0.553	1.000	0.207	0.276	0.286	0.289
	S <sub>3</sub>	-0.235	-0.226	-0.229	0.267	0.217	1.000	-0.008	0.123	0.298
Leaf area (cm <sup>2</sup> )	S <sub>1</sub>	0.701	0.713	0.690	0.651	0.294	-0.004	1.000	**	0.277
	S <sub>2</sub>	0.638	0.671	0.660	0.634	0.320	0.160	0.841	1.000	**
	S <sub>3</sub>	0.196	0.304	0.311	0.313	0.320	0.360	0.289	0.584	1.000
Leaf dry weight (mg)	S <sub>1</sub>	0.589	0.550	0.482	0.694	0.046	0.148	0.813	0.781	0.400
	S <sub>2</sub>	0.549	0.564	0.561	0.778	0.332	0.193	0.768	0.874	0.574
	S <sub>3</sub>	0.395	0.462	0.429	0.607	0.429	0.223	0.412	0.577	0.779
Leaves/plant (90 days)		-0.621	-0.622	-0.633	-0.403	-0.242	0.148	-0.538	-0.450	-0.074
Branches/plant (90 days)		-0.462	-0.449	-0.410	-0.475	-0.187	0.179	-0.461	-0.503	-0.076
Root dry weight/plant (90 days)		-0.252	-0.173	-0.189	0.051	0.063	0.542	0.036	0.155	0.362
Shoot dry weight/plant (90 days)		-0.011	0.075	0.115	0.227	0.298	0.405	0.359	0.408	0.365
Root/shoot weight ratio (90 days)		-0.450	-0.415	-0.478	-0.237	-0.236	0.407	-0.350	-0.262	0.111
Days to first bloom		-0.757	-0.727	-0.690	-0.843	-0.317	0.133	-0.623	-0.543	-0.242

\*Significant at p=0.05; \*\*Significant at p=0.01.

DROUGHT STRESS IN CHICKPEA

3

correlation coefficients of various morpho-physiological characters  
unirrigated environment

Leaf dry weight (mg)			Leaves/ plant	Branches/ plant	Root dry weight/ plant (mg)	Shoot dry weight/ plant (mg)	Root/ shoot weight ratio	Days to first bloom
S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>						
90 days								
** 0.579	** 0.533	** 0.391	** -0.551	** -0.438	-0.249	-0.007	* -0.442	** -0.744
** 0.541	** 0.537	** 0.455	** -0.573	* -0.429	-0.171	0.075	* -0.406	** -0.714
** 0.470	** 0.522	* 0.414	** -0.545	* -0.383	-0.183	0.109	** -0.459	** -0.670
** 0.619	** 0.660	** 0.543	-0.327	* -0.410	0.046	0.189	-0.203	** -0.753
0.042	0.278	0.377	-0.134	-0.179	0.057	0.262	-0.204	-0.287
0.122	0.147	0.176	0.149	0.132	* 0.441	0.336	0.321	0.108
** 0.796	** 0.725	* 0.405	** -0.457	** -0.428	0.034	0.343	0.341	** -0.605
** 0.777	** 0.843	** 0.673	* -0.404	** -0.468	0.154	* 0.398	-0.261	** -0.540
* 0.392	** 0.542	** 0.766	-0.071	-0.066	* 0.356	* 0.352	0.106	-0.239
1.000	** 0.791	** 0.605	* -0.353	* -0.348	0.182	0.327	-0.116	** -0.652
0.818	1.000	** 0.668	-0.327	* -0.445	0.120	0.331	-0.237	** -0.701
0.507	0.692	1.000	-0.179	-0.261	0.208	0.261	-0.047	** -0.646
-0.392	-0.376	-0.194	1.000	* 0.437	* 0.353	0.196	0.302	* 0.729
-0.370	-0.498	-0.285	0.534	1.000	0.276	0.208	0.242	* 0.410
0.183	0.125	0.209	0.392	0.292	1.000	** 0.743	** 0.675	0.122
0.334	0.349	0.269	0.223	0.225	0.762	1.000	0.024	-0.046
-0.116	0.245	-0.047	0.341	0.260	0.684	0.062	1.000	0.307
-0.653	-0.723	-0.649	0.468	0.438	0.123	-0.047	0.313	1.000

other with the results of the present investigation. Negative association of root to shoot weight ratio with growth of aerial parts, particularly with plant height, and positive association with days to first bloom may be due to the fact that short duration varieties have generally faster growth of aerial parts relative to growth of roots. Contrary to this, plant height does not affect water use efficiency and plant performance under stress in barley (Irvine *et al.*, 1980). The correlations between different morpho-physiological characters discussed so far related more to the escape mechanism whereby the plant tries to escape the adverse effect of the drought through quick growth, early flowering and maturity. But under the more severe and prolonged water stress condition the interpretation of these correlations get reversed, because the question in such a situation is not of yield but survival of the plants. According to Levitt (1972) and Turner (1979), under such a situation, importance of drought avoidance (plant's ability to endure periods without significant rainfall while maintaining high plant water status or turgor through change in rooting pattern or adjustment in leaf area) or drought tolerance (plant's ability to endure periods without significant rainfall and to endure low tissue water potential through osmotic adjustment or desic-

cation tolerance) mechanism needs hardly any emphasis. Mechanisms favouring drought survival and those favouring productivity are mutually opposed (Fischer and Turner, 1978). However, a mixture of both avoidance and tolerance mechanisms is required. Presently observed negative association of leaves/plant, branches/plant and root to shoot weight ratio with the growth of other aerial parts such as plant height, leaf area and leaf dry weight and positive association with days to first bloom suggested that water spending operations like increase in height, leaf area index, and leaf dry weight should be decreased and in their place number of small leaves and branches per plant should be increased (to meet the minimum photosynthesis requirement) which in turn shall delay the anthesis (highly energy consumptive process) and increase the ratio of root to shoot weight. Removal of flowers increased the root development in deeper zones of the soil in chickpea (Sheldrake and Saxena, 1979), ninety per cent of the plant dry matter may be in roots under extreme conditions of deficits (Fischer and Turner, 1978), root to shoot ratio of plant increases with water stress (Singh, 1991), and narrow leaves act as a stress adaptive trait in wheat (Blum, 1980), seem to favour the results of present investigation.

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## NUTRIENT UPTAKE AND QUALITY OF SPRING SUNFLOWER AS INFLUENCED BY FERTILITY LEVELS AND PLANT POPULATIONS

P. C. SARMAH\*, S. K. KATYAL and A. L. BHOLA\*\*

Department of Agronomy

CCS Haryana Agricultural University, Hisar - 125 004

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### ABSTRACT

To study the effect of fertility levels and plant populations on nutrient uptake and quality of sunflower, field experiments were conducted during spring 1989 and 1990. Variety EC 68415 C proved significantly superior to Morden with respect to oil content, oil yield (kg/ha) and total uptake of nitrogen and phosphorus. Fertility level above 40 kg N+20 kg P<sub>2</sub>O<sub>5</sub>/ha increased the protein content of seeds significantly over control but oil content decreased. Nitrogen uptake was maximum at 80 kg N+40 kg P<sub>2</sub>O<sub>5</sub>/ha while the maximum phosphorus uptake by seeds and stalk was observed at 60 kg N+30 kg P<sub>2</sub>O<sub>5</sub>/ha. Lower plant population (49,382 plants/ha) markedly increased the nitrogen and phosphorus contents of seeds and stalk as well as protein content of seeds. Highest oil yield and highest uptake of nitrogen and phosphorus were observed with medium plant population (74,074 plants/ha).

Optimum supply of major plant nutrients like nitrogen and phosphorus is important in increasing the seed and oil yields of sunflower. Besides increase in production, the quality of produce is also influenced by levels of fertilizer application. Studies on nutrient accumulation in different plant parts, viz. seeds and stalk as influenced by varieties, fertility levels and plant population are important for better understanding of nutrient needs of the crop. The present study was undertaken to assess the pattern of nutrient uptake and quality of produce as influenced by varieties, fertility levels and plant populations.

### MATERIAL AND METHODS

Field trial was carried out at Agronomy Research Farm, Haryana Agricultural University, Hisar, during spring 1989 and 1990. The trial was conducted in split plot design with two sunflower varieties (EC 68415 C and Morden) and four levels of fertility (control, 40 kg N+20 kg P<sub>2</sub>O<sub>5</sub>/ha, 60 kg N+30 kg P<sub>2</sub>O<sub>5</sub>/ha, and 80 kg N+40 kg P<sub>2</sub>O<sub>5</sub>/ha) as main plot treatments and four levels of plant population (111-111, 74,074, 55,555 and 49,382 plants/ha) as sub-plot treatments replicated thrice. The soil was sandy loam in texture, saline in reaction (pH 8.2), low

\*Regional Agricultural Research Station, P. O. Shillongani, Nagaon - 782 001.

\*\*Department of Plant Breeding.

in available nitrogen (138.0 kg/ha), medium in available phosphorus (24.2 kg/ha) and rich in available potassium (561.0 kg/ha).

The sowing was done by dibbling the seeds. The data pertaining to uptake of nutrients were computed by multiplying the concentration of nutrients in plant parts with the dry matter yield of respective plant parts. The protein percentage of seeds was worked out by multiplying the percentage of nitrogen in seeds with 5.3 (Jones, 1931; Mosse and Pernollet, 1983). The percentage oil content of seeds was determined by using Nuclear Magnetic Resonance Spectrometer (NMR). Oil content (percentage value) of the seeds was used to express the oil yield in kg/ha treatment-wise by multiplying it with corresponding seed yields.

## RESULTS AND DISCUSSION

### Effect of Varieties

No significant difference was observed between the varieties with respect to nitrogen and protein contents of seeds (Table 1). Similar results were reported by Narwal (1980) for sunflower varieties EC 69874 and EC 68415. Phosphorus content of seeds recorded for variety Morden was significantly higher than EC 68415 C during first year while reverse observations were made during second year. The variety EC 68415 C recorded significantly higher oil content in seeds (8.3%) and oil yield (13.7%) as compared to Morden in both the years. Corroborative findings were reported by Patil *et al.* (1988). The individual and total up-

take of nitrogen and phosphorus by seeds and stalk of the variety EC 68415 C were significantly higher than Morden during both the years except nitrogen uptake by seeds during 1990 and phosphorus uptake by seeds during 1989 (Table 2). This was due to the fact that total biomass yield (seed + stalk) was more in variety EC 68415 C than that of Morden.

### Effect of Fertility Levels

Higher level of fertiliser application upto 80 kg N+40 kg P<sub>2</sub>O<sub>5</sub>/ha caused significant increase in nitrogen content of seeds. But the highest phosphorus content was recorded in seeds when there was no application of fertilizer during 1990 and with the application of only 40 kg N+20 kg P<sub>2</sub>O<sub>5</sub>/ha during 1989. Further increase in fertility levels tended to decrease the phosphorus content of seeds.

Application of 40 kg N+20 kg P<sub>2</sub>O<sub>5</sub>/ha did not improve the protein content appreciably over control, but further increase in fertility levels enhanced the protein content significantly over control. A significant reduction in oil content was observed with the increase in protein content in seeds due to higher level of fertiliser application. On an average, application of 80 kg N+40 kg P<sub>2</sub>O<sub>5</sub>/ha increased the protein content of seeds by 23.5% but reduced the oil content by 6.8% over control. This decrease in oil content with higher fertility levels might be due to the utilization of carbohydrates in protein formation in presence of nitrogen. Girase *et al.* (1975) and Narwal and Malik (1985) reported that with higher doses

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TABLE 1  
Quality parameters and oil yield as influenced by sunflower varieties, fertility levels and plant populations

Treatment	Per cent N (seeds)		Per cent P (seeds)		Per cent oil (seeds)		Oil yield (kg/ha)		Per cent protein (seeds)	
	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990
<b>Varieties</b>										
EC 68415 C	2.621	2.247	0.704	0.723	46.53	46.68	610.18	556.72	13.83	11.91
Morden	2.603	2.291	0.723	0.681	45.15	41.15	567.95	464.85	13.80	12.14
S. Em±	0.009	0.041	0.005	0.005	0.10	0.33	1.85	7.38	0.06	0.22
C. D. at 5%	NS	NS	0.016	0.014	0.30	1.01	5.62	22.41	NS	NS
<b>Fertility levels (N + P<sub>2</sub>O<sub>5</sub> kg/ha)</b>										
N <sub>0</sub> +P <sub>0</sub>	2.285	2.680	0.696	0.721	48.70	46.85	415.56	343.51	12.11	11.02
N <sub>40</sub> +P <sub>20</sub>	2.497	2.227	0.734	0.655	46.40	44.61	589.89	509.67	13.23	11.81
N <sub>80</sub> +P <sub>40</sub>	2.737	2.285	0.712	0.719	45.73	43.03	667.01	592.19	14.47	12.11
N <sub>80</sub> +P <sub>40</sub>	2.928	2.483	0.711	0.715	44.53	42.16	684.78	597.77	15.44	13.16
S. Em±	0.014	0.058	0.008	0.007	0.14	0.47	2.62	10.44	0.09	0.31
C. D. at 5%	0.043	0.175	0.023	0.020	0.42	1.43	7.95	31.69	0.28	0.93
<b>Plant population/ha</b>										
111,111	2.528	2.149	0.686	0.650	46.02	44.08	537.15	485.58	13.40	11.39
74,074	2.582	2.223	0.707	0.695	46.54	44.51	667.74	604.87	13.56	11.78
55,555	2.634	2.329	0.717	0.721	45.55	43.73	644.12	545.30	13.96	12.34
49,382	2.703	2.374	0.742	0.743	45.26	43.34	508.24	407.60	14.33	12.58
S. Em±	0.014	0.032	0.007	0.015	0.12	0.40	2.82	8.00	0.09	0.17
C. D. at 5%	0.040	0.091	0.021	0.043	0.34	NS	8.01	22.74	0.25	0.48

TABLE 2  
Uptake of nitrogen and phosphorus as influenced by sunflower varieties, fertility levels and plant populations

Treatment	N uptake (kg/ha)						P uptake (kg/ha)					
	1989			1990			1989			1990		
	Seed	Stalk	Total	Seed	Stalk	Total	Seed	Stalk	Total	Seed	Stalk	Total
<b>Varieties</b>												
EC 68415 C	35.03	17.66	52.69	27.08	15.29	42.37	9.25	7.27	16.52	8.62	5.85	14.47
Morden	33.40	16.08	49.48	26.66	13.50	40.16	9.13	6.74	15.88	7.79	5.14	12.93
S. Em $\pm$	0.14	0.19	0.28	0.50	0.20	0.59	0.08	0.14	0.19	0.11	0.13	0.17
C. D. at 5%	0.41	0.58	0.87	NS	0.60	1.80	NS	0.42	0.58	0.34	0.39	0.52
<b>Fertility levels (N+P<sub>2</sub>O<sub>5</sub> kg/ha)</b>												
N <sub>0</sub> +P <sub>0</sub>	20.33	9.91	30.24	15.53	7.71	23.24	6.20	7.53	13.73	5.40	6.81	12.21
N <sub>45</sub> +P <sub>45</sub>	31.71	15.91	47.62	25.42	13.79	39.21	9.31	7.99	17.30	7.47	5.90	13.37
N <sub>90</sub> +P <sub>90</sub>	39.88	19.11	58.99	31.44	16.51	47.95	10.39	6.64	17.03	9.88	5.05	14.93
N <sub>135</sub> +P <sub>135</sub>	44.94	22.56	67.50	35.09	19.56	54.65	10.89	5.87	16.76	10.09	4.22	14.32
S. Em $\pm$	0.19	0.27	0.40	0.70	0.28	0.84	0.12	0.20	0.27	0.16	0.18	0.24
C. D. at 5%	0.58	0.82	1.23	2.14	0.84	2.55	0.36	0.59	0.82	0.48	0.56	0.74
<b>Plant population/ha</b>												
111,111	30.14	16.70	46.84	24.14	13.33	37.47	7.93	6.22	14.15	7.05	4.36	11.41
74,074	37.80	18.22	56.02	30.78	16.34	47.12	10.16	7.46	17.62	9.46	5.86	15.32
55,555	37.96	17.05	55.01	29.55	14.76	44.31	10.24	7.36	17.60	9.09	5.93	15.02
49,382	30.97	15.52	46.49	23.00	13.15	36.15	8.44	6.99	15.43	7.24	5.83	13.06
S. Em $\pm$	0.22	0.22	0.35	0.56	0.22	0.69	0.12	0.19	0.24	0.20	0.11	0.25
C. D. at 5%	0.61	0.61	1.00	1.59	0.63	1.96	0.34	0.54	0.69	0.58	0.32	0.72

of nitrogen application there was reduction in oil content of sunflower seeds.

Although there was reduction in per cent oil content of seeds due to higher levels of fertiliser application, the consequent increase in seed yield associated with higher levels of fertiliser increased the oil yield significantly (69.4%) at 80 kg N+40 kg P<sub>2</sub>O<sub>5</sub>/ha over control.

The uptake of nitrogen by seeds and stalk increased significantly with fertiliser application upto 80 kg N+40 kg P<sub>2</sub>O<sub>5</sub>/ha as the nitrogen content of seeds and stalk increased with higher fertility levels. Total phosphorus uptake by seeds and stalk increased at lower dose of fertiliser application because phosphorus content of seeds and stalk reduced at higher fertiliser levels. Total dry matter and concentration of the nutrients in seeds and stalk were the deciding factors for uptake of these nutrients.

#### Effect of Plant Population

A reduction in plant population from 111,111 to 49,382 plants/ha during first year and upto 55,555 plants/ha during second year resulted in significant increase in nitrogen content of seeds. Significantly higher phosphorus content of seeds was recorded with the lowest plant population during both the years and a general tendency of increasing phosphorus content with lowering of plant population was observed.

The increase in oil yield at medium plant density (74,074 plants/ha) was

the cumulative effect of higher seed yield and oil percentage at increasingly higher plant density as compared to lower plant density (49,382 plants/ha) and the corresponding increase in oil yield was 38.5 per cent

Protein content increased appreciably with lower planting density and the average increase in protein content was 8.7% with 49,382 plants/ha as compared to 111,111 plants/ha. This might be due to the provision of higher feeding area per plant (2025 sq. cm) in the former case than in the latter case (900 sq. cm). The higher nutritional area per plant at lower planting density might have supplied more amount of available nitrogen and phosphorus to the plant.

Total nitrogen and phosphorus uptake by seeds and stalk was significantly higher at medium planting density (74,074 plants/ha) as compared to other planting densities. This might be due to the fact that at medium plant population, production of dry matter by stalks and seeds improved significantly over other population levels.

#### Interaction Effect

A trend of gradual reduction in oil content was observed due to increase in fertility level. This reduction in oil content was significant when the fertility level exceeded 60 kg N+30 kg P<sub>2</sub>O<sub>5</sub>/ha in case of EC 68415 C and 40 kg N+20 kg P<sub>2</sub>O<sub>5</sub>/ha in case of Morden in both the years (Table 3). Phosphorus uptake by seeds increased positively with successive increase in fertility level and the variety EC 68415 C was found to be more efficient than

TABLE 3  
Interaction effect of variety and fertility levels on per cent oil content of seeds

Variety	Fertility level (N + P <sub>2</sub> O <sub>5</sub> kg/ha)							
	1989				1990			
	0+0	40+20	60+30	80+40	0+0	40+20	60+30	80+40
EC 68415 C	47.28	46.91	46.68	45.27	48.08	46.87	46.33	44.20
Morden	46.13	45.89	44.78	44.29	43.64	42.36	39.73	38.86
S. Em $\pm$		0.20				0.67		
C. D. at 5%		0.60				2.02		

TABLE 4  
Interaction effect of variety and fertility levels on phosphorus uptake (kg/ha) by seeds

Variety	Fertility level (N + P <sub>2</sub> O <sub>5</sub> kg/ha)							
	1989				1990			
	0+0	40+20	60+30	80+40	0+0	40+20	60+30	80+40
EC 68415 C	6.51	6.96	10.86	10.87	5.71	8.16	9.93	10.69
Morden	5.89	9.66	10.12	10.86	5.09	6.78	9.82	9.49
S. Em $\pm$		0.166				0.222		
C. D. at 5%		0.505				0.673		

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TABLE 5  
Interaction effect of fertility levels and plant populations on oil yield (kg/ha)

Fertility level (N + P <sub>2</sub> O <sub>5</sub> kg/ha)	Plant population (plants/ha)							
	1989				1990			
	111,111	74,074	55,555	49,382	111,111	74,074	55,555	49,382
0+0	369.57	479.56	456.48	356.64	316.43	397.55	377.32	282.72
40+20	536.23	670.07	646.51	606.77	497.41	614.11	548.27	378.89
60+30	615.54	749.13	724.94	578.41	657.63	702.80	624.84	480.06
80+40	627.28	772.19	748.54	691.12	570.83	704.23	628.77	488.71
S. Em±			5.64					16.01
C. D. at 5%			16.03					45.47

Morden with respect to phosphorus uptake by seeds (Table 4).

Irrespective of fertility level, the highest oil yield was recorded at a population density of 74,074 plants/ha in both the years (Table 5). The increase in oil yield due to highest level of fertiliser application was 292.63 and 306.68 kg/ha as compared to no fertiliser application during 1989 and 1990,

respectively.

Thus, it is concluded that the variety EC 68415 C was significantly superior to Morden with respect to nutrient uptake (N and P), oil content and oil yield. Irrespective of variety, significantly higher oil yield (kg/ha) was recorded with fertiliser application @ 60 kg N+30 kg P<sub>2</sub>O<sub>5</sub>/ha at a population density of 74,074 plants/ha.

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## EFFECT OF PRE-SOWING SEED TREATMENTS ON WATER RELATIONS, LEAF GAS EXCHANGE AND YIELD OF BAJRA UNDER RAINFED CONDITIONS

N. R. BISHNOI, S. N. GUPTA, R. S. KARWASRA\* and K. D. SHARMA\*\*

Department of Plant Breeding

CCS Haryana Agricultural University, Hissar - 125 004

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### ABSTRACT

Seeds of bajra cv. HHB-67 were treated with different pre-sowing treatments, viz. cycocel, phosphon-D, maleic hydrazide, B-9 and hardening, and seedlings were raised in rainfed conditions in sandy loam soil. It was observed that in all the pre-soaking seed treatments, the rate of photosynthesis, stomatal conductance and leaf water potential increased as compared to control at all the sampling stages.

From time to time, many pre-sowing seed treatments have been suggested for inducing resistance to drought. Halevy and Kessler (1963) were able to induce tolerance in bean plants to soil drought by application of cycocel (CCC). According to Lockhart (1965) CCC appeared to involve in an alteration of plant metabolism in such a way that it responds differently at lowered water potential. Application of CCC and cytokinin has been reported to delay senescence, thus, enhancing photosynthesis and mobilization of photosynthates to the reproductive sink (Santosh and Bharti, 1991). Leaf water potential and stomatal conductance are good indicators of plant water relations and are well associated with different plant functions (Xu *et al.*, 1990). The present study was conducted to

explore possibility of improving plant water status, leaf gas exchange, and grain yield in bajra under rainfed conditions.

### MATERIAL AND METHODS

A field experiment was carried out at Regional Research Station, Bawal, in kharif season of 1992 under rainfed conditions on bajra cv. HHB-67.

Seeds were pre-soaked in the solutions of CCC (10 ppm), phosphon-D (50 ppm), B-9 (20 ppm) and MH (12.5 ppm) for 4 h and then dried on filter paper for 24 h at room temperature with three repeated cycles along with hardening treatment in distilled water for 4 h. Soon after, treated seeds were raised in field in six rows of 4 m length

\*Department of Agronomy.

\*\*Department of Botany.

and 0.5 m apart under randomized block design with three replications. Plants were sampled at 20, 35 and 50 days after sowing. Photosynthetic rate and stomatal conductance in penultimate leaf were recorded with the help of portable leaf analyser (ADC, LCA-2). Leaf water potential ( $\psi_w$ ) was determined in a pressure chamber (PMS-Instrument Company, Oregon). Relative water content (RWC), leaf area and chlorophyll contents were estimated according to the methods of Weatherly (1950), LICOR-3000 and Arnon (1949), respectively. Number of fertile tillers, length of earhead and 1000-grain weight were recorded at the time of harvest.

## RESULTS AND DISCUSSION

At all the sampling stages, there was more decline in RWC in control plants as compared to pre-sowing treated plants. RWC was greatly influenced by CCC followed by phosphon-D, hardening, MH and B-9. Leaf  $\psi_w$  decreased with decrease in per cent soil moisture. Treatments had increased the leaf  $\psi_w$  significantly as compared to control plants at all the sampling stages (Table 1). Stomatal conductance declined as a consequence of fall in leaf  $\psi_w$ . Stalfelt (1955) reported that mild water stress gave a marked loss of solutes from guard cells, concurrent with stomatal closure. Govil (1985) observed that CCC acts directly on guard cell membrane or through the synthesis of proline or betaine which affect the membrane leading to reduction of  $K^+$  in guard cells, causing stomatal closure. Treated plants

appeared to be more turgid than control at same leaf  $\psi_w$  and also conformed the findings of Ramachandran and Sakharam Rao (1975).

Water deficits also reduced chlorophyll content and leaf area at all the sampling stages (Table 2). These results are in accordance with those of Hsiao (1973), who showed that decrease in chlorophyll content may be due to the decreased synthesis or degradation of chlorophyll. Pre-sowing seed treatments helped in better retention of green leaf area and chlorophyll that resulted in enhanced photosynthesis. These results are in conformity with Cheema *et al.* (1976). Effect of CCC on chlorophyll content might be due to the reduction in the cell size with denser cytoplasm as reported by Appleby *et al.* (1966).

Reduction in photosynthesis due to depression caused by soil water deficit has been usually considered as the result of stomatal closure (Brown *et al.*, 1976). An increase in the rate of photosynthesis, in treated plants could be primarily related to hydration and permeability of chloroplast and its membrane (Richmond *et al.*, 1971). A correlation of assimilation with leaf  $\psi_w$  is slightly better than with stomatal conductance, under rainfed conditions. Decrease in availability of water will result in lowering the leaf  $\psi_w$  and hence the closure of stomata and reduction in photosynthesis. Non-stomatal inhibition of photosynthesis could be there due to reduced water potential (Xu *et al.*, 1990).

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TABLE 1

Effect of treatments on relative water content, leaf water potential and stomatal conductance in bajra leaves

Treatment	RWC (%)			Leaf water potential (-MPa)			Stomatal conductance ( $\mu\text{mol}^{-2}\text{s}^{-1}$ )		
	Days after sowing → 20	35	50	20	35	50	20	35	50
Control	81.3	68.5	52.8	-0.95	-1.42	-2.69	329	266	142
Hardening (water)	85.3	75.6	61.4	-0.76	-1.19	-2.06	343	278	191
CCC (10 ppm)	89.6	81.8	67.4	-0.68	-0.91	-1.73	412	318	224
Phosphon-D (50 ppm)	86.5	79.3	64.8	-0.72	-1.08	-1.92	385	297	198
MH (12.5 ppm)	84.6	72.4	61.1	-0.78	-1.14	-2.12	360	276	162
B-9 (20 ppm)	84.7	71.3	58.3	-0.84	-1.27	-2.25	337	260	157
C. D. at 5%	1.9	3.4	2.1	0.05	0.08	0.14	19	12	11

TABLE 2

Effect of treatments on leaf area, chlorophyll content and photosynthesis in bajra leaves

Treatment	Leaf area (sq. cm)			Chlorophyll content ( $\text{mg g}^{-1}$ fresh wt.)			Photosynthesis ( $\mu\text{mol m}^{-2}\text{s}^{-1}$ )		
	Days after sowing → 20	35	50	20	35	50	20	35	50
Control	322	210	132	5.12	3.37	2.42	13.18	7.21	4.32
Hardening (water)	347	238	142	5.76	3.89	3.42	14.38	8.10	4.71
CCC (10 ppm)	385	262	180	7.28	5.02	4.12	15.76	9.35	5.70
Phosphon-D (50 ppm)	342	245	170	6.39	4.23	3.78	14.89	8.92	5.12
MH (12.5 ppm)	333	232	192	5.89	3.92	2.95	14.25	7.89	4.62
B-9 (20 ppm)	331	218	143	6.37	3.79	2.92	13.85	8.12	4.57
C. D. at 5%	10	7	11	0.27	0.13	0.24	0.31	0.18	0.15

TABLE 3

Effect of treatments on various yield parameters in bajra

Treatment	No. of fertile ears per plant	Ear length (cm)	1000-grain weight (g)
Control	11.27	17.6	9.31
Hardening (water)	13.83	16.8	9.52
CCC (10 ppm)	16.13	17.1	10.36
Phosphon-D (50 ppm)	14.78	16.8	10.11
MH (12.5 ppm)	12.83	16.1	9.42
B-9 (20 ppm)	12.12	15.4	9.53
C. D. at 5%	1.2	0.3	0.1

Yield contributing characters such as number of ear bearing fillers per plant was increased with the application of growth retardants, but ear length was decreased in all the treatments with significant differences in grain weight over control (Table 3). The curtailment of vegetative growth, and maintenance of osmotic adjustment by use of growth retardants resulted in better seed setting as observed by the average increase in 1000-grain weight. Humphries *et al.* (1965) attributed the increase in grain yield due to more solar

radiations reaching the lower parts of the growth retardant treated, shortened plants and promoting the development of lateral shoots. However, the results of present investigation are in conformity with those reported earlier in other crops (Santosh and Bharti, 1991).

In general, growth retardants and hardening caused a favourable change in RWC, leaf  $\psi_w$  and in stomatal conductance which played significant role in yield and improved the water status of plants.

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## EFFICACY OF SOIL AND FOLIAGE APPLIED HERBICIDES FOR WEED CONTROL IN MUNGBEAN (*VIGNA RADIATA* (L.) WILCZEK)

R. S. BALYAN, SAMUNDER SINGH and R. K. MALIK

Department of Agronomy

CCS Haryana Agricultural University, Hisar - 125 004

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### ABSTRACT

Two soil applied (trifluralin and pendimethalin) and one foliage applied (fluzifop-p-butyl) herbicides were evaluated for weed control in mungbean in field experiments. Trifluralin and pendimethalin controlled the broad leaf and grass weeds. Fluzifop-p-butyl controlled the barnyardgrass only. Pre-plant application of trifluralin or pre-emergence pendimethalin each at 0.75 and 1.0 kg/ha when supplemented by fluzifop controlled both types of weeds satisfactorily. Mungbean treated with trifluralin at 1.5 kg/ha or trifluralin at 0.75 and 1.0 kg/ha supplemented with early post-emergence (20 d. a. s.) application of fluzifop at 0.50 kg/ha produced pods/plant and grain yield similar to weed free and hand weeded twice at 3 and 6 w. a. s. Pre-plant trifluralin or pre-emergence pendimethalin both at 0.75 or 1.0 kg/ha followed by fluzifop at 0.25 kg/ha 20 d. a. s. also produced significantly higher seed yield of mungbean than untreated check during both the seasons.

Carpetweed (*Trianthema portulacastrum*) among broad leaf weeds and barnyardgrass (*Echinochloa colonum*) among grass weeds are dominant weeds of rainy season crops grown in tropical region of the world (Balyan and Malik, 1989 ; Balyan, 1992). In India, the average productivity of pulses is very low and presence of weeds being the major constraint. The weeds emerge either before the crop or alongwith pulse crops, thus, compete seriously and result in yield reduction by 70-80 per cent (AVRDC, 1978; Balyan *et al.*, 1987). Weed competition studies indicate that carpetweed and barnyardgrass are capable of drastically reducing yields of mungbean (Balyan, 1985).

Weed management in leguminous and oil seed crops is either altogether neglected, or hand hoeing or weeding is a common practice of controlling weeds. However, non-availability of labour and continuous rains prevent timely weed control. Fluchloralin, pendimethalin (Singh and Faroda, 1977), alachlor and nitrofen (Yadav *et al.*, 1982) have been reported to control weeds in pulses. Haloxifop, fluzifop and sethoxydim have been reported to provide selective control of barnyardgrass (Balyan and Malik, 1989; Balyan *et al.*, 1990). Until recently, no post-emergence selective herbicide was available/recommended to control weeds in pulse crops in India. The present in-

vestigation was carried out to study the efficacy of soil and foliage applied herbicides, alone or in supplementation, on weeds in mungbean.

## MATERIAL AND METHODS

Field experiments were conducted during rainy seasons of 1992 and 1993 at the Research Farm, CCS Haryana Agricultural University, Hisar. The soil was sandy loam (63.1% fine sand, 17.0% silt and 19.3% clay (Typic Ustochrepts) of slightly alkaline reaction (pH 8.1) and medium in fertility. A basal dose of 20 kg nitrogen as urea, 50 kg P<sub>2</sub>O<sub>5</sub> as single phosphate and 20 kg zinc as zinc sulphate per hectare were applied uniformly to all plots. Mungbean cv. Asha was drilled on 16 and 15 July in 1992 and 1993, respectively, in 30 cm rows. The plot size was 5.5 m × 2.7 m during both the seasons.

Twelve herbicide treatments, *i. e.* trifluralin at 1.0 and 1.5 kg/ha as pre-plant, pendimethalin at 1.0 and 1.5 kg/ha as pre-emergence, fluazifop-p-butyl at 0.5 and 0.75 kg/ha as post-emergence (20 d. a. s.), trifluralin at 0.75 and 1.0 kg/ha as pre-plant followed each by fluazifop 0.25 and 0.50 kg/ha as post-emergence, pendimethalin 0.75 and 1.0 kg/ha as pre-emergence followed by fluazifop 0.25 kg/ha as post-emergence were compared with manual weeding twice at 3 and 5 weeks after sowing (w. a. s.), unweeded check and weed free check (Table 1). Thus, in all 15 treatments were replicated three times in a randomized block design. Herbicides were sprayed with knapsack

manually operated sprayer as per their application time with a spray volume of 600 l/ha.

Visual phytotoxicity or per cent control data were recorded on 0-100 scale (where 0=no control, and 100=complete control) 50 d. a. s. The density and dry matter of weeds were recorded with the help of a quadrat (50 cm × 50 cm) placed randomly at three spots in each plot 50 and 75 d. a. s., respectively, during both the years. The original per cent weed control and density data were transformed by arcsin and  $\sqrt{n+1}$  transformation, respectively, prior to statistical analysis to reduce variation among treatments. Number of pods/plant and seed yield of mungbean were recorded at crop harvest during both the seasons.

## RESULTS AND DISCUSSION

### Effect on Weeds

The most pre-dominant weeds of experimental field during both the seasons were *Trianthema portulacastrum* L. among broadleaf weeds and *Echinochloa colonum* (L.) Link. among grass weeds constituting 71 and 24 per cent and 79 and 19 per cent of the total weed population in 1992 and 1993, respectively. Besides, *Digera arvensis* Forsk., *Celosia argentea* L., *Physallis minima* and *Cyperus rotundus* L. also infested the crop.

Weed density recorded 50 d. a. s. revealed that all the treatments except fluazifop-p-butyl application alone significantly reduced the density of broadleaf weeds compared to unweeded

check. Similarly grass weed population was also significantly lowered down by all the herbicide treatments during both the seasons (Table 1). Higher rate of herbicides reduced the density of weeds relatively more than their lower rate. Pre-plant incorporation of trifluralin and pre-emergence pendimethalin each at 1.5 kg/ha were most effective in minimizing the density of both types of weeds. Post-emergence application of fluazifop at 0.50 and 0.75 kg/ha reduced the density of grasses to 2 to 4 weeds compared to 21 to 83 of unweeded check during 1992 and 1993, respectively. The dry matter accumulation of weeds revealed an identical trend to that of density during both the seasons (Table 1). Maximum dry matter of broad leaf weeds (269.8 and 140.2) and grassy weeds (183.7 and 73.2 g/m<sup>2</sup>) was recorded in unweeded check during 1992 and 1993, respectively which was significantly higher than rest of the treatments, with the exception of fluazifop application alone at both the rates. Fluazifop application at 0.50 and 0.75 kg/ha 20 d. a. s. failed to reduce the dry matter of broad leaf weeds compared to unweeded check during both the years.

Pre-plant trifluralin and pre-emergence pendimethalin applied each at 1.0 and 1.5 kg/ha proved highly effective against broadleaf weeds. The control ranged from 73 to 92 per cent with trifluralin and 73 to 83 per cent with pendimethalin (Table 2). Post-emergence fluazifop failed to control broadleaf weeds during both the seasons. On an average of two seasons fluazifop at 0.5 and 0.75 kg/ha reduced

the dry matter accumulation of grassy weeds (barnyardgrass) to an extent of 81 and 89 per cent during 1992 and 1993, respectively. The control ranged from 70 to 88 per cent in 1992, and 83 to 93 per cent in 1993. Integration of pre-plant trifluralin or pre-emergence pendimethalin with post-emergence fluazifop proved effective against broad spectrum weeds and the control was as good as obtained with two manual weedings at 3 and 5 w. a. s. during both the season.

Broad spectrum control of both broadleaf and grassy weeds by combination of fluazifop or haloxyfop with fomesafen was also reported by Balyan *et al.* (1990). Excellent control of barnyardgrass with post-emergence application of haloxyfop 0.25 and fluazifop 1.0 kg/ha has been reported in soybean by Balyan *et al.* (1990). Higher dry matter of broad leaf weeds with fluazifop could be due to its failure to control any of the broadleaf weeds during growing season.

#### Effect on Crop

Maximum and minimum number of pods/plant were measured in season long weed free and unweeded plots, respectively during both the seasons. In 1992, all the herbicide treatments produced significantly more pods/plant than unweeded check. During 1993, trifluralin and pendimethalin each at 1.5 kg/ha and their application of 0.75 and 1.0 kg/ha when supplemented with fluazifop produced significantly more pods/plant than unweeded check (Table 2). Hand weeding twice recorded next

TABLE 1

Density (no /m<sup>2</sup>) and dry matter of weeds (g/m<sup>2</sup>) as influenced by different treatments

Herbicide	Dose (kg a. i./ha)	Density of weeds (60 DAS)				Dry matter of weeds (75 DAS)			
		Broad leaf weeds		Grassy weeds		Broad leaf weeds		Grassy weeds	
		1992	1993	1992	1993	1992	1993	1992	1993
Trifluralin	1.0	(8) 2.9	(6)2.6	(7)2.7	(7)2.7	47.1	15.2	30.2	6.7
Trifluralin	1.5	(3) 1.9	(5)2.5	(5)2.4	(5)2.5	34.8	12.8	20.5	4.3
Pendimethalin	1.0	(10) 3.3	(13)3.7	(13)3.6	(9)3.2	79.2	24.8	44.8	13.0
Pendimethalin	1.5	(7) 2.9	(12)3.6	(12)3.5	(7)2.9	61.5	19.8	33.2	8.7
Fluazifop-p-butyl	0.50	(137)11.8	(39)6.3	(4)2.2	(2)1.6	261.5	176.3	22.5	1.5
Fluazifop-p-butyl	0.75	(139)10.9	(39)6.4	(2)1.7	(0)1.0	269.7	179.2	14.3	0.3
Trifluralin fb fluazifop	0.75 fb 0.25	(21) 4.6	(7)2.9	(23)4.9	(21)4.6	38.7	15.6	28.3	14.1
Trifluralin fb fluazifop	1.00 fb 0.25	(18) 4.3	(5)2.5	(21)4.7	(18)4.3	11.6	9.7	26.4	13.6
Trifluralin fb fluazifop	0.75 fb 0.60	(25) 5.1	(8)3.0	(5)2.5	(13)3.7	10.2	5.3	24.1	8.3
Trifluralin fb fluazifop	1.00 fb 0.60	(19) 4.4	(5)2.5	(5)2.4	(10)3.3	9.5	2.9	16.5	2.7
Pendimethalin fb fluazifop	0.75 fb 0.25	(17) 4.3	(15)3.9	(19)4.5	(1)1.5	27.5	16.6	22.8	14.4
Pendimethalin fb fluazifop	1.00 fb 0.25	(15) 3.9	(8)2.9	(19)4.4	(3)2.1	18.0	16.3	13.3	12.3
Hand weeding (2)	3 & 5 WAS	(0) 1.0	(0)1.0	(0)1.0	(0)1.0	3.5	2.7	5.2	5.5
Unweeded check		(144)12.0	(46)7.0	(21)4.7	(83)9.2	269.8	183.7	140.2	73.2
Weed free check		(0) 1.0	(0)1.0	(0)1.0	(0)1.0	0	0	0	0
L. S. D. P=0.05		0.7	0.7	0.8	0.6	12.3	11.1	7.5	4.9

Original data are in parentheses.

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TABLE 2

Number of pods/plant and seed yield of mungbean as influenced by different treatments

Herbicide	Dose (kg a. i./ha)	Pods/plant		Seed yield (kg/ha)	
		1992	1993	1992	1993
Trifluralin	1.00	8	14	346	745
Trifluralin	1.50	12	19	519	927
Pendimethalin	1.00	8	12	303	606
Pendimethalin	1.50	10	17	374	794
Fluazifop-p-butyl	0.50	7	12	240	634
Fluazifop-p-butyl	0.75	8	14	328	737
Trifluralin fb fluazifop	0.75 fb 0.25	11	18	451	821
Trifluralin fb fluazifop	1.00 fb 0.25	12	19	466	922
Trifluralin fb fluazifop	0.75 fb 0.50	14	20	519	1048
Trifluralin fb fluazifop	1.00 fb 0.50	14	20	647	1099
Pendimethalin fb fluazifop	0.75 fb 0.25	10	14	321	771
Pendimethalin fb fluazifop	1.00 fb 0.25	12	18	469	828
Hand weedings (2)	3 & 5 WAS	14	21	568	1137
Unweeded check		4	10	71	531
Weed free check		15	22	628	1225
L. S. D. P=0.05		4	6	111	284

higher number of pods/plant to weed free treatment in both the years.

Maximum seed yield of 628 and 1225 kg/ha were recorded in season long weed free plots in 1992 and 1993, respectively (Table 2). Different herbicide treatments registered higher seed yield than untreated check. Mungbean plants treated with trifluralin 1.5 kg/ha alone and trifluralin at 0.75 and 1.0 kg/ha followed each by fluazifop at 0.50 kg/ha produced yields similar to the weed free conditions in both the seasons. Rest of the herbicide treatments applied alone or in supplement produced lower seed yields than the weed free.

Higher seed yields from the higher rates of trifluralin or pendimethalin and trifluralin at 0.75 or 1.0 kg/ha followed by fluazifop 0.50 kg/ha were mainly due to reduced population and dry matter of weeds particularly carpetweed and barnyardgrass (Table 1). Similarly higher and lower seed yields under different herbicide treatments were because of higher and lower pods/plant of mungbean (Table 2). Increase or decrease in seed yield under different weed control treatments was well supported by the significant negative correlation coefficient obtained between dry matter of weeds and seed yield of crop ( $r=0.897$  and  $0.680$  during 1992 and 1993, respectively). The relation-

ship was found linear. Higher seed yield of mungbean with tank mixture of sethoxydim and fomesafen, fluazifop and fomesafen, haloxyfop and fomesafen were also reported earlier by Balyan and Malik (1989). Similarly

early post-emergence application of haloxyfop, fluazifop or fomesafen when supplemented by wheel hoeing or hand weeding at 40 d. a. s. recorded higher soybean yields than herbicide application alone (Balyan, 1992).

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## GROWTH PERFORMANCE OF RICE CROP IN HARYANA

SHARAD BHATNAGAR

Directorate of Extension Education

CCS Haryana Agricultural University, Hisar - 125 004

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### ABSTRACT

The compound growth rates of rice for a period of 26 years (1966-67 to 1991-92) were found highly significant. Interaction between area and yield has played a significant role in increasing the production of the crop. Further, the production has increased to a large extent through the adoption of high yielding varieties, ample irrigation facilities and good consumption of fertilizers.

Rice crop plays a vital role in increasing the production of foodgrains in India. It had 42.32% of total production of foodgrains in India during 1990-91 out of which 2.46% of rice was produced in Haryana state only. Keeping in view the importance of this crop in Haryana, a study was conducted to work-out the growth performance of rice in area, production and yield based on time series data. The growth during pre-green revolution and post-green revolution periods has also been examined.

### METHODOLOGY

The study utilizes the data on area, production and yield of rice in Haryana state for a period of 26 years (1966-67 to 1991-92). Haryana state has been divided into two zones, viz. Eastern zone and Western zone according to their agro-climatic conditions. The former consists of Ambala, Yamunanagar, Karnal, Kurukshetra, Sonapat, Faridabad, Rohtak, Kaithal and Panipat

districts while the latter includes districts of Jind, Hisar, Sirsa, Bhiwani, Gurgaon, Mahendragarh and Rewari. A study on variability in area, production and yield of rice has been done for Haryana state as a whole and zone-wise.

Any increase or decrease in the production of a crop depends basically on the changes in area under the crop and its average yield. If the production, average yield and area are denoted by  $Q_n$ ,  $Y_n$  and  $A_n$  for the  $n^{\text{th}}$  year and  $Q_0$ ,  $Y_0$  and  $A_0$  for the base year, the increase in production  $Q=(Q_n-Q_0)$  in the  $n$  years over the base year is a function of change in area  $A=(A_n-A_0)$  and yield  $Y=(Y_n-Y_0)$ . Sharma (1977) has suggested the following relationship to measure the relative contribution of area, yield and their interaction in crop production. He measured the total change in the value of production as :

$$Q=A_0Y+AY_0+AY \quad \dots 1$$

where  $A_0Y$  = Yield effect,

$AY_0$  = Area effect, and

$AY$  = Interaction effect of area and yield.

Thus, the total change in production can be decomposed into three components, viz. yield effect, area effect and interaction effect of both yield and area.

The linear as well as compound growth rates of area, production and yield of rice have been worked out by fitting the linear and exponential functions.

The linear function is

$$Y = a + bt \quad \dots 2$$

where  $Y$  = Area/Production/Yield,

$a$  = Constant,

$b$  = Regression coefficient, and

$t$  = Time variable in years.

The exponential function is

$$Y = A B^t \quad \dots 3$$

where  $A$  = Constant, and

$B$  = Regression coefficient.

It can be expressed in the log form as

$$\log Y = \log A + t \log B \quad \dots 4$$

which is similar to linear equation (2). The compound growth rate (C. G. R.) has been calculated as :

$$\text{C. G. R. (\%)} = (\text{Anti log } B - 1) \times 100 \quad \dots 5$$

In order to have an idea of variability between estimated trend value and observed value, we calculated :

$$\text{Coefficient of variation for estimated trend value} = \frac{\sqrt{\frac{\sum (Y_i - \bar{Y})^2}{n-2}}}{\bar{Y}} \times 100 \quad \dots 6$$

where  $Y_i$  is the observed value and  $\bar{Y}$  is the corresponding estimated trend value for the  $i^{\text{th}}$  year.

$$\text{Coefficient of variation} = \frac{\text{Standard deviation}}{\text{Mean}} \times 100 \quad \dots 7$$

## RESULTS AND DISCUSSION

Rice crop had 17.81% of area and 19.86% of production of total food-grains in Haryana during 1991-92. The Eastern zone of the State includes more important rice growing districts in comparison to the Western zone. There is an increase in average area of 222.67 and 500.00 per cent in these zones, respectively, during the last 26 years by taking the triennium 1964-67 as base period and the triennium ending 1991-92 as current period (Table 1). For the State the average area of rice has increased from 190 to 663 thousand hectares (248.95 per cent) during this period. The per cent change in production has been to the tune of 604.78 and 1418.18 per cent for the Eastern and Western zones, respectively. The average production has increased from 231 to 1807 thousand tonnes for the State, i. e. an increase of 682.25 per cent. Similarly, average yield in Eastern and Western zones has increased by 118.44 and 153.11 per cent, respectively. The average yield of the State has increased from 1216

**GROWTH PERFORMANCE OF RICE CROP IN HARYANA**

**TABLE 1**

**Average area, production and yield of rice for trienniums 1964-67 and 1989-92**

Zones/State	Base period (1964-65 to 1966-67)	Current period (1989-90 to 1991-92)	Change	
			Net	Percentage
<b>Average area ('000' hectares)</b>				
Eastern zone	172	555	383	222.67
Western zone	18	108	90	500.00
State	190	663	473	248.95
<b>Average production ('000' tonnes)</b>				
Eastern zone	209	1473	1264	604.78
Western zone	22	334	312	1418.18
State	231	1807	1576	682.25
<b>Average yield (kg per hectare)</b>				
Eastern zone	1215	2654	1439	118.44
Western zone	1222	3093	1871	163.11
State	1216	2725	1509	124.10

**TABLE 2**

**Average area, production and yield of rice in pre-green revolution and post-green revolution periods**

Variable	Pre-green revolution period (1960-61 to 1966-67)		Post-green revolution period (1967-68 to 1991-92)		Change	
	Mean	Coefficient of variation (%)	Mean	Coefficient of variation (%)	Net	Percentage
Area	173.00	9.49	445.42	35.03	272.42	157.47
Production	206.57	17.41	1047.88	49.95	841.31	407.28
Yield	1194.00	14.98	2352.00	22.95	1158.00	96.98

**TABLE 3**

**Effect of yield, area and their interaction on rice production**

Effect	Eastern zone (%)	Western zone (%)	State (%)
Yield	19.8	10.8	18.2
Area	36.8	35.2	36.5
Interaction	43.6	54.0	45.3

to 2725 kg per hectare registering an increase of 124.10 per cent. The per cent growth is higher in Western zone as compared to Eastern zone showing the growing popularity of rice in the Western zone also. The growth in production is higher than the change in area and yield of the crop.

The level of growth of area, production and yield of rice during pre-green revolution and post-green revolution periods has been depicted in Table 2. The area under the crop has increased from 173 to 445.42 thousand hectares showing an increase of 157.47 per cent in post-green revolution period over the pre-green revolution period. The production of rice has shot up from 206.57 to 1047.88 thousand tonnes during this period registering an increase of 407.28 per cent. Similarly, yield has also increased from 1194 to 2352 kg per hectare accounting for an increase of 96.98 per cent in post-green revolution period. Post-green revolution period has adopted high yielding varieties of rice and modern technology of rice production. This is the reason for a revolutionary change in this period. The increase in production is more than that of area and yield in both the periods.

Further, the total change in production as decomposed into three components, during base period to current period is presented in Table 3. In the Eastern zone, the production of rice increased by 19.6 and 36.8 per cent due to yield and area effects, respectively, whereas their interaction has

43.6% effect. Similarly in Western zone, the yield, the area and their interaction have increased the production by 10.8, 35.2 and 54.0 per cent, respectively. For the State, the production has increased by 18.2% due to yield, 36.5% due to area and 45.3% due to the interaction of yield and area. Thus, the contribution of interaction of area and yield has played a major role in increasing the production of rice in comparison to their individual effects.

The trend analysis of area, production and yield has been set out in Table 4 for zones as well as State. The compound growth rates show that during the period under study the area, production and yield have increased significantly. For the Eastern zone, compound growth rate in respect of area is 4.56% (with a simple increase of 15.48 thousand hectares annually), whereas for Western zone it is 7.62% (with a simple increase of 4.04 thousand hectares annually). Thus, the area of rice in Western districts has increased rapidly. For the State, area has increased with 4.96 per cent compound growth rate, with a simple increase of 19.52 thousand hectare annually.

The production of rice has increased with compound growth rate of 7.63% (with a simple increase of 51.89 thousand tonnes annually) in the Eastern zone, whereas for Western zone, it has been 11.17% (with an increase of 13.12 thousand tonnes annually). It confirms that the increase in production is higher in relative terms, but

GROWTH PERFORMANCE OF RICE CROP IN HARYANA

TABLE 4

Per annum growth rates of area, production and yield of rice from 1966-67 to 1991-92

Zones/State	Compound growth rate (%)			Linear growth rate		
	Area	Production	Yield	Area	Production	Yield
Eastern zone	4.56** (0.001)	7.63** (0.002)	2.93** (0.002)	15.48** (0.87)	51.89** (3.01)	55.49** (7.21)
Western zone	7.62** (0.002)	11.17** (0.003)	3.29** (0.002)	4.04** (0.24)	13.12** (0.89)	67.71** (8.19)
State	4.96** (0.001)	8.11** (0.002)	3.01** (0.002)	19.52** (1.07)	65.01** (3.77)	57.88** (7.08)

Figures in parentheses are standard errors.

TABLE 5

Coefficient of variation in observed and estimated trend values of area, production and yield of rice

Zones/State	Variability in					
	Area		Production		Yield	
	Observed (%)	Trend (%)	Observed (%)	Trend (%)	Observed (%)	Trend (%)
Eastern zone	34.44	11.30	50.12	22.64	24.23	15.23
Western zone	50.95	23.64	67.96	35.35	28.51	15.88
State	36.83	12.48	52.81	23.98	24.73	14.91

lower in absolute terms in Western zone in comparison to Eastern zone. For State, the production of rice has increased with a compound growth rate of 8.11 per cent, *i. e.* with a simple increase of 65.01 thousand tonnes annually.

The compound growth rates for yield in Eastern and Western zones workout to 2.93 and 3.29 per cent while the simple annual increase is recorded at 55.49 and 67.71 kg per hectare, respectively. It shows that

the average yield has increased at a higher rate in the Western zone. For the State, yield has increased with a compound growth rate of 3.01 per cent, *i. e.* with a simple increase of 57.88 kg per hectare annually. The growth rate of production is higher than the growth rates for area and yield.

The variability in the observed values and estimated trend values of area, production and yield of rice has been given in Table 5. For area the

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coefficients of variation have been worked out 34.44 and 50.95 per cent for Eastern and Western zones, respectively which have reduced to 11.30 and 23.64 per cent for estimated trend values. The variability in crop's area of the State has also decreased from 36.83 to 12.48 per cent for estimated trend value. Coefficients of variation for production are found to be 50.12 and 67.96 per cent which are reduced to 22.64 and 35.35 per cent for estimated trend value in Eastern and Western zones, respectively. It has reduced from 52.81 to 23.96 per cent for estimated trend value of production for the State. Similarly for yield, the coefficients of variation are reduced from 24.23 to 15.23 and 28.51 to 15.88 per cent for estimated trend

values in Eastern and Western zones, respectively. For the State the variability in the yield of the crop has reduced from 24.73 to 14.91 per cent for estimated trend value. Amongst area, production and yield of the crop, production has more variation and the reduction in variability is more in Western zone than Eastern zone for estimated trend values.

During the period 1966-67 to 1991-92, the gross irrigated area of rice crop in the State has increased from 138 to 634 thousand hectares, i. e. an increase of 359.42% of gross irrigated area. Further, 99.53% of the total area of the crop has come under irrigated area and 74.6% under the high yielding varieties.

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## EFFECT OF SPACING AND NITROGEN ON FRUIT YIELD OF OKRA (*ABELMOSCHUS ESCULENTUS* (L.) MOENCH) CV. VARSHA UPHAR

BIRBAL, B. K. NEHRA and Y. S. MALIK

Department of Vegetable Crops

CCS Haryana Agricultural University, Hisar - 125 004

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### ABSTRACT

The study on okra cv. Varsha Uphar revealed that spacing of 30 × 30 cm resulted into significantly taller plants in comparison to wider spacings (45 × 45 cm and 60 × 30 cm). Branches per plant were observed significantly higher under 45 × 45 cm than all other spacings. Nitrogen at 100 and 150 kg/ha significantly increased the plant height and number of branches per plant over control and 50 kg/ha, however, both the higher doses were at par. Spacing treatments did not influence the days to 50% flowering, however, N at 100 and 150 kg/ha delayed the 50% flowering in comparison to control and 50 kg N/ha. Number of fruits per plant, weight of individual fruit, and fruit yield per plant were maximum under 45 × 45 cm which was followed by 60 × 30 cm and were significantly higher than other spacings. N at 100 kg/ha significantly improved these characters as well as fruit yield per ha over control and 50 kg N/ha. Significantly higher fruit yield per ha was recorded under 60 × 20 cm over all other spacings except 45 × 30 cm.

Okra is one of the important vegetable crops of sub-tropical and tropical regions. Its tender green fruits are used as a vegetable and are generally marketed in fresh state, but sometimes are also available in canned or dehydrated form. It is grown in an area of approximately 4800 ha in Haryana. Varsha Uphar, a newly developed cultivar of okra from CCS Haryana Agricultural University, Hisar is high yielding and resistant to yellow vein mosaic. Varying recommendations about the plant density and nitrogen requirement of the prevalent varieties of okra under different agro-climatic conditions are available (Verma *et al.*, 1970; Gupta *et al.*, 1981; Singh, 1990). Nevertheless,

the exact specification for this new cultivar was a matter for desirable research. It was with this view the present investigations were undertaken to study the effect of spacing and nitrogen on Varsha Uphar—a promising cultivar of okra.

### MATERIAL AND METHODS

The present experiment was conducted with okra cultivar Varsha Uphar during the rainy season 1992, at Vegetable Research Farm of CCS Haryana Agricultural University, Hisar. The experiment was conducted on deep friable sandy loam soil having a pH 8.5. Twenty treatment combinations consis-

ted of five plant spacings (30×30, 45×30, 45×45, 60×20 and 60×30 cm) and four levels of nitrogen (0, 50, 100 and 150 kg/ha). The experiment was laid out in split-plot design and each treatment was replicated three times. The crop was planted on 26 June, 1992 and the seeds were dibbled on flat beds. Recommended cultural practices and plant protection measures were adopted during the period of experimentation.

## RESULTS AND DISCUSSION

The data in Table 1 reveal that plant spacing influenced the fruit yield considerably and was significantly higher under 60×20 cm than all other spacings except 45×30 cm. Higher plant population under 60×20 cm spacing resulted in 29.3 and 9.5 per cent higher fruit yield than 45×45 and 60×30 cm, respectively. Increase in fruit yield with closer spacing was also reported by Mondal *et al.* (1989), Mondal and Mallik (1990) and Singh (1990).

Wider spacing increased the fruit yield per plant and it was maximum under 45×45 cm followed by 60×30 cm. Under wider spacing individual plant gets plenty of light and more nutrients in comparison to closer spacing which results into better performance in terms of more fruits per plant. Increased number of fruits per plant at wider spacing has also been reported as an attribute to high yield per plant by Kamalanathan *et al.* (1970) and Singh (1990). Wider spacing also improved the weight of individual fruit significantly in comparison to closer

spacing. These observations are in agreement with those of Singh (1990). Maximum fruit yield per plant but minimum per ha under 45×45 cm suggested that higher yield per plant was not sufficient to compensate the loss in fruit yield due to decreased number of plants per hectare.

Though, the plant population per unit area was maximum under 30×30 cm spacing, however, total fruit yield under this treatment was 20.3 per cent less than obtained under 60×20 cm spacing. Due to significant reduction in number of fruits and weight of individual fruit, the yield contribution of each plant under 30×30 cm was so low that higher plant population could not compensate the reduction in per plant yield. These findings suggest that plant population per unit area can only be increased upto a certain limit.

Application of nitrogen significantly increased the fruit yield per ha through its beneficial effect on plant growth which in turn resulted in an improvement in number of fruits per plant and weight of individual fruit. Significantly higher fruit yield was recorded under 100 kg N/ha, which was 65.6 and 22.0 per cent higher than control and 50 kg N/ha, respectively. Application of even 50 kg N/ha resulted in 35.8% increase in yield over control. However, increase in nitrogen upto 150 kg/ha did not result into further increase in fruit yield over 100 kg/ha. These results are in close confirmity of the findings of Verma *et al.* (1970) and Gupta *et al.* (1981).

TABLE 1  
Effect of spacing and nitrogen on growth and yield of okra cv. Varsha Uphar

Treatment	Plant height (cm)	Number of branches per plant	Days to 50% flowering	Node to first fruit	Number of fruits per plant	Weight per fruit (g)	Fruit yield per plant (g)	Fruit yield (q/ha)
<b>Spacing (cm)</b>								
30 x 30	109.2	1.9	53.5	3.1	13.4	12.1	164.1	115.4
45 x 30	106.2	2.2	54.5	3.2	14.7	14.1	203.6	128.0
45 x 45	104.4	2.5	53.5	3.1	16.1	17.9	249.8	107.3
60 x 20	107.7	2.0	54.0	3.2	14.0	14.5	202.9	138.9
60 x 30	103.3	2.3	54.5	3.1	15.3	16.8	230.6	126.8
C. D. at 5%	3.2	0.1	NS	NS	1.9	2.9	45.1	11.3
<b>Nitrogen (kg/ha)</b>								
0	89.5	1.6	51.0	3.3	12.2	10.9	134.8	88.4
50	99.8	1.8	52.0	3.2	14.2	13.4	194.8	120.0
100	115.7	2.6	56.5	3.0	16.3	18.1	260.4	146.4
150	120.5	2.5	57.0	3.1	16.1	17.9	250.8	138.3
C. D. at 5%	7.6	0.7	2.8	NS	1.6	2.1	36.4	12.8

TABLE 2  
Effect of spacing and nitrogen on fruit yield (q/ha) of okra cv. Varsha Uphar

Nitrogen (kg/ha)	Spacing (cm)				Mean
	30 x 30	45 x 30	45 x 45	60 x 20	
0	77.7	96.8	73.7	105.4	88.5
50	114.6	125.4	104.3	136.6	119.2
100	139.0	148.8	129.5	161.4	153.4
150	130.3	141.1	122.0	162.5	148.0
Mean	115.4	128.0	107.3	138.9	128.8

C. D. at 5%

Spacing

= 11.3

Nitrogen

= 12.8

Spacing x Nitrogen

= 21.4

Higher fruit yield per ha under 100 kg N was directly related to the yield contributed by individual plant as a result of significant increase in number of fruits per plant and weight of individual fruit over control and 50 kg N/ha. Even 50 kg N/ha resulted in significant improvement in these attributes over control. Shrestha (1983) and Majanbu *et al.* (1987) have also reported increase in number of fruits per plant and weight of individual fruit with nitrogen application.

Interaction between spacing and nitrogen (Table 2) was found to be significant in respect of fruit yield per ha. Highest fruit yield was obtained at 60×20 cm spacing and 100 kg N/ha, which was followed by 60×30 cm plant spacing at the same level of nitrogen. The minimum fruit yield was recorded under 45×45 cm spacing without nitrogen and the difference between maximum and minimum yield was 107.7 per cent. This indicated that the combined effect of lower plant population and crop raised without nitrogen affected the fruit yield adversely.

Studies on growth characters (Table 1) revealed that plant height was more under closer spacings, whereas significantly higher number of branches per plant was recorded under widest spacing of 45×45 cm compared to other spacings. Application of 100 kg N/ha significantly improved the plant height and number of branches in comparison to control and 50 kg N/ha. However, highest dose of 150 kg N/ha did not improve these characters over 100 kg N. Similar results on growth characters have been reported by Gupta *et al.* (1981). Various spacing treatments were ineffective in influencing the days taken to 50% flowering which proved the dependence of flowering on weather rather than on spacing treatments. However, application of nitrogen at 100 kg or more per ha significantly delayed the 50% flowering in comparison to control and 50 kg N/ha. The node to first fruit set was not influenced by any treatment which showed that it is varietal character and was not influenced by cultural practices.

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## THAWING EFFECTS ON THE RECOVERY AND QUALITY OF SOFT DATES FROM DIFFERENT CULTIVARS OF DATE PALM

R. K. GODARA, S. K. BHATIA, N. R. GODARA\* and O. P. PAREEK\*\*

Department of Horticulture

CCS Haryana Agricultural University, Hisar - 125 004

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### ABSTRACT

Soft dates were prepared during 1992 from Khadrawy, Shamran, Zahidi and Zaghloul varieties by thawing and dehydration for 24 and 96 hours at 4° and 50°C, respectively. The best quality of soft dates was obtained from cultivar Shamran with organoleptic rating of 8.3/10.0 but the maximum recovery was obtained from cultivar Zaghloul.

The date (*Phoenix dactylifera* L.)—locally known as 'Khajoor' is one of the oldest and most nourishing fruits of the world. Low rainfall areas of hot and dry regions with well drained deep sandy loam soils are best suited for its cultivation. The Mediterranean region of the world, where no rainfall occurs during February to September, is the only best area for the cultivation of dates. In India, such conditions do not exist anywhere, however, north-western region is somewhat suitable for the cultivation of dates but here the fruits just complete 'doka' stage (122-170 days) and the 'pind' or 'tamar' stage is not attained because of onset of rains. Experience of the past few years has shown that the climatic conditions prevailing in Haryana, which lies in north western region, are marginal for date cultivation. The fruits ripen in July-August when the

monsoon rains have started which cause cracking of the fruits. Therefore, farmers are forced to harvest the fruits before the onset of rains.

A technique to recover soft dates from fruits completing doka stage was developed. The present work was undertaken to identify the best cultivar to have the maximum recovery of quality soft dates from doka dates.

### MATERIAL AND METHODS

Uniform fruits of dates at doka stage of maturity were harvested from each of the four cultivars, viz. Khadrawy, Shamran, Zahidi and Zaghloul. The sorting and washing of fruits were done immediately. Two kg fruits of each cultivar were taken in each replication and the experiment was replicated four times.

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\*Director of Publications, CCS Haryana Agricultural University, Hisar - 125 004.

\*\*Director, N. R. C., Bikaner.

Fruit weight, pulp weight, seed weight, TSS and acidity of the fruits were recorded in the beginning of the experiment. Thawing of fruits was done at 4°C in a deep freezer for 24 h. After thawing, the fruits were exposed in air at room temperature for 12 h. These fruits were then kept at 50°C in air circulating dehydrator for 96 h to remove excess of moisture and resulted material was termed as soft dates. These soft dates were analysed for different physico-chemical characters, viz. recovery percentage, per cent moisture, sugar and organoleptic rating. Sugar was estimated by the Ferricyanide method given by Hulme and Narian (1931) and expressed as per cent of sugar. Titrable acidity was determined by titrating 5 g of pulp with 0.1 N NaOH using phenolphthalein as indicator and expressed as per cent of pulp (AOAC, 1970). Organoleptic rating was assigned following Hedonic Rating test of Ranganna (1977).

## RESULTS AND DISCUSSION

### Recovery Percentage

The results indicate that recovery percentage of soft dates was higher in

Zagloul followed by Zahidi. The minimum recovery percentage was noted in Shamran (Table 2). Recovery percentage of soft dates depends upon total soluble solids in the raw material and per cent moisture retention in the soft date. As the TSS in fruit of Zagloul was maximum and the soft dates prepared from these fruits also had more water retention it resulted in higher recovery percentage of soft dates. These results are in uniformity with those of Godara and Pareek (1985).

### Moisture Content

The moisture content was maximum in soft dates prepared from Zagloul cultivar while it was minimum in soft dates prepared from Shamran and Zahidi (Table 2). Similar results have been reported by Yousif *et al.* (1976).

### Total Sugar

The maximum total sugar content was noted in soft dates prepared from cultivar Shamran followed by Khadrawy while minimum was in Zagloul (Table 3). This might be due to high amount of moisture content in Zagloul cultivar.

TABLE 1

Physical and chemical characters of doka fruits of different cultivars of dates used for making soft dates

Cultivar	Fruit wt. (g)	Pulp wt. (g)	Seed wt. (g)	TSS	Acidity (%)
Khadrawy	11.23	9.83	1.40	33.65	0.249
Shamran	8.23	7.00	1.23	33.90	0.223
Zahidi	18.03	16.40	1.63	35.50	0.233
Zagloul	20.23	18.14	2.09	36.25	0.253
C. D. at 5%	0.03	0.23	0.06	0.66	0.004

RECOVERY AND QUALITY OF SOFT DATES

TABLE 2

Per cent recovery and per cent moisture in soft dates (Pind Khajoor) from doka fruits of different cultivars of dates by freeze ripening method

Cultivar	Recovery (%)				Moisture content (%)			
	A grade	B grade	C grade	Total	A grade	B grade	C grade	Mean
Khadrawy	10.94	10.20	14.40	35.54	29.47	29.02	26.34	28.27
Shamran	11.46	10.26	9.70	31.42	29.18	28.09	23.82	27.03
Zahidi	11.30	17.69	13.20	42.19	31.35	26.73	25.85	27.97
Zagloul	24.78	15.30	15.45	55.53	32.21	31.46	30.78	31.48
C. D. at 5%	0.65	0.42	0.34	1.65	0.49	0.56	0.72	

TABLE 3

Sugar content (%) and organoleptic rating of soft dates (Pind Khajoor) from doka fruits of different cultivars of dates by freeze ripening method

Cultivar	Sugar in A grade soft dates			Organoleptic rating (out of 10)		
	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	A grade	B grade	C grade
Khadrawy	70.34	66.62	3.72	7.7	6.3	4.3
Shamran	72.94	64.70	8.24	8.3	5.3	4.0
Zahidi	64.52	49.76	14.76	7.0	5.2	3.7
Zagloul	61.48	53.66	7.82	7.6	6.8	5.1
C. D. at 5%	1.09	0.83	1.10			

**Organoleptic Rating**

Organoleptic rating indicates that the soft dates prepared from Shamran

cultivar were of best quality followed by Khadrawy and Zagloul. The possible reason may be the high concentration of total sugars.

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## RESEARCH NOTE

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### HOST RESPONSE OF SOME CULTIVARS OF VEGETABLE AND SPICE CROPS AGAINST *MELOIDOGYNE* SPECIES AND EFFECT OF DIFFERENT INOCULUM LEVELS OF *MELOIDOGYNE JAVANICA* ON SPICES

R. S. KANWAR, K. K. WALIA, D. C. GUPTA and R. K. JAIN

Department of Nematology

CCS Haryana Agricultural University, Hisar - 125 004

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Root-knot nematode parasitizes most of the crops grown all over the world (Saka and Carter, 1987). Nevertheless, some crops and cultivars are less preferred hosts and can safely be included as alternative crops in cropping sequences aimed at minimising the nematode damage. Hence, some cultivars of vegetable and spice crops grown during rabi season were evaluated for their reactions against *Meloidogyne* species under pot house conditions. In addition, pathogenicity of *Meloidogyne javanica* on coriander, fennel and fenugreek was also investigated.

Seeds of commonly grown cultivars of vegetable crops (Table 1) and spices (Table 2) were sown in 15 cm earthen pots filled with nutrient deficient, nematode free sandy soil. Ten days after germination, one plant per pot was retained and each plant was inoculated with *M. incognita* and *M. javanica* separately @ 2 juveniles/g soil. In onion, four-week-old seedlings were inoculated ten days after

transplanting. In second experiment, fenugreek (cvs. PEB and Kasuri), coriander (cv. CO-2) and fennel (cv. GF-1) were inoculated ten days after germination at different inoculum levels (10, 100, 1000 or 10000 juveniles/plant). Uninoculated plants in each crop served as control for comparison.

For each crop four replications were maintained and pots were arranged randomly and maintained as per recommended practices. Observations on plant growth parameters and root-knot index (based on 1-5 scale, i.e. 1=no gall, 2=1-10 galls, 3=11-30 galls, 4=31-100 galls, and 5=100+ galls) were recorded after 75 days of inoculation in both the trials. In onion and garlic, this period was kept four and five months, respectively.

The host response of vegetable crops is given in Table 1. Against *M. javanica*, maximum root-knot index (3.0) was recorded in turnip (cv. White-4). Against *M. incognita*, Pusa chetki and Kalyanpur-1 cultivars of

TABLE 1  
Reaction of some vegetable crops to *Meloidogyne* species

S. No.	Crop	Cultivar	Root-knot index (1-5 scale)	
			<i>M. javanica</i>	<i>M. incognita</i>
1.	Redish ( <i>Raphanus sativus</i> )	Pusa chetki	2.5	3.8
		Kalyanpur-1	2.3	4.0
		Local	2.5	2.8
2.	Turnip ( <i>Brassica rapa</i> )	White-4	3.0	3.7
3.	Carrot ( <i>Daucus carota</i> )	HC-1	2.0	2.3
4.	Cauliflower ( <i>Brassica oleracea</i> var. <i>botrytis</i> )	Snow Ball-16	2.3	2.3
5.	Garlic ( <i>Allium sativum</i> )	Local-1	2.0	2.3
		Local-2	2.0	2.0
6.	Onion ( <i>Allium cepa</i> )	Hisar-2	2.0	Not tested

TABLE 2  
Reaction of some spices to *Meloidogyne javanica*

S. No.	Crop	Cultivar	Root-knot index (1-5 scale)
1.	Fenugreek ( <i>Trigonella foenum-graecum</i> )	Pusa Early	2.8
		Bunching	
		Kasuri	3.0
2.	Cumin ( <i>Cuminum cyminum</i> )	JC-11	2.0
		RZ-19	2.3
		UC-216	
3.	Coriander ( <i>Coriandrum sativum</i> )	CO-2	2.0
4.	Fennel ( <i>Foeniculum vulgare</i> )	PF-35	1.0
		HF-33	1.0
		HF-39	1.0
		GF-1	1.0
		Local	1.0

radish and White-4 cultivar of turnip recorded high root-knot indices (3.8, 4.0 and 3.7, respectively) in comparison to other crops. Although the crop varieties mentioned above showed high root-knot indices, ranging between 3.0-4.0, yet no reproduction was noticed on any of the crop/variety as evidenced by the absence of egg-masses on roots and juveniles in soil. Similar results were obtained by Kanwar (1989) regarding host response and multiplication of *M. javanica* on some of these crops under field conditions. In general, crop varieties in present study exhibited more galling against *M. incognita* as compared to *M. javanica* indicating that crops and varieties show differential response to different nematode species, and that *M. incognita* is more virulent than *M. javanica* on these crops.

RESPONSE OF VEGETABLE AND SPICE CROPS TO ROOT-KNOT NEMATODE

TABLE 3

Effect of *Meloidogyne javanica* on root-knot disease intensity in some spice crops (average of four replications)

Inoculum levels	Root-knot index (1-5 scale)			
	Fenugreek (cv. PEB)	Fenugreek (cv. Kasuri)	Coriander (cv. CO-2)	Fennel (cv. GF-1)
0 (check)	—	—	—	—
10	1.5	1.5	1.3	1.3
100	2.0	2.0	2.0	1.5
1000	3.5	2.5	3.3	1.8
10000	4.8	4.5	4.3	1.8
C. D. at 5%	0.7	0.8	0.7	NS

In spices, root-knot index was more on fenugreek than on cumin, coriander or fennel (Table 2). No galling was observed on any of the five cultivars of fennel. These results are in conformity with those of Paruthi *et al.* (1987). The nematode did not complete its life cycle on any of the spice variety as no soil population was recorded after 75 days of nematode inoculation. It seems that due to low temperature prevailing during crop growth, the nematode was unable to complete life cycle (Kaushik and Bhatti, 1986).

In second experiment, data on plant growth characters in all the four varieties of spice crops, at all inoculum

levels, were found to be statistically at par with those in uninoculated control and are, therefore, not presented. However, root-knot index on coriander and both the cultivars of fenugreek increased with increase in inoculum level (Table 3). Root-knot index was less (1.8) in fennel even at the highest inoculum level proving its highly resistant nature. It may be inferred from these results that at such low temperatures as occurred during these crops' growth, root-knot nematode is unable to inflict damage on fenugreek and coriander inspite of heavy galling because feeding, development, reproduction and multiplication of nematode are retarded to a great extent.

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## IMPACT OF HEALTH AND NUTRITION EDUCATION ON ICDS BENEFICIARIES

ANJU ANEJA and SUDHA CHHIKARA

Department of Child Development

CCS Haryana Agricultural University, Hisar - 125 004

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### ABSTRACT

Health and nutrition education component of ICDS programme certainly had positive impact on the knowledge of its beneficiaries regarding various aspects such as immunization/vaccination, contagious diseases, common ailments, prenatal care, family planning, weaning practices, and personal and environmental hygiene. There are few areas such as childhood disabilities and deficiency diseases in which ICDS respondents were ignorant.

The health and nutrition education component of the ICDS scheme aims at effective communication of certain basic health and nutrition messages with a view to enhance the mother's awareness of the child's needs within the family environment. Health and nutrition education is required to be given to all women in the age group 15-44 years, priority being given to nursing and expectant mothers. HNE component is very important part of the ICDS project as the problems of ignorance, ill health and malnutrition go hand-in-hand. HNE component provides knowledge on aspects such as immunization/vaccination, contagious diseases, common ailments, prenatal care, family planning, etc. Anganwadi workers impart knowledge to the women beneficiaries regarding health and nutrition component. The present study has been conducted to know the impact of HNE on ICDS beneficiaries.

### MATERIAL AND METHODS

Data were collected from six villages of Hisar district. Villages where ICDS programme was in operation were selected for ICDS sample, and for non-ICDS sample villages were selected where there was no ICDS programme. Three villages, viz. Mangali, Durjanpur, and Chaudhriwas were selected for ICDS sample and villages Chhan, Banbhori and Gyanpura were selected for non-ICDS sample. For ICDS sample one anganwadi from each village was randomly selected and 30 women beneficiaries from each anganwadi were drawn. Thus, 90 women beneficiaries formed the ICDS sample. For non-ICDS sample, 30 women in the age group of 15-44 years from each village were selected randomly. Thus, 90 women respondents formed the non-ICDS sample.

An interview schedule was prepared to collect information about knowledge of women regarding HNE aspects. Frequencies and percentages were calculated to describe the data. Chi-square was also used to see the impact of HNE on ICDS beneficiaries.

RESULTS AND DISCUSSION

The data in Table 1 for 180 women respondents (90 ICDS beneficiaries and 90 non-ICDS) reveal that there is association between knowledge of the respondents (ICDS and non-ICDS)

regarding different aspects of HNE and health and nutrition education programme. Calculated value of  $X^2$  was more than the tabulated value in all the activities of health and nutrition education such as immunization/vaccination, prenatal care, family-planning, weaning practices, and personal and environmental hygiene. It is clear from the frequency distribution that majority of the respondents in case of ICDS sample had complete knowledge regarding all the activities of health and nutrition education. From the perusal of results, it can be concluded that the HNE

TABLE 1  
Knowledge of the respondents as affected by health and nutrition education programme

	Level of knowledge			$X^2$ value	d. f.
	Complete	Partial	Not at all		
(a) Immunisation/vaccination					
ICDS	59 (65.6)	31 (34.4)	0	54.5*	2
Non-ICDS	0	71 (78.9)	19 (21.1)		
(b) Prenatal care					
ICDS	42 (46.6)	48 (53.4)	0	97.8*	2
Non-ICDS	2 (2.2)	88 (97.8)	0		
(c) Family planning					
ICDS	40 (44.4)	50 (55.6)	0	33.4*	2
Non-ICDS	3 (3.3)	65 (72.2)	22 (24.6)		
(d) Weaning practices					
ICDS	54 (60.0)	34 (37.8)	2 (2.2)	31.8*	2
Non-ICDS	20 (22.2)	45 (50.0)	25 (27.8)		
(e) Personal and environmental hygiene					
ICDS	60 (66.7)	29 (32.2)	1 (1.1)	11.4*	2
Non-ICDS	40 (44.5)	39 (43.3)	11 (12.2)		

Figures in the parentheses are percentages.

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component of ICDS programme certainly had positive impact on the knowledge of beneficiaries. Other studies also supported the results of present investigation. Deb and Arora (1985) reported that the knowledge of rural women about immunization had increased considerably after the implementation of ICDS programme.

Jain (1985) indicated that after implementation of HNE component, awareness and acceptance of various family planning methods and services

by the community had shown considerable improvement.

Vasundra and Srinivasan (1985) found that the acceptance of family planning was comparatively higher after launching of ICDS programme.

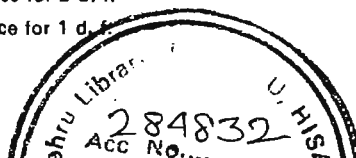
The data for knowledge regarding symptoms, causes and prevention of the contagious diseases and common ailments have been presented in Table 2. The data reveal that knowledge of the respondents regarding

TABLE 2  
Association between knowledge regarding common ailments, contagious diseases, and health and nutrition education programme

	Level of knowledge			X <sup>2</sup> value	d. f.
	Complete	Partial	Not at all		
<b>(a) Contagious diseases</b>					
<i>Symptoms</i>					
ICDS	4 (4.4)	86 (95.6)	0	7.85*	2
Non-ICDS	1 (1.1)	83 (92.2)	6 (6.7)		
<i>Causes</i>					
ICDS	13 (14.4)	69 (76.7)	8 (8.9)	44.35*	2
Non-ICDS	2 (2.2)	40 (44.4)	48 (53.4)		
<i>Prevention</i>					
ICDS	9 (10)	76 (84.4)	5 (5.6)	56.99*	2
Non-ICDS	0	40 (44.4)	50 (55.6)		
<b>(b) Common ailments</b>					
<i>Symptoms</i>					
ICDS	64 (71.1)	26 (28.9)	0	39.27*	1
Non-ICDS	22 (24.4)	68 (75.6)	0		
<i>Causes</i>					
ICDS	15 (16.7)	75 (83.3)	0	33.65*	2
Non-ICDS	2 (2.2)	65 (72.2)	23 (25.6)		
<i>Prevention</i>					
ICDS	10 (11.1)	76 (84.5)	4 (4.4)	38.58*	2
Non-ICDS	3 (3.3)	48 (53.3)	39 (43.4)		

X<sup>2</sup> table value—5.99 at 5% level of significance for 2 d. f.

X<sup>2</sup> table value—3.84 at 5% level of significance for 1 d. f.



contagious diseases had significant dependence on health and nutrition education as calculated value of  $X^2$  was higher than the tabulated value. The same trend was observed for the knowledge regarding common ailments.

Results reveal that knowledge of ICDS beneficiaries regarding contagious diseases and common ailments was better than non-ICDS respondents.

It can be concluded from the results that ICDS respondents had more knowledge than the non-ICDS respondents regarding all the aspects covered under health and nutrition education. The reasons may be that

Anganwadi workers organised vaccination/immunization camps monthly in collaboration with the Health Department to immunize the children, whereas in case of non-ICDS villages, parents did not had facilities to get their children immunized for different diseases in the same village. Knowledge regarding other aspects such as family planning, contagious diseases, common ailments, prenatal care, etc. was also higher in case of ICDS respondents than non-ICDS respondents. It may be due to that Anganwadi workers often discuss such matters with the mothers during HNE session or at the time of home visits.

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## EFFECTIVENESS OF MEDIA ON KNOWLEDGE OF CHILD DEVELOPMENT MESSAGES ON RURAL WOMEN

ACHLA MALAVIYA, RAJESH DAHIYA and BEENA YADAV\*

Department of Home Science Extension Education  
CCS Haryana Agricultural University, Hisar - 125 004

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### ABSTRACT

The study conducted on 120 illiterate rural women of Hisar and Rewari districts of Haryana revealed that the rural women significantly varied in their mean knowledge of child development message after exposure to slide-cum-synchronized commentry show. Approximately 50% of the respondents had substantially gained knowledge on all the child development messages. The knowledge gap was almost similar between pre- and post-exposure knowledge, i. e. 38.59 to 37.26 per cent in all the messages. The child development messages individually and combined were correlated with compatibility parameter of media effectiveness.

Media play a vital role in effective communication of a variety of information to the people and in bringing about change in their existing knowledge, beliefs, attitudes and behaviour. The interest of people can best be aroused if the message is conveyed through audio-visuals. This will not only encourage the audience but also lead them to act upon it.

Majority of our rural population is illiterate making the role of communication rather difficult and challenging. The situation of effective communication becomes more difficult for rural women who play distinctive roles not only in the process of earning for livelihood but managing the family. Considering the plight of rural women it becomes

important to improve their health. The health status of rural women deteriorates with every subsequent birth. The poor health of the women has a marked effect on children especially during pre- and postnatal stages. Many children become handicapped on account of childhood accidents. In such a situation it becomes imperative to communicate health related messages in such a way that the rural women can be benefitted. Considering the importance of media for effective communication, the slide-cum-synchronized commentry can go a long way in educating the rural women in health related messages about child development.

The present study has been framed with the objectives :

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\*Krishi Gyan Kendra, Sirsa - 125 055.

1. To find out the extent of knowledge gain through media about child development message among rural women.
2. To know the media effectiveness on child development messages among rural women.

### METHODOLOGY

The study was conducted in Hisar and Rewari districts of Haryana state. From each district one block was selected randomly. Two villages from each block were selected through random sampling technique and, thus, total villages selected were four. The list of households of each village was prepared and 30 households from each village were selected randomly and the woman heads of these households were interviewed. Thus, 120 women heads constituted the sample of the study.

Three messages on child development (i) prenatal, (ii) postnatal, and (iii) child accidents, were selected and these messages were prepared in slide-cum-synchronized commentary and shown to the selected women in the respective villages. The data were gathered from the selected respondents before and immediately after the slide-cum-synchronized commentary shown. The data were analysed into percentages, mean and correlation.

#### *Measurement of Variables*

(a) *Knowledge gained.* A knowledge inventory for each message of

child development was prepared on dichotomous responses and a score of 0 and 1 were assigned for wrong and correct answers, respectively. The scores of each respondent were aggregated for each message separately and combined for total child development message. The difference between pre- and post-exposure was taken to be gain in knowledge. The score range was 0 to 40 for total child development message and categorized into low, medium and high knowledge.

(b) *Media effectiveness.* The media, *i. e.* slides-cum-synchronized commentary was standardized through a scale on selected parameters. The parameters of standardized scale were audio literacy, visual literacy and compatibility with the respondents. The respondents were scored under three response categories, *i. e.* high, medium and low with 3, 2, 1 scores, respectively. The aggregate scores under each parameter were combined to compute the scores of each respondent.

All the respondents, taking one village at a time, were exposed to child development message through prepared media. The same respondents before exposure were taken to be the control group and after exposure of the message as experimental group. The respondents were tested for knowledge gain and perceived effectiveness of the prepared media using the developed standardized scale.

(c) *Knowledge gap.* It is the difference in the amount of information the rural women possessed about child

development messages and the amount of information which was given through slide-cum-synchronized commentary. The knowledge gap was assessed before and after media show to determine the reduction in knowledge gap. Analysis of knowledge gap was done for each message separately and for all the messages of child development together.

**RESULTS AND DISCUSSION**

**Knowledge Level of Respondents**

The data in Table 1 indicate the distribution of rural women according to the knowledge of child development message at pre- and post-exposure of slide-cum-synchronized commentary show. More than 60% respondents were found in low knowledge category at pre-exposure stage in all the three messages of child development (prenatal, postnatal and child accidents), whereas after the exposure more than

50% respondents fell on high knowledge category. This confirms that slide-cum-synchronized commentary show had increased the knowledge of rural women about the child development message. Similar findings have been reported by Candy (1988) and Yadav (1990).

Table 2 presents the mean knowledge scores of respondents at pre- and post-exposure stages. It is evident that the overall mean knowledge of child development message at pre- and post-exposure stage was 15.41 and 34.75 which is significant at 5% level of probability. The data further reveal that at pre-exposure stage the mean knowledge of prenatal care, postnatal care and child accidents was 4.72, 3.03 and 7.66, while at post-exposure stage it was 11.80, 6.80 and 16.15, respectively. The postnatal care knowledge at pre- and post-exposure stage was significantly different. This leads to conclude that rural women significantly

**TABLE 1**  
Distribution of respondents according to knowledge level in child development messages

Message	Knowledge level	Class interval	Pre-exposure	Post-exposure
Prenatal care	Low	0-6	84(70.00)	2(1.66)
	Medium	7-12	35(27.16)	53(44.16)
	High	13-19	1 (0.83)	85(54.16)
Postnatal care	Low	0-3	72(60.00)	3(2.50)
	Medium	4-6	48(40.00)	48(40.00)
	High	7-10	0(0.00)	69(57.56)
Child accidents	Low	0-7	73(6.83)	0(0.00)
	Medium	8-14	47(39.16)	56(46.66)
	High	15-22	0(0.00)	64(53.33)

Figures in parentheses are percentages.

TABLE 2  
Comparative mean scores at pre-exposure and post-exposure knowledge  
of respondents

Message	Pre-exposure	Post-exposure	't' value
Prenatal care	4.72	11.80	0.788
Postnatal care	3.03	6.80	6.174*
Child accidents	7.66	16.15	0.016
Overall child development messages	15.41	34.75	14.213*

\*P < 0.5

vary in the knowledge of child development at pre- and post-exposure of slide-cum-synchronized commentary show.

### Gain in Knowledge

It is evident from the data in Table 3 that of the total respondents in prenatal, postnatal and child accidents messages, higher percentage of them were in high knowledge categories after the exposure of slide-cum-synchronized commentary show, and in medium and low knowledge the percentage of respondents in all three messages was in descending order. This shows that after exposure of messages on child

development, rural women had increased their knowledge to high degree. Similar findings have been reported by Chaudhary (1984) and Nutun (1988).

### Gap in Knowledge on Child Development Messages

The data in Table 4 reveal that knowledge gap was maximum at pre-exposure and post-exposure level in prenatal care message, *i. e.* 75.15 and 37.89 per cent, respectively. The difference in knowledge gap between pre- and post-exposure knowledge was almost similar, *i. e.* 38.59 to 37.26 per cent in all the messages of Home Science.

TABLE 3  
Distribution of respondents according to knowledge gain in  
child development messages

Message	Knowledge level	Class interval	Frequency (N=120)	Percentage
Prenatal care	Low	1-6	30	25.00
	Medium	7-9	37	30.83
	High	10-14	53	44.16
Postnatal care	Low	2-4	23	19.16
	Medium	5-6	37	30.83
	High	7-10	60	50.00
Child accidents	Low	4-8	28	23.33
	Medium	9-11	33	27.50
	High	12-15	59	49.16

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**TABLE 4**  
Distribution of respondents according to change in knowledge gap in child development messages

Message	Pre-exposure knowledge gap scores		Post-exposure knowledge gap scores	Attainable scores
Prenatal care	14.28 75.16%		7.20 37.89%	19
		37.26%		
Postnatal care	6.97 69.70%		3.20 32.00%	10
		37.70%		
Child accidents	14.34 65.18%		5.85 26.59%	22
		38.59%		

**Parameters Effectiveness in Child Development Messages**

Correlation of parameters of media effectiveness with child development message has been presented in Table 5. It is evident from the data that compatibility parameter was correlated with prenatal care, child accidents and

all the messages of child development combined. Postnatal care message was not correlated. The other parameters were not correlated with any of the messages. The findings find support in studies conducted by Sawant (1982), Jagrati (1987), Kanujia (1987), Shashi (1987) and Rana (1988).

**TABLE 5**  
Correlation of parameters of media effectiveness with child development messages

Parameters of media effectiveness	Child development messages			
	Prenatal care	Postnatal care	Child accidents	Overall child development messages
Audio literacy	.054	.118	.158	.092
Visual literacy	.043	.022	.139	.072
Compatibility	.280*	.075	.190*	.192*
Overall parameters	.056	.048	.214	.129

\* P < .05

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## JOB SATISFACTION AMONG THE EXTENSION PERSONNEL IN HARYANA

S. P. SINGH, S. N. LAHARIA, R. S. MALIK and R. S. HOODA

Department of Extension Education

CCS Haryana Agricultural University, Hisar - 125 004

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### ABSTRACT

The study was conducted during 1992-93 on 302 Agricultural Development Officers (ADOs) working under T & V System in Haryana. About 75% of the respondents were dissatisfied while about 16% expressed satisfaction with job. They were dissatisfied with salary, promotion opportunities and recognition for good work. However, they were satisfied with the co-operation from colleagues, leave and job security. Insufficient office rent, lack of Govt. building for office and lack of funds for POL/field allowance were found to be the most serious problems perceived by them. Problems like frequent meetings, too much paper work, lack of technical guidance and non-agricultural extension duties were also faced. Age and experience had positive and significant correlation with job satisfaction, and mass-media had significant but negative association with functional problems. Other variables did not exhibit association with job satisfaction and financial problems.

Job satisfaction plays an important role in the life of employees. The work performance also considerably depends upon the degree of satisfaction. Rohilla (1966), Muthayat and Gnana-kannam (1973), Parshad (1973), Sandhu (1976) and Kumar and Dhaliwal (1988) also reported that the productivity of employees is significantly influenced by their job satisfaction. Agricultural Development Officers of the Department of Agriculture are no exception in this regard. They are key communicators in disseminating the agricultural research to the farmers. Job satisfaction is also related with the problems faced by the employees in performing their duties.

The present study was undertaken with the following objectives :

1. To assess the level of job satisfaction among the ADOs.
2. To identify the functional problems perceived by the ADOs.
3. To know the association between antecedent variables of the ADOs with their job satisfaction and functional problems perceived by them.

### METHODOLOGY

The present study was conducted in Haryana state as a whole during 1992-93. A district-wise list of ADOs

working in the Department of Agriculture in Haryana under Training and Visit system of Agricultural Extension was prepared with the help of Dy. Director Agriculture of the concerned district. The total number of posts of ADOs sanctioned was about 1200 but in fact, the total number of ADOs in position was much less. Therefore, it was decided to follow census approach rather than sampling. Hence, all the ADOs were taken as the respondents for the present study. On the basis of information collected from the Extension personnel, job chart, and senior scientists of Extension Education, a comprehensive set of questions about their background, functional problems and job satisfaction was prepared. The questionnaire was pretested and suitable modification was made on the basis of comments and suggestions offered by the ADOs. After developing questionnaire, data were collected personally from 302 ADOs with the help of group interview technique during fortnightly training camp or at their place of posting.

#### Variables and their Measurements

The job satisfaction and the functional problems perceived by them were taken as the dependent variables. For measuring job satisfaction, an eleven items job satisfaction scale developed by Sarkar and Patnaik (1967) with some modifications was administered. The responses obtained were on five point continuum scale ranging from highly satisfied to highly dissatisfied and were assigned the scores from 5 to 1.

An exhaustive list of functional problems perceived by ADOs in extension work was prepared. The respondents were asked to give their responses on five point continuum, *i. e.* most serious, very serious, serious, not so serious, and no problem at all and the weights of 4, 3, 2, 1 and 0 were assigned. The independent variables such as age, education, experience, parental occupation, rural-urban background, and attitude towards T & V system were measured with the help of the questionnaire developed for this purpose.

#### RESULTS AND DISCUSSION

The data in Table 1 reveal that 75% of the respondents were dissatisfied with the job while 28.14% expressed highly dissatisfaction. On the other hand, 15% were neither satisfied nor dissatisfied with their job. The mean job satisfaction score was 29.21 which indicates their feeling towards dissatisfaction. Similar findings have been reported by Singh and Mulay (1982), Kaur (1983) and Singh and Laharia (1990) who concluded that about 60% agricultural field functionaries were either in dissatisfaction or high dissatisfaction category of satisfaction.

The data in table 2 show item-wise mean score as well as their ranking. It is seen that the respondents were highly satisfied with the co-operation from their colleagues (3.74 mean score) followed by leave (3.48 mean score) and job security (3.32 mean score). About the nature of work,

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**TABLE 1**  
**Distribution of respondents according to their level of job satisfaction (N=302)**

S. No.	Level	Score range	F	Percentage
1.	Highly satisfied	45-55	6	1.99
2.	Satisfied	34-44	43	14.24
3.	Neutral	23-33	26	8.61
4.	Dissatisfied	12-22	142	47.02
5.	Highly dissatisfied	0-11	85	28.14

Mean score=29.21.

**TABLE 2**  
**Determinant of job satisfaction among ADOs**

S. No.	Job factors	Mean score	Rank order
1.	Co-operation from colleagues	3.74	I
2.	Leave	3.48	II
3.	Job security	3.32	III
4.	Nature of work	3.05	IV
5.	Congenial work atmosphere	2.59	V
6.	Status in the organization	2.60	VI
7.	Opportunities for further education	2.47	VII
8.	Participation in decision making	2.38	VIII
9.	Recognition for good work done	2.34	IX
10.	Opportunities for promotion	1.85	X
11.	Salary	1.67	XI

they were neither satisfied nor dissatisfied with job as the mean score was 3.05. The ADOs were highly dissatisfied with their salary, opportunities for promotion and recognition for good work. The results seem to be logical also as the pay scale of the ADOs working in Haryana is comparatively lower (Rs. 1640-2900) than the pay scale of their counterparts working in Punjab and Himachal Pradesh. The salary and promotion opportunities are important factors influencing the

job satisfaction of the employees. It also affects their work performance. It is, therefore, suggested that the better pay scale may be given to them and opportunities for promotion may be created to motivate them for good work.

#### Functional Problems

The functional problems perceived by ADOs during extension work/transfer of technology are reported in

Table 3. It was found that insufficient office rent, lack of Govt. building for office and lack of funds for POL/field allowance were the most serious problems. It was observed that about 99% of them were having their office in private building except those posted at the SDAOs headquarter. Since office rent allowance was very low, mostly the offices of ADOs were in very old and poor condition and also distantly located. A good office raises the status and credibility as well as improves the job efficiency. Hence, there should be provision of more office rent. However, in the long run the plan should be to have Govt. building for the office.

Other very important problems which need the attention of the authorities immediately are non-availability of inputs at ADOs/CAOs headquarters, non-agricultural extension duties, lack of audio-visual aids, lack of demonstration material and equipments, and problems of adulterated inputs. Under T & V system, the ADOs are supposed to devote full time in extension work but it is sad that they had pointed out the problems of non-agricultural extension work. Non-availability of inputs, demonstration material and audio-visual aids also affect their extension work. Some problems of frequent transfers, meetings, and too much paper work were also pointed out which need attention.

TABLE 3  
Functional problems perceived by the ADOs

S. No.	Problems	Mean score	Rank order
1.	Insufficient office rent	4.28	I
2.	Lack of Govt. building for office	4.24	II
3.	Lack of funds in POL/field allowance	3.88	III
4.	Non-availability of inputs at ADOs/CAOs headquarters	3.85	IV
5.	Non-agricultural extension duties	3.79	V
6.	Lack of audio-visual aids	3.65	VI
7.	Lack of demonstration material and equipments	3.52	VII
8.	Problem of adulterated inputs	3.30	VIII
9.	No office furniture	3.22	IX
10.	Lack of literature	3.19	X
11.	Lack of certified seeds	2.71	XI
12.	Frequent transfers	2.50	XII
13.	Problems of disposal of minikits	2.18	XIII
14.	Lack of practical guidance at the field	2.04	XIV
15.	Lack of soil and water testing facilities	1.89	XV
16.	Lack of supervision	1.79	XVI
17.	Lack of technical guidance	1.63	XVII
18.	Too much paper work	1.53	XVIII
19.	Frequent meetings/trainings	1.45	XIX

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The findings are in line with the study of Singh (1992).

**Association between Independent and Dependent Variables**

To establish the association between ADOs antecedent characteristics and their job satisfaction and problems perceived by them, the coefficients of correlation were worked out (Table 4). The data indicate that out of the nine independent variables, only two variables, *viz.* age and experience in the Department of Agriculture had positive and significant association with their job satisfaction. It implies that the experienced employees belonging to old age group were highly satisfied. In fact the aged employees have no more expectations of further promotion. Their basic pay is also comparatively high and, therefore, they are more satisfied. With the increase in age and experience, their feeling of self contentment and satisfaction naturally in-

creases. The remaining variables could not explain the significant correlation with the job satisfaction. The present findings are in line with the findings of Kooner (1979) and Kaur (1983) who had stated that age and experience had positive and significant relationship with the job satisfaction among the extension personnel.

As far as the functional problems are concerned, only one variable, *i. e.* mass-media exposure was found to have significant but negative correlation with the functional problems perceived by the respondents. It indicates that the respondents having higher exposure to mass-media did not perceive much problems to perform their extension duties. Probably, it might have increased their appreciation of the limitations of the rule as well as that of higher authorities in solving these problems and, therefore, they might have not felt these problems.

**TABLE 4**  
**Association between independent variables and job satisfaction and functional problems**

S. No.	Independent variables	Correlation coefficients	
		Job satisfaction	Functional problems
1.	Age	0.1409*	0.0261
2.	Qualification	-0.0203	0.0561
3.	Total experience	0.1054	0.0590
4.	Experience in the Department of Agriculture	0.1101*	0.0733
5.	Experience on the present post	0.0872	0.0732
6.	Parental occupation	-0.0327	0.0580
7.	Rural-urban background	0.0852	-0.0295
8.	Mass-media exposure	0.0572	-0.1200*
9.	Attitude of ADOs towards T & V systems	0.0648	-0.0928

\*Significant at 5% level.

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## CASTE VARIABILITY IN VEGETABLE CULTIVATION TECHNOLOGY

RAJ SINGH

Department of Sociology

CCS Haryana Agricultural University, Hisar - 125 004

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### ABSTRACT

In spite of increased quantum of innovations, average yield per hectare of vegetable crops on farmers' field is considerably low when compared with that obtained at the research farms indicating the existence of communication gap between innovations and their adoption. Cultivation of vegetables still represents a traditional pattern in the State as it is mostly practised by a hereditary class of growers who dwell around towns and cities. These vegetable growers represent backward classes; possessing smaller size of landholdings, illiterate and semi-literate; and localite in social outlook, hence, not attended to by the change agents for dissemination of innovations. So to popularise vegetable cultivation on scientific lines, the existing caste traditionality has to go.

As a result of phenomenal increase in population all efforts at the national level have been directed to attain self-sufficiency in foodgrains production to the neglect of the production of nutritive and protective foods thereby impairing considerably the health of the rural masses. It was estimated that per capita fruits and vegetables availability in our country is still less than 180 g per capita per day (Arakeri, 1982). Moreover, in a country where a very large bulk of the population is vegetarian, it is imperative to emphasize the production of protective foods in order to improve nutritional status, particularly those representing lower sections of the society. National Commission on Agriculture (1976) emphasised the production of protective foods for overall progress and prosperity. Bakhru

(1985) observed that self-sufficiency in foodgrains does not necessarily imply that quality of food available is upto the mark. There are many nutrients which are only supplied by horticultural crops. Singh and Brar (1990) reported that the Punjab Government has decided to promote cultivation of horticultural crops to attain overall prosperity of the rural masses. Katyal (1989) noted that area under vegetable crops is of the order of 2.5% of the total cropped area in the country, which is very much inadequate to meet the national requirements.

Cultivation of vegetables represents the traditional pattern as it is mostly practised by a hereditary class of growers who dwell around towns and cities. The holdings used for vegeta-

ble growing are very small and effective plant protection measures are usually missing. Since most individual holdings are very small, hence, many modern mechanised methods cannot be followed (National Commission on Agriculture, 1976). On the other hand, Barnala (1989) observed that most innovations, have not been exploited in full. There exists communication gap between research worker and the farmer. Vidyasagar (1991) noted that one of the major problems in vegetable production throughout the country at this time is the non-availability of quality seeds capable of giving very high yields. Kanwar (1991) revealed that list of improved varieties and technologies goes on increasing but their adoption and diffusion rate are slow. He emphasised the need for training and demonstration to farmers. Misra (1991) found that improvement in delivery system of modern inputs is imperative for increasing agriculture production. In the present paper issues relating to caste variability and vegetable cultivation technology in a region having lots of prospects for increasing production and productivity of vegetable crops have been studied.

#### METHODOLOGY

The present study was undertaken in the national capital region of the Haryana state. Delhi being a metropolitan city, provides for a big market for vegetables of all kinds throughout the year. Two villages, viz. Singhpura and Sohna representing, respectively, Rohtak and Gurgaon districts of the State were purposively selected for the present

study. A comprehensive list of farmers growing vegetable crops for commercial purposes of both the sampled villages was prepared. In Singhpura village, one hundred such farmers were identified while from Sohna village 130 farmers were located. However, only 40 vegetable growers from Singhpura and 60 from Sohna were interviewed for the purpose of primary data collection during 1991-92. An interview schedule was developed and used for gathering information on the topic under investigation. Appropriate statistical tools were used for analysing primary data, thus, collected.

#### RESULTS AND DISCUSSION

It has been established by research studies that caste had influenced adoption of innovations in varied manner. It has also conditioned farmers' decision about the crops to be grown and inputs to be applied. Different castes have different tradition to cultivate crops. An attempt has been made to examine the relation of caste with cultivation technology, traditionality of cultivation, and obstacles in vegetable cultivation technology.

#### Caste and Vegetable Cultivation Technology

An appraisal of Table 1 reveals that vegetable cultivation was practised by farmers of different castes possessing average landholding between 1.6 to 5.8 acres. Average holding of the respondents was 5.15 acres which represents the category of small farmers. Furthermore, around four-fifth

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of the respondents were representing backward castes/classes followed by upper castes (18%) and scheduled castes (4%). A vast majority amongst the backward castes was represented by *saini* or *mali* community. It may safely be concluded from above that vegetable cultivation is mainly confined to farmers possessing smaller size of landholdings, residing near towns and cities and representing a hereditary class of growers known as *saini*. National Commission on Agriculture (1976) also made similar observations about vegetable cultivation in the country. So the extension organizations have not succeeded to the desired extent to popularise vegetable cultivation technology amongst the

farmers other than traditional vegetables growers. Barnala (1989) and Kanwar (1991) reported the existence of communication gap between innovations and their adoption by the common farmer.

### Caste and Traditionality of Vegetable Cultivation

Traditionality of vegetable cultivation reveals that a particular caste in the region has specialised in vegetable crops. To test the assumption, it was decided to know caste background of respondents. Information on caste background and vegetable cultivation pattern in the sampled villages has been given in Table 2.

**TABLE 1**  
Classification of respondents according to landholdings, and area covered under vegetable crops

Caste	Total holding (acres)	Average holding (acres)	Area under vegetable crops (acres)
Upper	105.00	5.80	66 (63)
Backward	401.75	5.15	277 (69)
Scheduled	6.50	1.60	6 (92)
Total	513.25	5.13	435.3 (85)

Figures in parentheses are percentages.

**TABLE 2**  
Caste in relation to traditionality of vegetable cultivation amongst the respondents

Caste	Traditionality of vegetable cultivation		Total
	Yes	No	
Upper	3 (17)	15 (83)	18 (100)
Backward	77 (99)	1 (1)	78 (100)
Scheduled	--	4 (100)	4 (100)
Total	80	20	100

Figures in parentheses are percentages.

The data indicate that 99% respondents representing backward castes, dominated mainly by the *saini* community, were traditionally growing vegetable crops while in case of upper castes the percentage was 17 only. None of the scheduled castes respondents claimed to have grown vegetables traditionally. Although some respondents representing upper and scheduled castes have also started vegetable cultivation, but farmers representing *saini* community—a backward class, are cultivating vegetable crops on mass scale even in the national capital region of the State. Most of them are possessing small and marginal landholdings. A majority of them are either illiterate or semi-literate and localite in their social outlook, hence, modernization of vegetable cultivation is lacking with a few exceptions thereby leading to low production and productivity per unit area which is also responsible for their lower socio-economic status inspite of rising prices of vegetables. Poor socio-economic status and localite social outlook of vegetable growers were primarily responsible for lack of interest in the affairs of these people by the change agents and the government func-

tionaries. Shankariah (1965) observed almost similar situation in respect of farmers possessing smaller holdings and representing lower socio-economic status in the rural society.

### Caste and Obstacles in Vegetable Cultivation

The successful application of science and technology depends on the number and quality of men, material and other resources and above all their management. Low purchasing power, inadequate knowledge of innovations and non-availability of quality inputs at reasonable costs, also reported to be responsible for non-adoption of innovations by most farmers. Association between caste categories and obstacles experienced in adoption of innovations has been given in Table 3.

The data in Table 3 indicate that respondents representing all the three major caste categories have faced problems pertaining to inputs purchased at one stage or the other. Non-availability of recommended seeds from reliable sources, adulteration in inputs, and high costs of inputs were the major

TABLE 3  
Caste categories in relation to obstacles experienced by respondents in adoption of vegetable cultivation technology

Caste category	Obstacles experienced					Total
	Inputs not available	Lack of knowhow	No incentive	Low price	Much attention	
Upper	18 (100)	11 (61)	12 (67)	9 (60)	3 (17)	18
Backward	78 (100)	64 (82)	33 (42)	22 (28)	9 (12)	78
Scheduled	4 (100)	3 (75)	4 (100)	—	4 (100)	4
Total	100 (100)	78 (78)	49 (49)	31 (31)	16 (16)	100

Figures in parentheses denote percentages.

problems experienced by the respondents. Sinha and Sinha (1980), Singh and Mathur (1984), Misra (1991) and Vidyasagar (1991) also noted similar problems faced by the farmers in the adoption of recommendations. Most inputs were procured from private dealers by the respondents and these dealers were primarily interested in profiteering rather than serving the interest of the farming community. Lack of knowhow about innovations emerged as the second major obstacle in adoption of vegetable cultivation technology indicating poor performance of the personnel engaged in extension work within the State. Kanwar (1991) also observed that lists of improved varieties and technologies go on increasing, but their adoption and diffusion rate are slow. It is a well known fact that awareness of innovations is pre-requisite for their adoption, hence, the importance of change agent cannot be undermined in a country like ours where a vast majority of farmers is either illiterate or ignorant. Lack of incentives was reported by half of the respondents as obstacle in adoption. Sprayers on custom service, loan on easy terms and price protection were not provided to these respondents thereby restraining adoption of recom-

mendations. Phenomenal price fluctuation and toilsome involvement also discouraged farmers to go for vegetable cultivation technology particularly those representing upper and scheduled castes. These farmers were not accustomed to do toilsome work. Caste variability, therefore, influenced diffusion of innovations *i. e.* the scheduled castes respondents were less ignorant than those of backward castes. Similarly, backward castes farmers were less knowledgeable as compared with those representing upper castes. Shankariah (1965) also observed that farmers of lower castes were generally neglected by change agents in providing timely and latest innovations. A vast majority of the scheduled castes and upper castes respondents did not receive any incentive while amongst the backward classes people, this percentage was 42 indicating their awareness of possible incentives because of their traditional involvement in vegetable cultivation activities. A similar caste variability was also observed in respect of price fluctuations and toilsome nature of vegetable cultivation technology. Shankariah (1965) and Sachchidananda (1972) also noted similar trends in adoption of innovations in relation to caste variabilities.

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## SINGLE DOSE ANTICOAGULANTS AND MEDIAN PERIOD OF SURVIVAL OF RODENTS

GIRISH CHOPRA and T. R. KAPOOR\*

Department of Zoology

Kurukshetra University, Kurukshetra-132 119

(Accepted : March 10, 1995)

### ABSTRACT

Single day feeding of 0.005% bromadiolone bait resulted in absolute kill of *Rattus rattus*, *Rattus meltda*, *Bandicota bengalensis* and *Mus platythrix*. Brodifacoum bait at 0.005% concentration also resulted in 100% mortality of these four species as well as of *Tatera indica* and *Mus musculus* in single and no-choice laboratory feeding trials. Median period of survival (LT<sub>50</sub>) and 95% confidence limits at absolute mortality dose levels of bromadiolone and brodifacoum varied for different rodent species.

Among vertebrates, rodents pose serious threat to our economy by destroying food at all the stages of food production, processing, storage and distribution. Therefore, their management is essential. For this purpose, rodenticides are largely used in different parts of the world (Prakash and Mathur, 1987). Development of behavioural adaptations like bait shyness and poison aversion among rodents within a short time after treatment with acute toxicants (Barnett and Prakash, 1975), high bait and labour inputs as well as rodents showing resistance to multiple-dose anticoagulants (Hadler and Shadbolt, 1975) have led to the development of single-dose anticoagulants. Presently, two single-dose anticoagulants, *i.e.* bromadiolone and brodifacoum were evaluated in the laboratory to test their efficacy against predominant rodents.

### MATERIAL AND METHODS

The house rat, *Rattus rattus* and the house mouse *Mus musculus* were trapped from residential premises, poultry farms and store houses while the soft-furred field rat *Rattus meltda*, Indian mole rat *Bandicota bengalensis*, Indian gerbil *Tatera indica* and brown spiny mouse *Mus platythrix* were captured from crop fields. All these murids were lodged individually in cages in the laboratory and were acclimatised for a minimum of 10 days on laboratory diet prior to experimentation. Poison baits (0.005% bromadiolone bait and 0.005% brodifacoum bait) were prepared using cracked wheat and groundnut oil (98 : 2) and were exposed to the rodents for 24 h in separate no-choice trials. Water was provided *ad lib.* in each trial. Thereafter, the rodents were main-

\*Krishi Gyan Kendra, Kurukshetra-132 119.

TABLE 1

Efficacy of bromadiolone (0.005%) and brodifacoum (0.005%) against rodents when fed individually for 24 h

Rodent species	No. of individuals		Per cent mortality		Days to death (range)	
	Bm	Bd	Bm	Bd	Bm	Bd
<i>Rattus rattus</i>	10	10	100	100	5-11	5-16
<i>Rattus meltda</i>	9	10	100	100	5-8	5-11
<i>Bandicota bengalensis</i>	15	10	100	100	6-15	4-9
<i>Mus platythrix</i>	5	6	100	100	3-7	5-16
<i>Tatera indica</i>	—	10	—	100	—	2-12
<i>Mus musculus</i>	—	5	—	100	—	4-20

Bm=Bromadiolone; Bd=Brodifacoum.

TABLE 2

Survival times of rodents and 95% confidence limits after single day feeding of 0.005% brodifacoum and 0.005% bromadiolone baits

Species	LT <sub>10</sub> *	LT <sub>50</sub>	LT <sub>50</sub> and 95% confidence limits	S (Slope function) and 95% confidence limits
<b>Brodifacoum</b>				
<i>Rattus rattus</i>	3.6	10.5	7.1(5.07-9.94)	1.73(1.35-2.20)
<i>Rattus meltda</i>	4.0	9.0	6.4(4.94-8.29)	1.51(1.26-1.81)
<i>Tatera indica</i>	4.1	11.5	7.8(5.63-10.80)	1.69(1.34-2.12)
<i>Bandicota bengalensis</i>	3.6	7.4	5.5(4.40-6.88)	1.44(1.22-1.70)
<i>Mus musculus</i>	4.0	9.0	5.0(3.47-7.2)	1.53(1.16-2.00)
<i>Mus platythrix</i>	5.1	10.0	7.6(5.80-9.96)	1.41(1.15-1.71)
<b>Bromadiolone</b>				
<i>Rattus rattus</i>	4.6	7.5	6.0(5.15-6.99)	1.28(1.14-1.42)
<i>Rattus meltda</i>	5.3	6.6	5.9(5.51-6.31)	1.12(1.06-1.18)
<i>Bandicota bengalensis</i>	7.4	12.6	10.0(8.76-11.42)	1.31(1.18-1.44)
<i>Mus platythrix</i>	2.4	9.1	5.8(3.19-10.56)	2.00(1.28-3.11)

Figures in parentheses indicate range.

\*LT=Survival times of rodents in no-choice tests in which complete mortality occurred, expressed as the number of days to reach a particular mortality percentile.

## MEDIAN PERIOD OF SURVIVAL OF RODENTS

tained on plain laboratory diet and the time to death was recorded. The median period of survival or lethal time taken for 50% kill ( $LT_{50}$ ) and their 95% confidence limits were calculated following Litchfield (1949) and Mathur and Prakash (1981b).

### RESULTS AND DISCUSSION

Unlike multiple dose anticoagulants which require number of days of continuous feeding to produce effective rodent mortality (Chaturvedi *et al.*, 1975; Mathur and Prakash, 1981a, 1982; Chopra and Parshad, 1985a, b; Chopra, 1990), single dose anticoagulants have proved better alternatives so far as their potency against majority of predominant rodent species is concerned (Table 1). Marsh (1977), Dubock (1980), Chopra and Parshad (1985a, b), Parshad *et al.* (1985), Subiah and Mathur (1985), Parshad and Chopra (1986), Sheikher *et al.* (1987) and Parshad (1994) have also reported better performance of single dose anticoagulants than the first generation multiple dose anticoagulants.

Single day feeding of 0.005% bromadiolone and 0.005% brodifacoum baits resulted in absolute kill of predominant murids within 20 days of poison intake (Table 1). Median period of survival ( $LT_{50}$ ) and 95% confidence limits at absolute mortality dose levels of bromadiolone and brodifacoum for different rodent species were variable (Table 2). However, it was quite close to that of the multiple dose anticoagulant fumarin in case of *R. rattus* (Chopra, 1990). Based on the present as well as earlier findings, on the whole, feeding of bromadiolone and brodifacoum baits for one day resulted in absolute rodent mortality in almost same number of days as was observed after feeding first generation multiple dose anticoagulant baits for many days. It is, therefore, suggested that second generation anticoagulants at 0.005% concentration are better alternatives for rodent control than the first generation multiple dose anticoagulants as these are acceptable, highly potent and also require low bait and labour inputs.

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## TOXICITY OF TRANSITION METAL COMPLEXES TO THE GROWTH OF PLANT PATHOGENIC FUNGI

V. K. GARG, RAM PARTAP, P. S. RELAN and K. K. GIRDHAR

Department of Chemistry &amp; Biochemistry

CCS Haryana Agricultural University, Hisar-125 004

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Metal complexes of sulphur donor ligands have received great attention because of their versatile use as anti-fungal and antibacterial agents. The co-ordination of a metal ion with organic ligands may alter the activity pattern of the ligands and the resulting compounds may be more potential biodynamic agents with desirable characteristics (Sorenson, 1976). The compounds having C=O and C=S groups display significant antifungal activity which is further enhanced several times on complexing with metal ions (Satpathy *et al.*, 1983). The present study reports the effectiveness of some ternary and binary complexes, metal salts and organic ligands against three plant pathogenic fungi, *viz.* *Alternaria raphani*, *A. brassicicola*, and *Verticellium albo-atrum*.

Three ligands, *viz.* Thiolactic acid (TLA), Thiosalicylic acid (TSA) and Bipyridyl (By) obtained from Sigma, and sulphates of metals (Mn, Fe, Co, Ni and Zn) obtained from Sarabhai Chemicals were used without further purification. Metal (M) ligand complexes of the type M-By, M-By-TSA and M-By-TLA were prepared and characterised for metal, nitrogen and sulphur

contents using the method reported by Panchal and Bhattacharya (1973). Plant pathogenic fungi were obtained from the Department of Plant Pathology, CCS Haryana Agricultural University, Hisar, and maintained on Czapek-Dox agar slants at 5°C. Efficiency of the compounds was tested against three plant pathogenic fungi, *viz.* *Alternaria raphani*, *A. brassicicola* and *Verticellium albo-atrum* by poisoned food technique (Horsfall, 1945; Grover and Moore, 1992).

One hundred ml Czapek-Dox agar medium was autoclaved in 250 ml Erlenmeyer flasks at 15 lb/inch pressure for an hour. The required amount of each compound, dissolved in 1 ml double distilled water, was incorporated aseptically into 99 ml aliquot of sterilised medium to give final concentration of 1, 10, 50 and 100 µg/ml. After brief shaking, each lot of medium was poured into six petridishes and allowed to solidify. Each dish was inoculated centrally with 10 mm mycelial disc cut from the periphery of 2-3 days old fungal colonies. Inoculated petridishes were incubated at 30°±0.1°C in the dark. Colony diameter was measured after 120 h. The per

cent inhibition of mycelial growth was calculated on mean value of colony diameter using the formula :

$$\text{Inhibition of mycelial growth} = \frac{C-T}{T} \times 100$$

Where C = Average diameter of fungal colony in control plate,

T = Average diameter of fungal colony in treated plate.

Results reveal that all the metal complexes checked the growth of the test fungi. Data indicate that the inhibition of fungal growth increased gradually with the increase in concentration of test compound (Table 1). Toxicity of metal complexes varied depending upon the nature of metal ion as well as that of the ligand. The following decreasing order of the fungi-

TABLE 1

Fungicidal effect : average per cent inhibition after 120 h

No	(Name of compound/ Chemical formula)	<i>Alternaria raphani</i>				<i>Alternaria brassicicola</i>				<i>Verticellium albo-atrum</i>			
		1	10	50	100	1	10	50	100	1	10	50	100*
1.	[Zn (By) (TSA) (H <sub>2</sub> O) <sub>2</sub> ]	26	40	54	80	28	32	56	80	23	33	62	93
2.	[Ni (By) (TSA) (H <sub>2</sub> O) <sub>2</sub> ]	20	40	44	64	20	32	50	60	13	20	40	62
3.	[Mn (By) (TSA) (H <sub>2</sub> O) <sub>2</sub> ]	20	42	50	78	24	30	50	80	20	30	60	90
4.	[Co (By) (TSA) (H <sub>2</sub> O) <sub>2</sub> ]	18	30	41	60	10	24	36	62	16	18	37	81
5.	[Fe (By) (TSA) (H <sub>2</sub> O) <sub>2</sub> ]	20	36	52	66	20	32	54	76	16	26	49	63
6.	[Zn (By) (TLA) (H <sub>2</sub> O) <sub>2</sub> ]	28	40	60	80	26	34	46	60	22	52	65	92
7.	[Ni (By) (TLA) (H <sub>2</sub> O) <sub>2</sub> ]	22	30	40	50	21	28	40	54	15	50	64	82
8.	[Mn (By) (TLA) (H <sub>2</sub> O) <sub>2</sub> ]	24	36	46	74	24	24	40	58	18	45	67	80
9.	[Co (By) (TLA) (H <sub>2</sub> O) <sub>2</sub> ]	13	28	40	60	12	18	37	52	14	26	48	65
10.	[Fe (By) (TLA) (H <sub>2</sub> O) <sub>2</sub> ]	22	34	44	64	18	21	38	54	20	40	50	73
11.	[Zn (By) (H <sub>2</sub> O) <sub>4</sub> ]	10	24	34	48	12	18	33	50	17	28	46	66
12.	[Ni (By) (H <sub>2</sub> O) <sub>4</sub> ]	6	10	20	39	10	14	29	40	13	18	43	57
13.	[Mn (By) (H <sub>2</sub> O) <sub>4</sub> ]	8	24	30	43	12	18	31	46	11	22	43	60
14.	[Co (By) (H <sub>2</sub> O) <sub>4</sub> ]	5	13	21	26	8	14	20	38	8	18	32	47
15.	[Fe (By) (H <sub>2</sub> O) <sub>4</sub> ]	8	21	26	37	10	14	26	45	10	20	38	53
16.	ZnSO <sub>4</sub>	0	0	2	6	0	0	2	9	0	0	4	11
17.	NiSO <sub>4</sub>	0	0	0	0	0	0	0	3	0	0	2	8
18.	MnSO <sub>4</sub>	0	0	2	4	0	0	2	6	0	0	0	6
19.	CoSO <sub>4</sub>	0	0	0	0	0	0	0	0	0	0	0	0
20.	FeSO <sub>4</sub>	0	0	0	0	0	0	0	0	0	0	2	8
21.	TSA	7	11	18	23	8	11	18	21	3	12	23	33
22.	TLA	5	10	14	20	10	18	25	28	0	11	18	30
23.	By	5	10	18	21	4	9	16	24	6	14	23	34

\*Concentration in ppm

## TOXICITY OF TRANSITION METAL COMPLEXES

toxicity was obtained depending upon the nature of metal ion and free ligand :

<i>Fungi</i>	<i>Metal ion order</i>	<i>Ligand order</i>
<i>A. raphani</i>	Zn> Mn> Fe> Ni> Co	TSA> By> TLA
<i>A. brassi- cicola</i>	Zn> Mn> Fe> Ni> Co	TLA> TSA > By
<i>V. albo- atrum</i>	Zn> Mn> Fe> Ni> Co	By> TSA> TLA

The results also reveal that the TSA complexes are more toxic than TLA complexes for the test plant pathogens. The toxicity of ternary complexes (1 to 10) has been found considerably higher than binary complexes (11 to 15),

metal salts and free ligands (Table 1). This increased toxicity of the ternary complexes might probably be attributed either to the combined bioactive effects of the metal ion and both ligands present in the complexes or to the increased liposoluble nature of the complexes (Khanna *et al.*, 1982). Tripathi *et al.* (1984) reported that the increased diffusion of the metal complex through the cell membrane of the fungi might also play an important role in increasing the fungitoxicity of the metal chelates. It has also been postulated that the complexes affect the enzymes activity by exchanging the trace metals of the metalloenzymes, present in the cell fluid with the metal of the complexes under test (Zentimayer *et al.*, 1960).

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## KNOWLEDGE LEVEL OF EXTENSION PERSONNEL AND CONTACT FARMERS REGARDING WHEAT PRODUCTION TECHNOLOGY

V. P. S. YADAV and R. S. NARWAL

Department of Extension Education

CCS Haryana Agricultural University, Hisar-125 004

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### ABSTRACT

The extension personnel of all ranks and file studied had two times higher mean knowledge scores than that of contact farmers. There existed a significant difference between knowledge status of SMSs and CAOs; CAOs and ADOs with regard to wheat production technology. The contact farmers - users of technology, whom extension personnel contact frequently possessed only about one-fourth of total wheat production technology which is, in fact, disturbing and not at all in the overall interest of agricultural development. Hence, efforts need to be made to gear up extension machinery in a manner that makes the user farmers update the latest technical know-how.

There have been tremendous changes in overall agricultural situation in the country. However the major crops were and are given more attention by researchers and extensionists and as a result these are termed as research and extension blessed crops. A lot of useful production technology of wheat has been evolved and as such there is no dearth of technology but main concern is of its proper and timely dissemination and also its adoption to fullest extent. The transmission lapses are evident from reported yawning communication gap existed from point of technology generation to the point of technology utilization (Ray, 1980; Singh, 1983; Verma, 1985; Yadav, 1991). The users' poor knowledge of technology is also one of the major constraints for low adoption (Pandey and Mathur, 1983; Narwal *et al.*, 1985). The low adoption of improved technology

seems to be most probable reason for non-attainment of yield potential. Decreasing land under plough and fast increasing population call for acquiring requisite latest technical know-how both by extension functionaries, being transmitters, and farmers being users, in order to boost wheat production per unit area. The reorganized Training & Visit System of agricultural extension was introduced with the hope to increase and update knowledge of crop practices of extension functionaries and contact farmers through its strong inbuilt training component. The present investigation was planned and carried out with the following specific objectives :

1. To determine the knowledge level of extension personnel and contact farmers regarding wheat production technology.

2. To ascertain inter-respondents variation in knowledge about wheat production technology.

## METHODOLOGY

### Selection of Locale

The present investigation was carried out in districts of Hisar and Rewari of Haryana state because of the considerations that (i) technology research centres are located either at these district headquarters or areas falling under jurisdiction of these districts; (ii) district headquarters or area under the jurisdiction of district serves as Zonal Training Centre for monthly trainings of extension functionaries who, in turn, impart training to farmers; and (iii) easy accessibility. Two villages, viz. Satrod Khurad and Mayar from Hisar sub-division, and two villages, viz. Bikaner and Ghasera from Rewari sub-division were selected randomly. Thus, in all four villages were selected for study.

### Selection of Respondents

One, 2, 4 and 8, Sub-divisional Agricultural Officers (SDAOs), Subject-Matter Specialists (SMSs), Circle Agriculture Officers (CAOs) and Agricultural Development Officers (ADOs), respectively were drawn from each of the selected sub-divisions to form the sample for the study. Thus, 30 extension personnel of different rank and file constituted the sample. Ten contact farmers were selected randomly from each selected village. Thus, in all 40 contact farmers formed the sample for the study.

Knowledge of both extension personnel and contact farmers was mea-

sured through the administration of a standardized teacher-made type knowledge test having questions on wheat production technology. The score of one was assigned to 'correct' and zero to 'incorrect' or 'no' reply to a question or part thereof. The overall mean knowledge scores of respondents of each category were arrived at by adding the average practice-wise knowledge score of that category respondents and expressed in terms of percentage. The significance of knowledge possessed by different categories of respondents was determined by using 't' test.

## RESULTS AND DISCUSSION

The extent of knowledge possessed by extension personnel and contact farmers has been furnished in Table 1.

It is evident from the data that extension personnel had attained higher scores than that of contact farmers which is logical enough as extension personnel have professional training and qualifications in agricultural sciences. Similar observations have also been reported by Sood (1987). Looking at the differential mean knowledge scores of extension personnel, it was found that SDAOs had an upper edge over SMSs, SMSs over CAOs and CAOs over ADOs. The contact farmers' knowledge of wheat production technology was very low though they were regularly contacted, guided and supervised by extension personnel. The acquisition of wheat production technology by extension personnel varied marginally between ADOs and CAOs (0.33%), between CAOs and SMSs (4.54%) and between SMSs and

KNOWLEDGE LEVEL OF EXTENSION PERSONNEL

TABLE 1

Knowledge scores of extension personnel and contact farmers regarding wheat production technology

Respondent	Knowledge scores	
	Mean	Per cent
Sub-Divisional Agricultural Officer (SDAO) (N=2)	57.50	74.67
Subject Matter Specialist (SMS) (N=4)	55.50	72.07
Circle Agricultural Officer (CAO) (N=8)	52.00	67.53
Agricultural Development Officer (N=16)	51.75	67.20
Contact farmer (CF) (N=40)	26.55	34.48

TABLE 2

Variation of knowledge among different categories of respondents

Respondent	Mean score	Difference between mean	t' value	Pooled variance
SDAO	57.50	2.00	1.88 NS	1.52
SMS	55.50			
SMS	55.50	3.50	4.60**	1.54
CAO	52.00			
CAO	52.00	0.25	0.47 NS	1.48
ADO	51.75			
ADO	51.75	25.20	18.12**	22.03
CF	26.55			

NS=Non-significant

\*\*Significant at 0.01 level of probability.

SDAOs (2.60%). However, the difference in acquired knowledge between contact farmers and SDAOs was as high as 40.19 per cent. It suggested a wide gap in existing wheat production technology knowledge at the levels

of transmission and utilization. Thus, the ultimate user did not have requisite knowledge of available technology.

The higher mean knowledge scores of extension personnel may possibly

be due to their regular trainings and closeness to the information sources and research system. It is also likely that extension personnels' rich experience might have contributed to their abundantly higher knowledge. To test the significance of difference, if any, between the obtained mean knowledge scores of different categories of extension personnel, 't' test was employed.

The calculated 't' values of 4.60 and 18.12 for the mean knowledge scores between SMSs and CAOs, ADOs

and CFs, respectively were found to be statistically significant both at 0.05 and 0.01 levels of probability. This indicated that SMSs and CAOs, ADOs and CFs differed significantly with regard to knowledge about wheat production technology. However, the difference in mean knowledge scores between SDAOs and SMSs, CAOs and ADOs was not significant. The findings seem to be logical because of the probable reason that CAOs and CFs get information mainly from SMSs and ADOs, respectively.

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## YIELD STABILISATION OF SCENTED DWARF RICE (*ORYZA SATIVA*) L. UNDER LATE PLANTINGS THROUGH SPACING AND SEEDLING AGE

S. D. DHIMAN, HARI OM and BIKRAM SINGH

CCS Haryana Agricultural University  
Rice Research Station, Kaul-132 021

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### ABSTRACT

The effect of plant spacing ( $15 \times 15$  cm and  $20 \times 15$  cm) and age of seedlings (30, 40 and 50 days old) under different dates of planting (July 15, 25 and August 5) was studied on yield of scented dwarf rice variety Haryana Basmati-1 (HKR 228). Grain yield, panicles/m<sup>2</sup>, panicle weight, and grains/panicle were significantly reduced with delayed planting after July 15. Close spacing had no significant advantage on production over wide spacing. Younger seedlings (30 days old) yielded better (44.9 q/ha) when transplanted on July 15, but the older seedlings had beneficial effect on grain yield (32.1 q/ha) under late planting particularly with close spacing. Panicles/m<sup>2</sup> and panicle weight were affected by spacing, but these parameters were not affected significantly due to age of seedlings.

A newly developed dwarf scented rice (*Oryza sativa* L.) variety Haryana Basmati-1 has been recommended for cultivation in Haryana. It is very responsive to fertilizer and has quality traits comparable to Basmati 370. Farmers are often compelled to complete transplanting in late part of the season due to erratic rainfall or delay in supply of canal water. Age of seedling and plant spacing are the important cultural operations for yield exploitation in a given set of climatic conditions which may reduce undesirable influence of the climate to a considerable extent. Therefore, an attempt was made to find out the possibility of utilizing older seedlings and close spacing for stabilisation in yield of scented dwarf rice variety Haryana Basmati-1 under late planting.

### MATERIAL AND METHODS

The field experiments were conducted at CCSHAU Rice Research Station, Kaul (Haryana) during rainy seasons of 1990 and 1991. Eighteen treatment combinations consisting of three dates of transplanting (July 15, 25 and August 5), two plant spacings ( $15 \times 15$  cm and  $20 \times 15$  cm) and seedlings of three different ages (30, 40 and 50 days old) were laid out in a split plot design with four replications. The soil was clay loam with pH 8.1. The organic matter was 0.36%, and available N, P and K were 169, 18.6 and 335 kg/ha, respectively. The fertilizers were applied @ 90 kg N, 30 kg P<sub>2</sub>O<sub>5</sub> and 25 kg ZnSO<sub>4</sub>/ha. Whole of the P<sub>2</sub>O<sub>5</sub>, ZnSO<sub>4</sub> and 1/3 of the N were applied at the

time of puddling. The remaining N dose was applied in two splits as top dressing, 3 and 6 weeks after transplanting. The variety Haryana Basmati-1 (HKR 228) was sown for raising the nursery by wet method, using 40 g seed/m<sup>2</sup> area. Two seedlings/hill were transplanted and other cultural operations were provided as per need of the crop.

## RESULTS AND DISCUSSION

### Effect of Time of Transplanting

Number of panicles/m<sup>2</sup> recorded in July 15 planting was significantly higher over other dates of planting (July 25 and August 5) during both the years except during 1990 where it remained statistically at par with August 5 planting. Significantly higher panicle weight was recorded in July 15 planting as compared to other dates of planting during both the years, but there was no significant variation in panicle weight between the plantings of July 25 and August 5 during second year. Planting of crop on July 15 and 25 recorded significantly more number of grains per panicle over August 5 planting during 1990 but in 1991, July 25 and August 5 plantings had similar number of grains/panicle which was significantly lower than the number of grains produced in July 15 planting (Table 1). As evident from the data, the percentage of unfilled grains increased with delayed planting. Grain yield reduced significantly with delayed planting (July 25 and August 5) over July 15 planting during both the years. The increase in grain yield with July 15

planting was 4.8 and 3.3 q/ha over July 25 planting, and 15.0 and 6.7 q/ha over August 5 during 1990 and 1991, respectively. Similar results were reported by Ghosh (1982) and Pandey and Agarwal (1991).

### Effect of Plant Spacing

The data reveal that closer plant spacing had resulted in significantly more number of panicles/m<sup>2</sup> as compared to wider plant spacing during both the years (Table 1). Panicle weight was significantly influenced by plant spacing only during 1991. Number of grains/panicle and grain yield were not affected significantly due to plant spacing in any of the year. Similar findings have also been reported by Reddy and Reddy (1992).

### Effect of Age of Seedlings

Similar number of panicles/m<sup>2</sup> was recorded with 30 and 40 days old seedlings and these treatments were significantly superior over 50 days old seedlings during 1990. Significantly higher panicle weight was recorded with 30 and 50 days old seedlings over 40 days old seedlings during 1991. The crop planted with 30 days old seedlings gave significantly higher grain yield over 40 and 50 days old seedlings during second year of study. On an average, the crop planted with 30, 40 and 50 days old seedlings gave 36.20, 35.31 and 35.21 q/ha grain yield, respectively. The variability in grain yield in different years due to age of seedlings may be because of variation in prevailing weather conditions at

SCENTED DWARF RICE UNDER LATE PLANTING

TABLE 1  
 Grain yield and its attributes as influenced by time of transplanting, plant spacing and age of seedlings of scented dwarf rice variety Haryana Basmati-1 (HKR 228)

Factor	Grain yield (q/ha)		Panicles/m <sup>2</sup>		Panicle weight (g)		Grains/panicle		Unfilled grains (%)	
	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991
<b>Dates of transplanting</b>										
15 July (D <sub>1</sub> )	43.53	37.21	283	292	2.58	2.11	116	97	6.7	4.4
25 July (D <sub>2</sub> )	38.69	33.89	264	248	2.40	1.99	114	89	6.8	5.1
5 August (D <sub>3</sub> )	28.71	30.42	282	233	2.06	1.98	97	87	7.9	10.6
<b>Plant spacing (cm)</b>										
15 x 15 (S <sub>1</sub> )	37.57	34.32	300	277	2.32	1.98	106	86	6.8	7.2
20 x 15 (S <sub>2</sub> )	36.39	33.54	253	243	2.39	2.08	111	93	7.5	6.3
<b>Age of seedlings (days)</b>										
30 (A <sub>1</sub> )	36.34	35.06	286	259	2.36	2.12	109	95	7.5	7.1
40 (A <sub>2</sub> )	37.62	33.01	284	256	2.38	1.92	110	86	6.6	6.9
50 (A <sub>3</sub> )	36.98	33.45	260	258	2.32	2.05	106	91	7.5	6.1
<b>C. D. at 5%</b>										
Dates	3.68	1.80	9.8	21.6	0.15	0.10	13	3.5	—	—
Spacing	NS	NS	10.9	11.5	NS	0.06	NS	NS	—	—
Age	0.87	0.70	9.1	NS	NS	0.07	NS	NS	—	—
DAS	2.14	1.71	22.2	26.8	0.39	0.04	16	NS	—	—

**TABLE 2**  
**Interaction effect of time of transplanting, plant spacing and age of seedlings on scented dwarf rice variety Haryana Basmati-1 (HKR 228)**

Date of transplanting	S <sub>1</sub>						S <sub>2</sub>								
	A <sub>1</sub>		A <sub>2</sub>		A <sub>3</sub>		A <sub>1</sub>		A <sub>2</sub>		A <sub>3</sub>				
	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991			
<b>Grain yield (q/ha)</b>															
D <sub>1</sub>	44.86	40.60	44.86	36.90	42.04	37.30	44.45	39.7	43.16	35.10	41.81	34.10			
D <sub>2</sub>	39.46	34.70	41.81	33.00	41.94	33.10	36.08	34.8	37.48	33.60	36.38	34.50			
D <sub>3</sub>	27.08	30.40	26.94	30.30	29.08	32.10	27.10	30.4	31.43	29.40	30.64	30.00			
<b>Number of panicles/m<sup>2</sup></b>															
D <sub>1</sub>	283	285	310	245	312	278	266	232	270	226	254	221			
D <sub>2</sub>	298	298	296	299	274	304	248	274	251	205	218	275			
D <sub>3</sub>	337	244	313	239	276	263	281	223	261	219	225	216			
<b>Panicle weight (g)</b>															
D <sub>1</sub>	3.14	2.06	2.39	1.86	2.29	2.22	2.73	2.23	2.63	1.99	2.33	2.34			
D <sub>2</sub>	2.30	2.19	2.43	1.74	2.24	1.95	2.31	2.32	2.56	2.03	2.58	1.75			
D <sub>3</sub>	1.79	1.86	2.10	2.00	2.16	2.00	1.88	2.10	2.15	1.92	2.29	2.04			
<b>Number of grains/panicle</b>															
D <sub>1</sub>	133.0	94.0	116.0	86.5	106.0	99.5	122.0	99.5	118.0	95.5	127.0	110.0			
D <sub>2</sub>	116.0	101.0	119.0	77.5	114.0	86.5	123.0	103.0	126.0	87.5	118.0	78.0			
D <sub>3</sub>	87.0	79.0	113.0	88.0	101.0	85.5	105.0	94.7	108.0	82.7	109.0	89.2			

## SCENTED DWARF RICE UNDER LATE PLANTING

various phenophases of crop which ultimately had effect on establishment and development of the crop. The results are in conformity with those of Reddy and Reddy (1992).

### Interaction Effect of Time of Transplanting, Plant Spacing and Age of Seedlings

The data on the interaction effect of dates of planting, spacing and age of seedlings on grain yield and its attributes indicate that younger seedlings (30 days old) performed better under

normal planting (July 15) but 40 and 50 days old seedlings have their beneficial effect on grain yield under late plantings (July 25 and August 5) (Table 2). This effect was observed to be more under closer plant spacing of 15×15 cm as compared to wider plant spacing of 20×15 cm.

On the basis of mean of two years (1990 and 1991), the maximum grain yield of 42.8 q/ha was obtained by transplanting 30 days old seedlings at a plant spacing of 15×15 cm on July 15.

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## EFFECT OF ISOPROTURON AND 2, 4-D COMBINATION ON WEED CONTROL IN WHEAT

R. S. PANWAR, S. S. RATHI and R. K. MALIK

Department of Agronomy

CCS Haryana Agricultural University, Hisar-125 004

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### ABSTRACT

Field experiments were conducted during winter seasons of 1990-91 and 1991-92. The combination of isoproturon and 2, 4-D @ 1.00+0.25 kg/ha gave similar weed control as obtained with isoproturon @ 1.00 kg/ha alone. The grain yields of wheat in the plots treated with isoproturon+2, 4-D @ 1.00+0.50 kg/ha were significantly less than the weed free check. In the plots where isoproturon was used alone @ 1.00 kg/ha, the grain yield was similar to the weed free check. Malformation of wheat earheads due to 2, 4-D increased with increase in the dose of 2, 4-D in the mixture.

Isoproturon and 2, 4-D have been recommended for the control of grassy and broad leaf weeds, respectively (Malik *et al.*, 1989). Combinations of isoproturon and 2, 4-D have been successfully tried for the control of complex weed flora in wheat (Sharma *et al.*, 1987; Panwar *et al.*, 1990). At present tank mixtures of isoproturon and 2, 4-D are being tried by the farmers but such treatments require spray calibration for herbicides to be used in the tank mixture. The formulated mixture of isoproturon and 2, 4-D can help farmers to apply readymade mixture instead of tank mixture. The present study was, therefore, conducted to find out the effectiveness of isoproturon+2, 4-D used as tank mixture or as formulated mixture on the control of both grassy and broadleaf weeds in wheat.

### MATERIAL AND METHODS

A field experiment was conducted at CCS Haryana Agricultural University,

Hisar, during the winter seasons of 1990-91 and 1991-92. The soil of the experimental plot was sandy loam with pH 8.0 and an organic matter content of 0.4 per cent. The formulated mixture and tank mixture of isoproturon and 2, 4-D at different rates included were 1.200+0.300, 1.000+0.250, 0.750+0.187, 0.625+0.156 and 0.500+0.125 kg/ha, isoproturon alone at 0.750 and 1.000 kg/ha and 2, 4-D at 0.500 kg/ha. These treatments were compared with two controls, *i. e.* weedy and weed free check in a randomised block design with three replications. All the herbicides were applied 21 DAS with knapsack sprayer using 750 l water/ha. The wheat cultivar WH 283 was sown on November 30 and 16 in 1990 and 1991, respectively. Fertilizers, irrigation and other cultural practices were applied in accordance with recommendations given in the package of practices. Malformation in wheat earheads was

TABLE 1  
Effect of isoproturon and 2, 4-D combination on different weeds population at 90 DAS

Treatment	Dose (kg/ha)	Weed population (no./m <sup>2</sup> ) 90 DAS*						
		1990-91			1991-92			
		<i>A. ludoviciana</i>	<i>C. album</i>	<i>P. minor</i>	<i>C. album</i>	<i>R. maritimus</i>	<i>M. indica</i>	
Isoproturon + 2, 4-D (F)*	1.200+0.300	2.42 (5)	1.00 (0)	2.37 (5)	1.00 (0)	1.41 (1)	1.24 (1)	
Isoproturon + 2, 4-D (F)	1.000+0.250	2.98 (8)	1.00 (0)	2.63 (6)	1.00 (0)	1.00 (0)	1.41 (1)	
Isoproturon + 2, 4-D (F)	0.750+0.187	3.28 (10)	1.00 (0)	2.66 (7)	1.00 (0)	1.00 (0)	1.41 (1)	
Isoproturon + 2, 4-D (F)	0.625+0.156	3.29 (11)	1.00 (0)	3.20 (9)	1.00 (0)	1.00 (0)	1.66 (2)	
Isoproturon + 2, 4-D (F)	0.500+0.125	3.39 (12)	1.00 (0)	3.49 (13)	1.00 (0)	1.00 (0)	1.66 (2)	
Isoproturon + 2, 4-D (T)*	1.200+0.300	2.32 (5)	1.00 (0)	2.32 (5)	1.00 (0)	1.41 (1)	1.00 (0)	
Isoproturon + 2, 4-D (T)	1.000+0.250	2.63 (6)	1.00 (0)	2.75 (7)	1.00 (0)	1.41 (1)	1.00 (0)	
Isoproturon + 2, 4-D (T)	0.750+0.187	2.87 (7)	1.00 (0)	3.04 (9)	1.00 (0)	1.00 (1)	1.00 (0)	
Isoproturon + 2, 4-D (T)	0.625+0.156	2.98 (8)	1.00 (0)	3.49 (11)	1.00 (0)	1.41 (1)	1.00 (0)	
Isoproturon + 2, 4-D (T)	0.500+0.125	3.10 (10)	1.00 (0)	3.74 (13)	1.00 (0)	1.41 (1)	1.00 (0)	
Isoproturon	1.000	1.41 (1)	1.00 (0)	2.49 (5)	1.00 (0)	1.41 (1)	1.41 (1)	
Isoproturon	0.750	2.61 (7)	1.00 (0)	2.88 (8)	1.24 (1)	1.00 (0)	1.41 (1)	
2, 4-D	0.500	8.21 (78)	1.00 (0)	4.77 (22)	1.00 (0)	1.00 (0)	1.41 (1)	
Weedy check		8.51 (72)	3.49 (13)	4.98 (25)	3.57 (12)	4.39 (19)	5.02 (25)	
Weed free check		1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	
C. D. at 5%		1.30	0.63	0.96	0.29	0.71	0.87	

Actual weed counts are in parentheses, transformed to  $\sqrt{X+1}$   
P—Formulation, T—Tank mixed, DAS—Days after sowing.

WEED CONTROL IN WHEAT

recorded before the harvest of the crop. Visual observation of per cent weed control was recorded 120 days after sowing (DAS) on 0-100 scale (where 0=no control, 100=complete control). Total weed population (no./m<sup>2</sup>) at 60 and 90 DAS and dry weight of total weeds (g/m<sup>2</sup>) at 90 DAS were recorded with the help of 0.5 m×0.5 m random quadrat.

L.) and wild oat (*Avena ludoviciana* Durieu) while in second year the field was infested with wild canary grass (*Phalaris minor* Retz.), Golden dock (*Rumex maritimus* L.), and yellow sweet clover (*Melilotus indica* All.). The tank mixture of isoproturon and 2, 4-D at 0.625+0.156 kg/ha and 0.500+0.125 kg/ha effectively controlled all the weeds. The effect on weeds increased with increase in the concentration of formulated or tank mixture of isoproturon and 2, 4-D. The control of lambsquarter, Golden dock and yellow sweet clover remained similar at all doses of these mixtures (Table 1). However, the control of wild oat and

RESULTS AND DISCUSSION

Effect on Weeds

In the first year field was dominated by lambsquarter (*Chenopodium album*

TABLE 2  
Effect of isoproturon and 2, 4-D combination on the total weed population at 60 and 90 DAS

Treatment	Dose (kg/ha)	Total weed population (no./m <sup>2</sup> )			
		60 DAS		90 DAS	
		1990-91	1991-92	1990-91	1991-92
Isoproturon + 2, 4-D (F)	1.200+0.300	2.62 (6)	3.36 (11)	2.69 (6)	2.88 (7)
Isoproturon + 2, 4-D (F)	1.000+0.250	3.06 (9)	4.41 (19)	3.25 (10)	2.91 (8)
Isoproturon + 2, 4-D (F)	0.750+0.187	3.27 (10)	4.47 (19)	3.28 (10)	3.51 (11)
Isoproturon + 2, 4-D (F)	0.625+0.156	3.70 (15)	4.67 (21)	3.29 (11)	3.86 (14)
Isoproturon + 2, 4-D (F)	0.500+0.125	3.90 (17)	5.13 (26)	3.67 (13)	3.90 (15)
Isoproturon + 2, 4-D (T)	1.200+0.300	2.41 (16)	3.59 (12)	2.32 (5)	2.75 (7)
Isoproturon + 2, 4-D (T)	1.000+0.250	3.18 (8)	4.28 (17)	2.62 (6)	3.15 (9)
Isoproturon + 2, 4-D (T)	0.750+0.187	3.20 (11)	4.63 (21)	2.84 (7)	3.27 (11)
Isoproturon + 2, 4-D (T)	0.625+0.156	3.47 (12)	5.44 (29)	2.98 (8)	3.82 (14)
Isoproturon + 2, 4-D (T)	0.500+0.125	3.47 (12)	5.52 (29)	3.10 (10)	3.89 (15)
Isoproturon	1.000	2.62 (6)	3.94 (16)	1.41 (1)	3.15 (9)
Isoproturon	0.750	3.61 (13)	4.24 (17)	2.61 (7)	3.50 (11)
2, 4-D	0.500	6.37 (42)	6.75 (47)	5.99 (37)	4.91 (24)
Weedy check		11.36 (129)	15.65 (245)	9.51 (90)	9.62 (93)
Weed free check		1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)
C. D. at 5%		1.73	1.49	1.34	1.42

Actual weed counts are in parentheses, transformed to  $\sqrt{X+1}$   
F—Formulation, T—Tank mixed, DAS—Days after sowing.

TABLE 3

Effect of isoproturon and 2, 4-D combination on the per cent control of different weeds at 120 DAS

Treatment	Dose (kg/ha)	Per cent control (120 DAS)				
		<i>C. album</i>	<i>A. ludoviciana</i>	<i>P. minor</i>	<i>R. maritimus</i>	<i>M. indica</i>
Isoproturon + 2, 4-D (F)	1.200+0.300	77 (95)	74 (92)	72 (90)	72 (90)	72 (90)
Isoproturon + 2, 4-D (F)	1.000+0.250	77 (95)	70 (88)	69 (87)	72 (90)	72 (90)
Isoproturon + 2, 4-D (F)	0.750+0.187	77 (95)	59 (73)	66 (83)	72 (90)	72 (90)
Isoproturon + 2, 4-D (F)	0.625+0.156	77 (95)	57 (70)	60 (74)	72 (90)	72 (90)
Isoproturon + 2, 4-D (F)	0.500+0.125	77 (95)	54 (65)	59 (73)	72 (90)	69 (87)
Isoproturon + 2, 4-D (T)	1.200+0.300	77 (95)	77 (95)	69 (87)	72 (90)	72 (90)
Isoproturon + 2, 4-D (T)	1.000+0.250	77 (95)	77 (96)	69 (87)	72 (90)	72 (90)
Isoproturon + 2, 4-D (T)	0.750+0.187	77 (95)	73 (91)	69 (73)	72 (90)	72 (90)
Isoproturon + 2, 4-D (T)	0.625+0.156	77 (95)	67 (85)	66 (83)	72 (90)	72 (90)
Isoproturon + 2, 4-D (T)	0.500+0.125	77 (95)	67 (85)	64 (80)	72 (90)	72 (90)
Isoproturon	1.000	77 (95)	75 (93)	69 (87)	72 (90)	72 (90)
Isoproturon	0.750	75 (93)	67 (85)	69 (87)	72 (90)	72 (90)
2, 4-D	0.500	77 (95)	0 (0)	0 (0)	66 (83)	66 (87)
Weedy check		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Weed free check		90 (100)	90 (100)	90 (100)	90 (100)	90 (100)
C. D. at 5%		3	9	8	2	4

Actual per cent control data are in parentheses, transformed to arcsin.

TABLE 4

Effect of isoproturon and 2, 4-D combination on weed dry weight, malformation of earheads and grain yield of wheat

Treatment	Dose (kg/ha)	Total dry weight (g/m <sup>2</sup> ) 90 DAS		Malformation of earheads (%)		Grain yield (kg/ha)	
		1990-91	1991-92	1990-91	1991-92	1990-91	1991-92
		Isoproturon + 2, 4-D (F)	1.200+0.300	6.0	17.9	44	43
Isoproturon + 2, 4-D (F)	1.000+0.250	6.4	24.7	35	40	4415	4281
Isoproturon + 2, 4-D (F)	0.750+0.187	8.8	29.0	28	32	4595	4323
Isoproturon + 2, 4-D (F)	0.625+0.156	10.3	39.0	28	25	4762	4405
Isoproturon + 2, 4-D (F)	0.500+0.125	17.9	46.7	15	18	4859	4487
Isoproturon + 2, 4-D (T)	1.200+0.300	4.0	20.1	50	47	4276	4034
Isoproturon + 2, 4-D (T)	1.000+0.250	4.3	27.1	44	42	4373	4158
Isoproturon + 2, 4-D (T)	0.750+0.187	3.4	30.4	38	37	4498	4240
Isoproturon + 2, 4-D (T)	0.625+0.156	8.9	42.7	37	30	4526	4322
Isoproturon + 2, 4-D (T)	0.500+0.125	10.7	48.4	35	30	4568	4364
Isoproturon	1.000	0.6	27.6	0	0	4692	4528
Isoproturon	0.750	9.3	35.8	0	0	4651	4200
2, 4-D	0.500	34.0	78.9	50	52	4373	4034
Weedy check		102.6	249.3	0	0	3262	2817
Weed free check		0.0	0.0	0	0	5248	4775
C. D. at 5%		10.6	18.0	10	9	579	448

## WEED CONTROL IN WHEAT

wild canary grass was a function of herbicides concentration. The per cent control of these weeds increased with the increase in concentration (Table 3). Total weed population at 60 and 90 DAS and their dry weight, at 90 DAS in plots treated with 2, 4-D alone at 0.500 kg/ha were significantly less than weedy check (Tables 2 and 4).

### Effect on Crop

The malformation of wheat earhead increased with increase in concentration of 2, 4-D in the mixture. Maximum malformation was recorded following the treatment of 2, 4-D alone at 0.5 kg/ha (Table 4). The grain yield of wheat, therefore, depended on the malformation of the wheat earheads as effected by 2, 4-D concentration. Simi-

lar results were also reported by Balyan *et al.* (1990), and Yaduraju and Ahuja (1992). The grain yield of wheat following treatment of isoproturon at 0.5 kg/ha+2, 4-D at 0.125 kg/ha both in tank mixture and formulated mixture ranged from 4364 to 4895 kg/ha as compared to 4528 to 4692 kg/ha in plot treated with isoproturon alone at 1.00 kg/ha. Wheat cv. WH 283 is the susceptible variety against 2, 4-D (Malik *et al.*, 1986; Sharma *et al.*, 1987) and, therefore, the adverse effect on wheat grain yield was expected. Isoproturon alone at 1.00 kg/ha was most effective in increasing the wheat grain yield. Since the field was dominated by weeds which were susceptible to isoproturon, the advantage of 2, 4-D in the mixture could not be ascertained.

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## INTERACTION BETWEEN VA MYCORRHIZAE FUNGI AND RHIZOBIUM AND THEIR EFFECT ON THE GROWTH PARAMETERS OF *ACACIA NILOTICA* (L.) WILLD EX. DEL.

B. S. MANDAL and J. C. KAUSHIK

Department of Agroforestry

CCS Haryana Agricultural University, Hisar-125 004

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### ABSTRACT

Response of *Acacia nilotica* to inoculation with *Glomus constrictum*, *G. mosseae*, *Gigaspora gilmorei* and/or *Rhizobium* was studied in a phosphorus deficient sterile soil. Dual inoculation with both the organisms improved collar diameter, and root and shoot dry weights in comparison to single inoculation. Inoculation with *Glomus mosseae*+*Gigaspora gilmorei* and *Rhizobium* was found most effective, whereas *Glomus constrictum* was the least effective treatment. Root-shoot length was superior in rhizobium+VAM inoculated seedlings over uninoculated or only VAM inoculated treatments.

The growth promoting effects of VA mycorrhizal fungi and *Rhizobium*, alone or in combinations in Acacias and other leguminous tree species are well documented (Carling *et al.*, 1978; Bagyaraj *et al.*, 1979; Sivaprasad *et al.*, 1983; Punj *et al.*, 1987). The present investigations were aimed at studying the response of *A. nilotica* to three VAM fungi and their combination inoculated together with *Rhizobium* in promoting collar diameter and root-shoot dry weights and root-shoot lengths in nutrient deficient medium.

### MATERIAL AND METHODS

The studies were conducted in pots under greenhouse conditions in 1993-94. The seeds of *Acacia nilotica* (L.) Willd ex. Del. from local provenance

were used. Nutrient deficient river sand of pH 7.4 was used as the medium. In addition to with/without *Rhizobium* there were seven VAM inoculation treatments: (1) *Glomus mosseae*, (2) *G. constrictum*, (3) *Gigaspora gilmorei*, (4) *Glomus mosseae*+*G. constrictum*, (5) *Glomus constrictum*+*Gigaspora gilmorei*, (6) *Glomus mosseae*+*Gigaspora gilmorei*, and (7) uninoculated control.

Mycorrhizal inoculation was done by placing the seeds of *A. nilotica* over a thin layer of the mycorrhizal inoculum at the time of sowing. The mycorrhizal inoculum consisted of rootlets and soil from a pot culture of wheat (*Triticum indicum*) which was infected with *Glomus mosseae*, *G. constrictum* and *Gigaspora gilmorei*, separately and

grown for three months. The inoculum contained hyphae, vesicles, and arbuscules of VA mycorrhizal fungi. The *Rhizobium* inoculation was done by drenching the *Rhizobium* suspension @ one ml of bacterial suspension per seedling.

Observations on collar diameter and dry weight of root and shoot were taken 45 and 90 days after sowing. Collar diameter was determined by using dial vernier callipers.

## RESULTS AND DISCUSSION

### Collar Diameter

It is evident from the data in Table 1 that all the VAM inoculations improved the collar diameter differentially over control. *Glomus mosseae* alone or in combination with *Gigaspora gilmorei* was better than other treatments. *Rhizobium* inoculation significantly increased the collar diameter over uninoculated treatments irrespective of the VAM species. *G. mosseae*+*Gigaspora gilmorei*+*Rhizobium* inoculation treatment proved to be the best. Reena and Bagyaraj (1990) observed increased plant height and stem girth of VAM inoculated seedlings of *A. nilotica*. They also observed that *A. nilotica* seedlings responded best to *Glomus mosseae*.

### Root-shoot Dry Weight

Data in Table 1 indicate that dual inoculation with *Rhizobium* and either of the VAM species significantly increased the root-shoot dry weight of *A. nilotica* seedlings. At both the stages of observations, *Glomus mosseae*+*Gigaspora gilmorei* combination proved to be better than all other VAM treatments. Increased growth in *Rhizobium* and VAM inoculated treatments indicated a synergistic effect of both the organisms. Jasper *et al.* (1989) reported higher biomass production in *Acacia* sp. through VAM inoculations. Plant inoculated with both *Rhizobium* and VA mycorrhizal fungi increased the plant height, weight, and nodulation in comparison to control plants or those inoculated with individual organism separately (Bagyaraj *et al.*, 1979; Sharma *et al.*, 1989).

The double infected plants probably are benefitted from the physiological activities of endophytes which are responsible for mitigation of major elements N and P.

### Root-shoot Length

Dual inoculation with *Rhizobium* and either of VAM fungus increased the root and shoot lengths of *Acacia nilotica* seedlings. After 45 days, the maximum root (10.7 cm) and shoot (12.5 cm) lengths were recorded when the seedlings were inoculated with *Glomus mosseae*+*Gigaspora gilmorei* which were significantly better than others. In case of *Rhizobium*+VAM inoculated treatments the trend was similar except that *Glomus constrictum* was significantly better over control.

After 90 days, maximum root (24.0 cm) and shoot (25.5 cm) lengths were observed in *Glomus mosseae*+*Gigaspora constrictum*. *Rhizobium* inoculations in all treatments were better than VAM alone (Table 2).

TABLE 1  
Effect of VAM fungi and *Rhizobium* inoculations on collar diameter and root-shoot weight of *Acacia nilotica* seedlings

Treatment	Collar diameter (mm) after days				Root dry weight (g) after days				Shoot dry weight (g) after days				
	45		90		45		90		45		90		
	Without <i>Rhizo-</i> <i>bium</i>	With <i>Rhizo-</i> <i>bium</i>	Without <i>Rhizo-</i> <i>bium</i>	With <i>Rhizo-</i> <i>bium</i>	Without <i>Rhizo-</i> <i>bium</i>	With <i>Rhizo-</i> <i>bium</i>	Without <i>Rhizo-</i> <i>bium</i>	With <i>Rhizo-</i> <i>bium</i>	Without <i>Rhizo-</i> <i>bium</i>	With <i>Rhizo-</i> <i>bium</i>	Without <i>Rhizo-</i> <i>bium</i>	With <i>Rhizo-</i> <i>bium</i>	
<i>Glomus constrictum</i>	1.7	2.1	2.0	2.8	66	50	66	190	266	78	110	290	702
<i>G. mosseae</i>	2.1	2.1	2.3	3.0	58	58	79	210	330	91	121	380	806
<i>Gigaspora gilmorei</i>	1.8	2.1	2.1	2.9	55	72	72	200	300	87	117	340	774
<i>Glomus constrictum</i> + <i>G. mosseae</i>	2.2	2.4	2.7	3.0	78	98	98	260	452	103	150	490	981
<i>G. constrictum</i> + <i>Gigaspora gilmorei</i>	2.0	2.1	2.2	3.0	76	86	86	240	404	97	130	410	886
<i>G. mosseae</i> + <i>Gigaspora gilmorei</i>	2.6	2.8	2.9	3.3	88	110	110	280	504	112	160	600	1038
Control	1.4	1.7	1.5	2.6	46	58	58	170	210	68	97	260	610
C. D. at 5%	0.22	0.15	0.28	0.12	6.4	7.0	7.0	30.0	32.0	5.3	7.0	40.0	99.0
	Paired t=5.55		Paired t=7.32		Paired t=13.41		Paired t=5.28		Paired t=11.40		Paired t=24.95		
	t. tab. =2.44		t. tab. =2.44		t. tab. =2.44		t. tab. =2.44		t. tab. =2.44		t. tab. =2.44		t. tab. =2.44
	(5%)		(5%)		(5%)		(5%)		(5%)		(5%)		(5%)

TABLE 2  
Effect of VAM fungi and *Rhizobium* inoculations on root-shoot length and root-shoot ratio of *Acacia nilotica* seedlings

Treatment	Root length (cm) after days				Shoot length (cm) after days				Root-shoot ratio after days			
	45		90		45		90		45		90	
	Without <i>Rhizo-</i> <i>bium</i>	With <i>Rhizo-</i> <i>bium</i>	Without <i>Rhizo-</i> <i>bium</i>	With <i>Rhizo-</i> <i>bium</i>	Without <i>Rhizo-</i> <i>bium</i>	With <i>Rhizo-</i> <i>bium</i>	Without <i>Rhizo-</i> <i>bium</i>	With <i>Rhizo-</i> <i>bium</i>	Without <i>Rhizo-</i> <i>bium</i>	With <i>Rhizo-</i> <i>bium</i>	Without <i>Rhizo-</i> <i>bium</i>	With <i>Rhizo-</i> <i>bium</i>
<i>Glomus constrictum</i>	6.9	10.0	19.7	26.8	9.9	11.0	20.7	27.7	0.7	0.9	0.9	0.9
<i>G. mosseae</i>	8.2	12.0	21.3	28.4	10.5	13.9	22.2	30.2	0.8	0.9	1.0	0.8
<i>Gigaspora gilmorei</i>	7.6	11.9	20.5	27.5	10.0	13.0	21.1	28.9	0.8	0.9	1.0	1.0
<i>G. constrictum</i> + <i>G. mosseae</i>	9.9	15.0	23.0	30.0	11.9	17.0	24.0	31.0	0.8	0.9	1.0	0.9
<i>G. constrictum</i> + <i>Gigaspora gilmorei</i>	9.6	15.0	21.9	28.9	10.9	16.0	23.0	30.0	0.9	0.9	0.9	1.0
<i>G. mosseae</i> + <i>Gigaspora gilmorei</i>	10.7	17.6	24.0	30.0	12.5	18.5	25.5	32.2	0.9	0.9	0.9	0.9
Control	6.9	9.5	20.5	22.0	9.7	8.8	20.5	20.0	1.4	1.2	1.0	1.0
C. D. at 5%	0.17	0.41	0.53	1.46	0.37	0.68	0.76	1.27	0.06	0.03	0.02	0.05
	Paired t=7.88 t. tab. =2.44 (5%)		Paired t=7.88 t. tab. =2.44 (5%)		Paired t=5.30 t. tab. =2.44 (5%)		Paired t=6.41 t. tab. =2.44 (5%)		Paired t=0.70 t. tab. =2.44 (5%)		Paired t=0.70 t. tab. =2.44 (5%)	

## EFFECT OF VA MYCORRHIZAE FUNGI AND RHIZOBIUM ON ACACIA

The paired t-test indicated the superiority of *Rhizobium* application in all the treatments at 45 and 90 days after sowing, and all the VA mycorrhizal treatments had synergetic effect with *Rhizobium*.

### Root-shoot Ratio

The highest root-shoot ratio (1.4) was recorded in control (uninoculated) treatments which was significantly higher than all the other treatments at 45 days of inoculation. At 90 days, both *Rhizo-*

*bium*+VAM inoculated treatments were at par with only VAM inoculated seedlings. Control treatment was at par with *Gigaspora gilmorei* inoculated seedlings. The root-shoot ratio in VAM inoculated treatments was less than those of uninoculated plants as found by Hayman and Mosse (1971).

It is, thus, concluded that VA mycorrhizal fungi improved the growth of *A. nilotica* seedlings. However, dual inoculation with *Rhizobium*+VAM resulted in synergistic host response.

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## EFFICACY OF DIFFERENT PLANT EXTRACTS FOR MANAGING ROOT-KNOT NEMATODE, *MELOIDOGYNE JAVANICA* ON TOMATO

RAJESH VATS, S. N. NANDAL and M. R. DALAL

Department of Nematology

CCS Haryana Agricultural University, Hisar-125 004

(Accepted: July 11, 1995)

### ABSTRACT

Eighteen aqueous plant extracts were tried for their efficacy as soil drenching in tomato nursery for the management of root-knot nematode, *Meloidogyne javanica*. All the extracts were found effective in promoting growth parameters of tomato seedlings and in suppressing root-knot galls and number of egg masses per root of *M. javanica*. Leaf extracts of *Azadirachta indica* and *Eucalyptus tereticornis* were found to be the most effective. The extracts were found to have no adverse effect on germination of tomato seeds.

Root-knot nematode, *Meloidogyne javanica* is an important pest of vegetable crops. The commonly used method of nematode control is the use of chemicals. However, their exorbitant cost and non-availability coupled with risk of health hazards to the users as well as to the consumers of the produce proved a shattering blow to their utility potential. One of the promising alternatives is the use of plant products/extracts for the control of this pest (Vats and Nandal, 1993, 1994). The plants having nematicidal properties involve little cost, easy to apply, free of pollution hazards and have the capacity to improve the soil health structurally and nutritionally. Prompted by these considerations, an effort has been made to manage root-knot nematode, *M. javanica* in tomato nursery through soil drenching with different plant parts extracts.

### MATERIAL AND METHODS

Aqueous extracts were prepared by grinding 2 g of plant material in 5 ml of distilled water followed by filtration through muslin cloth. The extracts were kept in air tight bottles under refrigeration till further use and the contents were termed as 40% (w/v) stock solution.

Sixty earthen pots (30 cm high and 24 cm top diameter) were filled with heavily infested soil (4.5 kg/pot) containing 367 larvae/100 g of soil. Each pot was drenched with two litres of extract. One day after, 50 seeds per pot of tomato cv. Sel-7 were sown. Each treatment was replicated three times. The pots were closely observed for germination of seeds. Observations on various plant growth parameters and number of root-knot galls and egg

masses per root system were recorded 50 days after germination. Ten seedlings from each replication were taken for recording observations and their average was computed.

## RESULTS AND DISCUSSION

Observations on plant growth parameters (Table 1) reveal that all the treatments were significantly better

than the control (water and chemical). In treatments where bark as well as leaves were used for making extracts, leaves proved superior to bark. Among the treatments leaf extracts of *Azadirachta indica*, *Eucalyptus tereticornis* and *Ricinus communis* were found to be superior to other plant extracts in increasing the growth parameters of tomato seedlings. The maximum increase in plant growth

TABLE 1

Effect of soil drenching with different plant extracts on growth parameters of tomato seedlings raised in *M. javanica* infested soil

Treatment	Plant part used for extract preparation	Shoot height (cm)	Root length (cm)	Shoot weight (g)		Root weight (g)		Phytotoxicity
				Fresh	Dry	Fresh	Dry	
<i>Acacia nilotica</i>	Bark	20.0	14.5	3.5	0.58	2.4	0.39	++
	Leaves	21.0	15.5	4.0	0.66	2.7	0.44	—
<i>Azadirachta indica</i>	Bark	23.5	17.5	6.0	0.96	3.2	0.51	+
	Leaves	27.5	21.5	9.5	1.37	4.7	0.77	—
<i>Çajotropis procera</i>	Leaves	24.0	18.0	6.5	1.08	3.4	0.50	—
<i>Citrus sinensis</i>	Fruit skin	19.5	14.0	3.0	0.50	2.5	0.41	+++
<i>Datura stramonium</i>	Leaves	25.0	19.0	7.0	1.15	3.6	0.53	—
<i>Eucalyptus tereticornis</i>	Bark	23.0	17.0	5.0	0.81	2.8	0.42	+
	Leaves	27.0	21.0	9.0	1.30	4.5	0.71	+
<i>Leucaena leucocephala</i>	Leaves	21.5	16.0	4.5	0.71	2.9	0.49	+++
<i>Prosopis cineraria</i>	Leaves	22.5	17.0	5.5	0.89	3.0	0.50	—
<i>Ricinus communis</i>	Leaves	26.5	20.5	8.5	1.20	4.3	0.68	—
<i>Salvadora oleoides</i>	Leaves	22.0	16.5	5.0	0.79	3.1	0.54	—
<i>Tagetes erecta</i>	Leaves	26.0	20.0	8.0	1.14	4.1	0.56	+
	Root	20.5	14.5	3.0	0.49	2.1	0.35	+++
	Stem	24.5	18.5	6.0	0.95	3.4	0.47	++
	Whole plant	25.5	19.5	7.5	1.13	3.9	0.61	+
<i>Xanthium strumarium</i>	Leaves	19.0	15.0	3.5	0.55	1.9	0.31	+++
Posse 25 EC @ 1000 ppm		16.5	11.5	3.0	0.41	1.7	0.28	++
Control		14.0	8.5	2.5	0.34	1.5	0.23	—
C. D. at 5%		0.96	0.98	0.78	0.04	0.31	0.03	

— = No phytotoxicity, + = 25% drying of lower leaves, ++ = 50% drying of lower leaves, +++ = 100% drying of lower leaves.

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parameters was obtained where leaf extract of *A. indica* was applied followed by leaf extract of *E. tereticornis*. Further, it was observed that extracts obtained from fruit skin of *Citrus sinensis*, leaves of *Leucaena leucocephala*, and roots and leaves of *Tagetes erecta* were highly phytotoxic resulting into 100% drying of lower leaves. Fifty per cent drying of lower leaves was also observed in bark extract of *Acacia nilotica*, stem extract of *Tagetes erecta* and posse 25 EC @ 1000 ppm.

Number of galls and egg masses reduced significantly in all the treatments as compared to control. However, maximum reduction was recorded in case of *Azadirachta indica* leaf extract followed by *Eucalyptus tereticornis* leaf extract. The data in Table 2 reveal that leaf extracts proved superior to bark extracts. Among the leaf extracts of various plants, the maximum germination was recorded in *Azadirachta indica* treatment followed by *Datura stramonium*, whereas minimum germination was recorded in

TABLE 2

Effect of soil drenching with different plant extracts on germination of tomato seedlings, number of galls and egg masses produced by *M. javanica*

Treatment	Plant part used for extract preparation	Number of galls/ root system	Number of egg masses/ root system	Germination (%)
<i>Acacia nilotica</i>	Bark	39	13	71
	Leaves	45	17	76
<i>Azadirachta indica</i>	Bark	23	8	79
	Leaves	13	3	84
<i>Calotropis procera</i>	Leaves	19	7	73
<i>Citrus sinensis</i>	Fruit skin	31	10	69
<i>Datura stramonium</i>	Leaves	48	17	83
<i>Eucalyptus tereticornis</i>	Bark	43	15	74
	Leaves	18	5	81
<i>Leucaena leucocephala</i>	Leaves	39	14	67
<i>Prosopis cineraria</i>	Leaves	31	11	75
<i>Ricinus communis</i>	Leaves	27	8	78
<i>Salvadora oleoides</i>	Leaves	44	14	72
	Leaves	22	7	80
	Root	29	12	64
<i>Tagetes erecta</i>	Stem	26	13	75
	Whole plant	28	10	79
<i>Xanthium strumarium</i>	Leaves	43	16	63
Posse 25 EC @ 1000 ppm		53	19	70
Control		61	26	82
C. D. at 5%		3.36	1.99	

case of *Xanthium strumarium* followed by *Tagetes erecta* root extract.

Many chemical compounds are known to occur in plants. These are glucosides, quinones, unsaturated and saturated hydrocarbons, heterocyclic compounds, organic acids, aromatic compounds, esters, sulphur compounds and terpenes. Among terpenes mono-terpenes and sesquiterpenes show strong nematicidal properties. Some of these chemicals are very effective at low concentrations and some have systemic effect also (Egunjobi and Larinde, 1975). The alkaloids, *v/z.* Nimbinine, Nimbidine, Thionemone in neem leaf extracts and Thiophene in *Tagetes* leaf extracts might have

adverse effect on nematode biology (Hussain and Masood, 1975). Significant reduction in nematode population and increase in plant growth parameters have been reported when the extract of neem leaves was used (Egunjobi and Afolami, 1976; Kaliram and Gupta, 1980). The results of present investigation are in general agreement with the findings of these workers. The present studies, thus, give a strong indication that these extracts can be exploited and beneficially used to control the root-knot disease in transplanted crops. However, further efforts to use the minimum amount of these materials for making extracts may be tried by studying the effect of diluted plant extracts.

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## EFFICACY OF ATRAZINE APPLIED AT DIFFERENT TIMES TO CONTROL CARPETWEED IN PEARL MILLET

J. S. YADAV, ASHOK YADAV, R. K. MALIK, R. S. BALYAN and P. L. SACHAN

Department of Agronomy

CCS Haryana Agricultural University, Hisar-125 004

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### ABSTRACT

A field experiment was conducted in a loamy sand textured field, heavily infested with carpetweed (*Trianthema portulacastrum*) at CCSHAU Regional Research Station, Bawal in kharif 1993 and 1994. Atrazine, applied at 0.25 or 0.50 kg/ha at 10 or 15 days after sowing (DAS) proved more effective against carpetweed as compared to its pre-emergence application (0 DAS) at respective doses. The performance of atrazine at higher dose (0.50 kg/ha) was significantly better than its lower dose (0.25 kg/ha) at all stages, however, its application at both rates beyond 15 days (>0 DAS) failed to control carpetweed. Similarly, better crop yield was recorded with atrazine applied post-emergence (10 or 15 DAS) than its pre-emergence (0 DAS) or 20 DAS applications in both the years. In general, carpetweed reduced the grain yield of pearl millet to the extent of 40-42 per cent. On an average, atrazine application at 0.25 and 0.50 kg/ha at 10 or 15 DAS controlled the carpetweed, to the extent of 81.0 and 96.0 per cent, respectively, and as a result grain yield of pearl millet increased to the extent of 58.0 and 64.0 per cent.

Pearl millet (*Pennisetum americanum* (L.) K. Schum) is a rainy season crop of North-West India grown for fodder as well as grain purposes. However, in South-West Haryana it is one of the main kharif crop which can considerably tolerate water scarcity. Since sowing of this crop is mainly done after monsoon rains, weeds pose a serious problem. The emergence and competition of weeds particularly carpetweed (*Trianthema portulacastrum* L.) and other grassy weeds have been reported to reduce the grain yield of pearl millet to an extent of 16 to 94 per cent (Umrani *et al.*, 1980; Balyan, 1985). Deep ploughing, hand-hoeing, hand-weeding and other cultural/con-

ventional methods of weeding are more popular in pearl millet. However, due to non-availability of labour at critical stages of weeding and higher wages, these practices become difficult and very costly. Regeneration of weeds also remains a problem. In such situations, control of weeds with the use of herbicides becomes easier, economical and equally effective. Pre-emergence application of atrazine has been reported quite effective against weeds in pearl millet and sorghum (Malik *et al.*, 1980; Balyan, 1985; Jayakumar *et al.*, 1988; Singh *et al.*, 1988). But the acceptance of atrazine like other pre-emergence applied herbicides by farmers is poor. It is because farmers generally

take interest to control weeds only after their emergence in field crops. In general, post-emergence applied herbicides are easily accepted by the farmers in other crops like wheat and rice. Therefore, in the present investigation efficacy of atrazine applied at different times (pre- as well as post-emergence) was studied to control most competitive and aggressive weed like carpetweed in pearl millet particularly in loamy sand soils.

## MATERIAL AND METHODS

A two-year field investigation was carried out at the Research Farm of CCSHAU Regional Research Station, Bawal during rainy seasons of 1993 and 1994. The soil of experimental field was loamy sand in texture, low in organic carbon (0.22%) and low in N, medium in P, high in K and having pH value of 8.0 and EC of the soil equal to 0.32 dS/m. Six treatments of post-emergence atrazine @ 0.25 and 0.50 kg/ha at 10, 15 and 20 DAS, and one hand hoeing at 20 DAS were compared with pre-emergence applied atrazine @ 0.25 and 0.50 kg/ha, and unweeded and weed free checks. These treatments were replicated thrice in a randomised block design. Pearl millet variety HHB-67 was sown with hand plough at a seed rate of 5.0 kg/ha on July 7, 1993 and July 12, 1994 with a row spacing of 45 cm, and plant to plant distance of 12 cm was maintained by thinning. Recommended rate of fertilizers, i. e. 50 kg P<sub>2</sub>O<sub>5</sub> and 60 kg N/ha was applied before sowing and 60 kg N/ha was applied at the time of thinning (21 DAS) in both the years and no irri-

gation was applied throughout the growing season because there was sufficient moisture and moreover, this variety of pearl millet matures in a very short time (60 days). Atrazine was applied using knapsack sprayer fitted with flat fan nozzles using 650 litres of water/ha.

Visual phytotoxicity of atrazine on carpetweed was recorded at 30 DAS using a 0-100 scale, where 0 = no mortality and 100 = complete mortality. Density of carpetweed at 30 DAS and dry weight of carpetweed at 30 and 60 DAS were recorded by placing a quadrat of 50 cm × 50 cm randomly at three spots/plot. Toxicity data were transformed by arcsin values (angular transformation) and density data to  $\sqrt{X+0.5}$  transformation before analysis. Grain yield of crop was recorded to interpret results in both the years.

## RESULTS AND DISCUSSION

### Effect on Weeds

Weed species recorded in the experimental field were carpetweed (*Trianthema portulacastrum* L.), Motha (*Cyperus rotundus* L.), Kondhra (*Digera arvensis* Forsk) and Doob (*Cynodon dactylon*). Among these, carpetweed was major weed constituting more than 98.5% of the total weed population in unweeded check during both the years and hence, data recorded for carpetweed alone were subjected to analysis for interpretation of results.

The data on visual toxicity recorded at 30 DAS reveal that atrazine at 0.50

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kg/ha proved more toxic to carpetweed as compared to 0.25 kg/ha (Table 1). Application of atrazine @ 0.25 or 0.50 kg/ha at 10 or 15 DAS caused higher toxicity on carpetweed than its pre-emergence application at respective doses (Table 1). On an average, the toxicity ranged from 82.0 to 98.5 per cent at 10 DAS and 80.0 to 94.5 per cent at 14 DAS compared to 66.0 to 87.0 per cent at 0.25 and 0.50 kg/ha, respectively during both the years. However, atrazine application at 20 DAS failed to provide desirable control of carpetweed, since it could control carpetweed only to the extent of 20-35 per cent.

Maximum density of carpetweed at 30 DAS was recorded in unweeded check and minimum in the plots treated with atrazine at 0.50 kg/ha at 10 or 15 DAS during both the years (Table 1). The density of carpetweed was drastically reduced when atrazine was applied as pre-emergence @ 0.50 kg/ha or as post-emergence either at 10 or 15 DAS at both doses as compared to its pre-emergence application @ 0.25 kg/ha or one hand-hoeing (20 DAS) or atrazine applied at 20 DAS in both the years. Application of atrazine at 20 DAS failed to reduce the population of carpetweed to a significant extent compared to unweeded check (Table 1).

Significantly higher dry matter of carpetweed was recorded in unweeded check compared to all other treatments during both the years and at both the stages (30 and 60 DAS) of pearl millet (Table 2). Atrazine applied at 10 or 15 DAS @ 0.50 kg/ha reduced the dry

weight of carpetweed to the minimum and proved superior to its lower doses. Similarly, atrazine applied at 0.25 kg/ha at 10 or 15 DAS proved superior to its pre-emergence application at 0.25 kg/ha but at par with 0.50 kg/ha at both stages during both the years. Its application at 20 DAS at both rates did not prove as effective as its earlier applications in both the years. Balyan *et al.* (1993) also reported better control of carpetweed with atrazine applied at 7 or 14 DAS as compared to its application at 21 DAS or as pre-emergence (1 DAS).

### Effect on Crop Yield

Pre- as well as post-emergence application of atrazine produced significantly higher grain yield of pearl millet than unweeded control except atrazine at 0.25 kg/ha applied 20 DAS during both the years (Table 2). Maximum grain yield of 2060 and 2570 kg/ha in 1993 and 1994, respectively was recorded in the plots kept weed free throughout the crop season closely followed by atrazine at 0.5 kg/ha applied 10 or 15 DAS. In general, carpetweed reduced the grain yield of pearl millet to the extent of 40-42 per cent. On an average, atrazine application at 0.25 and 0.50 kg/ha at 10 or 15 DAS controlled the carpetweed to the extent of 81 and 96 per cent, respectively (Table 2), and as a result grain yield of pearl millet was increased to the extent of 58 and 64 per cent at different doses. Application of atrazine at 0.50 kg/ha (0 DAS) or at 0.25 and 0.50 kg/ha (10 or 15 DAS) produced grain yield at par with weed free check

TABLE 1  
Visual toxicity and density of carpetweed as influenced by atrazine application in pearl millet

Herbicide	Dose (kg/ha)	Time of application (DAS)	Visual toxicity (%) at 30 DAS		Density (No./m <sup>2</sup> ) at 30 DAS	
			1993	1994	1993	1994
Atrazine	0.25	0	(68)55.6	(65)53.7	(78)8.8	(96)9.8
Atrazine	0.50	0	(82)64.9	(88)69.7	(32)5.7	(57)7.6
Atrazine	0.25	10	(78)62.0	(86)68.0	(26)5.1	(42)6.5
Atrazine	0.50	10	(99)84.3	(98)81.8	(8)2.9	(13)3.7
Atrazine	0.25	15	(75)60.0	(85)67.2	(30)5.5	(39)6.3
Atrazine	0.50	15	(96)78.5	(93)74.7	(14)3.8	(23)4.8
Atrazine	0.25	20	(25)30.0	(20)26.6	(28)16.8	(290)17.0
Atrazine	0.50	20	(35)36.3	(32)34.5	(264)16.3	(308)17.6
One hand hoeing		20	— —	— —	(90)9.5	(137)11.7
Unweeded			(0)0	(0)0	(298)17.3	(352)18.8
Weed free			(100)90.0	100)90.0	(0)0.70	(0)0.70
C. D. at 5%			7.4	8.2	1.3	1.8

Original data of visual toxicity and density are given in parentheses which were transformed to arcsin and  $\sqrt{X+0.5}$  transformations, respectively.

TABLE 2  
Dry weight of carpetweed and grain yield of pearl millet as influenced by atrazine application

Herbicide	Dose (kg/ha)	Time of application	Dry weight (g/m <sup>2</sup> )				Grain yield (kg/ha)	
			30 DAS		60 DAS		1993	1994
			1993	1994	1993	1994		
Atrazine	0.25	0	31.4	71.9	45.9	99.5	1788	2218
Atrazine	0.50	0	20.0	28.6	30.0	36.2	1896	2380
Atrazine	0.25	10	19.8	35.0	34.5	45.9	1956	2398
Atrazine	0.50	10	2.5	6.4	5.4	8.1	1995	2450
Atrazine	0.25	15	15.3	40.7	22.0	50.7	1940	2400
Atrazine	0.50	15	3.9	11.8	8.6	14.3	1970	2418
Atrazine	0.25	20	70.6	190.3	102.4	250.0	1342	1642
Atrazine	0.50	20	56.9	130.2	90.2	189.1	1620	1845
One hand hoeing		20	32.2	85.5	99.7	203.2	1525	1833
Unweeded			98.5	215.0	140.8	295.2	1208	1533
Weed free			0.0	0.0	0.0	0.0	2060	2570
C. D. at 5%			9.9	15.1	11.2	17.7	149	192

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but superior to pre-emergence application of atrazine at 0.25 kg/ha. Application of atrazine at 20 DAS or hand weeding once at 20 DAS failed to produce satisfactory crop yield. Similar performance of atrazine on grain yield of pearl millet has been reported by Balyan *et al.* (1993).

Based on the results of present study it can be concluded that atrazine at 0.25 to 0.5 kg/ha may be applied at 10 or 15 DAS besides its pre-emergence recommendation @ 0.50 kg/ha in pearl millet to obtain satisfactory control of carpetweed.

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## RESEARCH NOTE

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### EFFECT OF DIFFERENT FORMULATIONS OF ISOPROTURON ON WEED CONTROL IN WHEAT

R. S. PANWAR, S. S. RATHI and R. K. MALIK

Department of Agronomy

CCS Haryana Agricultural University, Hisar-125 004

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Isoproturon has been widely accepted for the control of grassy weeds in wheat (Malik *et al.*, 1985). So far only wettable powder formulations were available but recently flowable formulations of this herbicide have been developed. Such formulations are considered relatively cheap and provide uniform distribution of isoproturon.

Field experiments were conducted during winter seasons of 1991-92 and 1992-93 at CCS Haryana Agricultural University, Hisar. Soil of the experimental field was sandy loam with pH 8.3 and an organic matter content of 0.4 per cent. The treatments were replicated three times in a randomized block design. All the herbicides were applied 30 days after sowing (DAS) with knapsack sprayer using 650 litres of water/ha. Wheat WH-283 was sown on 27 and 30 November in 1991 and 1992, respectively. All cultural practices were followed in accordance with standard local package of practices. Weed population (no./m<sup>2</sup>) and weed dry weight (g/m<sup>2</sup>) were recorded at 60 and 90 DAS with the help of 0.5 m × 0.5 m random quadrat.

The experimental field was dominated by almost equal population of wild canary grass (*Phalaris minor* Retz.) and lambsquarter (*Chenopodium album* L.) during both the years. All flowable formulations at all the doses of application provided similar control of wild canary grass and lambsquarter compared with wettable powder formulations of isoproturon at 1.0 kg/ha. The population of weeds at 60 DAS following the isoproturon (flowable) or wettable powder application was significantly less than the weedy check (Table 1). Population of wild canary grass was similar at all the doses of each formulation. The population of lambsquarter in 1992 in plots treated with isoproturon at 0.50 kg/ha was significantly more than the plots treated with 1.50 kg/ha. The population of total weeds and dry weight decreased with the increase in isoproturon dose from 0.5 to 1.5 kg/ha and were significantly different between lowest and highest concentrations of isoproturon. Similar response was reflected in the total dry weight at 90 DAS (Table 1).

**TABLE 1**  
**Influence of different isoproturon formulations on the population of different weeds, total weed population, total weed dry weight and grain yield of wheat**

Treatment	Dose (kg/ha)	Weed population (no./m <sup>2</sup> ) 60 DAS				Total weed population (no./m <sup>2</sup> ) 90 DAS		Total weed dry weight (g/m <sup>2</sup> ) 90 DAS		Grain yield (kg/ha)	
		<i>P. minor</i>		<i>C. album</i>		1991	1992	1991	1992	1991	1992
		1991	1992	1991	1992	1991	1992	1991	1992	1991	1992
Isoproturon (Milron flow)	0.50	2.2(4)*	3.6(13)	2.2(4)	2.8(7)	3.8(14)	4.5(19)	31.3	62.0	4621	4196
	0.75	1.8(3)	3.4(11)	1.8(3)	2.6(6)	2.8(7)	3.9(15)	26.7	56.6	5071	4566
	1.00	1.5(2)	3.1(9)	1.4(1)	2.0(3)	2.3(5)	3.5(11)	21.7	45.3	5482	4771
Isoproturon (Isoguard flow)	1.50	1.5(2)	2.3(6)	1.4(1)	1.4(1)	1.7(3)	2.5(6)	10.3	21.7	5565	4936
	0.50	2.4(7)	3.3(11)	2.5(5)	2.8(7)	4.2(17)	4.3(18)	33.1	57.7	4723	4366
	0.75	1.7(3)	2.8(7)	2.2(4)	2.5(5)	3.4(11)	3.7(13)	31.2	51.3	5074	4813
Isoproturon (Tafakan flow)	1.00	1.4(1)	2.5(5)	1.8(3)	1.8(2)	2.5(5)	3.2(9)	20.0	45.7	5519	4936
	1.50	1.4(1)	2.5(5)	1.4(1)	1.0(0)	2.2(4)	2.6(6)	12.0	17.3	5787	5018
	0.50	2.9(7)	3.6(12)	2.7(7)	2.3(5)	4.7(21)	4.4(19)	37.8	58.3	4547	4319
Isoproturon (Watable powder)	1.00	2.6(6)	2.4(6)	2.4(5)	1.4(1)	4.5(20)	3.9(14)	35.8	47.7	4704	4730
	1.00	2.6(6)	2.4(5)	2.0(4)	1.4(1)	4.2(17)	3.3(10)	25.2	41.0	5161	4854
	1.50	1.8(3)	2.0(3)	1.7(2)	1.0(0)	3.5(12)	2.8(8)	18.0	16.0	5461	4977
Weedy check	1.00	1.8(3)	2.3(5)	1.0(0)	1.2(1)	3.3(10)	2.7(8)	11.3	38.3	5695	4854
	5.5(30)	6.3(27)	4.3(17)	5.5(32)	7.8(59)	7.7(59)	7.7(59)	69.3	145.0	3463	3044
	1.0(0)	1.0(0)	1.0(0)	1.0(0)	1.0(0)	1.0(0)	1.0(0)	0.0	0.0	5833	5742
C. D. at 5%	1.5	1.4	1.0	1.1	1.4	1.2	1.2	4.5	6.3	407	657

\* Actual counts are in parentheses, data transformed to  $\sqrt{x+1}$   
 DAS = Days after sowing.

## WEED CONTROL IN WHEAT BY ISOPROTURON

The grain yield of wheat in weedy plots was significantly less than the weed free and plots treated with isoproturon. The grain yield in plots treated with flowable formulation of isoproturon at 1.00 or 1.50 kg/ha

was similar (Table 1). It may, therefore, be concluded that flowable formulation of isoproturon can be effectively used for the control of weeds in wheat.

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## EFFECT OF ANILOFOS ON THE TOTAL NUCLEOTIDES AND INSOLUBLE PROTEIN CONTENT DURING GERMINATION IN RICE AND BARNYARD GRASS

KUSAM BAJAJ\* and S. K. PAHWA

Department of Agronomy

CCS Haryana Agricultural University, Hisar-125 004

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Rice (*Oryza sativa* L.) is one of the most important cereal crops and major food grain for human consumption all over the world. Barnyard grass (*Echinochloa crusgalli* L.) is a major associated weed with rice which causes severe losses in rice fields (Prakash *et al.*, 1989). Anilofos (s-(2-(4-chlorophenyl) (1-methylethyl) 2-oxo ethyl) O, O-dimethyl phosphorodithionate) is used to control weeds in the rice fields. It is applied to the soil primarily to inhibit germination and growth of *E. crusgalli* (Prakash *et al.*, 1989). However, no work has been done so far to know how germination or seedling growth is inhibited by the herbicide. Present investigations were, therefore, conducted to study the effect of anilofos on the total nucleotides and insoluble protein content in rice and barnyard grass during germination.

Seeds of rice cv. Jaya and barnyard grass were soaked in distilled water or anilofos solution for 12 h. Solutions of 5, 10, 20 and 40 ppm of anilofos were used for pre-sowing soaking (PSS) treatment as well as for continuous treatment. Twenty soaked seeds

of rice and 200 seeds of barnyard grass were placed on filter paper in 9 cm diameter petridish separately. Five ml of distilled water for PSS treatment and anilofos solution for continuous treatment was added to each petridish. The petridishes were placed in B. O. D. incubator at  $30^{\circ} \pm 1^{\circ} \text{C}$  for germination of seeds. Samples were taken out for biochemical analysis at 2, 4, 6 and 8 days after treatment. Endosperm/seedlings sample was extracted in 80% ethanol. Total nucleotides and insoluble protein content were estimated by the method of Neiman and Paulson (1963) and Lowry *et al.* (1951), respectively. Statistical analysis of the data was carried out using factorial CRD.

Synthesis as well as degradation of nucleic acids are essential for the growth of embryo axis which involves synthesis of proteins, cell division and cell elongation (Bewley and Black, 1978). Total nucleotides content increased with the passage of time and decreased with the application of anilofos both in rice and barnyard grass endosperms as well as seedlings

\*Department of Botany.

**TABLE 1**  
Effect of anilofos on total nucleotides (mg/g fresh weight) in endosperm and seedlings of rice

Treatment conc. (ppm)	Pre-sowing soaking					Continuous				
	Time of sampling (DAT)					Time of sampling (DAT)				
	2	4	6	8	Mean	2	4	6	8	Mean
<b>Endosperm</b>										
0	0.84	1.02	1.32	1.42	1.15	0.92	1.14	1.41	1.55	1.25
5	0.64	0.89	1.05	1.36	0.98	0.72	0.94	1.48	1.38	1.05
10	0.52	0.67	0.92	1.10	0.80	0.58	0.78	0.96	1.14	0.86
20	0.44	0.54	0.69	0.98	0.66	0.49	0.62	0.72	0.99	0.70
40	0.39	0.48	0.59	0.95	0.55	0.42	0.51	0.64	0.78	0.51
Mean	0.56	0.72	0.91	1.12		0.62	0.79	0.98	1.17	
C. D. at 5%	Period=0.14; Concentration=0.14; PSS × Cont.=NS.									
<b>Seedlings</b>										
0	0.00	0.00	0.38	0.49	0.22	0.00	0.00	0.44	0.52	0.24
5	0.00	0.00	0.31	0.40	0.18	0.00	0.00	0.39	0.44	0.20
10	0.00	0.00	0.25	0.38	0.16	0.00	0.00	0.32	0.40	0.18
20	0.00	0.00	0.29	0.35	0.19	0.00	0.00	0.27	0.37	0.16
40	0.00	0.00	0.19	0.30	0.12	0.00	0.00	0.22	0.33	0.13
Mean	0.00	0.00	0.27	0.38		0.00	0.00	0.32	0.41	
C. D. at 5%	Period=0.37; Concentration=0.11; PSS × Cont.=NS.									

**TABLE 2**  
Effect of anilofos on total nucleotides (mg/g fresh weight) in endosperm and seedlings of *E. crusgalli*

Treatment conc. (ppm)	Pre-sowing soaking					Continuous				
	Time of sampling (DAT)					Time of sampling (DAT)				
	2	4	6	8	Mean	2	4	6	8	Mean
<b>Endosperm</b>										
0	0.67	0.72	0.98	1.04	0.85	0.69	0.76	1.02	1.10	0.89
5	0.54	0.62	0.76	0.94	0.71	0.58	0.69	0.79	0.96	0.75
10	0.44	0.58	0.68	0.78	0.62	0.47	0.60	0.70	0.79	0.66
20	0.39	0.46	0.59	0.69	0.53	0.42	0.49	0.62	0.72	0.56
40	0.31	0.38	0.44	0.52	0.41	0.35	0.41	0.54	0.56	0.45
Mean	0.47	0.55	0.69	0.79		0.50	0.59	0.72	0.83	
C. D. at 5%	Period=0.11; Concentration=0.12; PSS × Cont.=NS.									
<b>Seedlings</b>										
0	0.00	0.00	0.30	0.42	0.18	0.00	0.00	0.37	0.46	0.21
5	0.00	0.00	0.24	0.38	0.15	0.00	0.00	0.30	0.40	0.17
10	0.00	0.00	0.19	0.35	0.13	0.00	0.00	0.24	0.37	0.15
20	0.00	0.00	0.17	0.29	0.11	0.00	0.00	0.20	0.28	0.12
40	0.00	0.00	0.10	0.22	0.08	0.00	0.00	0.17	0.24	0.10
Mean	0.00	0.00	0.20	0.33		0.00	0.00	0.26	0.33	
C. D. at 5%	Period=0.12; Concentration=0.20; PSS × Cont.=NS.									

EFFECT OF ANILOFOS ON NUCLEOTIDES AND PROTEIN DURING GERMINATION

**TABLE 3**  
**Effect of anilofos on total insoluble protein content (mg/g fresh weight)**  
**in endosperm and seedlings of rice**

Treatment conc. (ppm)	Pre-sowing soaking					Continuous				
	Time of sampling (DAT)					Time of sampling (DAT)				
	2	4	6	8	Mean	2	4	6	8	Mean
<b>Endosperm</b>										
0	12.02	13.92	13.62	13.94	13.10	13.41	13.92	14.21	14.70	14.06
5	12.55	13.05	13.92	14.22	13.43	13.93	14.04	14.52	14.92	14.34
10	12.98	13.65	14.28	14.78	13.89	14.41	14.78	14.92	15.25	14.84
20	13.42	13.96	14.75	15.08	14.30	14.89	14.92	15.27	15.62	15.17
40	13.82	14.34	15.04	15.42	14.65	15.02	15.24	15.52	15.92	15.42
Mean	12.95	13.56	14.30	14.68		14.33	14.58	14.88	15.28	
C. D. at 5%	Period=0.29; Concentration=0.19; PSS × Cont.=NS.									
<b>Seedlings</b>										
0	0.00	0.00	6.72	5.92	2.91	0.00	0.00	5.92	6.04	2.09
5	0.00	0.00	5.92	6.19	3.01	0.00	0.00	6.19	6.25	3.09
10	0.00	0.00	6.12	6.22	3.08	0.00	0.00	6.28	6.35	3.15
20	0.00	0.00	6.19	6.42	3.15	0.00	0.00	6.35	6.52	3.21
40	0.00	0.00	6.41	6.50	3.22	0.00	0.00	6.52	6.62	3.28
Mean	0.00	0.00	6.07	6.24		0.00	0.00	6.24	6.36	
C. D. at 5%	Period=0.20; Concentration=0.12; PSS × Cont.=NS.									

**TABLE 4**  
**Effect of anilofos on total insoluble protein content (mg/g fresh weight)**  
**in endosperm and seedlings of *E. crusgalli***

Treatment conc. (ppm)	Pre-sowing soaking					Continuous				
	Time of sampling (DAT)					Time of sampling (DAT)				
	2	4	6	8	Mean	2	4	6	8	Mean
<b>Endosperm</b>										
0	14.72	14.94	15.24	15.78	15.17	15.04	15.54	15.99	16.28	15.71
5	14.24	14.52	14.89	15.29	14.73	14.72	14.69	15.62	15.92	15.33
10	13.98	14.28	14.47	14.92	14.41	14.41	14.82	15.18	15.52	14.98
20	13.74	13.82	13.18	14.59	14.08	14.02	14.50	14.92	15.19	14.65
40	13.22	13.65	13.72	14.20	13.63	13.89	14.13	14.55	14.87	14.36
Mean	13.98	14.24	14.50	14.95		14.42	14.81	15.25	15.85	
C. D. at 5%	Period=0.22; Concentration=0.31; PSS × Cont.=NS.									
<b>Seedlings</b>										
0	0.00	0.00	7.04	7.24	3.57	0.00	0.00	7.15	7.52	3.67
5	0.00	0.00	6.92	7.02	3.49	0.00	0.00	7.04	7.26	3.57
10	0.00	0.00	6.79	6.99	3.44	0.00	0.00	6.96	7.06	3.50
20	0.00	0.00	6.52	6.82	3.33	0.00	0.00	6.78	6.97	3.44
40	0.00	0.00	6.24	6.72	3.24	0.00	0.00	6.62	6.78	3.35
Mean	0.00	0.00	6.71	6.96		0.00	0.00	6.91	7.12	
C. D. at 5%	Period=0.20; Concentration=0.12; PSS × Cont.=NS.									

under PSS and continuous treatment (Tables 1 and 2). This may be correlated with the activities of hydrolysing enzymes such as RNase and DNase and germination of the seeds which also decreased with the application of herbicide in rice and barnyard grass (Bajaj, 1992). The reduction in germination of seeds was more in barnyard grass than in rice.

Synthesis of protein is pre-requisite for radicle and plumule emergence (Bewley and Black, 1978). The total insoluble protein content increased in endosperm as well as seedlings of rice with the application of anilofos

(Table 3) under both the conditions. But in barnyard grass (Table 4), the content decreased with herbicide application. The effect increased with the increase in the concentration of herbicide in rice and barnyard grass. The differential response regarding insoluble protein content may be due to variation in plant species. The reduction of protein content in barnyard grass may be one of the reasons of more reduction in germination of seeds. Petibskaya (1987) also reported that there was increase in protein content when rice was treated with pendimethalin.

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## EFFECT OF DATE OF SOWING AND STAGE OF CROP GROWTH ON SEVERITY OF SCLEROTINIA-ROT OF SUNFLOWER (*HELIANTHUS ANNUUS* L.)

RAJENDER SINGH and N. N. TRIPATHI

Department of Plant Pathology

CCS Haryana Agricultural University, Hisar-125 004

Sunflower is photoinensitive oil-seed crop, and can be grown in all seasons in different agro-climatic zones. Spring and autumn seasons, however, have been found ideal under Indian conditions. Sclerotinia-rot caused by *Sclerotinia sclerotiorum* (Lib.) De Bary takes maximum toll of sunflower grown in spring (Singh, 1994). Therefore, an attempt has been made to correlate the disease severity with sowing dates.

Sunflower (HS-1) was sown on three different dates, *i. e.* Dec. 28, 1993 and Jan. 10 and 29, 1994 in plots of 1.5 m × 1.5 m in randomized block design keeping five replications. In each plot, 150 sclerotia were added prior to sowing.

In another experiment sunflower (HS-1) was sown in five plots of 1.5 m × 1.5 m in randomized block design to ascertain susceptibility at different stages of crop. Each plot was inoculated with 150 sclerotia in furrows prior to seed sowing. All normal agronomic practices were maintained. Disease incidence was recorded on the basis of healthy and

diseased plants every third day till maturity of the crop.

It was noted that crop sown on Dec. 28, 1993 expressed 38.94% Sclerotinia-rot as compared to 34.66% in plots sown on Jan. 10, 1994. The lowest disease was observed in crop sown on Jan. 29, 1994. Similarly, Kolte and Tewari (1977) while working on Sclerotinia-rot of sunflower observed lowest disease when sunflower was sown in second week of January as compared to crop sown in October-November. The significant reduction in disease incidence in late sown crop (January) may be correlated with sudden increase in temperature during the susceptible growth period of the crop. This observation gets positive support of Minkevich and Kosorukova (1987) who observed that high temperature did not favour the growth and development of pathogen. It is, therefore, concluded that delayed sowing precluded the pathogen to invade and, thus, the crop escapes infection.

It is clear from Table 1 that 7 days old seedlings contracted 5.34% disease followed by 18 days old seedlings

TABLE 1

Incidence of Sclerotinia-rot at different growth stages of sunflower

	Crop age (days)								
	7	18	30	44	60	70	81	96	105
Per cent disease incidence	5.34* (13.35)**	4.66 (12.47)	3.83 (11.29)	3.07 (10.11)	2.33 (8.78)	1.93 (7.99)	3.00 (9.97)	4.25 (11.90)	3.41 (10.63)

C. D. at 5% = 1.52

\*Average of three replications.

\*\* Figures in parentheses are angular transformed values.

(4.66%). As the plant grew older disease incidence reduced upto 70 days (1.93%). However, disease incidence increased in same plots with increase in the age of the plants, the highest being 4.25% in 95 days old plants. In general, minimum Sclerotinia-rot was recorded in 30 to 70 days old plants. After this period, the disease increased which clearly indicates that there are two susceptible stages of crop in one season. Working

on Sclerotinia-rot on sunflower, Huang and Kozub (1990) correlated the variation in disease severity to different stages of crop growth. The variation in disease severity in relation to crop age may be due to physiological changes occurring during plant growth at various stages. This clearly indicates that the Sclerotinia-rot of sunflower appears with different severity at different stages of crop growth.

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## CONTENT ANALYSIS OF WOMEN'S PROGRAMMES TELECAST FROM DELHI DOORDARSHAN

MEENA BAKSHI, UMA VARMA and R. KUMAR\*  
Department of Home Science Extension Education  
CCS Haryana Agricultural University, Hisar-125 004

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### ABSTRACT

The study on the contents of women's TV programmes indicates that informational items were delivered verbally in studio through monologue, demonstration, interview and group discussion. The analysis further brought out that captions were used only in 15% of messages. The speed of speech was reported as 115-125 words per minute. There were no prior announcements regarding the items of the programme.

People are becoming increasingly aware of the world around them. The role of television is well known in the present era of communicational network development. The electronic media particularly television has enormous potentiality for mass communication. One of the objectives of Doordarshan is to highlight the social welfare measures including welfare of women and children, and less privileged. Women's television programmes can play a crucial role in changing and moulding attitudes, instill confidence, creating general awareness in women and help them in securing a dignified and rightful place in the society. The potential impact of women's programmes as a means of informing women may be greater than other programmes, since it is specially for women. The success of any programme largely depends upon extent to which, it is need based, problem-oriented, socially and culturally compatible.

With scientific content analysis of women's television programme, we can easily determine the quality of programme and can modify accordingly.

### METHODOLOGY

Out of three women's programmes telecast on Doordarshan regularly (Malik, 1987), only two programmes, viz. 'Grameen Mahilaon Ke Liye' (GMKL) and 'Ghar Sansar' (GS) were selected. The GMKL and GS programmes are telecast on every Wednesday (7.00 to 7.30 p.m.) and Friday (6.35 to 6.55 p.m.), respectively. For collecting the data, GMKL (from December 5, 1990 to February 27, 1991) and GS (from January 4, 1991 to March 29, 1991) programmes were video-recorded.

In all, there were 12 telecasts of each programme which constituted the

\*Dairy Extension Division, National Dairy Research Institute, Karnal-132 001.

sample of this study. For analysing the data, the authors carefully watched all the recorded programmes and made self judgement on various parameters of content analysis.

## RESULTS AND DISCUSSION

### Status of Items

It refers to the broad categories of the items of programme content. The 12 telecasts of each programme, viz. GMKL and GS during three months period contained 33 and 18 items, respectively. The items were categorized on the basis of material these contained.

The status of items has been presented in Table 1. Majority of the items were having only informational status in GMKL (63.64%) and GS (83.33%) programmes. This finding is in agreement with the findings of Chauhan (1980), Joshi (1987) and Adlakha (1990). The recreational items were comparatively of short duration in nature. Similar findings were reported by Singh (1978) and Joshi (1987).

The distribution pattern of the items as well as time seems to be very logical, as basic objective of women's TV programmes is to educate women about home related activities, whereas entertaining or recreational items are only to motivate viewers, maintain their interest and to break the monotony. It was observed that a few items were focused on recreation alongwith information. Adlakha (1990) reported the same. It is suggested that programme planners should devote more time to informational-cum-recreational items as women viewers prefer the entertaining educational programmes.

### Content Analysis of Items

Content analysis can be regarded as the application of the principles of scientific research to the analysis of communication content. Content analysis of items of women's TV programmes has been presented in Table 2.

### Situation analysis

Situation analysis refers the situation in which the item of the programme is telecast. It includes those

TABLE 1

Distribution of items according to status in women's TV programmes

S. No.	Status of item	TV programme	
		GMKL (N=33)	GS (N=18)
1.	Informational	21 (63.64)	15 (83.33)
2.	Informational-cum-recreational	6 (18.18)	—
3.	Recreational	6 (18.18)	3 (16.67)

Figures in parentheses are percentages.

CONTENT ANALYSIS OF DELHI DOORDARSHAN WOMEN'S PROGRAMMES

TABLE 2

Content analysis of items of women's TV programmes according to different parameters

S. No.	Content analysis parameters	Category	TV programme	
			GMKL (N=27)	GS (N=15)
1.	Situation analysis	Studio based	11 (40.74)	11 (73.33)
		Film based	6 (22.22)	1 (6.67)
		Studio-cum-film based	10 (37.04)	3 (20.00)
2.	Speakers of items	Experts	7 (25.93)	6 (40.00)
		Housewives	14 (51.85)	3 (20.00)
		Experts and housewives	6 (22.22)	6 (40.00)
3.	Language used	Hindi	15 (55.56)	2 (13.33)
		English and Hindi	9 (33.33)	13 (86.67)
		Hindi and Haryanvi	3 (11.11)	—
4.	Eye contact of speakers	Towards audience	2 (7.41)	—
		Towards compere	20 (74.07)	11 (73.33)
		Towards audience and compere	5 (18.52)	4 (26.67)
5.	Speed of presentation (words per minute)	110-115	7 (25.93)	1 (6.67)
		115-120	16 (59.26)	4 (26.66)
		120-125	4 (14.81)	10 (66.67)
6.	Nature of message	Verbal	23 (85.19)	13 (86.67)
		Written and verbal	4 (14.81)	2 (13.33)

Recreational items are not included.

Figures in parentheses indicate percentages.

items in which message is delivered by speaker whether in studio or in actual situation. Large number of the items in GMKL (11 out of 27) and majority of items in GS (11 out of 15) were studio based. It was intriguing to note that film based items were comparatively less. In studio based programme, it becomes sometimes difficult to show actual situation where learning would be more. It would, however, not be impertinent to suggest that programme should telecast more film based items.

*Speaker of items*

More than half of the items were delivered by housewives in GMKL programme and 40% of items were delivered by only experts in GS programme. It can be inferred that only experts or only housewives as speakers may become barrier in utilising information. It may possibly be due to the fact that experts may be away from actual practical situation and housewives may not be able to explain. It is suggested to

programme producers that experts and housewives should deliver that message. Experts should provide information and housewives utilising information should be interviewed.

#### *Language used*

It is the language through which the ideas, feelings, knowledge and like are shared with other people. In GMKL programme the message of 15 out of 27 items was delivered in Hindi. In GS programme in an overwhelming majority of items (13 out of 15) combination of English and Hindi languages was used. As far as combination of English and Hindi languages is concerned, a few words of English were used. In some items of women's programme some technical words were used. It may become impediment in receiving the information. It is suggested that such words should be explained in Hindi at the same time, when they are used.

#### *Eye contact of speakers*

To draw attention and interest of the audience, eye contact helps the speakers in achieving the objectives as well as making the speech more impressive to audience. In about three-fourth of the items, speakers were having eye contact with comperes in GMKL and GS programmes. Joshi (1987) conforms with these findings. Eye contact of speaker with audience in women's TV programmes was negligible, which may be impediment in drawing attention of the audience. Hence, it is suggested that expert speakers should be selected

and they should have eye contact with audience as well as comperes.

#### *Speed of presentation*

The speed of speech, i.e. number of words per minute was taken item wise and maximum and minimum were worked out. In GMKL programme, in about 60% of the items, messages were delivered with speed of 115-120 words per minute. In 10 items out of 15 in GS programme, messages were presented at a speed of 120-125 words per minute.

It can be inferred that overall speed in women's programmes was 115 to 125 words per minute. The normal speed should be 125 to 150 words per minute (Berke *et al.*, 1977). Keeping this standard in view, it was observed that the speed of presentation in women's TV programme was slow. Similar findings regarding speed of presentation were highlighted by Momi and Shukla (1983) and Adlakha (1990).

#### *Nature of message*

An overwhelming majority of the items were presented verbally in GMKL and GS programmes. It is a well known fact that verbal message cannot maintain the attention of audience for a longer period. It is surprising to note that only less than 15% of the messages were presented in caption or written form. It is, thus, suggested that title of message and major points should be emphasized in written form.

TABLE 3

Modes of presentation used in women's TV programmes

S. No.	Mode of presentation	TV programme	
		GMKL (N=41)*	GS (N=17)
1.	Monologue (information given by experts)	13 (31.71)	5 (29.41)
2.	Interview	11 (26.83)	2 (11.77)
3.	Demonstrations	7 (17.07)	5 (29.41)
4.	Group discussion	1 (2.44)	3 (17.65)
5.	Reading by compere	—	1 (5.88)
6.	Folk song	3 (7.32)	—
7.	Folk dance	4 (9.76)	—
8.	Story	2 (4.88)	1 (5.88)
9.	Reply of letter	—	—

Figures in parentheses are percentages.

\*Multiple response

*Modes of presentation used*

The perception of the message depends, to a great extent, on the mode of presentation of the message, besides other important elements. It is evident from Table 3 that in GMKL programme, the modes which formed the larger percentage were monologue (31.71%), interview (26.83%) and demonstration (17.07%). In case of GS programme, majority of the items used monologue, demonstration and group discussion as modes of presentation.

The other important modes of presentation such as folk songs and folk dance were used meagrely (less than 10% that too for very limited time) in GMKL programme. The data reveal that items were presented through monologue, demonstration, interview and group discussion in women's TV programmes. The present findings are

in line with the findings of Chauhan (1980) and Joshi (1987). It can be inferred that the programmes could have been more interesting and educative, if other modes of presentation like story, folk songs and dances and reply of letters were also included.

On the basis of observations, it is suggested that :

1. Doordarshan should launch a weekly programme, viz. women's programme Sameekha, comprising criticism, comments and suggestions from the viewers on its programmes.
2. Doordarshan is one way communication. If a viewer does not understand some message, he cannot clarify that. Thus, the address of the programme should be given at the end of every programme. The reply to their letters must be included in the programme.

3. In many programmes, more than one item is included. It may become barrier in utilizing information of home related activities of women's programmes. Thus, there is need that each item should get sufficient time and detailed information is given.
4. Many times there is no prior announcement regarding the items of programme. Announcement would ensure proper publicity and create interest among the audience. Major highlights of the items should be told in the starting and at the end of the programme with the announcement of next week programme.

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## RESEARCH NOTE

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### LEVELS OF COGNITIVE ABILITIES AMONG PRE-SCHOOLERS

LATA KUMARI and SUDHA CHHIKARA

Department of Child Development

CCS Haryana Agricultural University, Hisar-125 004

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The age of 3-6 years or pre-school years is considered crucial for the child's development, particularly cognitive development. Available researches indicate that much of the child's mental development takes place before the age of six years. Children in the age group of 3-6 years are highly active, curious and eager to learn. They develop the ability to use symbols in their thoughts and actions. They like to explore, seek new experiences for the sheer pleasure of sensing and knowing. Thus, the pre-school years form a significant period of growth in cognitive skills and capacities.

Various welfare programmes, particularly integrated Child Development Services (ICDS), are focussing their attention on the around development of children. In Haryana, ICDS has been operating since 1975. Anganwadis, nodal centres, are carrying package of services for the harmonious development, particularly cognitive development of children. Therefore, children's progress needs to be evaluated in terms of acquisition of basic concepts. The assessment of cognitive domain will provide a frame-

work for the field functionaries to introduce the intervention programme for the children with low cognition level. The present study was conducted to examine the existing level of cognitive abilities among pre-schoolers so that, in future, intervention programme could be introduced to enhance the cognitive competence among pre-schoolers.

One village, Mangali, was selected randomly from Hisar district of Haryana state. Eighty pre-schoolers (3-6 years) were purposively selected from eight randomly selected anganwadis of the village. Three tests were used to measure different concepts under cognition because the concepts intended for measurement were not available in single test. The knowledge on the concept of verbal identification, size, shape, colour, number and recalling was measured by McCarthy Scales for Children's Abilities (McCarthy, 1972), whereas the Boehm's Test of Basic Concepts-R (Boehm, 1986) was used to measure the knowledge regarding the concept of matching, discrimination of part and whole, and distance. The knowledge on the concept of object assembling, texture discrimination,

TABLE 1  
Existing level of cognitive abilities of pre-school children

Level of cognitive abilities	Score range	Frequency
Low	19-25	30
Medium	26-32	42
High	33-39	8

TABLE 2  
Performance of pre-school children on different concepts

S. No.	Concept	Frequency
1.	Perception	
	(a) Matching	54(67.50)
	(b) Object assembling	64(80.00)
	(c) Texture discrimination	48(60.00)
	(d) Verbal identification	44(58.05)
	(e) Discrimination of part and whole	39(48.75)
	(f) Object permanence	54(67.50)
2.	Conceptual Development	
	(a) Speed	52(65.00)
	(b) Size	53(66.25)
	(c) Shape	60(75.00)
	(d) Colour	46(57.50)
	(e) Number	38(47.50)
	(f) Distance	43(53.75)
	(g) Temperature	37(46.25)
	(h) Time	34(42.50)
	(i) Weight and volume	59(73.75)
3.	Recalling	32(40.00)
4.	Intuitive thought	47(58.75)
5.	Reasoning	40(50.00)
6.	Seriation	55(68.75)
7.	Reversibility	27(33.75)
8.	Conservation	28(35.00)
9.	Invariance	25(31.25)
10.	Classification	50(62.50)

Figures in parentheses are percentages.

object permanence, speed, distance, temperature, time, weight and volume, intuitive thought, reasoning, seriation, reversibility, conservation, invariance and classification were tested as per Bishnoi (1983). Total 46 items were included in the study. The scoring system of each test was same, *i. e.* a score of one was assigned to each correct response. Cognitive level of the pre-schoolers was divided into three categories on the basis of individually obtained scores—low, medium and high level. Data were analysed in terms of frequency and percentages to draw inferences.

Data presented in Table 1 show that most of the pre-schoolers had medium level of cognitive abilities followed by low and high level.

As regards the performance of pre-school children on different concepts, the data in Table 2 reveal that under perception, the items related to the concept of matching, object assembling, texture, discrimination, verbal identification, and under the conceptual development, the items related to the concept of speed, size, shape, colour, distance, weight and volume, as well as the items related to the concept of seriation and classification were performed by most of the respondents.

On the basis of results it can be concluded that children performed better on lower order concepts as compared to higher order concepts. At pre-school stage child is intellectually incompetent and his thinking is dominated by his immediate perceptions. He is greatly influenced by what he

sees, hears or otherwise experiences at a given moment. He does not pay attention to transformations or changes from one state to another. Child actively seeks sensory experiences and touches objects eagerly, grasps them, runs his finger over them. During this pre-operational stage thought of child is irreversible. He thinks that events and relations occur only in one direction. He is mentally unable to undergo a series of steps in a problem and then reverse their direction. Pre-operational child has a problem with classification and sequence of any kind is difficult for him. Because of these cognitive inadequacies, he fails to pass a wide variety of cognitive abilities.

Apart from these reasons, rural children do not have enriched environment to explore as their mothers are very busy in household chores and agricultural operations and are not able to provide much time and attention to their young ones. Sometimes elder siblings take care of their younger sister or brother. Besides this, exposure to media is also very poor in case of young children.

In case of urban children, although their mothers are engaged in different professions, but being educated, they are more concerned towards their children's needs. Children have a lot of exposure to media. Besides this, they have more time to interact with parents as compared to rural children. This study suggests that there is a need for parent education programmes. Parents should be provided with knowledge of importance of pre-school years and enriched environment during these crucial years of life.

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## ENERGY CONSUMPTION PATTERN IN RURAL HOUSEHOLDS OF HARYANA

VINOD KUMARI and T. M. DAK

Department of Sociology

CCS Haryana Agricultural University, Hisar-125 004

(Accepted : February 14, 1995)

### ABSTRACT

The study on energy consumption pattern in rural households in various agro-climatic zones of Haryana reveals that non-commercial sources were used in greater amount as compared to commercial sources. The share of non-commercial and commercial energy was 91.7 and 8.3 per cent, respectively, and firewood was the major source of household energy consumption which accounted for 50.0% of total non-commercial energy.

Energy is a critical commodity and acts as essential ingredient in life. There is positive association between per capita income and per capita consumption of energy (Govt. of India, 1979; Dunkerley, 1980; Culp, 1990). As economy develops, the demand for energy tends to increase and its consumption pattern in terms of energy forms, sources and amount also tends to change. The energy sources used by people are often classified into commercial (modern) and non-commercial (traditional) fuel items. The rural scene is characterised by use of non-commercial energy sources which are being fast replaced by commercial sources on account of increasing agricultural mechanization, rapid rural industrialization, improvement in the standard of living and life. National Commission on Agriculture (1976) estimated that almost 90% of energy for domestic use came from non-commercial sources. It further noted that 65% of domesti-

cally utilized non-commercial energy came from firewood, 15% from dung-cakes and 20% from agricultural waste. About 90% of households used firewood and agricultural waste as fuel for cooking (Govt. of India, 1979) and firewood is most abundantly used source of fuel for domestic affairs (Mannan, 1981; United Nations, 1981). As elsewhere, rural scene in general represents a glaring imbalance in the availability and use of different energy sources which are influenced by use pattern, and by several socio-economic considerations including cost, technology and cultural variables, etc. The present paper analyses the energy consumption pattern in Haryana in relation to commercial as well as non-commercial sources used by rural people.

### METHODOLOGY

The study was conducted in Haryana state. From agro-climatic

considerations, Haryana state was divided into three regions. The first is north-eastern region which possesses more assured irrigation facilities and relatively more fertile soils. The second zone is comprised of south-western districts of the State and it has relatively less irrigation facilities and sandy soils and may be termed as the agriculturally backward dry farming region. In between these two lies third region which is more advanced to south-western region but backward to agriculturally advanced north-eastern region. Because of adequate variations found in the State, it was considered appropriate to follow multistage sampling procedure. One district was randomly selected from each of the three zones. Accordingly, three districts viz. Karnal, Bhiwani and Hisar were selected. From each district, one block representing the major characteristics of its district, was selected purposively. Thus, Nissang block from Karnal district, Bhiwani block from Bhiwani district and Hisar Block-I from Hisar district were selected. From each block two villages, one near the block headquarter and other away from it were purposively selected to see the impact of urbanization on use pattern of energy sources. As the present study seeks to investigate the use pattern of energy sources both in household and agriculture sector, it was considered necessary to include in the sample both male and female respondents. From each village, 50 active males and 50 active females were selected for the study. The sample, thus, consisted of 600 respondents in all.

## RESULTS AND DISCUSSION

Non-commercial sources were available and used by an overwhelming majority of respondents from the very beginning while commercial sources were made available to some of them recently. This is attributed to the fact that non-commercial energy sources are locally available to them, while commercial sources introduced from outside involve cost, time and transport which work as disincentive for rural people. Furthermore, the energy sources which have been in use for centuries continue to remain in vogue as a matter of first preference without realizing the need for newer sources of energy especially for household operations.

A probe regarding amount of various energy sources used was also made (Table 1). More than three-fourth of respondents (78.3%) used upto 16 kg firewood per day. Almost same percentage of respondents was using equal amount of dung cakes per day. However, use of agro-waste by these respondents was found to be less, *i. e.* 1-4 kg/day. Some of the respondents were found using greater amount of non-commercial sources. This indicates the dependency of respondents on non-commercial sources mainly for cooking purposes.

With regard to amount of commercial sources used, three-fourth respondents (75.2%) were found using 5-10 litres of kerosene per month, while use of coal 2 kg or more per day was confined to only one-fifth of respondents

ENERGY CONSUMPTION PATTERN IN RURAL HOUSEHOLDS

**TABLE 1**  
Distribution of respondents as per amount used of various energy sources (n=600)

	Energy used	Frequency	Percentage
<b>Non-commercial</b>			
Firewood/day	Not used	51	8.5
	Upto 8 kg	216	36.0
	9-16 kg	524	42.3
	17-24 kg	30	5.0
	25-32 kg	49	8.2
Dungcakes/day	Not used	51	8.5
	Upto 8 kg	124	20.7
	9-16 kg	286	47.6
	17-24 kg	88	14.7
	25-32 kg	51	8.5
Agro-waste/day	Not used	106	77.6
	Upto 4 kg	397	66.2
	5-8 kg	49	8.2
	9-12 kg	48	8.0
<b>Commercial sources</b>			
Kerosene/month	Not used	100	16.6
	5 litres	318	53.0
	6-10 litres	133	22.2
	11 litres & above	49	8.2
Coal/day	Not used	476	79.4
	2 kg & above	124	20.6
Household electricity units/month	Not used	21	3.5
	25 units	29	4.8
	26-50 units	227	37.8
	51-75 units	42	7.0
	76-100 units	165	27.5
	101-150 units	81	13.5
	151-200 units & above	35	5.8
Diesel/season	Not used	410	68.3
	50 litres	46	7.5
	51-150 litres	47	8.2
	151 litres & above	96	16.0
Petrol/bimonthly	Not used	397	66.2
	50 litres	115	19.2
	51-100 litres	50	8.3
	101 litres & above	38	6.3
	Liquid Petroleum Gas	Not used	536
	31-45 days	26	4.3
	46-60 days	32	5.4
	61 days & above	6	1.0

(20.6%). The consumption of electricity was found 26-100 units/month. The majority of respondents was not found using diesel, petrol and L. P. G. Among the users of diesel, 31.7% were using 50 litres or more/season. The users of L. P. G. were very few and those using it, consumed only one cylinder of L. P. G. in about a month or more than month's time.

The reasons for non-use of commercial sources except electricity and kerosene are obvious as these are not accessible to majority of respondents and these also involve cost, time and transport. Rao (1977), Pant (1982) and Reddy (1982) in their studies also indicated the less use of kerosene, electricity, coal and diesel by rural people.

**Monthly Household Energy Consumption**

The rural household sector, particularly the cooking, consumes by far the largest amount of energy. To determine the energy consumption pattern quantitatively, the energy used was quantified into energy units, *i.e.* Giga Joules (Appendix 1). The monthly household energy consumption pattern of both commercial and non-commercial fuel items has been analysed in Table 2.

It is clear from the results that non-commercial energy sources were used in greater quantity as compared to commercial sources. The share of non-commercial and commercial sources was 91.7 and 8.3 per cent, respectively (Table 2). A further probing regarding monthly household consumption by

TABLE 2  
Monthly household energy  
consumption

Energy	Amount (GJ)*	Per cent	Per house- hold (GJ)	Per capita (GJ)
Non-commercial	7067.66	91.70	4.44	0.570
Commercial	639.92	8.30	0.44	0.058
Total	7707.58	100.00	4.88	0.628

GJ=Giga Joules

\*For conversion factor see Appendix 1.

type of energy reveals that firewood was the major non-commercial source which accounted for about 50% of total non-commercial energy followed by dungcakes (2759.18 GJ) and agro-waste (730.82 GJ). While in terms of actual units the quantity of dungcakes

used was greater than that of firewood. Among the commercial sources petrol (266.80 GJ) seems to be the major commercial source used by respondents. This was followed by electricity (152.50 GJ), coal (101.14 GJ) and kerosene (99.04 GJ), while L. P. G. (20.03 GJ) was the least used source. The results are in conformity with the findings of Pant (1982) and Yadav (1988). The firewood remained the major source of cooking energy in rural areas mainly because of rapidly rising prices of alternate fuels like coal, kerosene, L. P. G., etc. Moreover, the non-commercial sources were available to an overwhelming majority, while commercial sources were used by small percentage of respondents mainly by better off sections.

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ENERGY CONSUMPTION PATTERN IN RURAL HOUSEHOLDS

APPENDIX 1

Energy values of various sources

Energy source	Unit	Energy value (MJ)
<b>Non-commercial</b>		
Firewood	Kg	19.71
Dungcake	Kg	12.55
Agro-waste	Kg	15.07
<b>Commercial</b>		
Kerosene	Litre	38.18
Coal	Kg	26.34
Electricity	Kwh	3.60
Diesel	Litre	46.30
Petrol	Litre	46.30
L. P. G.	Litre	32.35
<b>Energy Conversion Factor</b>		
One Kilo calorie	=	$4.186 \times 10^3$ Mega Joule
One Giga Joule (GJ)	=	$10^3$ Mega Joule



## STUDIES ON QUALITY OF FRESH AND STORED WHEY BASED CARROT JUICE BEVERAGE

SURAJ PAL SHARMA, D. N. SRIVASTAVA and C. M. KAPOOR  
Department of Animal Products Technology  
CCS Haryana Agricultural University, Hisar - 125 004

(Accepted : October 16, 1995)

### ABSTRACT

A whey based carrot juice beverage was prepared with carrot juice and paneer whey in the ratio of 60 : 40 using 7% sugar. The product was added with three levels of benzoic acid as preservative and then in-bottle pasteurized at 90°C for 20 min. The composition, physico-chemical and bacteriological qualities and sensory attributes of the product remained unchanged during storage upto 20 days at 5°-10°C. Upto this level of storage the preservative had also no specific role to extend the shelf-life of the beverage.

Whey as a substrate for soft drinks and beverages has appealed to many users, that can be utilized on profitable basis, while being usually thrown away as a waste material. Many workers have reported the preparation of whey beverages using various supplements to enhance its nutritive value and acceptability, but the information on the use of whey alongwith carrot juice is very scanty. Thus, whey based carrot juice beverage was prepared using carrot juice and whey in the ratio of 60 : 40, and the composition, physico-chemical and bacteriological qualities, and shelf-life of this product were determined.

### MATERIAL AND METHODS

Fresh whey was obtained as a byproduct of buffalo milk paneer and carrot juice was extracted out of

carrots procured from the local market. The carrot juice and whey were mixed in the ratio of 60 : 40 and sugar was added at the rate of 7 per cent. The mixture was pre-heated at 72°C by flash method to check the bacterial growth prior to final heat treatment. Three levels of benzoic acid (0, 300 and 600 ppm) as sodium benzoate were added and then the product was in-bottle pasteurized at 90°C for 20 min and stored at 5°-10°C for 0, 5, 10, 15 and 20 days. The trials were conducted in triplicate during Feb.-March, 1992.

The samples of fresh and stored product were analysed for pH, acidity, moisture and specific gravity as per IS : 1479 (Part I)-1961; protein, NPN, ash and total solids contents as per IS : 1479 (Part II)-1961 and SPC and coliform count

as per IS : 1479-1962. The fat content (by EMT-Reil), B-carotene (AOAC, 1984), carbohydrates (by difference), viscosity (Kulkarni and Dole, 1956), Brix° and Refractive index (by using refractometer) were also determined. Sensory evaluation of the product was conducted by a panel of five selected judges using a 9-point Hedonic Scale.

## RESULTS AND DISCUSSION

The composition of the fresh beverage has been given in Table 1. On an average, the product contained 86.44, 0.50, 0.70, 0.098, 11.79, 0.56 and 13.55 per cent of moisture, fat, protein, NPN, carbohydrates, ash and total solids, respectively and the B-carotene content 11.79 mg/100 ml of the beverage. On storage of this product at 5°-10°C upto 20 days, no significant change in these values was observed.

The physico-chemical and bacteriological qualities of the fresh

beverage have been presented in Table 2. On an average the pH, acidity (per cent), specific gravity, viscosity (centipoise), brix° and refractive index measured in fresh product were 5.57, 0.156, 1.037, 1.53, 12.33 and 1.35, respectively, while SPC and coliform count/ml were 14 and nil, respectively. No significant effect of the storage of beverage upto 20 days at 5°-10°C was observed on these values as well. The results of physico-chemical quality of the product were comparable with the findings of Grewal and Jain (1982) who prepared a milk based carrot juice beverage.

The mean sum of squares for moisture, fat, protein, NPN, carbohydrates, ash, total solids and B-carotene of the beverage on storage is presented in Table 3. The data showed that neither the level of preservative, nor the storage period and their interactions had any significant ( $P < 0.05$ ) effect on composition of the product during storage

TABLE 1  
Composition of the beverage at different storage periods

Particulars	Storage (5°-10°C) period (days)				
	0	5	10	15	20
Moisture (%)	86.44	86.05	86.16	86.07	86.05
Fat (%)	0.50	0.50	0.50	0.50	0.50
Protein (%)	0.70	0.71	0.71	0.71	0.71
NPN (%)	0.098	0.097	0.097	0.097	0.095
Total carbohydrates (%)	11.79	12.26	12.04	12.17	12.17
Ash (%)	0.56	0.57	0.60	0.55	0.57
Total solids (%)	13.55	13.95	13.84	13.93	13.95
B-carotene (mg/100 ml)	11.79	11.93	12.19	11.60	12.05

Average of nine observations.

TABLE 2

Physico-chemical and bacterial qualities of the beverage at different storage periods

Particulars	Storage (5°-10°C) period (days)				
	0	5	10	15	20
pH	5.57	5.58	5.58	5.58	5.57
Acidity (%)	0.156	0.157	0.158	0.156	0.158
Sp. gr. (27°C)	1.037	1.035	1.036	1.037	1.037
Viscosity (Centipoise)	1.53	1.53	1.53	1.53	1.53
Brix°	12.33	12.33	12.33	12.33	12.33
Refractive index	1.35	1.35	1.35	1.35	1.35
SPC/ml	14	13	16	15	16
Coliform count/ml	Nil	Nil	Nil	Nil	Nil

Average of nine observations.

TABLE 3

Analysis of variance for the chemical composition of the beverage

Source	d. f.	Mean sum of squares							
		Moisture	Fat	Protein	NPN	Total carbo- hydrates	Ash	Total solids	B-carotene
Preservatives	2	0.1117	0.0000	0.0003	0.00016	0.1773	0.0029	0.1117	0.0834
Storage period	4	0.2545	0.0000	0.0001	0.00020	0.3034	0.0024	0.2545	0.4706
Preservatives × Storage period	8	0.1503	0.0000	0.0002	0.00007	0.1702	0.0006	0.1503	0.9003
Error	30	0.3184	0.0217	0.0309	0.00328	0.3856	0.0065	0.3184	6.1976

upto 20 days at 5°-10°C. The mean sum of squares for pH, acidity, specific gravity, viscosity, brix°, refractive index and SPC of the beverage on storage has been presented in Table 4. No significant effect of storage periods and preservatives on physico-chemical and bacteriological qualities of the product was observed. Gagrani *et al.* (1987)

also prepared the whey beverages with fruit juices and 6-12 per cent of sugar and reported that whey could be utilized in the preparation of acceptable and nutritious beverages.

The sensory score of overall acceptability of the fresh beverage and preserved with three levels of

preservative and stored at 5°-10°C for 20 days has been presented in Table 5. It may be observed from the data that there was no significant effect of the three levels of preservative on various attributes such as flavour, colour, uniformity, consistency and overall acceptability of the beverage on its storage upto 20 days at refrigeration temperature. Jayaprakash *et al.* (1986) also found no off flavour or microbiological spoilage in whey drink prepared with fruit flavouring followed by in-bottle pasteurization/sterilization and stored

at room temperature for two months. However, Reddy *et al.* (1987) developed the whey beverages and conducted sensory evaluation, but they preferred refrigeration storage than room temperature.

From the above findings, it is concluded that a high quality and nutritious beverage can be prepared by using carrot juice and whey in the ratio of 60 : 40 with a shelf-life much more than 20 days at storage temperature of 5°-10°C.

TABLE 4

Analysis of variance for physico-chemical and bacterial qualities of the beverage

Source	d.f.	Mean sum of squares						
		pH	Acidity	Sp. gr.	Viscosity	Brix°	Refractive index	SPC
Preservatives	2	0.0010	0.00001	0.000	0.00007	0.000	0.000	6.85
Storage period	4	0.0003	0.00001	0.000	0.00004	0.000	0.000	16.78
Preservatives × Storage period	8	0.0016	0.00001	0.000	0.00009	0.000	0.000	9.09
Error	30	0.0013	0.00007	0.000	0.00081	0.000	0.000	60.94

TABLE 5

Mean scores of the sensory evaluation of fresh and stored beverages

S. No.	Sensory attributes	Fresh	Stored at 5°-10°C for 20 days with preservative (ppm)		
			0	300	600
1.	Flavour	8.20	8.13	8.23	8.27
2.	Colour	7.75	8.10	8.07	8.10
3.	Uniformity	—	8.14	8.13	8.13
4.	Consistency	8.09	8.27	8.25	8.31
5.	Overall acceptability	7.77	8.13	8.22	8.23

Average of three replications.

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## PATTERN OF VARIABILITY EXPRESSION AMONG MUNGBEAN GENOTYPES HAVING DIFFERENTIAL PHOTOTHERMAL RESPONSIVENESS

AJIT SINGH and K. P. SINGH

Department of Genetics

CCS Haryana Agricultural University, Hisar - 125 004

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### ABSTRACT

The pattern of variability expression among 60 mungbean genotypes having differential photothermal responsiveness was studied under two natural photothermal environments, for six quantitative traits. The mean performance of pods per plant, grains per pod and grain yield per plant was better in the *kharif*, while 1000-grain weight was better in spring season. High estimates of heritability and genetic advance were obtained for all the traits except grains per pod. The estimates of spring were higher than those of *kharif* season for grain yield per plant and 1000-grain weight. The expression of variability for days to flowering and maturity was better in *kharif* than spring season, while reverse was the situation for grains per pod, grain weight and grain yield per plant. Although most of the values of group-wise estimates were less than those based on all the 60 genotypes, but improved group-wise estimates of grain yield and component traits in respect of groups I and II were obtained. Moreover, variability pattern for grain yield and component traits under different environments was better resolved in group-wise estimates providing deep insight for understanding expression of variability for these traits.

The mungbean (*Vigna radiata* (L.) Wilczek) is grown throughout the year except winter months. Consequently, large amount of intraspecific variability in response to environmental factors especially day length and temperature has evolved. Besides, interspecific hybridization of *Vigna* species has also contributed towards this variability. The management and utilization of genetic variability in any breeding programme require understanding about the variability pattern in the genotypes. Therefore, the present study was conducted to know

the variability pattern in relation to photothermal responsiveness of mungbean progenies derived from inter and intraspecific hybrids.

### MATERIAL AND METHODS

The experimental material consisted of 60 genotypes (21 progenies from interspecific hybrids, 15 from intraspecific hybrids and 24 germplasm lines). Three metre long single row plots with a spacing of 30 cm between rows and 15 cm between plants were raised in random-

mised block design for each genotype in each of the two natural photothermal environments, *i. e.* **kharif** 1991 and spring 1992 seasons. Observations on days to flower, maturity, grains per pod, 1000-grain weight (g) and yield per plant (g) were recorded. Genotypic and phenotypic coefficient of variability (GCV and PCV) for all the genotypes as well as for photothermal groups were calculated as suggested by Panse and Sukhatme (1967).

## RESULTS AND DISCUSSION

Differences in the mean performance of different genotypes under spring and **kharif** seasons were obvious (Table 1). The mean performance of pods per plant, grains per pod, and yield per plant was better in **kharif**, while 1000-grain weight was better in spring. The estimates of PCV were higher than the estimates of GCV of all the characters in both the environments. The estimates of coefficient of variability in respect of days to flower and maturity in spring season were less than the estimates of **kharif** season, indicating better expression of variability in **kharif** for these traits. This was due to the fact that in spring season there was quick growth and development of the mungbean crop leading to narrowing down of the time taken for flowering and maturity among different mungbean genotypes. On the contrary, expression of variability for grains per pod, grain weight and grain yield was better in spring season as compared to **kharif**. Such

variations in estimates of variability for different characters in **kharif** and spring seasons or under different environments have been reported by earlier workers (Yohe and Poehlman, 1972; Imrie *et al.*, 1981; Kumari and Verma, 1983; Ramana and Singh, 1987). The high estimates of heritability were obtained for days to flower, days to maturity, pods per plant, 1000-grain weight and grain yield per plant, while grains per pod had average heritability. The estimates of genetic gains were also on the pattern of that of heritability. The selection gains for flowering, maturity and grains per pod in spring were expected to be poor than gains of **kharif** selection but selection for pods per plant, grain weight and grain yield would prove more effective in spring compared to **kharif** crop. Ramana and Singh (1987) reported identical magnitudes of heritability and genetic advance but estimates of spring and **kharif** seasons presented different picture.

The **kharif** and spring seasons differ in photothermal factors of the environment. Consequently, specific varieties for **kharif** and spring seasons have been developed (Sarkar, 1989). The varieties of spring season are photothermo-insensitive, while **kharif** season varieties had some degree of responsiveness to photoperiod and temperature. Therefore, assessment of expression of variability among the genotypes having differential photothermal responsiveness is desirable. The genotypes of the present study were

TABLE 1  
 Mean, phenotypic and genotypic coefficients among 60 genotypes of mungbean for six quantitative traits  
 under two natural photothermal environments

Component	Environment	Days to flower	Days to maturity	Pods/plant	Grains/pod	1000-grain weight (g)	Grain yield/plant (g)
Mean	E <sub>1</sub>	48.58 ± 1.22	65.80 ± 0.78	44.67 ± 3.52	10.84 ± 0.53	31.49 ± 1.33	12.20 ± 0.78
	E <sub>2</sub>	46.20 ± 1.34	59.58 ± 1.39	18.14 ± 0.98	8.96 ± 0.51	37.82 ± 0.98	4.95 ± 0.31
PCV	E <sub>1</sub>	16.69	11.29	23.60	10.27	12.15	23.94
	E <sub>2</sub>	7.98	6.25	21.30	8.69	12.84	26.14
GCV	E <sub>1</sub>	16.39	11.20	21.53	8.27	10.98	22.61
	E <sub>2</sub>	7.15	5.55	20.23	5.14	12.44	24.96
h <sup>2</sup>	E <sub>1</sub>	97.05	98.34	83.25	64.88	89.23	81.79
	E <sub>2</sub>	76.03	78.91	90.17	35.05	91.19	93.84
G. A.	E <sub>1</sub>	33.37	22.88	40.47	13.73	44.00	20.47
	E <sub>2</sub>	14.18	10.16	39.57	6.28	49.11	24.84

E<sub>1</sub> = July 1991, E<sub>2</sub> = March 1992.

classified into seven photothermal groups by observing extent of delay in flowering under long days (>12 h) and temperature below 24°C indicating photoperiodic and thermal responsiveness of genotypes, respectively (Singh *et al.*, 1994).

The group-wise data presented in Table 2 reveal that genotypes of groups I and II, III and IV, and V, VI and VII constituted early, medium and late flowering categories. A critical examination of results revealed that the estimates of variability in *kharif* and spring were identical in respect of genotypes belonging to groups I, II, V, VI and VII, but in case of groups III and IV genotypes, values of estimates were much larger in *kharif* than spring season. Thus, genotypes of groups III and IV had differential expression under different photothermal environments, but genotypes of groups I and II and groups V, VI and VII had stable expression. For maturity, genotypes of group IV only exhibited differential pattern of variability in *kharif* and spring seasons, while genotypes of rest of the groups had stable expression as indicated by identical estimates of variability in different environments.

The group-wise specificities for expression of variability under two seasons were also evident for grain yield and component traits. The genotypes of group I had better resolution of variability for grains per pod, grain weight and grain yield per plant in *kharif* season as eviden-

ced by higher estimates of GCV and PCV in *kharif* than spring, while reverse was true for genotypes of group VII, which had better expression of variability for these genotypes in spring season. The genotypes of groups II and IV had larger estimates of PCV and GCV for grain weight and grain yield in spring season than *kharif*. While for pods per plant and grains per pod estimates were almost identical under two environments. Similarly, genotypes of groups III and VI had better resolution of variability for grains per pod and grain yield in spring than in *kharif* environment, but pods per plant and grain weight had identical expression of variability in two environments. The genotypes of group V were unique in the sense that in their case variability of pods per plant and grain yield were better expressed in *kharif* than spring season.

Thus, the group-wise deviations in the expression of variability under two natural photothermal environments of *kharif* and spring seasons for all the six traits studied indicated interaction of genotype with photo- and thermal-factor of the two environments. Moreover, the estimates of the variability (GCV and PCV) calculated without grouping of genotypes provided identical estimates in respect of grain yield and its components in different environments but group-wise estimates provided deep insight of variability expression, and different values were obtained under different environments for different genotypes.

**TABLE 2**  
**Mean, phenotypic and genotypic coefficients of variation of mungbean genotypes belonging to seven photothermal groups for six quantitative traits under two natural photothermal environments**

Group	Component	Environment	Days to flower	Days to maturity	Pods/plant	Grains/pod	1000-grain weight (g)	Grain yield/plant (g)
1	2	3	4	5	6	7	8	9
G I	Mean	E <sub>1</sub>	39.23±1.02	56.61±0.72	38.66±3.20	10.63±0.50	31.33±1.20	10.64±0.68
		E <sub>2</sub>	43.03±0.70	56.28±0.77	18.57±0.69	9.02±0.39	39.43±0.95	4.79±0.25
	PCV	E <sub>1</sub>	7.84	3.86	27.04	16.37	12.36	25.39
		E <sub>2</sub>	6.45	4.94	10.95	9.74	5.46	20.46
	GCV	E <sub>1</sub>	7.16	3.53	25.07	15.31	11.42	24.13
		E <sub>2</sub>	6.14	4.65	9.94	8.10	4.58	19.41
G II	Mean	E <sub>1</sub>	42.35±1.10	60.20±0.92	46.42±3.65	10.31±0.74	31.30±1.16	12.04±0.73
		E <sub>2</sub>	44.88±1.44	58.35±1.11	17.95±0.98	8.88±0.49	38.68±0.95	5.04±0.28
	PCV	E <sub>1</sub>	9.18	6.19	22.90	12.95	11.73	22.96
		E <sub>2</sub>	7.55	6.05	22.32	7.84	15.37	22.34
	GCV	E <sub>1</sub>	8.61	5.90	29.78	9.45	10.80	21.71
		E <sub>2</sub>	6.44	5.58	21.28	3.85	15.07	21.25
G III	Mean	E <sub>1</sub>	44.66±0.94	62.33±0.69	38.54±3.70	10.75±0.66	32.22±1.54	10.01±0.86
		E <sub>2</sub>	45.08±1.44	58.20±1.70	17.70±0.87	8.85±0.49	40.77±1.04	4.87±0.24
	PCV	E <sub>1</sub>	12.23	6.63	19.34	7.51	10.50	15.01
		E <sub>2</sub>	7.89	6.22	19.19	10.72	10.54	21.41
	GCV	E <sub>1</sub>	11.96	6.59	15.35	6.02	8.70	10.64
		E <sub>2</sub>	6.84	5.08	18.36	8.20	10.07	26.79
G IV	Mean	E <sub>1</sub>	49.95±1.11	66.95±0.92	46.57±4.48	10.98±0.56	30.71±1.50	13.40±1.07
		E <sub>2</sub>	46.71±1.19	60.19±1.63	15.80±0.89	8.99±0.46	36.74±1.13	4.37±0.23
	PCV	E <sub>1</sub>	15.26	10.37	23.22	6.43	10.45	19.60
		E <sub>2</sub>	7.61	6.53	17.69	8.60	16.82	24.14
	GCV	E <sub>1</sub>	15.01	10.23	20.01	1.51	8.55	16.96
		E <sub>2</sub>	6.94	5.61	16.29	5.81	16.38	23.24

Contd.

1	2	3	4	5	6	7	8	9
G V	Mean	E <sub>1</sub>	57.44 ± 1.28	73.83 ± 0.77	50.77 ± 2.15	11.01 ± 0.34	26.82 ± 0.96	13.40 ± 1.07
		E <sub>2</sub>	47.77 ± 1.76	61.22 ± 1.69	14.72 ± 0.76	9.02 ± 0.37	34.52 ± 0.78	4.37 ± 0.23
	PCV	E <sub>1</sub>	4.28	4.97	20.17	5.23	6.62	21.29
		E <sub>2</sub>	7.63	4.96	16.56	6.61	7.69	14.45
	GCV	E <sub>1</sub>	4.26	4.97	20.70	5.23	6.23	21.79
		E <sub>2</sub>	6.15	3.61	15.27	4.29	7.17	11.56
G VI	Mean	E <sub>1</sub>	55.14 ± 1.18	72.40 ± 0.64	43.25 ± 2.18	11.09 ± 0.23	33.43 ± 1.59	14.38 ± 0.67
		E <sub>2</sub>	48.25 ± 1.21	61.66 ± 1.49	21.18 ± 1.20	9.21 ± 0.57	36.84 ± 0.82	50.55 ± 0.38
	PCV	E <sub>1</sub>	5.38	4.06	16.94	8.81	10.68	21.00
		E <sub>2</sub>	4.72	3.99	19.48	9.26	10.52	24.60
	GCV	E <sub>1</sub>	4.70	3.91	15.77	8.41	8.96	20.30
		E <sub>2</sub>	3.57	2.68	18.19	5.22	10.15	23.11
G VII	Mean	E <sub>1</sub>	58.7 ± 1.62	73.37 ± 0.56	48.12 ± 2.98	11.57 ± 0.31	33.24 ± 1.46	12.92 ± 0.62
		E <sub>2</sub>	48.58 ± 1.05	62.08 ± 1.14	19.75 ± 1.28	8.83 ± 0.68	36.34 ± 0.79	5.67 ± 0.45
	PCV	E <sub>1</sub>	8.13	4.39	26.44	3.71	12.19	24.53
		E <sub>2</sub>	7.84	5.45	20.66	9.06	12.61	30.70
	GCV	E <sub>1</sub>	7.35	4.29	25.32	1.71	10.93	20.80
		E <sub>2</sub>	7.38	4.96	19.06	3.23	12.32	29.10

E<sub>1</sub>=July 1991, E<sub>2</sub>=March 1992.

## VARIABILITY AMONG MUNGBEAN GENOTYPES

Although, the values of most of the estimates for different groups reduced but estimates of variability especially of groups I and V were larger

for grain yield and component traits than those calculated from all the 60 genotypes. This will help in selection of parents for hybridization.

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## ROLE OF VARIOUS FACTORS IN DEVELOPMENT OF WHITE RUST DISEASE IN RAPSEED-MUSTARD

VIRENDRA KUMAR, C. D. KAUSHIK and P. P. GUPTA  
Department of Plant Pathology  
CCS Haryana Agricultural University, Hisar - 125 004

(Accepted : July 17, 1995)

### ABSTRACT

Detailed studies were undertaken on various epidemiological factors affecting development of white rust in Indian mustard caused by *Albugo candida* (Lev.) kunze. Older (lower) leaves were found more susceptible as compared to younger (upper) leaves. Older leaves showed symptoms after four days of inoculation with disease intensity 11.2% as compared to younger leaves on which symptoms appeared after six days with disease intensity 5.7 per cent. Symptoms appeared after three days of inoculation on lower surface with intensity (after 10 days of inoculation) 14.6% as compared to upper surface where symptoms appeared after five days with disease intensity 10.5 per cent. One g/pot oosporic material was found to be optimum for white rust development. White rust appeared within 23 days when inoculum was placed at a depth of 7.5 cm in soil, whereas it took 56 days when the inoculum was placed at a depth of 10 cm. Late sown crop suffered maximum from white rust infection.

The loss in yield of rapeseed-mustard due to diseases may vary depending upon the nature of the pathogen and the severity of the attack. White rust caused by *Albugo candida* (Lev.) kunze appears in various proportions on Indian mustard in India year after year taking a heavy toll of the crop. When the infection is localized only on the leaves it may not result in severe yield loss of the crop. But in case of floral infection it results in malformation (stagehead) of inflorescence. Saharan *et al.* (1981, 1984) reported the yield losses to the tune of 36.8% due to floral infection in late sown Indian mustard. In present study, the effect of different factors

affecting white rust development in Indian mustard was studied.

### MATERIAL AND METHODS

To study the effect of leaf position on white rust development, detached leaf technique (Hooker and Yarwood, 1966; Pillai and Roy, 1970) was used. Ten leaves from five randomly selected 40 days old mustard plants of variety 'RH 30' were taken from lower, middle and upper portions of the plants. These leaves were washed with distilled, sterilized water and kept in moist chamber (rectangular jars of size 12.5 cm × 7.5 cm × 2.5 cm) containing freshly prepared 2% sucrose

solution. Lower lamina of leaves was inoculated by evenly spraying sporangia/zoospores suspension keeping uninoculated leaves as check. These jars were kept under laboratory conditions (temp. ranging from 5°-10°C). Lesion development and disease intensity were recorded after 10 days.

To record the effect of upper and lower leaf surfaces, 20 leaves from lower portion of 40 days old plants of var. RH 30 were collected and properly washed. Ten leaves were inoculated on the upper surface, while remaining 10 were inoculated on the lower surface by sporangia/zoospores suspension having ten number per microscopic field. Lesion development and disease intensity were recorded after 10 days.

To study the effect of inoculum concentration, oosporic material (floral infection) of white rust was collected from the previous year crop of mustard variety RH 30. The material was grinded uniformly into fine powder. Five levels of this oosporic material, i. e. 0.5, 1.0, 1.5, 2.0 and 2.5 g/pot were thoroughly mixed with sterilised sandy loam soil (2 kg/pot) in 25 cm size earthen pots alongwith uninoculated check. Ten seeds of variety RH 30 were sown in each pot with three replications. Time taken for lesion development in foliage and per cent disease intensity in each treatment were recorded.

To study the effect of inoculum depth, powdered oosporic material was placed at 0 (at surface), 2.5, 5.0, 7.5 and 10.0 cm depth below the soil surface in 25 cm size earthen pots separately containing 2.5 kg sterilized sandy loam soil. The soil was sterilized three times successively on alternate days. Three replications were maintained for each treatment. Other details of raising and maintenance of plants were similar to those given in the previous experiment. The time taken for lesion development was recorded in each treatment.

To study the effect of sowing dates, the experiment was conducted under field conditions. Two varieties RH 30 and Prakash were sown on Sept. 30, Oct. 10, 20, 30 and Nov. 9, in 1.5 m × 4 m plots with three replications. Oosporic material of *A. candida* was mixed with seeds at the time of sowing. White rust development on leaves for each date of sowing was recorded after 90 days and floral infection was noted 20 days before harvesting the crop. Per cent disease intensity on leaves and per cent floral infection were calculated.

To record the disease intensity on leaves, 50 leaves (starting from bottom) were taken from 10 randomly selected plants. Based on the leaf area infected, the leaves were graded on 0-5 scale.

The disease intensity (D. I.) was calculated according to the formula :

$$D. I. (\%) = \frac{\text{Total number of numerical ratings}}{\text{Number of leaves observed}} \times \frac{100}{\text{Maximum grading}}$$

To record the floral infection, total number of plants and diseased plants (floral infected) were counted 20 days before harvesting and disease incidence was calculated as follows :

$$\text{Floral infection (\%)} = \frac{\text{Total number of infected plants/plot}}{\text{Total number of plants/plot}} \times 100$$

## RESULTS AND DISCUSSION

### Effect of Leaf Position

White rust appeared earlier in older (lower) and medium (middle) leaves, *i. e.* after four days of inoculation as compared to younger (upper) leaves on which disease appeared after six days of inoculation. The disease intensity after 10 days on older, medium and younger leaves was 11.2, 10.3 and 5.7 per cent, respectively. It indicated that older leaves were more prone to white rust than middle aged or younger leaves (Table 1). Saharan *et al.* (1980) also reported early develop-

TABLE 1

Effect of leaf position on white rust development

Leaf position	Disease appearance (days)	Disease intensity after 10 days (%)
Lower (old leaves)	4	11.2
Middle (medium aged leaves)	4	10.3
Upper (young leaves)	6	5.7

ment of symptoms and high susceptibility of lower leaves of Indian mustard cv. 'Prakash'.

### Effect of Leaf Surface

The disease appeared after five days when inoculated on upper surface, whereas it took only three days when inoculated on lower surface of leaves. The size of pustule on upper surface was smaller than the size of pustule on lower surface of leaves at the time of recording. The disease intensity was 10.5 and 14.6 per cent in case of upper and lower surface of leaves, respectively (Table 2). These findings show that the lower surface of the leaves was more susceptible to white rust

TABLE 2

Effect of leaf surface on the development of white rust

Leaf surface	Disease appearance (days)	Disease intensity after 10 days (%)
Upper	5	10.5
Lower	3	14.6

as compared to upper surface. The present findings are in accordance with Singh and Singh (1983).

**Effect of Inoculum Level**

The time taken for disease appearance was medium (40 days) when inoculum level was 0.5 g/pot and minimum (25 days) when inoculum level was 1 g/pot. Further increase in inoculum concentra-

tion has not given any significant difference on the appearance of disease. Disease intensity was recorded minimum (15%) at inoculum level of 0.5 g/pot and was maximum (43%) at inoculum level of 2.5 g/pot (Fig.1). There was sharp increase in disease intensity with increase in inoculum level from 0.5 to 1 g/pot. This revealed that optimum level of inoculum for white rust development was 1 g/pot.

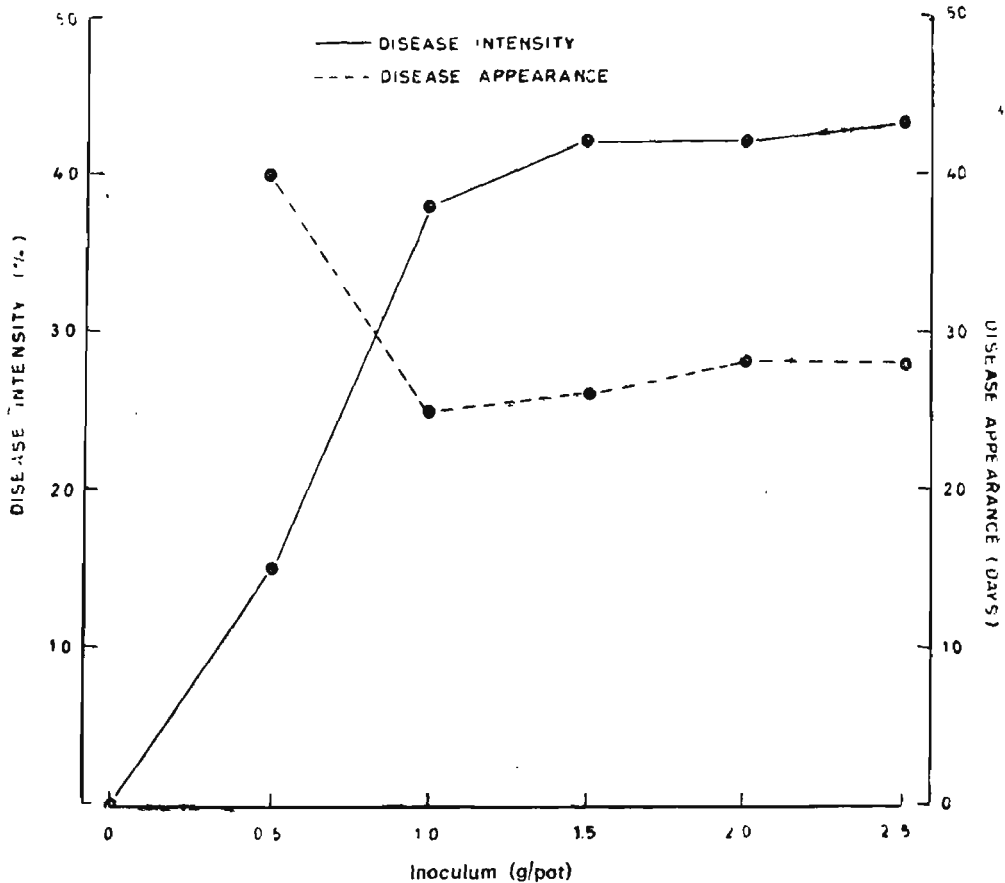


Fig. 1. Effect of inoculum level on white rust development in Indian mustard.

**Effect of Inoculum Depth**

Disease did not appear in pots where inoculum was placed on soil surface. With the increase in depth of inoculum placement from 2.5 to 7.5 cm, the number of days of appearance of white rust disease decreased. The number of days for appearance of white rust was minimum (23 days) when inoculum was placed at a depth of 7.5 cm. Further increase in depth of inoculum from 7.5 to 10 cm resulted in the sharp increase in number of days, *i. e.* 23

to 56 days for appearance of disease (Fig. 2). The study, thus, indicates that the optimum depth of inoculum for white rust development is 7.5 cm. Similar results were also reported by Saharan *et al.* (1980) while working on white rust of Indian mustard cv. Prakash. They observed that the disease appeared within 20-25 days of sowing when the inoculum was placed at a depth of 7.5 cm. Disease appearance took time when inoculum was placed on soil surface and at a depth of 2.5 cm.

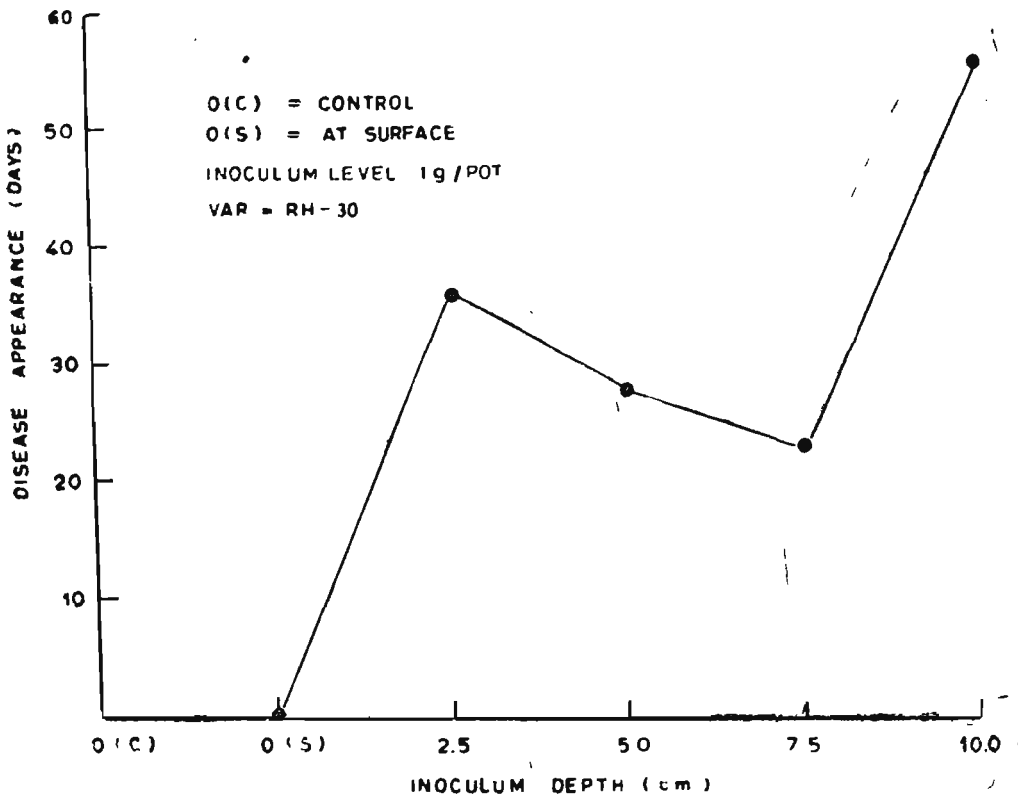


Fig. 2. Effect of inoculum depth on white rust development in Indian mustard.

**Effect of Sowing Dates**

White rust appeared on leaves of cultivars 'Prakash' on first date of sowing, whereas cultivar 'RH 30' escaped infection till that time. There was no floral infection in both the cultivars in initial two dates of

sowing and it was observed only in crop sown on onward dates (Fig. 3). The data also indicate that the disease intensity as well as floral infection in both the cultivars increased with the advancing of sowing dates. The disease intensity in both the cultivars was maximum

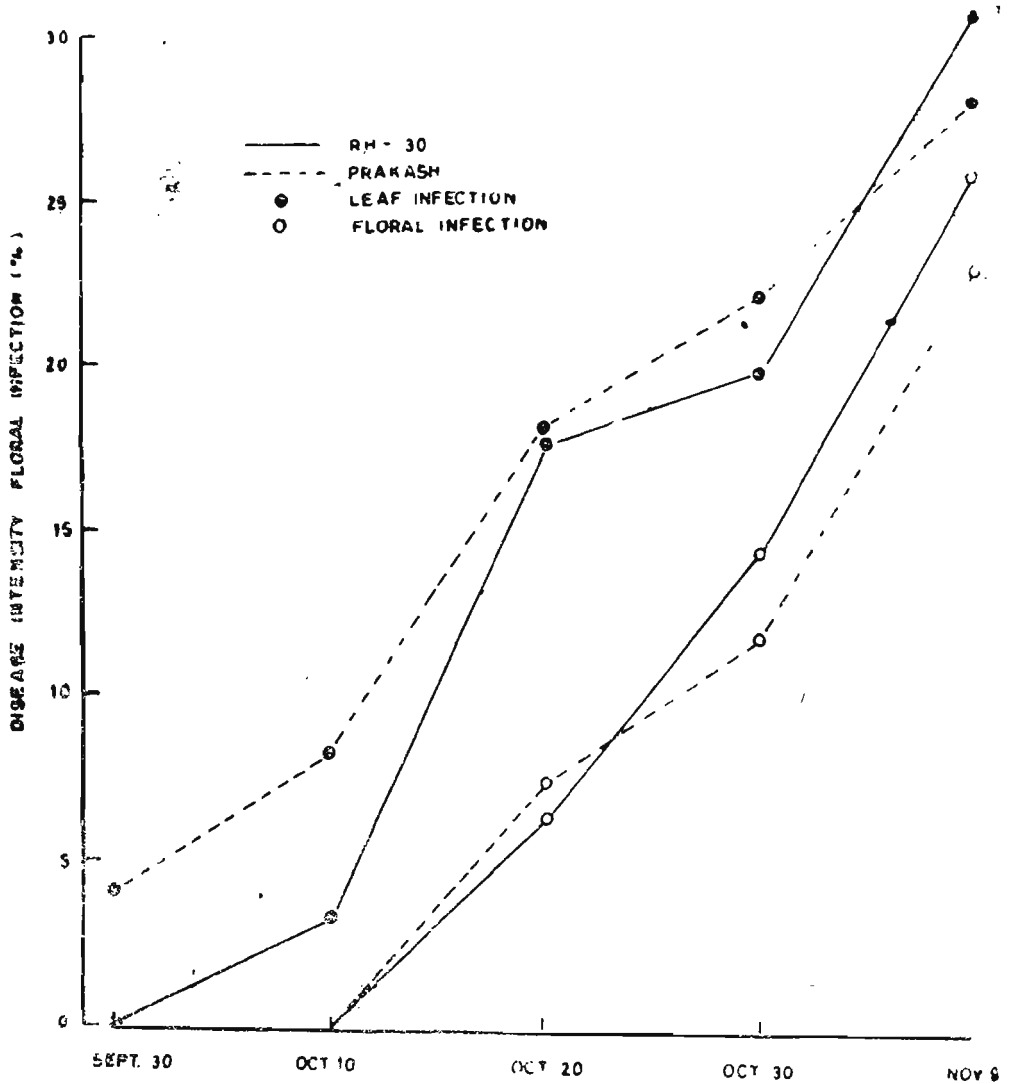


Fig. 3. Effect of different dates of sowing on white rust development in Indian mustard.

## WHITE RUST IN INDIAN MUSTARD

(28.33, 23.1, 30.6 and 20.3 per cent, respectively) when sown late. Thus, the late sown crop of Indian mustard suffered maximum due to white rust as compared to earlier and normal

sown crops. Similar results were reported by other workers, while working on white rust of Indian mustard (Tripathi and Kaushik, 1978).

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## STUDIES ON THE NUTRITIONAL REQUIREMENT OF TUBEROSE (*POLIANTHES TUBEROSA* L.) CV. SINGLE DURING GROWTH

AMARJEET SINGH and N. R. GODARA

Department of Horticulture

CCS Haryana Agricultural University, Hisar - 125 004

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### ABSTRACT

An experiment with five levels of nitrogen (0, 100, 200, 300 and 400 kg/ha) and three levels (0, 100 and 200 kg/ha) each of phosphorus and potassium was undertaken to find out the nutritional requirement of tuberose cv. Single. The increasing levels of nitrogen, phosphorus and potassium reduced the sprouting period and increased the number of leaves per plant and plant height significantly. However, potassium did not influence the sprouting period considerably.

Tuberose, commonly known as Rajnigandha, is a bulbous perennial summer flowering ornamental crop. It is widely grown for aesthetic, medicinal and commercial purposes in India, France, Italy and other tropical and sub-tropical countries (Sadhu and Bose, 1973). In India, its commercial cultivation is mainly confined to Tamil Nadu, Karnataka, Maharashtra and West Bengal (Nambisan and Krishnan, 1983). In North India, tuberose cultivation is gaining popularity, because of its immense export potentiality. However, little attention has been paid regarding its nutritional requirement for growth, flowering and improving the yield and quality of flowers.

Amongst the three major nutrient elements, nitrogen plays comparatively more important role than phosphorus and potassium in influencing the growth in tuberose. Growth of

tuberose is very important as it is related directly with all the other characters of yield and quality. So, to find out nutritional requirement of tuberose under Haryana conditions, the present studies were conducted.

### MATERIAL AND METHODS

The present studies were carried out at the Horticulture Research Farm of CCS Haryana Agricultural University, Hisar during 1991 and 1992. The soil of the experimental field was sandy loam with pH 8.0 and 8.10 and it contained 0.48% organic carbon, 186.51 and 187.65 kg available nitrogen, 14.96 and 14.97 kg available phosphorus, and 360.93 and 358.25 kg available potash per hectare in 1991 and 1992, respectively. Plot size was 1.8 m × 1.5 m with 30 plants in each plot. Plant to plant and row to row spacing was 30 cm ×

30 cm. Bulbs of uniform size (2.0 to 2.5 cm dia.) were planted at a depth of about 5 cm on 25th March in both the years of study.

There were 45 treatment combinations with five levels of nitrogen, *i. e.* N<sub>0</sub> (control), N<sub>1</sub> (100 kg/ha), N<sub>2</sub> (200 kg/ha), N<sub>3</sub> (300 kg/ha) and N<sub>4</sub> (400 kg/ha), and three levels each of phosphorus, *i. e.* P<sub>0</sub> (control), P<sub>1</sub> (100 kg/ha) and P<sub>2</sub> (200 kg/ha), and potash, *i. e.* K<sub>0</sub> (control), K<sub>1</sub> (100 kg/ha) and K<sub>2</sub> (200 kg/ha). Each plot received 10 kg of well rotten farm-yard manure before planting. The experiment was conducted following split-split plot design, keeping one plot as one unit and the set was replicated thrice.

Half the dose of nitrogen and full dose of phosphorus and potash were made as basal dose while remaining nitrogen was applied at the time of spike emergence by top dressing method. Urea, single super phosphate and muriate of potash were the sources of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O, respectively.

Observations for sprouting of bulbs were recorded daily till it was over, whereas data for number of leaves per plant and plant height were recorded at the time of harvesting of the bulbs (25th November in both the years).

## RESULTS AND DISCUSSION

Sprouting of bulbs was advanced significantly by the application of nitrogen and phosphorus, whereas

potassium and various interactions were observed to be non-significant in both the years (Table 1). Treatment N<sub>4</sub> took 8.50 and 8.02 days for sprouting as compared to 12.74 and 14.94 days in N<sub>0</sub> during 1991 and 1992, respectively. Similarly, P<sub>2</sub> treatment enhanced the sprouting and took 9.85 and 10.32 days over P<sub>0</sub> (10.09 and 10.65 days) in 1991 and 1992, respectively. Increasing levels of potassium also shortened the sprouting period, though the effects were non-significant. This decrease in sprouting period with the subsequent increase in nitrogen and phosphorus levels may be possible due to early absorption of nitrogen and phosphorus through the surface of bulbs or by primary roots which might have stimulated early sprouting of bulbs. Similar results were also obtained by Sadhu and Bose (1973), Yadav *et al.* (1985), Mukhopadhyay and Bankar (1986) and Bankar and Mukhopadhyay (1990). The effect of potassium in promoting sprouting might be due to sufficient availability of potassium in the soil.

In both the years of study, application of nitrogen, phosphorus and potassium considerably increased the number of leaves/plant and plant height (Table 1). The maximum number of leaves (66.35 and 68.21) with maximum length (52.18 and 52.96 cm) were obtained under N<sub>4</sub> (400 kg/ha) level in 1991 and 1992, respectively. Phosphorus and potassium application has also promoted these characters but the effect of nitrogen was more pronounced than

NUTRITIONAL REQUIREMENT OF TUBEROSE

TABLE 1

Effect of NPK on growth of tuberose plant cv. Single

Treatment	Days taken for sprouting of bulbs		Number of leaves/plant		Plant height (cm)	
	1991	1992	1991	1992	1991	1992
<b>Nitrogen</b>						
N <sub>0</sub>	12.74	14.94	36.36	35.55	34.82	35.32
N <sub>1</sub>	10.51	11.51	48.22	48.22	41.30	42.55
N <sub>2</sub>	09.51	09.64	55.04	56.86	46.80	47.14
N <sub>3</sub>	08.59	08.39	62.05	64.10	49.85	50.39
N <sub>4</sub>	08.50	08.02	66.35	68.21	52.18	52.96
C. D. at 5%	0.14	0.18	0.14	0.13	0.13	0.13
<b>Phosphorus</b>						
P <sub>0</sub>	10.09	10.65	53.12	54.06	44.60	45.32
P <sub>1</sub>	9.97	10.53	53.58	54.55	45.00	45.64
P <sub>2</sub>	9.85	10.32	54.11	55.16	45.36	46.05
C. D. at 5%	0.14	0.15	0.08	0.07	0.08	0.07
<b>Potassium</b>						
K <sub>0</sub>	10.02	10.57	53.44	54.41	44.87	45.57
K <sub>1</sub>	9.97	10.50	53.60	54.59	44.98	45.65
K <sub>2</sub>	9.93	10.43	53.76	54.78	45.11	45.79
C. D. at 5%	NS	NS	0.09	0.09	0.10	0.09

phosphorus and potassium. The favourable effect of nitrogen, phosphorus and potassium in promoting leaf number and length might be due to an increased uptake of these elements being constituent of protein, component of protoplasm and chlorophyll. All these factors contributed to cell multiplication, cell

enlargement and cell differentiation resulting in increased photosynthesis and translocation. These findings are in consonance with Achal *et al.* (1984), Bankar and Mukhopadhyay (1985 and 1990), Yadav *et al.* (1985), Mukhopadhyay and Bankar (1986) and Gowda *et al.* (1991).

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## STUDY OF STERILITY AND FERTILITY REACTIONS IN HYBRIDS OF SUNFLOWER (*HELIANTHUS ANNUUS* L.)

S. R. KHURANA and NISHCHINT BHATIA

Department of Plant Breeding

CCS Haryana Agricultural University, Hisar - 125 004

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### ABSTRACT

None of the hybrids could produce complete fertile plants, the maximum being 63.3 per cent. Most of the hybrids were either having low or very low number of fertile plants and thus showed maintainer behaviour of the population and their S<sub>1</sub> progenies. The progeny EC 68415-S<sub>3</sub> could give the fertile plants (75%) in all the CMS lines. The EC 68415-S<sub>4</sub> progeny could be inbred further followed by selection which can give new restorer lines. S<sub>1</sub> progenies showing superior performance in crosses (Morden S<sub>3</sub>, S<sub>4</sub> and S<sub>1</sub>) and EC 68415-S<sub>4</sub> and EC 68415-S<sub>2</sub> could be selfed and directly be used as maintainers.

On the basis of their maintainer-restorer behaviour, it was inferred that two completely sterile crosses, viz. CMS 7-1A × EC 68415-S<sub>2</sub>, and CMS 234A × Morden-S<sub>1</sub> possessing high yield and oil content can be converted to early maturing CMS line through repeated back crossing.

Oilseeds, the second most important group of agricultural commodities in the country, also play a predominant role in Haryana's agriculture and occupy an area of 3.6 million hectares. Of these, sunflower alone occupies 35% area under oilseeds. Since this crop has made a dent in past few years, the extent to which increase in area and production of this crop in coming years is possible, depends upon the market availability of good quality hybrid seeds at a reasonable price. Various breeding approaches in hybrid seed production and technology are underway. Previous studies indicate that high seed yield is chiefly attributed

to per cent seed filled per head, test weight and head diameter (Perumal and Chidambaram, 1989). Present investigation was taken up to explore the possibility of finding out good maintainers and restorers based on sterility and fertility reactions in hybrid combinations.

### MATERIAL AND METHODS

Four cytoplasmic male sterile lines, viz. CMS 234A, CMS 207A, CMS 7-1A and CMS 300A genetic were crossed to 12 testers (2 bulk populations + 10 S<sub>1</sub> progenies) in line × tester fashion to obtain 48 hybrid combinations. In 1992-93,

the 48 hybrids along with 16 parents and two check hybrids AFSM-II and MFSM-8 were grown in randomised block design with three replicates in rows 3 m long, 60 cm apart with plant spacing of 30 cm. Each entry with two rows was grown in continuous block. Prior to flowering five plants, selected randomly in each cross, were tagged to record observations on sterility-fertility. The number of seeds set/head in each of the three replications for each of 48 crosses was recorded at harvest, averaged to compute mean values per head.

## RESULTS AND DISCUSSION

The data on sterility/fertility reactions are presented in Table 1. Out of the 48 hybrids tested, 21 hybrids were found to be completely sterile and the rest 27 showed 1.56 to 63.33% fertility. Only five hybrids showed more than 50% fertility. The number of fertile hybrids and the fertility percentage in parents from EC 68415 population compared to Morden progenies were found to be higher. Except  $S_3$  progeny of Morden population, the remaining progenies of this population and that of EC 68415- $S_4$  may be singled out as pollinators giving sterile hybrids and hopefully these may prove potential maintainers.

Majority of the hybrids differed in number of fertile plants, One progeny EC 68415- $S_6$  produced more than 50% fertile plants. This inbred could further be bred to next

generations followed by single plant selection and crossing with CMS lines so that the possibility of developing a new restorer is explored. Vranceanu and Stoenescu (1971) and Virupakashappa *et al.* (1991) also studied maintainer restorer behaviour in some lines of sunflower.

Crosses with low per cent of fertile plants (less than 20%) were not considered worthwhile. The  $S_1$  progenies of Morden and  $S_3$ ,  $S_4$  and  $S_1$  of EC 68415- $S_4$ , which exhibited superior performance in cross combinations were found completely sterile and exhibited complete maintainer type of reactions. These progenies could directly be used as maintainers and selfed simultaneously or used in a repeated back cross programme for their conversion to a new CMS line.

The  $S_1$  progeny of Morden  $S_3$ ,  $S_4$ ,  $S_3$  and EC 68415- $S_4$  produced hybrids which were completely male sterile. Through repeated back crossing the male sterility character may be transferred to agronomically superior inbred lines to develop new male sterile lines.

Most of the hybrids were either sterile or partially fertile. EC 68415- $S_6$  and EC 68415- $S_1$  restored fertility to a greater extent in all the four male CMS lines of this study. New restorer lines may be developed through inbreeding and selection among these lines. On the other hand, Morden  $S_3$  and EC 68415- $S_4$

STERILITY AND FERTILITY REACTIONS IN SUNFLOWER HYBRIDS

TABLE 1  
Sterility/fertility reaction observed in the crosses in sunflower

Hybrid	Fertile plants	Sterile plants	Total plants	Per cent of fertile plants
CMS 234A × EC 68415 (Bulk)	6	60	66	9.09
" × " (S <sub>1</sub> )	27	37	64	42.18
" × " (S <sub>2</sub> )	4	59	63	6.33
" × " (S <sub>3</sub> )	6	57	63	9.52
" × " (S <sub>4</sub> )	0	64	64	0.00
" × " (S <sub>5</sub> )	38	22	60	63.33
" × Morden (Bulk)	2	45	47	4.25
" × " (S <sub>1</sub> )	0	46	46	0.00
" × " (S <sub>2</sub> )	11	41	52	21.15
" × " (S <sub>3</sub> )	0	50	50	0.00
" × " (S <sub>4</sub> )	0	57	57	0.00
" × " (S <sub>5</sub> )	1	57	58	1.72
CMS 300A × EC 68415 (Bulk)	13	48	61	21.31
" × " (S <sub>1</sub> )	32	23	55	58.18
" × " (S <sub>2</sub> )	1	53	54	1.85
" × " (S <sub>3</sub> )	4	54	58	6.89
" × " (S <sub>4</sub> )	0	56	56	0.00
" × " (S <sub>5</sub> )	39	25	64	60.93
" × Morden (Bulk)	1	57	58	1.72
" × " (S <sub>1</sub> )	0	56	56	0.00
" × " (S <sub>2</sub> )	6	56	62	10.71
" × " (S <sub>3</sub> )	0	60	60	0.00
" × " (S <sub>4</sub> )	0	63	63	0.00
" × " (S <sub>5</sub> )	1	63	64	1.56
CMS 7-1A × EC 68415 (Bulk)	1	47	48	2.88
" × " (S <sub>1</sub> )	18	26	44	40.90
" × " (S <sub>2</sub> )	0	60	60	0.00
" × " (S <sub>3</sub> )	2	59	61	3.27
" × " (S <sub>4</sub> )	0	59	59	0.00
" × " (S <sub>5</sub> )	36	26	62	55.38
" × Morden (Bulk)	0	47	47	0.00
" × " (S <sub>1</sub> )	0	61	61	0.00
" × " (S <sub>2</sub> )	2	58	60	3.33
" × " (S <sub>3</sub> )	0	57	57	0.00
" × " (S <sub>4</sub> )	0	65	65	0.00
" × " (S <sub>5</sub> )	0	64	64	0.00
CMS 207A × EC 68415 (Bulk)	5	56	61	8.19
" × " (S <sub>1</sub> )	21	39	60	35.00
" × " (S <sub>2</sub> )	0	56	56	0.00
" × " (S <sub>3</sub> )	14	46	60	23.33
" × " (S <sub>4</sub> )	1	61	62	1.61
" × " (S <sub>5</sub> )	40	25	65	61.53
" × Morden (Bulk)	0	62	62	0.00
" × " (S <sub>1</sub> )	0	63	63	0.00
" × " (S <sub>2</sub> )	10	54	64	15.62
" × " (S <sub>3</sub> )	0	66	66	0.00
" × " (S <sub>4</sub> )	0	64	64	0.00
" × " (S <sub>5</sub> )	0	63	63	0.00

produced agronomically good hybrids which were found completely sterile (Table 2). Therefore, these lines may be explored for drawing new male sterile lines.

Among CMS lines CMS 7-1A was adjudged to be the best for seed yield and component traits (Table 3). The hybrids derived from this parent

were also observed to be promising for oil content. Highest oil yield per plant was noticed in crosses with Morden-S<sub>3</sub> and EC 68415-S<sub>1</sub>. These lines were good general combiners and were involved in highest yielding hybrids. Hence, these two parents can be further used for developing hybrids in various combinations.

TABLE 2

Mean performance of agronomically good hybrids of sunflower

Hybrid	Seed yield/plant (g)	Oil content (%)
CMS 234A × EC 68415 S <sub>4</sub>	32.15	29.87
CMS 300A × EC 68415 S <sub>4</sub>	50.86	40.80
CMS 7-1A × EC 68415 S <sub>4</sub>	49.25	35.57
CMS 207A × EC 68415 S <sub>4</sub>	20.36	32.97
CMS 234A × Morden S <sub>3</sub>	39.69	33.40
CMS 300A × Morden S <sub>3</sub>	45.89	39.93
CMS 7-1A × Morden S <sub>3</sub>	46.83	38.57
CMS 207A × Morden S <sub>3</sub>	38.13	37.90

TABLE 3

Performance of some promising sunflower hybrids with CMS 7-1A as the female parent for seed yield components and oil content

Hybrid	Head diameter (cm)	Mean seed filling (g)	1000-seed wt. (g)	Seed yield (g)	Oil content (%)
CMS 7-1A × EC 68415 (Bulk)	24.50	70.67	7.05	37.38	35.07
CMS 7-1A × EC 68415 (S <sub>1</sub> )	21.33	85.47	5.82	40.85	40.27
CMS 7-1A × EC 68415 (S <sub>2</sub> )	24.83	91.40	6.78	56.89	31.80
CMS 7-1A × EC 68415 (S <sub>3</sub> )	23.50	87.80	6.06	47.20	34.10
CMS 7-1A × EC 68415 (S <sub>4</sub> )	26.33	86.53	5.88	49.25	35.57
CMS 7-1A × EC 68415 (S <sub>5</sub> )	17.33	69.40	4.15	18.17	35.70
CMS 7-1A × Morden (Bulk)	21.67	91.20	6.74	55.82	36.70
CMS 7-1A × Morden (S <sub>1</sub> )	21.83	89.00	7.36	43.29	37.00
CMS 7-1A × Morden (S <sub>2</sub> )	23.17	93.01	5.17	45.09	37.90
CMS 7-1A × Morden (S <sub>3</sub> )	23.50	88.73	6.66	46.83	38.57
CMS 7-1A × Morden (S <sub>4</sub> )	17.67	72.87	5.53	24.65	35.67
CMS 7-1A × Morden (S <sub>5</sub> )	21.00	61.40	4.97	19.97	34.23

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## EFFECT OF ISOPROTURON AND ITS COMBINATION WITH TRALKOXYDIM ON CONTROL OF WEEDS IN WHEAT

R. S. PANWAR, R. K. MALIK and S. S. RATHI

Department of Agronomy

CCS Haryana Agricultural University, Hisar - 125 004.

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### ABSTRACT

Field studies were conducted to evaluate isoproturon alone or in combination with tralkoxydim for control of weeds in wheat. Tralkoxydim at 0.3 kg/ha or diclofopmethyl at 1.0 kg/ha was effective against grass weeds but not against broad leaf weeds. Isoproturon at 0.375 kg/ha + tralkoxydim at 0.200 kg/ha proved effective against grassy and broad leaf weeds and produced comparable wheat yields to that of weed free conditions.

Wild canary grass (*Phalaris minor* Retz.) and wild oat (*Avena ludoviciana* Durieu) are major grass weeds in wheat in north-west India. Broad leaf weeds like common lamb-quarter (*Chenopodium album* L.) and yellow sweet clover (*Melilotus indica* L.) also occur in association with grassy weeds. Isoproturon has been found to control wild canary grass and few broad leaf weeds (Walia and Gill, 1985) in wheat crop. Diclofopmethyl and tralkoxydim are reported for the successful control of wild oat (Rola, 1987; Sutton *et al.*, 1987). Isoproturon is less effective against wild oat when applied at or after six leaf stage (Gupta *et al.*, 1990). The combination of isoproturon and tralkoxydim may increase the spectrum of weed kill. In the present investigation, an attempt has been made to test the efficacy of isoproturon applied alone and in combination with tralkoxydim on mixed weed flora in wheat.

### MATERIAL AND METHODS

Field experiment was conducted during winter season in 1991 and 1992 at CCS Haryana Agricultural University, Hisar. During both the years, the experiment was conducted on a sandy loam soil with pH 8.4 and organic matter content 0.4 per cent. Fifteen treatments comprising isoproturon, chlortoluron, diclofopmethyl, tralkoxydim, mixture of isoproturon with tralkoxydim or fluroxypyr, weedy and weed free control (Table 1) were replicated thrice in a randomized block design. Wheat cv. WH-157 was sown at a seed rate of 125 kg/ha in rows 22.5 cm apart on 17 and 20 November in 1991 and 1992, respectively. The gross and net plot sizes were 6.0 m x 2.7 m and 5.0 m x 2.25 m, respectively. The field was infested with natural population of grassy and broad leaf weeds. All the herbicides were applied 30 days after

sowing (DAS) with knapsack sprayer using 650 litres water/ha. Fertilizers, irrigation and other cultural practices were applied in accordance with standard local practices. Visual score of percent weed control was done at 120 DAS on the basis of 0-100 scale (where 0 = no control and 100 = complete control). Weed population (no./m<sup>2</sup>) and dry weight of total weeds (g/m<sup>2</sup>) were recorded 60 and 90 DAS with the help of 0.25 m<sup>2</sup> random quadrat from two places in each plot. Number of effective tillers per metre row length and grain yield of wheat were recorded at crop harvest.

## RESULTS AND DISCUSSION

### Effect on Weeds

Weed flora of the experimental field comprised common lambs-quarter (*Chenopodium album*), wild canary grass (*Phalaris minor*), wild oat (*Avena ludoviciana*) and yellow sweet clover (*Melilotus indica*) in that order. Population of common lambsquarter and yellow sweet clover at 60 DAS following the application of diclofopmethyl and tralkoxydim was similar to weedy check. Isoproturon and chlortoluron each applied alone effectively controlled these two weeds. Combination of isoproturon at 0.125, 0.250, 0.375 and 0.500 kg/ha with tralkoxydim at 0.1 or 0.2 kg/ha significantly reduced the population of both the weeds at 60 DAS (Table 1). The response was similar during both the years. The effect of tralkoxy-

dim + fluroxypyr at 0.3 + 0.2 kg/ha on the population of common lambs-quarter was less than the combination treatments of isoproturon + tralkoxydim. However, the effect of this combination was similar on the population of yellow sweet clover when compared with the combination treatment of isoproturon + tralkoxydim. Diclofopmethyl at 1.0 kg/ha or tralkoxydim at 0.3 kg/ha significantly reduced the population of wild oat and wild canary grass as compared to the weedy check (Table 1). The effect of chlortoluron (1.0 kg/ha) on the population of wild oat at 60 DAS was less than diclofopmethyl, tralkoxydim or isoproturon (Table 1). The population of wild oat at 60 DAS during 1991 and 1992 following the treatments of isoproturon + tralkoxydim at 0.375 + 0.100, 0.500 + 0.100 or 0.375 + 0.200, 0.500 + 0.200 kg/ha and tralkoxydim + fluroxypyr 0.300 + 0.200 kg/ha was similar to isoproturon, diclofopmethyl or tralkoxydim each applied alone (Table 1). Minimum population of total weeds at 60 DAS during both the years was recorded in plots treated with isoproturon + tralkoxydim at 0.5 + 0.2 kg/ha (Table 2). The per cent control recorded at 120 DAS showed that diclofopmethyl or tralkoxydim did not control common lambsquarter (Table 2). The combination of isoproturon and tralkoxydim at higher doses was effective in controlling all the four weeds during both the years (Tables 1 and 2). The effect of combination treatments was also reflected in the dry weight of total

CONTROL OF WEEDS IN WHEAT

**TABLE 1**  
**Influence of isoproturon and its combination with tralkoxydim on population of different weeds**

Treatments	Rate (kg/ha)	Weed population <sub>1</sub> (no./m <sup>2</sup> ) 60 DAS							
		Common lambs- quarter		Yellow sweet clover		Wild oat		Wild canary grass	
		1991	1992	1991	1992	1991	1992	1991	1992
Isoproturon	1.0	1.0(0)*	1.4(1)	1.4(1)	1.4(1)	3.6(12)	3.0(8)	2.5(5)	2.5(5)
Chlortoluron	1.0	1.0(0)	1.7(2)	1.4(1)	2.6(6)	4.7(22)	4.5(20)	3.0(9)	3.4(11)
Diclofopmethyl	1.0	4.9(23)	5.0(25)	4.1(16)	4.0(15)	3.3(10)	3.4(12)	3.1(9)	3.3(10)
Tralkoxydim	0.3	4.7(21)	5.0(26)	4.1(16)	3.6(13)	2.5(5)	2.9(7)	2.6(6)	2.9(8)
Isoproturon + Tralkoxydim	0.125 + 0.1	3.6(12)	3.8(15)	3.6(13)	3.4(12)	5.1(25)	5.3(27)	4.2(18)	3.4(11)
Isoproturon + Tralkoxydim	0.250 + 0.1	2.2(4)	2.3(6)	2.0(3)	2.7(5)	4.0(17)	5.0(24)	3.5(11)	3.3(10)
Isoproturon + Tralkoxydim	0.375 + 0.1	1.4(1)	1.7(2)	1.6(2)	2.0(4)	3.5(11)	4.0(15)	3.1(19)	3.0(9)
Isoproturon + Tralkoxydim	0.500 + 0.1	1.0(0)	1.4(1)	1.4(1)	1.4(1)	2.53(7)	3.4(11)	2.4(5)	2.8(7)
Isoproturon + Tralkoxydim	0.125 + 0.2	3.3(12)	3.0(9)	2.6(6)	2.7(7)	4.5(20)	4.8(23)	3.7(14)	2.7(7)
Isoproturon + Tralkoxydim	0.250 + 0.2	2.4(5)	2.6(6)	1.5(1)	1.8(3)	3.3(11)	3.5(13)	3.3(11)	2.5(5)
Isoproturon + Tralkoxydim	0.375 + 0.2	1.4(1)	2.0(4)	1.0(0)	1.4(1)	3.1(10)	3.3(11)	2.8(7)	2.1(4)
Isoproturon + Tralkoxydim	0.500 + 0.2	1.0(0)	1.4(1)	1.0(0)	1.0(0)	2.5(5)	2.3(4)	2.8(7)	2.0(4)
Tralkoxydim + Fluroxypyr	0.300 + 0.2	3.9(15)	2.6(13)	1.7(3)	2.0(3)	2.8(7)	2.8(9)	2.4(5)	1.4(1)
Weedy check		5.1(25)	5.2(25)	4.6(21)	4.0(15)	6.5(41)	6.8(45)	7.3(53)	5.5(32)
Weed free check		1.0(0)	1.0(0)	1.0(0)	1.0(0)	1.0(0)	1.0(0)	1.0(0)	1.0(0)
C. D. at 5%		0.8		1.4	1.5	1.8	1.6	1.7	1.8

DAS= Days after sowing.

Actual weed counts are in parentheses, transformed to  $\sqrt{n+1}$ .

**TABLE 2**  
**Influence of isoproturon and its combination with tralkoxydim on control of different weeds and total weed population**

Treatments	Rate (kg/ha)	Per cent control (120 DAS)						Total weed population (no./m <sup>2</sup> ) 60 DAS	
		Wild oat		Wild canary grass		Common lambquarter		1991	1992
		1991	1992	1991	1992	1991	1992	1991	1992
Isoproturon	1.0	54.7	46.9	66.1	68.8	66.1	71.5	4.4(19)	5.6(24)
Chlorotoluron	1.0	41.1	37.1	56.9	57.2	66.6	61.0	5.7(32)	7.8(61)
Diclofopmethyl	1.0	58.9	73.3	68.1	65.6	0.0	0.0	7.7(59)	7.6(57)
Tralkoxydim	0.3	66.6	75.2	66.1	66.1	0.0	0.0	7.5(56)	7.9(63)
Isoproturon + Tralkoxydim	0.125 + 0.1	56.2	49.0	60.2	56.9	62.4	66.1	6.7(47)	8.2(67)
Isoproturon + Tralkoxydim	0.250 + 0.1	56.7	50.7	61.2	56.9	66.1	71.5	5.8(33)	7.4(53)
Isoproturon + Tralkoxydim	0.375 + 0.1	56.7	50.7	66.1	58.9	66.4	71.5	5.1(25)	5.8(36)
Isoproturon + Tralkoxydim	0.500 + 0.1	61.2	53.7	66.1	63.9	66.6	71.5	4.4(19)	5.7(31)
Isoproturon + Tralkoxydim	0.125 + 0.2	54.7	60.4	61.2	61.2	66.6	68.8	5.4(28)	7.0(49)
Isoproturon + Tralkoxydim	0.250 + 0.2	58.9	60.7	66.6	71.5	67.4	71.5	4.9(25)	6.7(44)
Isoproturon + Tralkoxydim	0.375 + 0.2	60.2	63.5	66.6	71.5	67.4	71.5	4.3(19)	4.4(19)
Isoproturon + Tralkoxydim	0.500 + 0.2	63.4	70.1	68.8	71.5	68.0	71.5	3.6(12)	3.5(14)
Tralkoxydim + Fluroxypyr	0.300 + 0.2	66.6	82.7	67.4	54.9	55.0	55.6	5.6(32)	6.5(43)
Weedy check		0.0	0.0	0.0	0.0	0.0	0.0	19.0(361)	14.5(211)
Weed free check		90.0	90.0	90.0	90.0	90.0	90.0	1.0(0)	1.0(0)
C. D. at 5%		8.7	11.9	7.7	10.3	9.2	9.5	3.6	2.3

Actual per cent control data are transformed to arcsin.

**TABLE 3**  
**Influence of isoproturon and its combination with tralkoxydim on the total dry weight of weeds and grain yield of wheat**

Treatments	Rate (kg/ha)	Total dry weight (g/m <sup>2</sup> )				Grain yield (kg/ha)		Pooled grain yield (kg/ha)
		60 DAS		90 DAS		1991	1992	
		1991	1992	1991	1992	1991	1992	
Isoproturon	1.0	17.2	18.4	39.7	29.8	3952	3868	3910
Chlortoluron	1.0	18.8	11.3	47.6	35.0	3507	3446	3476
Diclofopmethyl	1.0	26.2	28.6	43.2	31.0	3604	3588	3596
Tralkoxydim	0.3	28.1	22.3	47.4	27.8	3730	3695	3712
Isoproturon + Tralkoxydim	0.125 + 0.1	14.5	11.4	65.2	50.0	3631	3177	3404
Isoproturon + Tralkoxydim	0.250 + 0.1	8.6	10.1	55.3	47.3	3680	3413	3546
Isoproturon + Tralkoxydim	0.375 + 0.1	7.7	9.3	47.4	38.7	3730	3681	3705
Isoproturon + Tralkoxydim	0.500 + 0.1	5.3	6.9	33.5	28.1	3977	4137	4057
Isoproturon + Tralkoxydim	0.125 + 0.2	10.6	9.5	42.9	43.3	3754	3237	3496
Isoproturon + Tralkoxydim	0.250 + 0.2	8.2	8.5	36.3	43.1	4076	3764	3920
Isoproturon + Tralkoxydim	0.375 + 0.2	5.7	6.1	28.8	26.3	4100	3972	4036
Isoproturon + Tralkoxydim	0.500 + 0.2	4.7	1.6	18.0	20.3	4347	4230	4288
Tralkoxydim + Fluroxypyr	0.300 + 0.2	8.3	7.5	29.7	27.4	4051	3808	3929
Weedy check		170.7	119.3	268.9	264.3	1210	1509	1359
Weed free check		0.0	0.0	0.0	0.0	4421	4537	4479
C. D. at 5%		8.5	6.8	37.1	29.6	630	816	726

weeds recorded at 60 and 90 DAS (Table 3). Isoproturon + tralkoxydim at 0.5 + 0.1 or 0.2 kg/ha can be effectively used for the control of annual broad leaf weeds like common lambsquarter and yellow sweet clover and grassy weeds like wild canary grass and wild oat.

### Effect on Crop

On an average of two years, unweeded situation caused a reduction by 70% in grain yield as compared to weed free conditions (Table 3). Isoproturon + tralkoxydim at 0.5 + 0.2 kg/ha significantly increased the average grain yield of wheat compared to weedy check.

Combination of isoproturon at 0.375 kg/ha and 0.500 kg/ha with tralkoxydim at 0.1 or 0.2 kg/ha caused a significant increase in grain yield of wheat as compared to weedy check and were at par with the weed free check (Table 3). Similarly, combination of tralkoxydim at 0.3 kg/ha + fluroxypyr at 0.2 kg/ha also increased the grain yield to the level of weed free check. Similar results were reported earlier by Panwar *et al.* (1989). It is evident from this study that diclofopmethyl, tralkoxydim or isoproturon can be effectively used against grassy weeds but in case of mixed weed infestation, combination of isoproturon and tralkoxydim may prove useful.

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## CORRELATION STUDIES OF YIELD, YIELD CONTRIBUTING AND QUALITATIVE CHARACTERISTICS OF SEGREGATING AND STABLE MATERIALS OF COTTON

SHARAD BHATNAGAR  
Directorate of Extension Education  
CCS Haryana Agricultural University, Hisar—125 004

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### ABSTRACT

A comprehensive and comparative study of correlation between quantitative and qualitative characters of segregating materials H-777 × Del. Cot (F<sub>2</sub>), H-777 × Texas-1 (F<sub>2</sub>), HS-168 × BR-181 (F<sub>2</sub>) and stable strain HS-6 and variety H-777 has been done. The effect of other characters on yield has also been studied. The cross H-777 × Del. Cot (F<sub>2</sub>) had better correlation for seeds per boll with yield, number of open bolls per plant, boll weight and seed index, whereas the other cross H-777 × Texas-1 (F<sub>2</sub>) had shown better association of boll weight with yield, seed index, ginning percentage and lint index. The third cross HS-168 × BR-181 (F<sub>2</sub>) had slightly higher correlation between seed index and lint index. The strain HS-6 had better relationship for yield with number of open bolls per plant, seed index and lint index; number of open bolls per plant with ginning percentage and lint index; and seed index with ginning percentage and lint index. The variety H-777 had shown higher association of yield with ginning percentage; number of open bolls per plant with boll weight and ginning percentage; and seeds per boll with ginning percentage and lint index. The yield was affected by all the other quantitative and qualitative characters also.

The knowledge of degree of association between yield, yield contributing and quality characters of any material plays an important role for further improvement and comparison with other materials. Jagtap and Kolhe (1986), Kumar and Chaudhary (1986), Sandhu *et al.* (1986), Giri and Nankar (1989), and Chiman-shette *et al.* (1990, 1992) have undertaken correlation studies on cotton. This paper presents the study of correlation between yield, number

of open bolls per plant, boll weight, seeds per boll, seed index, ginning percentage and lint index, and regression study of yield on other characters of segregating and stable materials of cotton plant.

### METHODOLOGY

The experiment was conducted during kharif at Cotton Research Station, Sirsa (Haryana). The data on yield, yield contributing and

quality characters of 100 plants each were recorded from segregating materials H-777  $\times$  Del. Cot ( $F_2$ ), H-777  $\times$  Texas-1 ( $F_2$ ) and HS-168  $\times$  BR-181 ( $F_2$ ), and stable materials HS-6 (strain) and H-777 (variety). Ten samples each based on the average of 10 plants, were taken to record the data of each character. The correlation between different characters was calculated and studied. The character yield has direct association with other characters, so the regression equation of yield with other characters had also been fitted. The procedure followed and calculations done were as described by Snedecor and Cochran (1967).

## RESULTS AND DISCUSSION

The average performance and variability of quantitative and qualitative characters of segregating and stable materials of cotton plant are depicted in Table 1. The strain HS-6 has shown maximum yield per plant (46.01 g), number of open bolls per plant (17.20) and ginning percentage (34.28) on account of 38.46, 39.74 and 1.99 per cent of variation, respectively. The cross HS-168  $\times$  BR-181 ( $F_2$ ) has given maximum boll weight (3.24 g), seed index (8.45) and lint index (4.31) at the cost of 8.53, 3.68 and 5.12 per cent of variation, respectively. The cross H-777  $\times$  Del. Cot ( $F_2$ ) had maximum number of seeds per boll (24.18) at 5.59 per cent of variation.

Data in Table 2 present the correlation between different charac-

ters. Firstly, the correlation of yield with number of open bolls per plant, boll weight, seeds per boll, seed index, ginning percentage and lint index has been discussed. The coefficient of correlation ranged from 0.032 to 0.987 and from  $-0.268$  to 0.990 for segregating and stable materials, respectively. The association of yield with number of open bolls per plant was found highly significant and positive for both the materials. The cross H-777  $\times$  Texas-1 ( $F_2$ ) and variety H-777 had positive and significant correlation between yield and boll weight. Yield also had positive and significant association with seeds per boll for the cross H-777  $\times$  Del. Cot ( $F_2$ ) and variety H-777. It had negative association with seed index for variety H-777. The strain HS-6 had better association for yield with number of open bolls per plant, seed index and lint index, whereas the crosses H-777  $\times$  Texas-1 ( $F_2$ ), H-777  $\times$  Del. Cot ( $F_2$ ) and variety H-777 had better correlation for yield with boll weight, seeds per boll and ginning percentage, respectively.

The number of open bolls per plant had significant and positive correlation with seeds per boll for the cross H-777  $\times$  Del. Cot ( $F_2$ ) and variety H-777, and with seed index for strain HS-6, whereas it had negative association with seed index for the cross HS-168  $\times$  BR-181 ( $F_2$ ) and variety H-777. The degree of association of number of open bolls per plant with other characters was not found significant. Its value varied from  $-0.016$  to 0.744 for segregat-

## CORRELATION STUDIES IN COTTON

**TABLE 1**  
**Average performance and variability of different characters of segregating and stable materials of cotton**

Material	Character	Mean	Coefficient of variation (%)
H-777 × Del. Cot (F <sub>2</sub> )	Yield per plant (g)	35.89	52.26
H-777 × Texas-1 (F <sub>2</sub> )		35.01	27.57
HS-168 × BR-181 (F <sub>2</sub> )		31.60	22.53
HS-6 (Strain)		46.01	38.46
H-777 (Variety)		38.28	19.61
HS-777 × Del. Cot (F <sub>2</sub> )	Number of open bolls per plant	15.31	57.62
H-777 × Texas-1 (F <sub>2</sub> )		14.28	24.62
HS-168 × BR-181 (F <sub>2</sub> )		10.02	23.72
HS-6 (Strain)		17.20	39.74
H-777 (Variety)		16.42	17.53
H-777 × Del. Cot (F <sub>2</sub> )	Boll weight (g)	2.56	7.24
H-777 × Texas-1 (F <sub>2</sub> )		2.59	7.50
HS-168 × BR-181 (F <sub>2</sub> )		3.24	8.53
HS-6 (Strain)		2.85	6.78
H-777 (Variety)		2.55	2.55
H-777 × Del. Cot (F <sub>2</sub> )	Seeds per boll	24.18	5.59
H-777 × Texas-1 (F <sub>2</sub> )		21.01	4.60
HS-168 × BR-181 (F <sub>2</sub> )		21.40	9.00
HS-6 (Strain)		22.30	5.70
H-777 (Variety)		22.46	7.25
H-777 × Del. Cot (F <sub>2</sub> )	Seed index	7.00	7.15
H-777 × Texas-1 (F <sub>2</sub> )		7.84	4.32
HS-168 × BR-181 (F <sub>2</sub> )		8.45	3.68
HS-6 (Strain)		8.00	5.11
H-777 (Variety)		7.15	2.10
H-777 × Del. Cot (F <sub>2</sub> )	Ginning percentage	32.93	1.60
H-777 × Texas-1 (F <sub>2</sub> )		33.16	2.43
HS-168 × BR-181 (F <sub>2</sub> )		33.76	1.37
HS-6 (Strain)		34.28	1.99
H-777 (Variety)		31.96	1.09
H-777 × Del. Cot (F <sub>2</sub> )	Lint index	3.44	7.66
H-777 × Texas-1 (F <sub>2</sub> )		3.89	5.60
HS-168 × BR-181 (F <sub>2</sub> )		4.31	5.12
HS-6 (Strain)		4.18	7.06
H-777 (Variety)		3.36	2.36

TABLE 2

Correlation between different characters of segregating and stable materials of cotton

Material	Character	Number of open bolls per plant	Boll weight	Seeds per boll	Seed index	Ginning percentage	Lint index
H-777 × Del. Cot (F <sub>2</sub> )	Yield per plant	0.987**	0.576	0.744*	0.237	0.095	0.257
H-777 × Texas-I (F <sub>2</sub> )		0.958**	0.672*	0.271	0.384	0.185	0.414
HS-168 × BR-181 (F <sub>2</sub> )		0.979**	0.398	0.517	0.032	0.071	0.047
HS-6 (Strain)		0.990**	0.141	0.368	0.558	0.015	0.423
H-777 (Variety)		0.972**	0.652*	0.681*	-0.268	0.518	0.111
H-777 × Del. Cot (F <sub>2</sub> )	Number of open bolls per plant		0.533	0.744*	0.157	0.031	0.161
H-777 × Texas-I (F <sub>2</sub> )			0.476	0.101	0.228	0.214	0.314
HS-168 × BR-181 (F <sub>2</sub> )			0.422	0.510	-0.016	0.094	0.023
HS-6 (Strain)			0.127	0.297	0.646*	0.088	0.520
H-777 (Variety)			0.742	0.711*	-0.270	0.537	0.128
H-777 × Del. Cot (F <sub>2</sub> )	Boll weight			0.828**	0.648*	0.143	0.655*
H-777 × Texas-I (F <sub>2</sub> )				0.527	0.689*	0.213	0.666*
HS-168 × BR-181 (F <sub>2</sub> )				0.742*	0.418	0.071	0.326
HS-6 (Strain)				0.667*	0.055	-0.162	-0.032
HS-777 (Variety)				0.636*	-0.053	0.181	0.091
H-777 × Del. Cot (F <sub>2</sub> )	Seeds per boll				0.404	-0.160	0.332
H-777 × Texas-I (F <sub>2</sub> )					0.031	0.138	0.117
HS-168 × BR-181 (F <sub>2</sub> )					0.106	-0.308	-0.048
HS-6 (Strain)					-0.219	-0.436	-0.346
H-777 (Variety)					0.042	0.746*	0.530
H-777 × Del. Cot (F <sub>2</sub> )	Seed index					0.051	0.947**
H-777 × Texas-I (F <sub>2</sub> )						0.004	0.762*
HS-168 × BR-181 (F <sub>2</sub> )						0.603	0.948**
HS-6 (Strain)						0.444	0.929**
HS-777 (Variety)						-0.194	0.755*
H-777 × Del. Cot (F <sub>2</sub> )	Ginning percentage						0.367
H-777 × Texas-I (F <sub>2</sub> )							0.650*
HS-168 × BR-181 (F <sub>2</sub> )							0.825**
HS-6 (Strain)							0.743*
H-777 (Variety)							0.496

ing and  $-0.270$  to  $0.742$  for stable materials. The character under study had good association with boll weight and ginning percentage for variety H-777, whereas it had highest correlation with seed index and lint index for the strain HS-6, and with seeds per boll for the cross H-777  $\times$  Del. Cot ( $F_2$ ).

Relationship of the character boll weight with seeds per boll was highly significant and positive for the cross H-777  $\times$  Del. Cot ( $F_2$ ), whereas it was significant and positive for cross HS-168  $\times$  BR-181 ( $F_2$ ), strain HS-6 and variety H-777. For the crosses H-777  $\times$  Del. Cot ( $F_2$ ) and H-777  $\times$  Texas-I ( $F_2$ ), it had significant positive correlation with seed index and lint index. But it has shown negative correlation with seed index for H-777, and with ginning percentage and lint index for strain HS-6. The coefficient of correlation varied from  $0.071$  to  $0.828$  and from  $-0.032$  to  $0.667$  for segregating and stable materials, respectively. The cross H-777  $\times$  Del. Cot ( $F_2$ ) had better association between boll weight and seeds per boll, whereas it had good association with seed index, ginning percentage and lint index for the cross H-777  $\times$  Texas-I ( $F_2$ ).

The character seeds per boll had significant and positive correlation only with ginning percentage for variety H-777. It was negatively correlated with all the characters for HS-6, with ginning percentage and lint index for the cross HS-168  $\times$

BR-181 ( $F_2$ ), and with ginning percentage for the cross H-777  $\times$  Del. Cot ( $F_2$ ). The coefficient of correlation varied from  $-0.048$  to  $0.404$  for segregating and from  $-0.219$  to  $0.746$  for stable materials. The variety H-777 had better association for seeds per boll with ginning percentage and lint index, whereas it had good association with seed index for the cross H-777  $\times$  Del. Cot ( $F_2$ ).

Relationship of seed index with lint index was found positive and highly significant or significant, whereas it had negative correlation with ginning percentage for variety H-777. Its value varied from  $0.004$  to  $0.948$  for segregating and from  $-0.194$  to  $0.929$  for stable materials. The strain HS-6 had good relationship for seed index with ginning percentage and lint index.

Ginning percentage had positive and highly significant correlation with lint index for the cross HS-168  $\times$  BR-181 ( $F_2$ ). It also had significant and positive association for the cross H-777  $\times$  Texas-I ( $F_2$ ) and strain HS-6. The value ranged from  $0.367$  to  $0.825$  and  $0.496$  to  $0.743$  for segregating and stable materials, respectively.

The data in Table 3 reveal the regression of yield with other characters. It had highly significant and positive regression with number of open bolls per plant for both the materials. The strain HS-6 showed 97.93% effect of number of open bolls per plant on yield. Regression

TABLE 3

Regression of yield on other characters in segregating and stable materials of cotton

Material	Character	Regression equation $Y=a+bx$		Coefficient determination $R^2$ (%)
		a	b	
H-777 × Del. Cot (F <sub>2</sub> )	Number of open bolls per plant	3.753	2.099**	97.49
H-777 × Texas-1 (F <sub>2</sub> )		-2.544	2.630**	91.78
HS-168 × BR-181 (F <sub>2</sub> )		2.217	2.933**	95.86
HS-6 (Strain)		1.948	2.562**	97.93
H-777 (Variety)		-3.332	2.534**	94.47
H-777 × Del. Cot (F <sub>2</sub> )	Boll weight	-113.359	58.324*	33.17
H-777 × Texas-1 (F <sub>2</sub> )		-51.460	33.412*	45.20
HS-168 × BR-181 (F <sub>2</sub> )		-1.610	10.251	15.83
HS-6 (Strain)		9.290	12.867	1.98
H-777 (Variety)		-153.731	75.299*	42.46
H-777 × Del. Cot (F <sub>2</sub> )	Seeds per boll	-213.783	10.327**	55.34
H-777 × Texas-1 (F <sub>2</sub> )		-21.853	2.707	7.36
HS-168 × BR-181 (F <sub>2</sub> )		-9.261	1.910	26.70
HS-6 (Strain)		68.157	5.120	13.55
H-777 (Variety)		-32.190	3.137*	46.37
H-777 × Del. Cot (F <sub>2</sub> )	Seed index	-26.315	8.887	5.62
H-777 × Texas-1 (F <sub>2</sub> )		-50.756	10.935	14.76
HS-168 × BR-181 (F <sub>2</sub> )		25.479	0.724	0.10
HS-6 (Strain)		-147.062	24.150*	31.15
H-777 (Variety)		134.340	-13.435	7.19
H-777 × Del. Cot (F <sub>2</sub> )	Ginning percentage	-75.276	3.376	0.90
H-777 × Texas-1 (F <sub>2</sub> )		-38.312	2.211	3.41
HS-168 × BR-181 (F <sub>2</sub> )		-5.626	1.103	0.51
HS-6 (Strain)		32.641	0.390	0.02
H-777 (Variety)		-319.527	11.195	26.83
H-777 × Del. Cot (F <sub>2</sub> )	Lint index	-27.064	18.312	6.62
H-777 × Texas-1 (F <sub>2</sub> )		-36.313	18.325	17.09
HS-168 × BR-181 (F <sub>2</sub> )		25.006	1.531	0.22
HS-6 (Strain)		-60.079	25.405	17.93
H-777 (Variety)		2.944	10.520	1.24

a—Intercept,

b—Regression coefficient.

of yield with boll weight had come out positively significant for the cross H-777 × Del. Cot ( $F_2$ ), H-777 × Texas-1 ( $F_2$ ) and variety H-777. The cross H-777 × Texas-1 ( $F_2$ ) explained 45.20% of variation in yield which was due to boll weight. The cross H-777 × Del. Cot ( $F_2$ ) and variety H-777 had given highly significant and significant positive regression of yield with seeds per boll, respectively. Seeds per boll had 55.34% effect on yield

for the cross H-777 × Del. Cot ( $F_2$ ). The regression of yield with seed index was found significant and positive for strain HS-6 which showed that 31.15% yield was affected by seed index. Regarding relation of yield with ginning percentage and lint index, it had not given significant regression. The yield was affected 26.83 and 17.93 per cent by ginning percentage and lint index for variety H-777 and strain HS-6, respectively.

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## TREND AND VARIABILITY IN AGRICULTURAL PRODUCTION IN HARYANA STATE

V. P. MEHTA, A. C. GANGWAR and S. K. MEHTA\*

Department of Agricultural Economics

CCS Haryana Agricultural University, Hisar - 125 004

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### ABSTRACT

In the present study, an attempt has been made to estimate the trend and variability in area, production and productivity of principal crops grown in Haryana for the period 1960-61 to 1992-93. In the time series analysis, trend was removed from the data before instability was measured. The results indicated that yield variability of bajra was highest (33%) followed by gram (21.69%), jowar (17.80%) and rapeseed and mustard (14.50%). Wheat crop had the least yield variability (4.63%) followed by sugarcane (5.20%), barley (9.72%), cotton desi (10.10%), maize (10.52%), cotton (American) (10.81%) and rice (12.30%). Production variability was highest in gram (32.72%) followed by bajra (27.16%), cotton (American) (26.54%), barley (24.80%), maize (21.31%), jowar (20.29%) and sugarcane (16.01%): The lowest production variability was observed in wheat (9.72%) followed by rice (11.8%). The basic difficulty in achieving the desired results is still infested in the non-availability of inputs at the right time and place, infra-structural imperfections, low managerial skills, credit squeeze, price policy and highly dependence on weather conditions: An analysis on the basis of variability, keeping in view the secular trend of the important crops in Haryana reveals that different policy frames are to be prepared for yield and area components of the total production in the state.

The role of agricultural sector in the early stages of economic development is well recognized. The performance of agricultural sector is primarily determined by the generation and sustenance of growth in production. The agricultural sector being unstable in nature may substantially impede the economic growth of the country in two ways. Firstly, the production instability tends to be transmitted to the

markets and may cause wide fluctuations in prices of agricultural produce. The poorer section, spending higher proportion of income on food, is adversely affected. Secondly, the fluctuations in prices caused by production instability would render the already used inputs misallocated because the expected prices on the basis of which the farmers have allocated the resources among various crops, may not turn out to

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\*Department of Extension Education.

be correct. This inefficiency in production certainly would hamper the economic growth of the country.

It has been debated frequently that the new technology has brought out significant changes in instability in crop production. The green revolution has failed to raise the overall rate of growth of agricultural output in the country above the level achieved during 15 years prior to 1965 (Dantwala, 1979). No matter how the period of new technology is counted, the growth rate of yield appears to be higher than that in the period upto 1964-65. However, it has also resulted in increased yield variability. This raises the question whether there is a casual relationship between growth and variability of agricultural output.

The existence of this link was first hypothesised by Sen (1967) in the early post-independence period when growth was largely based on area expansion and subsequently discussed by Hanumantha Rao (1975) in the context of growth based on productivity in the 1960's. Whereas Sen's explanation was largely based on the hypothesis that variability increased as cultivation was extended to marginal lands, Hanumantha Rao took the line that since variability in yield per hectare tends to be far greater than that of area, productivity based fluctuations have largely contributed to variability in output. This raises an important question about the source of variability of output. In view of

these facts and adverse effect of instability, an intensive examination of instability becomes necessary. Also it is needed for policy evaluation and guidance.

Considering that variety of crops are grown in highly diverse conditions in the different parts of the State and the spread of modern technology is quite uneven from one crop to another, an attempt has been made to study the trend and variability in area, production and productivity of principal crops in Haryana state.

#### METHODOLOGY

The study was limited to rice, jowar, bajra, maize, wheat, barley, gram, rapeseed and mustard, cotton (American and desi) and sugarcane crops. These crops together accounted for about 86% of total cropped area of the State in 1992-93. The study is based on secondary data for the period 1960-61 to 1992-93. Time series data on area, yield and production for the crops under study were collected from Statistical Abstracts of Haryana.

For working out the trend in area, production and productivity of the crops, linear, semi-log, square root, quadratic and Cobb-Douglas equations were tried. The linear equation was finally selected on the basis of best fit.

Several measures of variation such as percentage change, average percentage change, moving average,

Coppok index, and the coefficient of variation have been used in the literature on variability (Coppok, 1962; Knudsen and Parnes, 1975). Time series data contain trend and it adds to variability when measured around mean. Thus, trend was removed from the data to measure instability simply on the ground that trend was predictable, therefore, did not constitute instability. It was, thus, necessary to remove such trends but this is fairly subjective process. However, here 3-year, 5-year and 7-year moving average methods were tried and finally 3-year trend was observed in the data. The coefficient of variation was worked out for the crops under study after the elimination of trend from the original data.

## RESULTS AND DISCUSSION

### Trend in Area, Production and Productivity

The data in Table 1 indicate that there has been significant increase in area, production and productivity of rice crop. The reason for this increase may be attributed to the availability of good quality seeds of high yielding varieties, increased availability of irrigation water, use of higher doses of fertilizers and increase in relative profitability of the crop. For jowar, which is the main kharif fodder crop, the regression coefficient shows significant decline in area and production. It is because with the expansion of irrigation facilities the area from

jowar has been replaced by rice and cotton crops. However, the regression coefficient of yield has been positive and significant and, thereby, indicating improvement in yield.

Though the  $R^2$  values for bajra and maize crops are very low and estimates have little reliability, the trend values of these crops have been discussed to have a general view of these crops. In case of bajra, the regression coefficients of area and production are non-significant, thereby indicating stagnation in area and production of this crop. However, yield of bajra has increased significantly due to the adoption of hybrid seeds. The trend analysis of maize shows that area and production of the crop have declined significantly. The plausible reasons for ever declining trend in maize acreage and stagnation in yield level may be replacement of maize by rice crop with increased availability of irrigation water.

Wheat is one of the most important crops grown in all the districts of State under irrigated conditions. The regression coefficients of area, production and productivity show significant increase during the period under study. It has been possible because of introduction of high yielding wheat varieties and expansion of irrigation facilities in the State. In barley, the regression coefficient of yield in respect of time is significant thereby indicating improvement in the yield over the years. The regression

TABLE 1

Trend in area, production and productivity of principal crops in Haryana state

Crop	Area			Production			Productivity		
	Intercept	B value	R <sup>2</sup>	Intercept	B value	R <sup>2</sup>	Intercept	B value	R <sup>2</sup>
Rice	.80.23	18.14** (1.01)	0.92	82.43	56.92** (4.02)	0.88	1181.38	54.67** (9.00)	0.59
Jowar	297.94	-7.14** (0.34)	0.87	51.47	-0.77** (3.96)	0.27	167.61	3.33* (1.35)	0.29
Bajra	806.40	1.31 (2.40)	0.41	316.58	6.73 (3.96)	0.32	367.95	8.90* (3.85)	0.37
Maize	129.91	-2.37** (0.47)	0.49	147.97	-3.02** (0.87)	0.32	1004.70	4.16 (3.95)	0.14
Wheat	493.39	50.11** (1.86)	0.96	101.75	170.81** (8.80)	0.93	1085.04	61.73** (4.71)	0.87
Barley	147.87	-1.91 (0.81)	0.47	140.01	0.18 (1.42)	0.20	816.39	27.01** (4.21)	0.62
Total cereals	1970.69	57.49** (3.21)	0.92	675.36	230.86** (11.48)	0.94	—	—	—
Gram	1333.02	-25.96** (4.78)	0.54	943.46	-20.15** (6.77)	0.26	711.79	-3.30 (4.97)	0.21
Total pulses	1412.06	-25.98** (4.93)	0.52	970.52	-19.34** (6.89)	0.23	—	—	—
Total foodgrains	3381.93	31.38** (6.45)	0.48	1645.30	211.54** (15.74)	0.87	—	—	—
Rapeseed and mustard	144.82	3.15 (1.63)	0.33	56.70	4.08** (1.28)	0.28	443.63	10.76** (2.91)	0.35
Total oilseeds	157.91	3.17 (1.64)	0.33	65.69	4.32** (1.35)	0.28	—	—	—
Cotton (American)	28.13	8.53** (0.79)	0.82	2.35	21.77** (1.91)	0.83	237.23	6.60** (1.16)	0.56
Cotton (desi)	75.85	1.63* (0.66)	0.20	116.05	2.59* (1.17)	0.26	231.94	1.64 (1.04)	0.29
Sugarcane (gur)	148.21	-0.35 (0.59)	0.31	533.14	5.61 (3.18)	0.21	3725.90	26.56* (12.56)	0.25

\*, \*\*Significant at 5 and 1 per cent levels of probability, respectively.

Figures in parentheses are standard errors of respective regression co-efficients.

TABLE 2

Coefficient of variation after elimination of trend in area, production and productivity of principal crops in Haryana state (1960-61 to 1992-93)

Crop	(per cent)		
	Area	Production	Productivity
Rice	6.53	11.87	12.30
Jowar	7.23	20.29	17.80
Bajra	3.87	27.16	22.33
Maize	7.59	23.21	10.52
Wheat	2.66	9.72	4.63
Barley	19.93	24.80	9.72
Total cereals	2.63	6.93	—
Gram	16.00	33.12	21.69
Total pulses	15.34	33.86	—
Total foodgrains	5.79	9.76	—
Rapeseed and mustard	20.23	25.72	14.50
Total oilseeds	18.98	21.97	—
Cotton (American)	8.17	26.54	10.81
Cotton (desi)	8.97	9.94	10.10
Sugarcane (gur)	13.73	16.01	5.90

coefficient of total cereals shows significant increase in area and production.

In gram, which is the main pulse crop of the State, however, the regression coefficients show significant decline in area and production of the crop. It has been due to the absence of high yielding and disease resistant varieties of gram. The crop is also more susceptible to change in weather and climatic conditions. It is a matter of great concern in view of our nutritional requirements and increased demand for gram. So, there is need for appropriate government

policies which may lay emphasis on increasing area under gram crop. Similar have been the results in case of total pulses.

Rapeseed and mustard, which are the main oilseed crops of the State, the regression coefficients show significant increase in production and productivity of the crop. This may be on account of continuous favourable price situation of oilseeds and adoption of high yielding varieties of rapeseed and mustard. Cotton (American), which is one of the most important cash crops of the State, there has been significant increase in area, yield and production

of the crop. It has been due to the combined result of adoption of hybrid varieties of cotton and expansion of irrigation network in the State. Although there has been significant increase in production of cotton (desi) as indicated by regression coefficient (2.59), yet there has not been much improvement in the yield of desi cotton. This may be on account of significant trend observed for acreage. Sugarcane, which is another commercial crop of the State, there has not been much increase in the production as the regression coefficient of area showed decline.

### Variability

Rapeseed and mustard showed the highest area variability in Haryana state. The least area variability has been observed in case of wheat because this crop is grown under assured supply of irrigation water. The main reason for low acreage variability in bajra has been due to its importance in the cropping pattern of dry land farmers. It is also the crop which contributes maximum to the total cereals for human food and fodder for animals in the dry areas of Haryana.

The yield variability in bajra was highest (22.33%) followed by gram (21.69%), jowar (17.80%) and rapeseed and mustard (14.50%). It is because bajra, gram and rapeseed and mustard are rainfed crops and are also more susceptible to attack of insects, pests and diseases. Wheat

crop has the least yield variability, i. e. 4.63% and is followed by sugarcane (5.90%), barley (9.72%), cotton (desi) (10.10%), maize (10.52%), cotton (American) (10.81%), and rice (12.30%). The variability in production was found more in comparison to the area and yield of principal crops except in case of rice where production variability was less as compared to yield variability. Production variability has been highest in case of gram (33.12%) followed by bajra (27.16%), cotton (American) (26.54%), rapeseed and mustard (25.72%), barley (24.80%), maize (21.31%), jowar (20.29%) and sugarcane (16.01%). On the other hand, lowest production variability was observed in case of total cereals (6.93%) being followed by wheat (9.72%), total foodgrains (9.76%), cotton desi (9.94%) and rice (11.87%). The lowest variability observed for rice and wheat may be on account of these crops being grown under irrigated conditions. On the basis of above findings it can be concluded that irrigation has led to stability in production of rice, wheat and cotton (desi) in Haryana state. Higher variability in production in case of cotton (American) is observed because this crop is more prone to the various insect-pests and diseases.

### CONCLUSIONS AND POLICY IMPLICATIONS

The estimated coefficient of variation after elimination of trend

depicted that production of total cereals, wheat, total foodgrains, cotton (desi) and rice was more stable, whereas variability in production was higher in total pulses, gram, **bajra**, rapeseed and mustard, and barley in the State. Regarding yield variability, it was higher in **bajra** gram, **jowar**, and rapeseed and mustard and lower in wheat, sugarcane, barley, cotton (desi), cotton (American) and rice. As regards the area variability, it was lower in total cereals, wheat, **bajra**, total foodgrains, and rice, and higher in rapeseed and mustard, gram and total pulses in the State. Area and yield variability has to be stabilized in order to reduce the production variability. Thus, policies directed towards minimizing the area variability such as suitable price policy should be strengthened in rapeseed

and mustard, gram and sugarcane. Yield stabilization policies would be more effective in reducing the production variability in cereals, pulses and oilseeds through extension and efficient management of irrigation, assured supply of inputs (like irrigation, fertilizers, electricity, credit, etc.), use of plant protection measures and development of infrastructural facilities. This can be helpful in reducing the yield variability and hence production variability. Comparatively higher production instability in coarse cereals, pulses and oilseeds needs special attention. For this appropriate technology for problematic soils, where these crops are grown, has to be evolved. Assessing the relative strength of these variables balanced crop production can be a fruitful area for further research.

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## RESEARCH NOTE

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### INFLUENCE OF FORMULATED AND TANK MIXTURES OF ISOPROTURON AND 2, 4-D ON WEED CONTROL IN WHEAT

R. S. PANWAR, R. S. MALIK, S. S. RATHI and R. K. MALIK  
Department of Agronomy  
CCS Haryana Agricultural University, Hisar - 125 004

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Wheat is one of the most important cereal crops of North India. With the increased use of fertilizers and irrigation, weed problems have increased in the high yielding semi-dwarf wheat varieties.

A field experiment was conducted during the winter seasons of 1991-92 and 1992-93 at Agronomy Research Farm. The soil of the experimental field was sandy loam, low in N, medium in P and high in K having, organic matter of 0.4 per cent. The treatments (Table 1) were replicated thrice in a randomized block design. Wheat variety WH-283 was sown on 30 and 27 November in 1991 and 1992, respectively and herbicides were applied 20 DAS before the first irrigation. The density and dry weight of weeds were recorded 90 DAS with a random quadrat of 0.5 m × 0.5 m. Fertilizers, irrigation and other cultural practices were applied in accordance with local package of practices.

The experimental field was infested with grassy and annual broad leaf weeds. Pre-dominant weed was *Chenopodium album* L. Weed popu-

lation and dry weight of total weeds were significantly reduced by different weed control treatments compared to weedy check. The minimum weed population and dry weight of weeds were recorded in isoproturon (WP)+2, 4-D treatment applied at 1.0 + 0.5 kg/ha. The effect on weeds increased with the increase in the concentration of formulated and tank mixture of isoproturon (flowable and WP)+2, 4-D. Similar results were reported by Panwar *et al.* (1990). The lowest dry matter of weeds showed the highest weed control efficiency. It was 88.7% in 1991 and 85.6% in 1992, where the tank mixture of isoproturon (WP)+2, 4-D was applied (Table 1). Among the weed control treatments, significantly highest population and dry weight of weeds were observed in plots treated with 2, 4-D. There was no significant difference in population and dry weight of weeds among isoproturon applied alone at 0.75 or 1.00 kg/ha, however, these were significantly lower than weedy check treatment.

All the weed control treatments increased the grain yield of wheat

TABLE 1

Influence of formulated and tank mixture of isoproturon and 2, 4-D on the total weed density, total weed dry weight, effective tillers, grain yield of wheat and weed control efficiency

Treatment	Dose (kg/ha)	Total weed density (no./m <sup>2</sup> ) 90 DAS		Total weed dry weight (g/m <sup>2</sup> ) 90 DAS		Effective tillers (m. r. l.)		Grain yield of wheat (kg/ha)		Weed control efficiency (%)	
		1991	1992	1991	1992	1991	1992	1991	1992	1991	1992
<b>Formulated mixture</b>											
Isoproturon + 2, 4-D	0.500+0.125	2.8 (6)*	3.5 (13)	14.5	20.7	85.7	75.7	5278	4237	80.5	74.8
Isoproturon + 2, 4-D	0.625+0.156	2.4 (5)	2.6 (6)	10.0	15.3	88.3	80.0	5486	4585	86.6	81.4
<b>Tank mixture</b>											
Isoproturon (F) + 2, 4-D	0.750+0.250	2.4 (6)	3.1 (10)	15.7	21.0	87.0	76.0	5301	4237	78.9	74.5
Isoproturon (F) + 2, 4-D	0.750+0.500	1.9 (4)	2.5 (5)	10.4	14.3	88.0	78.0	5547	4446	86.1	82.6
Isoproturon (F) + 2, 4-D	1.000+0.250	2.3 (5)	2.4 (5)	14.3	17.5	88.7	73.3	5454	4376	80.1	78.0
Isoproturon (F) + 2, 4-D	1.000+0.500	1.9 (3)	1.8 (3)	9.3	13.0	90.0	80.3	5741	4550	87.5	84.2
Isoproturon (WP) + 2, 4-D	0.750+0.250	2.6 (7)	2.7 (7)	15.0	18.7	90.0	76.7	5454	4307	79.9	77.3
Isoproturon (WP) + 2, 4-D	0.750+0.500	2.2 (5)	2.1 (3)	10.0	12.8	91.3	79.3	5667	4654	86.6	84.4
Isoproturon (WP) + 2, 4-D	1.000+0.250	2.1 (4)	2.4 (5)	13.2	15.7	90.3	79.0	5593	4550	82.3	80.9
Isoproturon (WP) + 2, 4-D	1.000+0.500	1.8 (3)	2.0 (3)	8.5	11.8	92.0	82.7	5852	4758	88.7	85.6
Isoproturon	0.750	2.3 (5)	2.8 (7)	16.8	19.7	90.7	75.7	5482	4376	77.5	76.1
Isoproturon	1.000	1.8 (3)	2.5 (5)	12.0	16.0	92.7	79.3	5815	4584	83.9	80.5
2, 4-D	0.500	3.7 (13)	4.1 (16)	33.6	38.3	82.3	73.3	5111	4203	55.0	53.5
Weedy check		7.6 (58)	8.6 (73)	74.6	82.3	73.7	53.3	3468	2918	0.0	0.0
Weed free check		1.0 (0)	1.0 (0)	0.0	0.0	96.3	87.3	6047	5106	100.0	100.0
C. D. at 5%		1.9	1.2	12.6	8.8	6.8	5.9	912	656	7.1	6.9

\*Actual weed counts are in parentheses, transformed to  $\sqrt{x+1}$ .

DAS = Days after sowing, F = Flawable, WP = Wettable powder.

m, f, l = metre row length.

## CHEMICAL WEED CONTROL IN WHEAT

significantly over weedy check. Tank mixture of isoproturon (flowable or WP)+2, 4-D or their formulated mixture resulted in significantly higher grain yield of wheat over weedy check but did not differ significantly with other control treatments except 2, 4-D. The increase in grain yield of wheat with the application of herbicides was due to effective control of weeds and higher number of effective tillers. Isoproturon alone at 0.75 or 1.00 kg/ha and 2, 4-D at 0.5

kg/ha were also effective in increasing the grain yield of wheat. Sharma *et al.* (1987) also reported similar findings. Therefore, it was concluded that in the presence of wild canary grass and annual broad leaf weeds, formulated or tank mixture of isoproturon (flowable or WP) and 2, 4-D at 0.750+0.250 kg/ha or formulated mixture of isoproturon 0.625+2, 4-D at 0.150 kg/ha can be successfully used.

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## RESEARCH NOTE

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### GERMPLASM EVALUATION FOR DIFFERENT FODDER TRAITS IN FORAGE SORGHUM (*SORGHUM BICOLOR* L.)

P. S. SABHARWAL, S. K. PAHUJA and G. P. LODHI  
Department of Plant Breeding  
CCS Haryana Agricultural University, Hisar - 125 004

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Information on the nature and magnitude of genetic variability is of immense value for starting any systematic breeding programme in crops (Simmond, 1962), because the presence of considerable genetic variability in the base material ensures better chances of evolving desired plant types. The present study was undertaken to assess the genetic variability for various agronomic traits in the germplasm of sorghum (*Sorghum bicolor* L.) collected from various sources as this kind of information is meagre in sorghum. Such an information will be useful in categorization and identification of suitable genetic stocks for their exploitation in developing improved cultivars.

Fifty-five strains of forage sorghum alongwith three checks, viz. SSG 59-3, SSG 988 and HC 136 were grown in the farm during kharif season of 1994 in an augmented design having five blocks, each having 11 entries. Each entry had two rows of four metre length spaced 45 cm with spacing of 15 cm between the plants. After every 10 rows of strains checks were planted

to constitute one block. Data were recorded on five competitive plants selected at random from each strain including checks, for plant height (cm), leaf length (cm), leaf breadth (cm), tillers per plant, leaves per plant, leaf weight per plant (g), stem weight per plant (g), total fresh weight per plant (g), dry weight per plant (g) and stem borer incidence. Mean and range of variation for each character were worked out and the germplasm lines were categorized for different characters.

Considerable variation with respect to various traits was observed in the genotypes of sorghum germplasm (Table 1). The range of variation for days to 50% flowering was from 62 (IS 71683) to 106 days (IS 3203). The range for important characters like plant height, leaf length, leaf breadth, leaves per plant, tillers per plant, leaf weight per plant and stem weight per plant was from 98.67 (IS 71694) to 262.33 cm (IS 2384), 53.33 (IS 3214) to 99.33 cm (S 508), 3.27 (G 73) to 10.03 cm (IS 3275), 14 (S 508) to 63.33 (G 46), 1 (S 508) to 6.67 (IS 71687), 80.00 (S 508) to 473.33 g (S 505) and

TABLE 1

Mean and range of variation for different fodder traits in sorghum

Character	Mean value		Range of variation		No. of strains below/above checks for various traits		
	Checks*	Genetic stock	Minimum	Maximum	Below	At par	Above
Days to 50% flowering	88.00	89.91	62.00 (IS 71683)	106.00 (IS 3203)	6	1	48
Plant height (cm)	193.44	179.07	98.67 (IS 71694)	262.33 (IS 2384)	33	6	16
Leaf length (cm)	78.89	78.05	53.33 (IS 3214)	99.33 (S 508)	23	8	24
Leaf breadth (cm)	3.30	6.23	3.27 (G 73)	10.03 (IS 3275)	1	5	49
Leaves/plant**	45.30	37.45	14.00 (S 508)	63.33 (G 46)	35	9	11
Tillers/plant	5.11	3.21	1.00 (S 508)	6.67 (IS 71687)	50	3	2
Leaf weight/plant (g)	111.00	192.33	80.00 (S 508)	473.33 (S 505)	9	5	41
Stem weight/plant (g)	402.33	674.55	226.66 (IS 3213)	1033.33 (P 57)	7	5	43
Total fresh weight/plant (g)	513.33	866.27	113.33 (IS 3214)	1466.67 (P 57)	8	3	44
Dry weight/plant (g)	85.00	43.63	43.33 (IS 3213)	278.33 (S 505)	14	4	37

\*Mean value of three checks, viz. SSG 59-3, SSG 988 and HC 136.

\*\*Sum of the leaves of all the tillers.

226.66 (IS 3213) to 1033.33 g (P 57), respectively. Green fodder yield per plant varied from 113.33 (IS 3214) to 1466.67 g (P 57), whereas range of variation for dry matter yield per plant was from 43.33 (IS 3213) to 278.33 g (S 505). It is obvious that range of variation for dry matter yield per plant was more. The wide range of variation also existed for other fodder yield components in the

present germplasm stock as has also been reported by Lodhi and Grewal (1988) and Patil *et al.* (1993).

The germplasm lines were classified based on tillering/non-tillering type, leafiness and dry matter yield (Table 2). The strains with yellow, brown and green midrib colour in leaves were found sweet, whereas the lines having white midrib in leaf were non-sweet. Only two strains,

TABLE 2

Classification of sorghum germplasm based on some important characters

Character	Group	Number	Name of strains falling in each group
Tillering	Non-tillering type (one tiller only)	2	S 508, IS 70742-1.
	Tillering type (more than two tillers/plant)	53	IS 3072, 3213, 3236, 3238, 3240, 3214, 3275, 14314, 6018, 3353, 3237, 5717, 71697, 3274, 70759, 31130, 71683, 5431, 3225, 71664, 3268, 71701, 70744-2, 71687, 71702, 3192, 71694, 3203, 3289, 70764, 19280-1, 2384, 3374, 70743, 3266. G 1, G 20, R 123.  S 505, S 507, R 565, R 152, R 1925, R 71, G 48, G 76, G 73, G 46, P 57, R 472, R 516, S 509, S 510.
Leafiness	More leafy (more than 30 leaves/plant)	39	IS 3072, 3213, 3236, 3238, 3240, 3214, 3275, 14314, 6018, 3353, 3237, 5717, 71697, 3274, 70759, 31130, 71683, 5431, 3225, 71664, 3268, 71701, 70744-2, 71687, 71702, 3192, 71694.  S 505, S 507, R 565, R 152, R 1925, R 71, G 48, G 76, G 73, G 46, P 57, R 472.
	Less leafy (less than 30 leaves/plant)	16	IS 3203, 3289, 70794, 70742-1, 19280-1, 2384, 3374, 70743, 3266.  S 509, S 510, S 508, R 516, R 123, G 1, G 20.
Dry matter yield	Low yielder (upto 100 g/plant)	27	IS 3213, 3266, 71687, 71683, 70742-1, 5431, 71664, 3225, 71697, 3240, 3353, 3072, 3203, 3289, 3238, 5717, 19280-1, 3274, 71702, 71694, 3192, 3214.  S 508, G 20, R 71, R 123, R 565.
	Medium yielder (100- 200 g/plant)	20	IS 3374, 71701, 70743, 3236, 14314, 70744-2, 3275, 6018, 3237, 70746, 70759, 31130.  S 507, S 509, S 510, G 73, G 48, G 1, R 516, R 1925.
	High yielder (more than 200 g/plant)	8	IS 2384, 3268, P 57, R 472, R 152, S 505, G 46, G 76.

viz. S 508 and IS 70742 were found non-tillering type in the present genetic stock. Rest of the genotypes were tillering type as confirmed after uprooting three plants selected at random from each strain.

Some of the lines, viz. S 507, S 505, P 57, G 46, IS 3192, IS 3240, IS 3238, IS 71694, IS 71687 and IS 71664 were very leafy (more than 50 leaves per plant) with leaf length more than 70 cm and leaf

breadth 3.9-8.7 cm. These were high tillering also (tillers per plant ranged from 4-6). Some of the strains, viz. IS 3374, G 73 and G 76 were found almost free from diseases and insect pests. Hence, these lines may be a good source of resistance. On the basis of dry matter yield per plant the whole germplasm stock was grouped into three categories. Some of the strains, viz. IS 2384, IS 3268, P 57, R 472, R 152, S 505, G 76 and G 46 were

high yielding and had dry matter yield more than 200 g per plant.

From the above it is obvious that sufficient variability for various forage characters exists and there are many promising lines for important agronomic and yield traits. Such lines can be utilized in hybridization programme for breeding high dry matter yielding and good quality sorghum genotypes suitable for single and multicut programme.

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## OCCUPATIONAL PATTERN OF SCHEDULED CASTE RURAL WOMEN

ASHA RANI and SAROJ KASHYAP

Department of Home Science Extension Education  
CCS Haryana Agricultural University, Hisar - 125 004

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### ABSTRACT

The study was carried out on 200 scheduled caste rural women of Hisar district to know their occupational pattern. The results reveal that majority of the scheduled caste rural women was illiterate and hence few women were involved in service and were performing low paid laborious jobs which resulted in their social, economic and cultural backwardness. These women were doing jobs because of economic necessity. Maximum (54.55%) number of women was working as agricultural labourers and could not have self-employment. Even now scheduled caste women are not allowed to perform some domestic jobs. Because of some social taboo, marketability of some of the food products (pappad, etc.) prepared by these scheduled caste women is a problem.

Indian women as an economically productive human resource, have justified their existence by gradually sharing more and more responsibilities to contribute towards home as well as country's wealth and prosperity. Majority of the rural women among scheduled caste household remains engaged in multiple activities, *viz.* labour service, field work, animal care, self-employment, house servant, collection of fuel and fodder, and also as a housewife. More than 52% of scheduled castes/scheduled tribes in rural areas possess no land or property while another 35% own less than five acres of land (NSSO, 1988). However, the work force participation rate among the SC/STs women is much higher compared to women from other castes and there is evidence of higher incidence of

casual labour amongst the scheduled caste women. These women are placed at the lowest ladder in rural society and are among that segment of society which has lowest employment rate.

Thus, a need was felt to generate data on the general employment pattern and the reasons behind joining the job among the scheduled caste rural women.

### METHODOLOGY

The study was conducted in Hisar district of Haryana state. Two blocks Block-I and Block-II were randomly selected and out of these two blocks, two villages, *viz.* Gangwa and Muklan were selected. For the identification of various

occupations in which scheduled caste rural women were involved, 200 women were interviewed. The pre-testing of the scheduled caste women revealed five major occupations which the women were performing in rural areas. These were : service, labour, self-employed, house servant and housewife. Each of these five occupations was further sub-divided into different categories, *i. e.* service category was sub-divided into 19 categories, labour in 3, self-employed in 12, house servant in 6 and housewife in 4 categories. The total score in each cell was worked out and the percentage was calculated.

## RESULTS AND DISCUSSION

### Identification of Various Occupations of Scheduled Caste Rural Women

The study revealed that most of the women (43.0%) were housewives (domestic, animal and farming work) followed by labour (27.5%), service and self-employed (11.0% each) and house servant (7.5%) (Table 1). The respondents revealed that their husbands did not encourage them for joining jobs outside their home. The low percentage of women working as house servant is a common phenomenon in rural areas. This may be because of several reasons such as (i) women prefer to work as labourer than servant, (ii) people belonging to higher caste do not keep servant from lower caste, and (iii) the wages of a servant are lower than that of a labourer.

### *Service category*

The data within service category (Table 1) reveal that 18.2% rural women were sweepers and mid-wives followed by teachers, Anganwadi workers and Anganwadi helpers (13.6% each). The study also reveals that the scheduled caste rural women were involved in eight occupations, *i. e.* teacher, peon, beldar, Anganwadi helper, Anganwadi worker, Anganwadi supervisor, sweeper and mid-wife. This can be due to the fact that rural women are not educated and are victims of ignorance, suppression, economic backwardness and negative attitude of parents towards girls' education. They are mainly involved in low paid laborious jobs. The study of Trivedi (1976) also supports the present findings that out of total population of India, the illiteracy among women is 65.5% and for scheduled caste women, it is 90.0 per cent. It was also reported that on account of literacy, most of scheduled caste women continued to do some type of low paid laborious occupations.

### *Labour category*

The study revealed that more scheduled caste women were working as agricultural labours (54.55%) than construction (33.36%) or industrial labours (9.09%) (Table 1). The results obtained in the study are in agreement with earlier results (Azad *et al.*, 1985; Sisodia, 1985) that per household family labour participation was higher in agricul-

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TABLE 1

Identification of various occupations of scheduled caste rural women

S. No.	Occupations	Raw score	Percentage in the whole sample (n=200)	Percentage within category
1	2	3	4	5
<b>I.</b>	<b>Service</b>			
	Lecturer/Professor	—	—	—
	Teacher	3	1.5	13.64
	Doctor	—	—	—
	Nurse	—	—	—
	Bank employee	—	—	—
	Post office employee	—	—	—
	Clerk	—	—	—
	Steno-typist	—	—	—
	Attendant	—	—	—
	Peon	2	1.0	9.09
	Foster mother	—	—	—
	Cook	—	—	—
	Beldar	2	1.0	9.09
	Police	—	—	—
	Anganwadi supervisor	1	0.5	4.54
	Anganwadi worker	3	1.5	13.64
	Anganwadi helper	3	1.5	13.64
	Sweeper	4	2.0	18.18
	Mid-wife	4	2.0	18.18
	<b>Total</b>	<b>n=22</b>	<b>11.0</b>	<b>100.00</b>
<b>II.</b>	<b>Labour</b>			
	Agricultural labour	30	15.00	54.55
	Building construction labour	20	10.00	36.36
	Industrial labour	5	2.5	9.09
	<b>Total</b>	<b>n=55</b>	<b>27.5</b>	<b>100.00</b>
<b>III.</b>	<b>Self-employed</b>			
	Tailoring	8	4.0	36.36
	Embroidery work	4	2.0	18.18
	Vadi/pappad making	2	1.0	9.09
	Waste paper collection	—	—	—
	Agarbati making	—	—	—
	Retail trading	—	—	—
	Envelope making	—	—	—
	Broom making	3	1.5	13.64
	Canning	—	—	—
	Dari making	5	2.5	22.73
	Cretch	—	—	—
	Beautician	—	—	—
	<b>Total</b>	<b>n=22</b>	<b>11.0</b>	<b>100.00</b>

1	2	3	4	5
IV.	<b>House-servant</b>			
	Animal related work	6	3.0	40.00
	Dish and cloth washing+sweeping and mopping	5	2.5	33.33
	Dish washing	2	1.0	13.33
	Cloth washing	2	1.0	13.33
	Child attendant	—	—	—
	Total	n=15	7.5	99.99
V.	<b>Housewife</b>			
	Domestic work	20	10.0	23.26
	Domestic and animal work	40	20.0	46.51
	Domestic work and farming	11	5.5	12.79
	Domestic and animal work+farming	15	7.5	17.44
	Total	n=86	43.0	100.00

ture for scheduled caste females. Mohan Ramaiah (1989) also stated that while there are more cultivators among others, there are more agricultural labours among scheduled castes and scheduled tribes both in 1971 and 1991 census among both males and females.

#### *Self-employed category*

The data in Table 1 reveal that within this category 36.36% women were involved in tailoring, followed by dari making (22.73%), embroidery work (18.1%), broom making (13.64%) and vadi/pappad making (9.09%).

The study indicated that maximum number of women was engaged in tailoring. Similar results were also reported by Yadav (1993). Low percentage of women was involved in vadi/pappad making. It can be due to the fact that women from higher castes do not buy vadi/pappad made by women belonging to lower caste.

#### *House servant*

The data in Table 1 reveal that within this category maximum number (40.0%) of house servants was involved in animal related work followed by dish and cloth washing plus sweeping and mopping (33.33%), and dish washing and cloth washing (each 13.13%).

Maximum number of house servants was doing animal related work and less percentage worked as cloth washer or dish washer. This was because being scheduled caste women, higher caste people did not prefer them to do cloth washing or dish washing and were preferred to do animal related work.

#### *Housewife*

The data in Table 1 show that within this category maximum number of women (46.51%) was involved in domestic work as well as animal related work followed by domestic work (23.26%), domestic work as

well as animal related work and farming (17.44%) and domestic work as well as farming (12.79%).

Scheduled caste women were engaged only in five occupations. However, a shift from these activities is evident because of less incentives, non-availability of raw material, problem of selling the product and lack of credit facilities.

### **Reasons for Illiteracy as Reported by Rural Women**

The reasons for illiteracy as reported by rural women have been presented in Table 2. The main reason for their illiteracy was backwardness, followed by field work, looking after the siblings, parents not in favour of education, girls involved in contributing towards family income, no school in the village, school at distance, and household and family responsibilities.

### **Reasons for Joining the Job by Rural Women**

The data in Table 3 indicate that in rural areas the respondents had mainly joined the job to get money for basic support, to raise economic status, and better facilities for children (rank I), need for achievement and recognition (rank II), self-sufficiency (rank III), inadequacy of husband's income (rank IV), increase in self-esteem (rank V), escape from unhappy atmosphere at home (rank VI) and repayment of loans (rank VII).

The study reveals that economic necessity was the main reason for joining the job by rural women. Similar results have been reported by Shah (1959) and Ramanamma and Bambawale (1984).

Earlier studies (Oza, 1975; Trivedi, 1976; Azad *et al.*, 1985) have reported that the women were engaged in occupations like agricultural labour, farming, livestock, forestry, fishing and ignored household as an occupation. In the present study household has been considered as one of the occupations of the scheduled caste women. Only 10% women were engaged in domestic work. Rest all the women were engaged in their own animal or agricultural related activities while staying at home. Thus, work done by a housewife for animal and agriculture related activities remains invisible. Boulding (1977) rightly pointed out that the major problem faced by the enumerators of employed person is that most of the productive labour takes place in what is called as the fifth world, the kitchen and the farm/nursery. Economists do not assign monetary value to this labour but use a category 'not economically active home makers' to cover women having this type of occupation.

It can, thus, be concluded from this study that maximum number of women was working as agricultural labourer and could not have self-employment. The respondents revealed that even today scheduled caste women are considered as 'untouchable' for occupations like

TABLE 2  
Reasons for illiteracy as reported by illiterate rural women

S. No.	Reasons for illiteracy	Occupational categories						Total	Rank
		Service	Labourer	Self-employed	House servant	Housewife			
1.	Co-education	5	15	25	0	5	10	VIII	
2.	School distance	5	5	5	20	25	12	VII	
3.	Household and family responsibility	10	5	15	15	5	12	VII	
4.	Expensive education	5	5	0	5	0	3	X	
5.	Early marriage	5	0	10	0	0	3	X	
6.	No women teacher	5	5	5	0	5	4	IX	
7.	Girls contributing towards family income	35	40	45	50	5	35	V	
8.	Parents not in favour of education	30	60	25	30	50	39	IV	
9.	Looking after the siblings	25	45	55	80	35	48	III	
10.	Field work	30	75	55	80	15	51	II	
11.	No school in the village	10	40	20	20	0	18	VI	
12.	Due to backwardness	40	90	60	65	45	60	I	

Figures are percentage values.

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**TABLE 3**  
**Reasons for joining the job by rural women belonging to various occupations**

S. No.	Reasons for joining the job	Occupational categories					Total	Rank
		Service	Labourer	Self-employed	House servant	House-wife		
1.	Money for basic support	100	100	100	100	—	100.00	I
2.	To raise economic status	100	100	100	100	—	100.00	I
3.	Ambition for career	35	0	70	0	—	26.25	XII
4.	To have independent income	55	65	65	10	—	48.75	VIII
5.	Feeling of security	35	50	50	20	—	38.75	IX
6.	Escape from boredom	0	0	20	0	—	5.00	XV
7.	Sense of pride	30	40	40	0	—	27.50	XI
8.	Self-sufficiency	70	75	85	75	—	76.25	III
9.	Social reform	20	20	35	10	—	21.25	XIII
10.	Escape from unhappy atmosphere at home	70	75	85	20	—	62.50	VI
11.	Temporary escape from household tasks	20	10	35	0	—	16.25	XIV
12.	Desire for outside communication and friendship	0	0	0	0	—	0.00	XVI
13.	Interest of husband's family members	30	50	15	25	—	30.00	X
14.	Need for achievement and recognition	90	80	85	75	—	82.50	II
15.	Increase in self-esteem	100	60	100	0	—	65.00	V
16.	Better facilities for children	100	100	100	100	—	100.00	I
17.	Repayment of loans	60	65	40	60	—	56.25	VII
18.	Inadequacy of husband's income	80	85	55	75	—	73.75	IV
19.	Husband's neglect of family responsibilities	25	25	20	35	—	26.25	XII

Housewives were not involved in other occupations outside their houses.  
Figures are percentage values.

house servant in the villages. People do not buy vadi/pappad made by them and thus, their self-employment was affected. Besides, the respondents were unaware of financial institutions which give loans, etc. to start the self-employment. A major

ity of scheduled castes rural women was illiterate and hence few women were involved in service and were performing low paid laborious jobs which result in their social, economic and cultural backwardness.

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## EFFECT OF MOTHER'S NUTRITION KNOWLEDGE LEVEL ON NUTRITIONAL STATUS OF SCHOOL GOING CHILDREN OF PANIPAT CITY

SONIA CHANDNA and SALIL SEHGAL

Department of Foods & Nutrition

CCS Haryana Agricultural University, Hisar - 125 004

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### ABSTRACT

A study was conducted on 6-12 years old school children and their mothers to determine the effect of mother's nutrition knowledge level on nutritional status of school going children of Panipat city. Eleven per cent of mothers were having excellent knowledge regarding various aspects of nutrition while majority of mothers (40-41%) were having good and fair knowledge scores. Intake of cereals, milk and milk products was significantly higher in children whose mothers were having excellent, good and fair nutrition knowledge as compared to children whose mothers were having poor nutrition knowledge. An increasing trend in consumption of most of food-stuffs and nutrients was observed with the increase in nutrition knowledge scores. Height, weight, mid-arm circumference and triceps skinfold values were significantly higher in children whose mothers were having excellent, good and fair nutrition knowledge than children whose mothers were having poor nutrition knowledge. Higher nutrient intake in children whose mothers were having excellent, good and fair nutrition knowledge resulted in better anthropometric and higher values of Hb and serum vit A level. Thus, the study indicated that nutrition knowledge level of mothers significantly affected the nutritional status of their school going children.

School going children form an important vulnerable segment of population and constitute about 20% of total population of India. The school age is one of the crucial periods of life as about 40% of physical growth and 80% of mental growth are believed to take place during this age. Growth and development depend upon nutrition to support physiological and metabolic processes of the body. The growing child requires a high intake of energy because of the great activity, and an

abundance of good quality proteins and minerals because of his rapid growth. The deficiency of one or more nutrients may produce different diseases in accordance with varying degrees of deficiency of nutrients, human resistance and variable climatic conditions (Tiwari, 1990).

The role of mothers in combating malnutrition through changing the socio-cultural barriers for good nutrition is vital and unique. They alone are responsible for the methods adop-

ted for the preparation and serving of food. They play a major role in influencing the dietary habits of their children. The nutritional status of family members is influenced by the sound knowledge, attitude, beliefs and values possessed by the house lady. Mother's nutrition knowledge level has a significant effect on child's nutritional status (Abbi *et al.*, 1988). Keeping in view, the study was undertaken to determine the effect of mother's nutrition knowledge level on nutritional status of school children.

#### MATERIAL AND METHODS

For selecting the subjects, list of all Government Primary schools of Panipat city was procured from Deputy Education Officer. The city was divided into five years. From each area one/two schools were selected randomly. List of school children between 6 to 12 years was prepared from the selected schools. Total 192 respondents were selected randomly and their food consumption, nutrient intake, anthropometric measurements and biochemical parameters were estimated. Food consumption and nutrient intake were estimated by 24-hour dietary recall. Height, weight, mid-arm circumfer-

ence (MAC) and triceps skinfold (TSF) measurements were assessed as per the method of Jelliffe (1966). A questionnaire was prepared pertaining to various aspects, viz. human nutrition, food groups, feeding during disease, conservation of nutrients, immunization, and prevalent food fads and fallacies. For the purpose of quantifying the qualitative data related to assessment of the extent of knowledge, an inventory was prepared and responses were obtained under 'Yes' and 'No' categories. Correct answer was given a score of 'one' and incorrect answer as score 'zero'. Aggregate scores were computed to find out the extent of knowledge possessed by the respondents.

#### RESULTS AND DISCUSSION

##### Nutrition Knowledge

On the basis of nutrition knowledge scores, the respondents' mothers were divided into four categories (Table 1). Only 11.5% mothers were having excellent knowledge regarding various aspects of nutrition. Majority of mothers (81.7%) were having fair and good knowledge while only 6.8% were having poor nutrition knowledge.

TABLE 1  
Nutrition knowledge scores of respondent's mothers

Nutrition knowledge	Score	Frequency (n=192)
Excellent	80% & above	22(11.5)
Good	60-79%	78(40.6)
Fair	40-59%	79(41.1)
Poor	Below 40%	13(6.8)

Figures in parentheses are percentages.

### Food Consumption Pattern

Effect of mother's knowledge on food consumption pattern has been presented in Table 2. Intake of cereals was highest (283.18 g) in children whose mothers were having excellent nutrition knowledge followed by children (280.98 g) whose mothers were having good nutrition knowledge and by children (273.29 g) whose mothers were having fair nutrition knowledge. Least intake of cereals was found in children (230.46 g) whose mothers were having poor nutrition knowledge. Significant differences were observed in intake of cereals between children whose mothers were having excellent-poor, good-poor and fair-poor nutrition knowledge. Similar trend was observed in intake of vegetables by children. Intake of pulses, fats and oils, and sugar and jaggery was similar in children whose mothers were having different levels of nutrition knowledge. Significant differences in intake of fruits were observed in children whose mothers were having good-fair and good-poor knowledge. Intake of milk and milk products was significantly different in children whose mothers were having excellent-fair, excellent-poor, good-fair and good-poor nutrition knowledge. Intake of most of the food stuffs was highest in children whose mothers were having excellent/fair/good nutrition knowledge as compared to children whose mothers were having poor nutrition knowledge. Higher consumption of most of the food-stuffs in children whose

mothers were having more nutrition knowledge might be due to the fact that these mothers were knowing about the higher requirements of food-stuffs for the children during their growth period and fed them accordingly.

Intake of energy was highest (1673.22 KCal) in children whose mothers were having excellent nutrition knowledge followed by children (1511.34 KCal) whose mothers were having good nutrition knowledge and by children (1434.37 KCal) whose mothers were having fair nutrition knowledge and least intake of energy was found (1390.07 KCal) in children whose mothers were having poor nutrition knowledge (Table 3). Significant differences were observed in intake of energy by children whose mothers were having excellent-good, excellent-fair, excellent-poor, good-fair and good-poor nutrition knowledge. Non-significant differences were observed in intake of energy between children whose mothers were having fair-poor nutrition knowledge. Similar trend was observed in intake of proteins. Intake of fat was significantly different in children whose mothers were having excellent-fair, excellent-poor and good-fair nutrition knowledge. Significant differences in intake of calcium were observed in children whose mothers were having excellent-fair, excellent-poor and good-poor nutrition knowledge. Intake of iron was significantly higher in children whose mothers were having excellent-poor, good-fair, good-

TABLE 2  
Effect of mother's nutrition knowledge score on food intake of school children

Food stuffs	Mean food intake (g)				C. D. value							
	Nutrition knowledge score											
	Excellent (I)	Good (II)	Fair (III)	Poor (IV)	I vs. II	I vs. III	I vs. IV	II vs. III	II vs. IV	III vs. IV		
Cereals	283.18±40.52	280.98±48.98	237.29±57.42	230.46±31.45	NS	NS	NS	NS	NS	NS	29.89	29.86
Pulses	25.00±2.72	25.00±2.82	24.62±3.49	24.76±3.39	NS	NS	NS	NS	NS	NS	NS	NS
Vegetables	69.00±8.28	59.83±18.08	44.55±16.93	35.00±14.21	7.81	7.80	11.30	5.16	3.40	6.39	9.70	NS
Fruits	6.18±14.11	6.34±14.04	1.40±6.16	0.00±0.00	NS	NS	NS	NS	NS	NS	21.67	NS
Milk and milk products	105.40±24.34	97.10±34.66	56.55±39.01	69.23±52.19	NS	17.43	25.31	11.53	NS	NS	NS	NS
Fats and oils	23.81±2.93	23.93±2.69	24.13±2.45	24.53±3.23	NS	NS	NS	NS	NS	NS	NS	NS
Sugar and jaggery	14.86±4.36	14.43±4.91	11.13±5.28	9.61±5.93	NS	NS	NS	NS	NS	NS	NS	NS

NS=Non-significant.

TABLE 3  
Effect of mother's nutrition knowledge score on nutrient intake of school children

Nutrient	Mean intake				C. D. value					
	Nutrition knowledge score									
	Excellent (I)	Good (II)	Fair (III)	Poor (IV)	I vs. II	I vs. III	II vs. III	III vs. IV		
Energy (KCal)	1673.22±367.74	1511.34±210.81	1434.37±221.72	1390.07±103.12	110.28	110.10	159.89	72.86	136.93	NS
Protein (g)	42.88±4.98	39.62±6.35	36.19±5.27	35.63±4.84	2.68	2.68	3.89	1.77	3.33	NS
Fat (g)	55.18±9.36	52.29±9.49	45.44±7.61	48.20±5.91	NS	4.03	5.84	2.67	NS	NS
Calcium (mg)	435.25±135.78	367.38±126.07	339.46±98.01	292.50±79.83	53.87	53.87	78.09	NS	66.67	NS
Iron (mg)	15.07±2.93	14.77±3.64	13.47±4.18	10.07±1.78	NS	NS	2.54	1.16	2.18	2.18
Thiamine (mg)	1.35±0.11	1.32±0.19	1.16±0.17	1.11±0.18	NS	0.08	0.12	0.05	0.10	NS
Riboflavin (mg)	0.66±0.13	0.63±0.13	0.52±0.12	0.65±0.20	0.06	0.06	NS	0.04	NS	0.08
Vit C (mg)	47.70±14.29	41.23±22.20	18.07±9.02	21.94±3.38	NS	7.66	11.13	5.07	9.53	NS
β-carotene (μg)	1576.75±585.55	1197.53±685.74	356.32±172.94	329.44±55.59	NS	233.47	393.03	154.50	290.35	NS

NS= Non-significant.

poor and fair-poor nutrition knowledge. Intake of thiamine, vitamin C and  $\beta$ -carotene was significantly different in children whose mothers were having excellent-fair, excellent-poor, good-fair and good-poor nutrition knowledge. Significant differences were observed in intake of riboflavin in children whose mothers were having excellent-good, excellent-fair, good-fair and fair-poor nutrition knowledge. Thus, increasing trend in intake of most of the nutrients by children with the increase in level of nutrition knowledge of the mothers was observed. It may be due to the fact that feeding pattern was comparatively better in mothers having excellent/good/fair knowledge regarding nutrition than mothers with poor nutrition knowledge. Kaur and Sehgal (1994) also reported beneficial effect of educational status on nutrient intake of pregnant women. Hunt *et al.* (1986) also suggested the effectiveness of the nutrition education programme in improving the nutrient intake. Maternal education was also reported to influence the maternal attitude (Dargent *et al.*, 1994). Occupation and education influenced the frequency and duration of breast feeding and nutritional quality and type of weaning foods (Igbedioh, 1993).

Significant differences were observed in weight, and mid-arm circumference of children whose mothers were having excellent-poor, good-poor and fair-poor nutrition knowledge. Height is a genetic trait but similar trend was observed

for it. Triceps skinfold measurements were similar in children whose mothers were having excellent, good, and fair nutrition knowledge scores. Children whose mothers were having good and fair knowledge scores were having higher values as compared to the children whose mothers were having poor nutrition knowledge scores.

Hb level was highest in children whose mothers were having excellent nutrition knowledge followed by children whose mothers were having good nutrition knowledge followed by children whose mothers were having fair nutrition knowledge and least in children whose mothers were having poor nutrition knowledge (Table 5). Hb level was significantly different in children whose mothers were having excellent-good, excellent-fair, excellent-poor, good-fair and good-poor nutrition knowledge. Similar trend was observed for vit. A level. An improvement in mean serum folate levels was observed to be influenced by the nutrition education (Hunt *et al.*, 1986). Similarly, improvement in night blindness situation was observed due to increased nutrition knowledge of household heads irrespective of their occupation, income and formal education in school.

Better consumption pattern resulted in better nutrient intake. Better nutritional status of children whose mothers were having better nutrition knowledge may be due to the fact that they were aware or conscious about the nutritional req-

TABLE 4

Effect of mother's nutrition knowledge score on anthropometric measurements of school children

Anthropometric measurements	Mean values				C. D. value							
	Nutrition knowledge score				I		II		III		IV	
	Excellent (I)	Good (II)	Fair (III)	Poor (IV)	vs. II	vs. III	vs. IV	vs. I	vs. II	vs. III	vs. IV	
Height (cm)	123.38±7.54	123.36±9.13	122.64±8.93	114.63±6.63	NS	NS	NS	5.99	NS	5.12	5.12	
Weight (kg)	24.95±1.72	24.58±2.68	24.07±2.45	22.26±1.56	NS	NS	NS	1.67	NS	1.43	1.43	
Mid-arm circumference (inch)	7.34±0.09	7.31±0.15	7.26±0.18	7.14±0.17	NS	NS	NS	0.111	NS	0.095	0.095	
Triceps skinfold (mm)	13.09±1.34	13.82±1.55	13.62±1.53	12.61±1.26	NS	NS	NS	NS	NS	0.98	0.98	

NS=Non-significant.

TABLE 5

Effect of mother's nutrition knowledge score on biochemical parameters of school children

Biochemical parameters	Mean values				C. D. value							
	Nutrition knowledge score				I		II		III		IV	
	Excellent (I)	Good (II)	Fair (III)	Poor (IV)	vs. II	vs. III	vs. IV	vs. I	vs. II	vs. III	vs. IV	
Hemoglobin (g/100 ml)	14.60±1.03	13.29±1.92	10.96±1.05	10.00±0.78	0.69	0.69	1.00	0.45	0.85	NS	NS	
Serum vit A (µg%)	24.52±2.40	20.66±5.58	12.93±2.43	12.00±1.96	1.90	1.90	2.75	1.25	2.36	NS	NS	

NS=Non-significant.

uirements of children and fed their children properly which resulted in their better health status.

Thus, the study revealed that mother's nutrition knowledge level significantly affected the nutritional status of their school children. There-

fore, nutrition counselling and education to mothers should be an important component of health services which will help to decrease the effect of ignorance and faulty practices and would result in improvement of nutritional status of their children.

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## SOCIAL MATURITY PATTERNS AMONG BOYS AND GIRLS : A LONGITUDINAL STUDY OF HISAR DISTRICT

ANJU MANOCHA, KANTA GUPTA\* and BIMLA DHANDA  
Department of Child Development  
CCS Haryana Agricultural University, Hisar - 125 004

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### ABSTRACT

For assessing patterns of social maturity, the parents were interviewed on Vineland Social Maturity Scale. As the parents insisted upon females to care for themselves about eating, dressing, etc., and also because of their inborn capacities, the girls were better in fine motor development over the boys.

Children being the most crucial human resource of any society require special care and attention, right from the beginning for their health alongwith physical, social and emotional growth. The well-being of the child and his/her future are totally dependent upon the care and attention bestowed upon him/her before and after birth during infancy and pre-school age. The family acts as an important and meaningful teacher in his/her development and social maturity especially in the early years of life. Social maturity is the behaviour appropriate to the age of an individual and his ability to exercise personal independence and social responsibility. The pattern of social maturity for a particular task may be different in males and females. The biological changes could not establish the cause of differential pattern in girls and boys. However, the social environment and

family's role might be a significant contribution. The present study aims at finding the sex difference in social maturity caused by the differential treatments given to girls and boys. The 6-year longitudinal study is expected to provide a scientific bench-mark for future work in rural areas.

### METHODOLOGY

A longitudinal study was carried out during 1986-92. Two clusters of villages from Hisar-I and II blocks were selected. A total of 14 villages, seven from each cluster were included in the study. A sample of 100 newly born infants with equal number of boys and girls was taken from these villages by simple random sampling method. The researchers visited every selected household and interviewed the parents on Vineland Social Maturity Scale. The study

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\*Present address : Krishi Vigyan Kendra, Sadalpur.

was carried out with the objective to assess social maturity pattern of children during 0-6 years of age and to compare the social maturity pattern in girls with that in boys. The data were collected at weekly intervals upto 3 months, monthly intervals upto 2 years and twice a year upto the age of 6 years.

## RESULTS AND DISCUSSION

The data reveal that as far as physical development is concerned there were no visible differences in girls and boys till the age of three years (Table 1). The reason for this might be that males and females are not born with different endowment for physical development. But the difference was evident after three years of age when the children need external support and opportunity to grow. Extra care, extra diet and lack of suppression made the boys better developed over the girls. Bhogle

(1991) also found that both the sexes had similar physical development until the age of 1 year. However, after that males got more attention, care and stimulation, whereas girls were probably the ignored ones.

Regarding fine motor development females surpassed their male counterparts, *i. e.* 85% of females as against 78% males at 2-3 years, 88% females and 74% males at 3-4 years, and 73% females and 65% males at 4-6 years of age could perform same number of activities showing fine motor development of females. Thus, it is evident that from 0-6 years of age the differences were in favour of girls. This might be due to either inborn capacities or differential role expectations.

Generally, it has been noticed that the mother as well as grandmother feed meals to the males with

TABLE 1  
Social maturity scores (in percentage) of respondents from 0-6 years

Aspects of social maturity	Age in years									
	0-2		2-3		3-4		4-5		5-6	
	F	M	F	M	F	M	F	M	F	M
Physical development	82	80	81	79	83	86	80	88	35	40
Physical mobility	92	90	85	90	70	82	72	86	—	—
Fine motor development	72	71	85	78	88	74	73	65	—	—
Social development	93	91	94	88	93	71	96	82	28	24
Language development	91	93	90	88	85	82	85	80	18	12
Cognitive development	66	59	80	70	72	75	74	84	22	72

F—female, M—male.

their own hands, whereas they insist on females to eat themselves. The fine motor development begins to differ from here. The female is also supposed to serve food and water to her parents and siblings, whereas the males are not expected to do so. Domestic works are for girls and others for boys.

As far as social development is concerned, females excelled males. The data in Table 1 show that 94% females and 88% males at 2-3 years of age, 93% females and 71% males at 3-4 years of age, 96% females and 82% males at 4-5 years of age, and 28% females and 24% males at 5-6 years of age could perform same number of activities exhibiting social development of females. Males become more possessive than females. Boys do not want to share their things and are less co-operative. Females are always asked to give their things to others especially to males. The female has to sacrifice all the times. The outcome is attributed to the formal structure of female oriented socialization process.

The data in Table 1 also reveal that females were more developed in their linguistic approach. As the girls are less supported for physical development and have to share more responsibility of household work as well as rearing the siblings, their linguistic skills get better developed. Repucci (1971) documented that girls were more advanced than boys in all aspects of language such as age of onset, vocabulary size, etc. Saharan (1993) also

revealed that female respondents performed better than males in all sections of language comprehension and language expression of Reynell language development. Garai and Scheinfeld (1988) reported that females possessed greater verbal fluency than males since their infancy onwards. It is also found that girls' voice organ matures earlier than that of boys and results in earlier age of speech onset. In addition studies revealed that girls exhibited greater verbal fluency from the age of 12 months throughout their high school and college life.

The data also reveal that females were ahead of males in cognitive development upto 3 years, *i. e.* 66% females and 59% males at 0-1 year, and 80% females and 70% males at 2-3 years of age could perform same number of activities. But later on due to differences in environmental stimulation provided by parents, variations started coming up and the girls lagged behind, as at 3-4 years of age 72% females and 75% males, at 4-5 years of age 74% females and 84% males, and at 5-6 years of age 22% females and 72% males could perform the same number of activities. This is indicative of discrimination and variation in child rearing environment provided by parents. Clarke (1973) also found that children who were provided with a greater number and variety of play material and activities tended to be cognitively advanced. Moreover, mediation of materials by the

mothers is more closely related to the infants skill with objects than mere exposure to stimulating physical development. Hence in later stages as males are provided with better environment they are better in their cognitive development. Saini (1991) also supported these findings and reported that it is enriched environment which can help children surpass their performance. Sangwan (1991) also revealed that personal and social factors have a greater impact on the cognitive development of an infant. An economically and socially deprived infant does not get

enough opportunities and facilities for his optimum cognitive development.

Thus, if equal opportunities and similar environment are provided to children of both the sexes nothing can hinder the females to come ahead. The study also shows that nature never discriminates and overall development of girls and boys in early years is similar. But with the advancement in age differences start coming up because the girl child is ignored, assigned secondary roles and suppressed.

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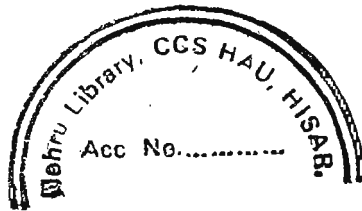
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