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CHEMICAL COMPONENTS OF THE STEM BARK OF *PROSOPIS CINERARIA* L. (DRUCE)

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ABSTRACT

The phytochemical studies on the stem bark of *Prosopis cineraria* resulted in isolation of four compounds, namely, bis-trideca-2,6-dienyl ketone, propyl nonadecanoate, β -sitosterol and catechin. These were characterized on the basis of spectral analysis and other data. Bis-trideca-2,6-dienyl ketone is an hitherto unreported compound and propyl nonadecanoate is being reported for the first time from this plant.

Key Words : *Prosopis cineraria*, Leguminosae, Methanolic extract, Bis-trideca-2,6-dienyl ketone, Propyl nonadecanoate, β -sitosterol, Catechin.

Prosopis cineraria (L.) Druce syn. *P. spicigera* L. (Leguminosae; subfamily Mimosaceae) is commonly found in dry and arid regions of north-western India (Kirtikar and Basu, 1984). It is commonly known as Jand, Jandi, Khejra, Khejri or Safed Keekar. Its leaves and pods are extensively used as fodder for cattle, camels and goats. This tree is also highlighted for its positive effect on grass or crop production and has been extensively used in indigenous system of medicine as folk remedy for various ailments (Kirtikar and Basu, 1975). Bark and leaf galls are used for tanning. The bark of *P. cineraria* is dry, acrid, bitter with a sharp taste and known to have cooling, anthelmintic, antirheumatic and tonic properties. Swami *et al.* (1989) studied the stem bark of *P. cineraria* and reported the presence of n-hexacosanoic acid, n-octacosanoic acid and n-octacosanyl acetate in it. The present study describes the isolation of four additional compounds from the methanolic extract of the bark of which one was found to be new.

MATERIAL AND METHODS

The melting points were measured on Ganson electrical melting point apparatus. ^1H NMR spectra were recorded in CDCl_3 using tetra methyl silane (TMS) as internal standard on Bruker AC-300F 300 MHz NMR spectrometer. Pellets were formed in KBr

and IR spectra were recorded on Hitachi 570 infrared spectrophotometer. Mass spectra were recorded on VG-70S 11-250J GC-MS-DS Mass spectrometer.

Plant material. Stem bark of the plant was obtained from the Landscape Department, CCSHAU, Hisar.

Extraction and isolation. Six kg dried and chopped stem bark was extracted with hot methanol (10 l). Removal of the solvent yielded methanolic extract (200 g). The silica gel (60-120 mesh) column chromatography of the methanolic extract (200 g) afforded four compounds (A-D). Elution with petroleum ether, petroleum ether - benzene (9 : 1), benzene - petroleum ether (1 : 1) and ethyl acetate - benzene (1 : 1) afforded bis-trideca-2,6-dienyl ketone, propyl nonadecanoate, β -sitosterol and catechin, respectively.

Compound A (Bis-trideca-2,6-dienyl ketone, 1)

It was obtained on elution with petroleum ether as light yellow oil, 10 ml (Found C, 83.92; H, 11.90. $\text{C}_{27}\text{H}_{46}\text{O}$ required C, 83.94; H, 11.91%); IR: ν_{max} (KBr) 668, 772, 1031, 1112, 1379, 1402, 1462, 1649, 2361, 2854, 2924 cm^{-1} ; ^1H NMR (δ , CDCl_3): 5.80 - 4.95 (8H, m, 4 x $\text{CH}=\text{CH}$), 2.0 (12H, m, 6 x $-\text{CH}_2-\text{CH}=\text{}$), 1.28 (20H, br s, 10 x $-\text{CH}_2-$), 0.82 (6H, t, J 7.0 Hz, 2 x -

CH_3); MS m/z (rel. int.): 386 (M^+ , 1), 372 (1), 358 (1.5), 344 (1.5), 330 (2), 295 (3), 281 (5), 267 (5), 253 (7), 239 (7), 225 (8), 211 (9), 197 (11), 183 (14), 169 (15), 155 (16), 141 (18), 125 (24), 111 (42), 97 (68), 85 (100).

Compound B (Propyl nonadecanoate, 2)

The compound was obtained on elution with petroleum ether - benzene (9:1) as a white crystalline solid, 20 mg, m. p. 103°C (lit. m. p. no report, Marosi and Schlenk, 1973); IR: ν_{max} (KBr) 536, 672, 721, 1059, 1262, 1466, 1706, 2358, 2849, 2919 cm^{-1} ; $^1\text{H NMR}$ (δ , CDCl_3): 3.64 (2H, t, J 7.0 Hz, $-\text{COOCH}_2-$), 2.34 (2H, t, J 7.0 Hz, $-\text{CH}_2\text{COO}-$), 1.64 - 1.54 (2H, m, $\text{H}_2\text{C}-\text{H}_2\text{C}-\text{COO}-$), 1.26 (30H, br s, 15 x $-\text{CH}_2-$), 0.87 (6H, t, J 7.0 Hz, 2 x $-\text{CH}_3$); MS m/z (rel. int.): 335 (M^+ , 3), 320 (2), 291 (3.5), 280 (12), 257 (12), 243 (3), 228 (4), 214 (12), 185 (10), 178 (31), 167 (40), 149 (100), 129 (22).

Compound C (β -Sitosterol, 3)

It was obtained on elution with benzene - petroleum ether (1:1), 18 mg, m. p. 135°C (lit. m. p. 136 - 137°C, Heilbron *et al.*, 1965). Liebermann-Burchard reaction (Compound + CHCl_3 + Ac_2O + Conc. H_2SO_4) yielded a green colour; IR: ν_{max} (KBr) 669, 961, 1058, 1107, 1191, 1376, 1460, 1666, 1708, 2361, 2864, 2938, 3414 cm^{-1} ; $^1\text{H NMR}$ (δ , CDCl_3): 5.32 (1H, br, **H-6**), 5.19 - 4.80 (1H, br, **H-3**), 2.61 - 1.45 (29H, m, 11 x $-\text{CH}_2-$ and 7 x $>\text{CH}-$), 1.03 (6H, s, 2 x $-\text{CH}_3$), 0.94 (3H, s, $-\text{CH}_3$), 0.91 (3H, s, $-\text{CH}_3$), 0.83 (3H, s, $-\text{CH}_3$), 0.68 (3H, s, $-\text{CH}_3$); MS m/z (rel. int.): 414 (M^+ , 70), 399 (32), 383 (21), 352 (9), 330 (25), 304 (23), 272 (43), 256 (47), 230 (57), 214 (47), 159 (48), 147 (56), 124 (92), 107 (75), 95 (88), 81 (100).

Compound D (Catechin, 4)

The compound was obtained on elution with ethyl acetate - benzene (1:1) as light yellow solid. It crystallized from methanol, 500 mg, m. p. 215°C (lit. m. p. 212-214°C, Heilbron *et al.*, 1965); IR: ν_{max} (KBr) 511, 539, 603, 621, 668, 757, 815, 864, 939, 1026, 1048, 1132, 1195, 1229, 1294, 1445, 1534, 1611, 2361, 2919,

3358, 3539 cm^{-1} ; $^1\text{H NMR}$ (δ , CDCl_3): 7.28 (2H, m, **H-2'**, **H-6'**), 7.18 (1H, dd, J 8.4 and 2.5 Hz, **H-5'**), 6.76 (1H, d, J 2.1 Hz, **H-8**), 6.68 (1H, d, J 2.3 Hz, **H-6**), 5.28 (1H, m, **H-3**), 5.17 (1H, d, J 7.9 Hz, **H-2**), 2.89 (1H, dd, J 6.0 Hz, **H-4e**), 2.70 (1H, dd, J 8.4 Hz, **H-4a**), 2.32 (12H, s, 4 x $-\text{OOC}-\text{CH}_3$), 2.07 (3H, s, $-\text{OOC}-\text{CH}_3$); MS m/z (rel. int.): 290 (100), 278 (30), 273 (13), 206 (7).

RESULTS AND DISCUSSION

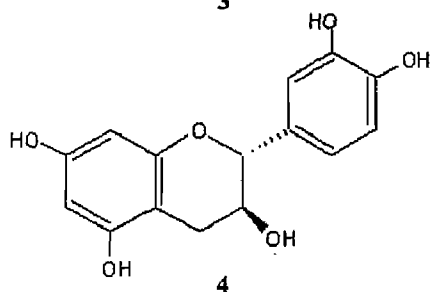
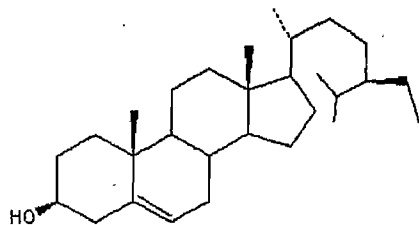
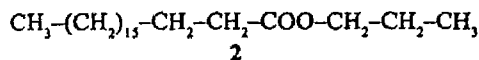
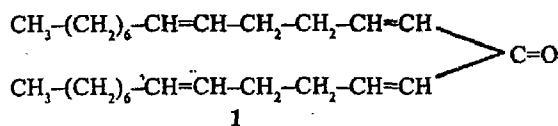
Compound A (Bis-trideca-2,6-dienyl ketone, 1)

Bis-trideca-2,6-dienyl ketone (1) was obtained on elution with pure petroleum ether as an oil. The IR spectrum of the compound showed the presence of a carbonyl group at 1649 cm^{-1} . The MS and elemental analysis of the compound suggested the molecular formula to be $\text{C}_{27}\text{H}_{46}\text{O}$. The $^1\text{H NMR}$ of the compound in CDCl_3 showed no signal in the aromatic region indicating the aliphatic nature of the compound. A multiplet at δ 5.80 - 4.95 for eight protons could be due to eight olefinic protons ($=\text{CH}-$). Another multiplet at δ 2.00 integrating for 12 protons could be due to six methylene groups α - to double bond. A broad signal at δ 1.28, representing 20 protons, was assignable to 10 methylenes. A triplet at δ 0.82 (J 7.0 Hz), integrating for six protons, was assignable to two terminal methyl groups. The compound was characterized as bis-trideca-2,6-dienyl ketone (1) on the basis of spectral data. The MS fragmentation pattern (experimental) also supported the proposed structure 1. Since naturally occurring aldehydes and alcohols like 2, 6-octadien-4-ynedioic acid; 2, 6-decadien-4-ynal; 2, 6-decadien-4-ynoic acid, 2, 6-decadien-4-yn-1-ol, *etc.* contain double bond usually at 2 and 6 positions (Buckingham, 1994), the position of double bond in 1 is based on biogenetic considerations.

Compound B (Propyl nonadecanoate, 2)

The compound B was obtained on elution with benzene- petroleum ether (1 : 9). The IR spectrum of the compound showed the presence of carbonyl group (1706 cm^{-1}). The MS of the compound suggested its

PHYTOCHEMICAL STUDIES OF *PROSOPIS CINERARIA*



molecular mass to be 340 and the molecular formula $\text{C}_{22}\text{H}_{44}\text{O}_2$. It was identified as propyl nondecanoate (2) on the basis of spectral data (Marosi and Schlenk, 1973).

Compound C (β -Sitosterol, 3)

It was obtained on elution with benzene – petroleum ether (1:1) and crystallized from methanol. A green colour with Liebermann-Burchard reaction suggested the compound to be a steroid. The IR spectrum exhibited the presence of hydroxyl group (3414 cm^{-1}). A comparison of the spectral data with literature values (Heilbron *et al.*, 1965) and direct comparison (m.p., mixed m.p. and CoTLC) with an authentic sample of β -sitosterol (Kalidhar *et al.*, 1982) confirmed the identity of compound C as β -sitosterol (3).

Compound D (Catechin, 4)

The compound was obtained on elution with ethyl acetate – benzene (1:1) as a light yellow solid. The MS showed the molecular mass of the compound to be 290 and suggested molecular formula to be $\text{C}_{15}\text{H}_{14}\text{O}_6$. The spectral data suggested compound D to be catechin (4) and found to be in agreement with the literature data of catechin (4, Heilbron *et al.*, 1965). Thus, it was characterized as catechin.

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STATUS OF PROTEIN METABOLITES IN STERILE (CMS-7-1A) AND FERTILE (CMS-7-1B) LINES OF SUNFLOWER UNDER *IN VITRO* CONDITIONS

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Changes in protein, amino acid contents and protease activity in calli of sterile (CMS-7-1A) and fertile (CMS-7-1B) lines of sunflower were studied to compare the biochemical behaviour of two lines during callus growth. The studies revealed that protein content initially decreased and thereafter increased with growth of the calli, whereas converse was true for total amino acid and protease activity in both the lines. Among the two lines, fertile lines showed higher contents of protein and amino acids alongwith activity of protease as compared to sterile line.

Biochemicals play a major role in modifying the growth and development. Among various biochemicals, proteins are the most important as these hold the key through which genetic information is expressed. Proteins perform different biological roles. Proteins on being hydrolysis produce amino acids and protease affect the content of these two. The activity of enzymes and amount of metabolites change with the age of calli (Vinod, 1994; Ahlawat, 1999; Vinita, 2001). Biochemical changes occurring during callus culture can elucidate the mechanism underlying organogenesis. In the present investigation two lines of sunflower – cytoplasmic male sterile line (CMS-7-1A) and maintainer line (CMS-7-1B) were compared on the basis of protein, amino acid contents and protease activity in calli of two lines.

Seeds of A and B lines of *Helianthus annuus* were cultured on MS basal medium. The cotyledon, hypocotyl, petiole and lamina segments were excised from 7-10 days old seedlings and used for callus induction on MS medium supplemented with NAA (0.5 ppm) and BAP (1.0 ppm). Thirty days old calli were further subcultured on MS medium with variable combination of additives to obtain optimum growth of calli. Among the tested combinations, the most

convincing callus growth was obtained on medium containing NAA (0.5 ppm), BAP (1.0 ppm), GA₃ (0.1 ppm), CM (500 ppm) and adenine sulphate (10 ppm) and this was selected for further studies. Callus samples in triplicate were collected at 10, 20 and 30 days of subculture and subjected to biochemical estimations and enzyme activity.

For extraction of metabolites one hundred mg of dry weight callus was homogenized in 80% ethanol (v/v). The homogenate was refluxed for 15 min on a water bath and centrifuged. The residue was further refluxed thrice with 80% ethanol. The supernatants were pooled together and volume was made 5 ml. Estimation of protein and amino acid was done following the methods of Lowry *et al.* (1951), and Yemm and Cocking (1955), respectively.

For quantifying activity of enzyme protease, one gram of fresh callus drawn at defined time intervals was employed. The callus was homogenized in a chilled glass mortar with a pestle using acid washed sand as an abrasive. The extraction medium contained 0.1 M, Tris HCL (pH 7.4), 0.25 mM EDTA, 2.5 mM cystein HCL and 2.5% polyvinyl pyrrolidone (PVP) and its pH was adjusted to 7.4. The homogenate was centrifuged at 10,000 Xg for 10 min at 4°C in a cooling centrifuge (Remi C-30). The supernatant was used for estimating the protease activity by the method of Beevers (1968). The enzyme proteins in the extract were determined according to Lowry *et al.* (1951) after precipitating the extract with 20% TCA and redissolving the residue in 0.1% NaOH on boiling water bath for 10 min.

Free amino acid content of calli of A line showed an increase upto 10 days and thereafter gradually decreased (Fig. 2). But in petiolar calli content declined only after 20 days of callus growth. Calli of B

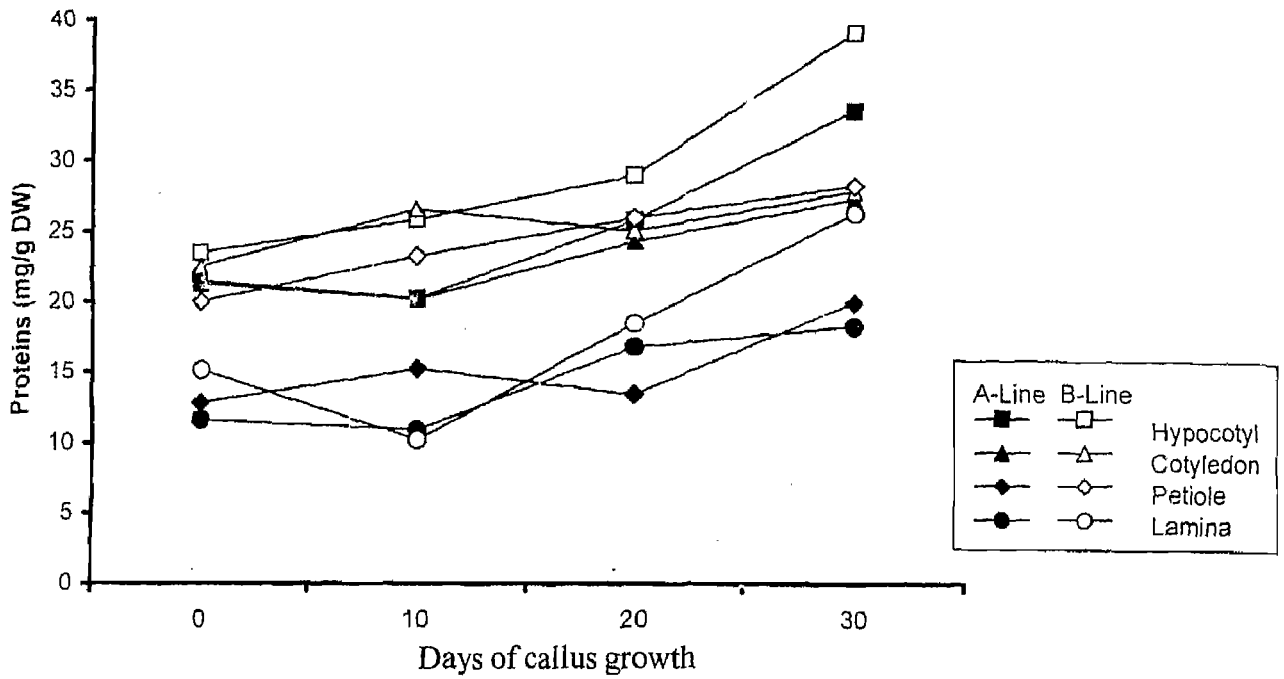


Fig. 1. Amount of proteins in calli of various explants of A and B lines of sunflower.

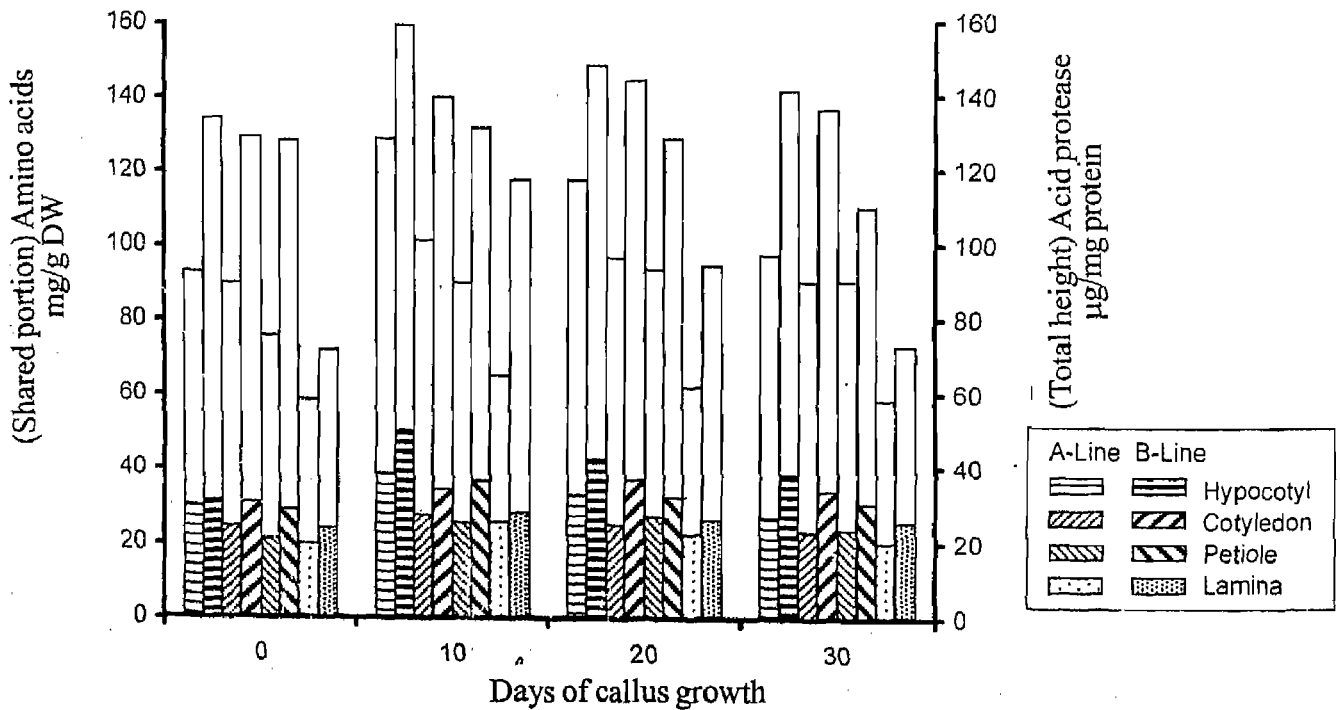


Fig. 2. Amount of amino acid and acid protease in calli of various explants of A and B lines of sunflower.

line raised on both the media followed similar trend as that of A line calli. However, callus of cotyledonary origin showed an increase in free amino acids content upto 20 days and thereafter a decline was evident. Overall free amino acid of B line calli was higher than A line calli. Gupta (1998) also observed an increase in free amino acids content of sunflower calli during callus growth which decreased gradually during differentiation.

Protein content exhibited a reverse trend in calli of both A and B line (Fig. 1). It declined initially and then increased with passage of time. Ahlawat (1999) also observed an increase in protein content during growth of hypocotylar callus in *Brassica*. Chatrath *et al.* (1996) observed higher protein in differentiating shoot tip than the non-differentiating hypocotyls explants of chickpea. Accumulation of protein in somatic embryos at torpedo or maturation stage too has been reported by various workers (Joy *et al.*, 1991; Komatsuda *et al.*, 1992; Misra *et al.*, 1993; Bronner *et al.*, 1994). Similarly, embryogenic callus of hypocotyls had higher

protein content than non-embryogenic callus (Dave and Batra, 1995).

Protease involved in protein hydrolysis followed trend similar to free amino acids. This initial increase in free amino acids may be because of increase in protein hydrolysis and decrease in free amino acids and enzyme activity with the passage of time shows that hydrolysis of protein has been slowed down. Decrease in free amino acids may also be because of the synthesis of protein or export of free amino acids.

Overall protein and free amino acids contents and specific activity of protease of B line calli were higher than that of A line calli. It is presumed that metabolic rate in the callus of B line was higher than that of A line calli as evinced by content of tested metabolites and enzyme activity. Since protein synthesis is translational product of expression of genetic information, observed differences in metabolites and enzyme activity are consequence of difference of genetic make up of the lines.

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AZOSPIRILLUM STRAINS COMPENSATING NITROGEN REQUIREMENT IN PEARL MILLET UNDER RAINFED CONDITIONS

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Over two-third of the total arable land world over is dedicated to the production of the cereal grains, which provide 80% of the food that humans consume. High yielding varieties of cereals require high input of fertilizer increasing the cost of production that is beyond the reach of small and marginal farmers. Further, the chemical fertilizers are manufactured at the cost of petrochemicals and thus depreciating our foreign exchange. The possibility of substituting N fertilizer with biological nitrogen fixation (BNF) would have very considerable economic and environmental advantages. As excess N is normally lost to ground water supplies, which constitutes a potential health hazard and can also cause acid rain in the environment. Hence, the elimination or substantial reduction of N fertilizer application through organic farming is considered a key factor in making agriculture more friendly to the environment.

Pearl millet is one of the most important **kharif** coarse food crops of South-West Haryana. In Haryana, it is grown in about six lakh hectares land having average productivity of about 10 q/ha. Various pot and field experiments conducted world over have established *Azospirillum* as a good associative nitrogen fixing inoculant in various cereal crops (Sumner, 1990). Field studies conducted at Regional Research Station, Bawal have also shown superiority of some mutants of *Azospirillum lipoferum* over *Azotobacter chroococcum* at basal dose of nitrogen in pearl millet (Kumar *et al.*, 2002). The present study was conducted to evaluate nitrogen complementation by different strains of *Azospirillum* sp. and *Azotobacter chroococcum* in pearl millet under field conditions.

The experiment was conducted in randomized block design at Regional Research Station, Bawal during 2001-03. *Azospirillum* cultures used in the study

were SP-7, S-8 and S-11. They were compared with high temperature resistant mutant HT-54 of *Azotobacter chroococcum* and with biomix. The biomix was the amalgam of *A. chroococcum* Mac68 and *Azospirillum lipoferum* J-11. The soil was loamy in texture, slightly alkaline with pH (1 : 2) 8.3, poor available nitrogen (185 kg/ha), medium in P and K (16.82 and 270 kg/ha, respectively). Early maturing cultivar HHB-68 of pearl millet was tested for biofertilizer response at 0, 50 and 75 per cent of recommended fertilizer dose ($N_{30}P_{15}$) under rainfed conditions. Plot size was 4 x 3 m and each treatment had three replications. Dose of phosphorus as per calculation plus half of nitrogen were applied at the time of sowing and rest half of nitrogen was top dressed at four weeks stage of the crop. The rainfall received during **kharif** 2001 was 517 mm, whereas during **kharif** 2002 and 2003 the values were 176 and 687 mm, respectively. The data were recorded in terms of seed yield (q/ha).

Effect of Cultures on Seed Yield

On pooled basis (2001, 2002 and 2003) the response of *Azospirillum* cultures was more at 50% RF and in the treatment without nitrogen fertilizer as compared to 75% RF (Table 1). Mean data indicated increase in grain yield varying from 4-15 per cent over the control at 75% RF. Grain yield was highest at RF, however, the difference of values at 75% RF with cultures S-8 and S-11 to RF was non-significant indicating a saving of 15-20 per cent of fertilizers. Grain yield at RF dose during 2001, 2002 and 2003 was 24.04, 15.63 and 27.20 q/ha, respectively. *Azospirillum* cultures S-8 and S-11 gave better responses over *Azotobacter chroococcum* culture HT-54 (commercially used strain in pearl millet) in all the treatments during the period of experimentation.

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TABLE 1

Effect of different cultures on grain yield (q/ha) of pearl millet (HHB 68)

Culture	Control				50% RF				75% RF				Mean
	01	02	03	Mean	01	02	03	Mean	01	02	03	Mean	
Control	10.34	8.62	15.52	11.49	18.39	12.29	20.46	17.05	19.92	13.71	22.04	18.56	15.70
SP-7	14.18	-	-	14.18	20.11	-	-	20.11	20.98	-	-	20.98	18.42
S-8	14.85	11.34	17.64	14.61	20.31	13.47	22.04	18.61	22.22	14.65	24.69	20.52	17.91
S-11	14.85	10.87	18.17	14.63	20.88	13.84	25.75	20.16	22.13	14.87	26.80	21.27	18.69
Biomix	-	11.08	17.81	14.44	-	12.92	22.57	17.74	-	13.94	24.69	19.31	17.16
HT-54	11.97	10.54	17.46	13.32	19.92	13.28	20.81	18.00	20.88	14.07	23.87	19.61	16.98
C. D. at 5%	1.92	1.46	1.58		1.56	1.39	1.21		1.86	1.65	1.08		

TABLE 2

Effect of different cultures on stover yield (q/ha) of pearl millet (HHB 68)

Culture	Control				50% RF				75% RF				Mean
	01	02	03	Mean	01	02	03	Mean	01	02	03	Mean	
Control	22.75	18.87	34.76	25.46	41.02	27.41	44.80	37.74	43.62	30.12	48.36	40.63	34.61
SP-7	33.46	-	-	33.46	45.85	-	-	45.85	47.50	-	-	47.50	42.26
S-8	34.89	25.46	39.87	33.40	46.08	38.78	49.03	44.63	48.66	33.65	54.07	45.46	41.16
S-11	35.14	23.78	40.52	33.14	46.98	39.54	58.45	48.32	48.12	34.56	58.63	47.10	42.85
Biomix	-	25.12	39.63	32.37	-	36.64	49.42	43.03	-	32.52	53.58	43.05	39.48
HT-54	26.90	22.94	38.92	29.58	42.21	37.70	45.57	41.82	45.72	31.93	52.08	43.24	38.21
C. D. at 5%	3.41	2.82	2.39		4.02	4.45	3.12		3.38	2.37	4.52		

All the three cultures of *Azospirillum*, HT-54 of *A. chroococcum* and biomix responded significantly over the uninoculated control at zero level of fertilizer during the period of study. The maturity of the crop was not significantly affected by any of the treatments. In general, all the four cultures tested along with the biomix significantly affected biological yield over the uninoculated control at different doses of nitrogen. Grain yield in all the treatments in 2002 was comparatively low due to poor rainfall during the crop period. S-8 and S-11 contributed significantly in grain yield of pearl millet as compared to uninoculant control at zero, 50% RF and 75% RF. The response of biomix was comparable to the two strains of *Azospirillum* sp., however S-11 consistently performed better over other strains tested.

Plants are able to utilize only 25-30 per cent N supplied (Sumner, 1990). The rest is either leached in the soil or lost due to denitrification. Further most of the diazotrophs are unable to perform their best at higher nitrogen doses. Better response of *Azospirillum* cultures over HT-54 can be attributed to the presence of nitrate reductase activity and their proximity to root zone of the crop. The successful bacterization by nitrate tolerant mutants of *Azospirillum* in pearl millet was explored as better expression of nitrogenase activity and excretion of ammonia by these mutants in the presence of inorganic sources of nitrogen (Christiansen-Weniger and Van-Veen, 1991, Sarita *et al.*, 2002). Hence, trials should also be conducted at farmers' field for exploitation of these nitrate tolerant strains to the extent possible for nitrogen saving in pearl millet and other cereal crops.

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ECONOMICS OF PEARL MILLET-WHEAT CROPPING SYSTEM AS INFLUENCED BY ORGANIC AND INORGANIC SOURCES OF NUTRIENTS

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ABSTRACT

An investigation was undertaken to study the economics of pearl millet-wheat cropping system as influenced by integrated nutrient management treatments for two consecutive years (2002-03 to 2003-04). The pooled grain yield data for both pearl millet and wheat for both the years depicted that treatment T₅ (100% RD-NPK in both the crops) and T₆ (50% NPK+50% N through FYM in pearl millet and 100% RD-NPK in wheat) were at par and significantly superior over rest of the treatments. This indicates that 50% N can be supplied through FYM in pearl millet in pearl millet-wheat cropping system. The gross and net returns and B : C ratio also followed similar trend.

Key Words : Pearl millet, Wheat, INM, Grain yield, System yield, Gross returns, Net returns, B : C ratio.

Pearl millet and wheat are the most widely cultivated food grain crops of India spreading over arid and semi-arid eco-regions. Pearl millet-wheat cropping system is spread in an estimated area of 2262.4 thousand hectares in India and 208.7 thousand hectares in Haryana (Yadav and Suba Rao, 2002). In India, the contribution of this cropping system in total food grain production is considerably large. Sustaining productivity of this system is essential in view of rapid increase in human population and decrease in arable land area. This is possible through enhancing integrated nutrient management expression by various agronomic adjustments. Increase in cost of essential inputs, particularly fertilizers has forced the researchers to think about a system that can help in efficient use of these inputs without any adverse effect on environmental sustainability and productivity. Strategies need to be developed that can enhance gross as well as net returns in pearl millet-wheat cropping system. These can be in the form of integration of inorganic fertilizers with organic manures.

Keeping in view the escalating cost of agricultural inputs, especially fertilizers and for optimum utilization of this precious resource, the present investigation was undertaken to study the economics of pearl millet-wheat

cropping system as influenced by different integrated nutrient management treatments.

MATERIAL AND METHODS

The field experiment was carried out in permanent laid out research plots during 2002-03 and 2003-04. The soil of experimental site was sandy loam in texture, having pH value of 7.3, poor in available nitrogen (149.1 kg ha⁻¹), poor in organic carbon (0.35%), high in phosphorus (36.8 kg P₂O₅ ha⁻¹) and rich in potassium (310.6 kg K₂O ha⁻¹). The experiment was laid out in randomized block design with 12 treatment combinations replicated four times. The treatments were : T₁ – control (no fertilizer); T₂ – 50% recommended NPK to pearl millet and wheat; T₃ – 50% recommended NPK to pearl millet and 100% recommended NPK to wheat; T₄ – 75% recommended NPK to pearl millet and wheat; T₅ – 100% recommended NPK to pearl millet and wheat; T₆ – 50% NPK+50% N (farmyard manure) to pearl millet and 100% NPK to wheat; T₇ – 75% NPK+25% N (farmyard manure) to pearl millet and 75% NPK to wheat; T₈ – 50% NPK+50% N (wheat straw) to pearl millet and 100% NPK to wheat; T₉ – 75% NPK+25% N (wheat straw) to pearl millet and 75% NPK to wheat; T₁₀ – 50% NPK+50%

N (*Sesbania* spp.) to pearl millet and 100% NPK to wheat; T₁₁ – 75% NPK+25% N (*Sesbania* spp.) to pearl millet and 75% NPK to wheat, and T₁₂ – farmers' practice.

The recommended levels of nitrogen and phosphorus were 125 and 62.5 kg ha⁻¹ for pearl millet and 150 and 60 kg ha⁻¹ for wheat. The farmers' practice based on state average was 36.5 and 41.7 kg ha⁻¹ for nitrogen and 3.0 and 2.0 kg ha⁻¹ for phosphorus during first and second year of the study, respectively, for pearl millet. In wheat the farmers' practice based on state average was 114.5 and 129 kg ha⁻¹ for nitrogen and 55 and 53 kg ha⁻¹ for phosphorus during first and second year of study, respectively. The pearl millet variety used was HHB-67 with 5 kg seed ha⁻¹, keeping intra row spacing of 10 cm and inter row spacing of 45 cm. The wheat variety sown was PBW-343 with 125 kg seed ha⁻¹ keeping inter row spacing of 20 cm. Pearl millet was sown on 20 July 2002 and 1 July 2003 and was harvested on 5 October 2002 and 30 September 2003 during first and second year, respectively. Similarly, wheat was sown on 19 November 2002 and 13 November 2003 and was harvested on 18 April 2003 and 11 April 2004 during first and second year, respectively. The nitrogen content in different organic materials was determined each year and the amount of these materials required for substituting a specified amount of nitrogen as per the treatment was calculated. The organic sources of nutrients, viz. FYM, wheat straw and green manure were incorporated in soil 60, 60 and 30 days, respectively, before sowing pearl millet crop. The recommended nitrogen and phosphorus were applied through urea and DAP, respectively. Three post sowing irrigations were applied during 2002 but during 2003 no post sowing irrigation was applied in pearl millet due to sufficient rains. Similarly, in wheat four irrigations were applied each year. Recommended package of practices were followed in both the crops for other agronomic operations.

The pooled grain yield and total productivity of the system were calculated by adding the grain yield of pearl millet and wheat along with pooled system yield.

Cost of cultivation and gross returns (Rs. ha⁻¹) for different treatments were calculated on the basis of the approved market rates for inputs and rates of output/produce fixed by Director of Farms, CCS Haryana Agricultural University, Hisar. The rate fixed for pearl millet grain was 500 and 505 Rs. q⁻¹, while for wheat it was 620 and 630 Rs. q⁻¹ for 2002-03 and 2003-04, respectively. The straw/stover yield of pearl millet and wheat was 75 and 100 Rs. q⁻¹, respectively for both the years. Net returns (Rs. ha⁻¹) were worked out by subtracting the total cost of cultivation of each treatment from the gross income of respective treatment. Benefit : cost ratio was also worked out to ascertain the economic viability of different treatments.

RESULTS AND DISCUSSION

Pearl millet

Yield studies

After careful analysis of data from pooled system yield of pearl millet (Table 1) for two years depicted that treatments T₅, i.e. 100% RD-NPK in both the crops (3312 kg ha⁻¹) and T₆, i.e. 50% RD-NPK+50% N through FYM in pearl millet and 100% RD-NPK in wheat (3276 kg ha⁻¹) were at par and both were significantly superior to rest of the treatments. T₅ resulted in 162 and 165 per cent higher pooled grain yield over control and farmers' practice, respectively. The higher grain yield in pearl millet in these treatments might be due to easy availability of plant nutrients and higher photosynthetic activities as compared to under dose fertilizer treatments. Similar observations were revealed by Singh *et al.* (1999) in pearl millet-wheat cropping sequence.

Wheat

Yield studies

Perusal of data for pooled grain yield of wheat for two years depicted that treatment with 100% RD-NPK in both the crops (4758 kg ha⁻¹) and 50% RD-NPK+50% N through FYM in pearl millet and 100% RD-NPK in wheat (4652 kg ha⁻¹) were at par and

TABLE 1

Effect of different treatments on pearl millet and wheat grain yield and pearl millet-wheat system grain yield

Treatment	Pooled grain yield (kg ha ⁻¹)		Pooled pearl millet equivalent yield (kg ha ⁻¹)
	Pearl millet	Wheat	
T ₁	1264	1074	1336
T ₂	2008	3065	3813
T ₃	2023	4303	5351
T ₄	2702	4099	5098
T ₅	3312	4758	5917
T ₆	3276	4652	5817
T ₇	3156	4379	5447
T ₈	2850	4413	5362
T ₉	3006	4166	5119
T ₁₀	3148	4392	5462
T ₁₁	3132	4240	5235
T ₁₂	2007	3813	5030
SEmt	31	44	-
CD (P=0.05)	88	125	-

significantly superior over rest of the treatments. This indicates that 50% N can be supplied through FYM in pearl millet in pearl millet-wheat cropping system. The pooled yield with 100% RD-NPK in both the crops was 343 and 25 per cent higher over control and farmers' practice, respectively. The results are in conformity to the findings of Katyal *et al.* (2002).

Perusal of pooled grain yield data for two years revealed that there was no significant difference in grain yield of wheat recorded at 100% NPK and the treatment where nitrogen was substituted through FYM to the tune of 50% in pearl millet followed by 100% NPK in wheat. This might be attributed to availability of nitrogen for entire growing season due to slow mineralization of organic nitrogen from FYM in pearl millet-wheat cropping sequence. Tandon (1997) also corroborated these findings. Contrary to this application of wheat straw in pearl millet resulted in slight reduction in the yield. This reduction in yield with the application of wheat straw might be due to wider C : N ratio.

Among the organic sources higher yield was recorded when FYM was applied, followed by green manure and wheat straw.

Pearl millet Equivalent Yield

Pooled pearl millet equivalent yield of the system for the two years (Table 1) shows that T₅ (5917 kg ha⁻¹) resulted in highest yield followed by T₆ (5817 kg ha⁻¹).

Among organic sources, FYM performed better and it was followed by green manure and wheat straw. In general pearl millet equivalent yield was more when 50% N was applied through FYM, wheat straw and green manure as to that when 25% N was applied through these sources in pearl millet.

Economics

Maximum gross return of Rs. 62209 ha⁻¹ (Table 2) was incurred in treatment T₅ (100% RD-NPK in both the crops) followed by T₆ (50% RD-NPK+50% nitrogen through FYM in pearl millet and 100% RD-NPK in wheat) with Rs. 59505 ha⁻¹ during first year. During second year maximum gross return of Rs. 58197 ha⁻¹ was incurred in T₆ and it was closely followed by T₅ with Rs. 57154 ha⁻¹.

Maximum net return of Rs. 35584 ha⁻¹ was obtained in T₅ followed by T₆ with Rs. 33067 ha⁻¹ during first year. During second year maximum profit of Rs. 31672 ha⁻¹ was recorded in T₆ which was closely followed by T₅ with Rs. 30549 ha⁻¹. Raising of pearl millet-wheat without fertilizer was in loss during both the years. The net returns have been calculated based on variable cost only and rental value of the land has been excluded.

Data in Table 2 further demonstrate that the maximum B : C ratio of 2.34 was recorded in T₅ followed by T₆ with 2.25 during first year of the study. During second year of the experiment highest B : C ratio of 2.19 was observed in T₆ closely followed by T₅ (2.15).

TABLE 2

Economics of different treatments in pearl millet-wheat cropping system

Treatment	Gross returns (Rs.)			Net returns (Rs.)			B : C ratio		
	2002-03	2003-04	Mean	2002-03	2003-04	Mean	2002-03	2003-04	Mean
T ₁	18194	16246	17220	-2155	-4006	-3080	0.89	0.80	0.84
T ₂	39404	36934	38169	15749	13387	14568	1.67	1.57	1.62
T ₃	49220	46647	47933	23907	21330	22618	1.94	1.84	1.89
T ₄	53010	49136	51073	27850	24127	25988	2.11	1.96	2.03
T ₅	62209	57154	59681	35584	30549	33066	2.34	2.15	2.24
T ₆	59505	58197	58851	33067	31672	32369	2.25	2.19	2.22
T ₇	57434	53441	55437	31608	26681	29144	2.22	2.00	2.11
T ₈	54828	51804	53316	25932	22977	24454	1.90	1.80	1.85
T ₉	54690	51234	52962	27773	24320	26046	2.03	1.90	1.96
T ₁₀	58319	54118	56218	31891	27682	29786	2.21	2.04	2.12
T ₁₁	56634	52840	54737	30889	27080	28984	2.20	2.05	2.12
T ₁₂	45464	44825	45144	21495	21273	21384	1.90	1.90	1.90

Economics has been calculated on variable cost basis.

Land rent has not been included.

Returns include both grain as well as straw yield.

The highest mean values of gross returns; net returns and B : C ratio were recorded in T₅ (100% RD-NPK in both the crops) at the end of two years of study. The application of 100% RD-NPK in both the crops fetched 55% higher net returns over farmers' practice. Almost equal B : C ratio was obtained when 100% RD-NPK was applied in both the crops and when 50% N was supplemented through FYM in pearl millet. This is attributed due to higher grain yield of the

pearl millet-wheat cropping system. The results are in conformity with those of Patil *et al.* (1995) and Katyal *et al.* (2002) in pearl millet-wheat cropping system. They reported that 50% N substitution in pearl millet through FYM and 100% NPK through inorganic fertilizers to wheat crop recorded almost similar (6.16 t ha⁻¹) system productivity to that of 100% NPK. Patidar and Mali (2001) observed similar findings with regard to net returns and B : C ratio.

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PRINCIPAL COMPONENT AND FACTOR ANALYSIS IN OAT (*AVENA SATIVA* L.) GERMPLASM

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ABSTRACT

The pattern of diversity in 100 germplasm lines of oat (*Avena sativa* L.) was analyzed using the principal component method of factor analysis. The first six principal components could explain about 76.7% of the total variation in 22 quantitative attributes which were mainly associated with green fodder yield and its components, seed component traits, outer glume length and width, 100-grain weight, florets spikelet⁻¹, days to maturity and peduncle length. The remaining principal components made very minor contribution towards total variation and thus cannot be considered of much practical value to the plant breeder. It is concluded that first three factors play a pivotal role towards diversity in oat. The genotypes HFO 604, HFO 566, HFO 305, HFO 644 and HFO 552 were found better for green fodder yield and HFO 138, HFO 717, HFO 244 and HFO 264 were found better for seed yield. The results of the present investigation provide confirmatory evidence of diversity in oat, which was earlier, studied by generalized distance and hierarchical cluster analysis and thus proves the adequacy of the principal component method in biological investigations.

Key Words : Principal component analysis, Factor analysis, Oat, Germplasm, Variation.

Owing to lack of knowledge regarding relative importance and usefulness of variables, the investigator tried to include all possible variables which made the data matrix perceivably large, complicated, unmanageable and beyond comprehension. Therefore, the investigator required a technique for systematic reduction and summarization of data.

Principal component analysis basically a data reduction technique, initially floated by Pearson (1901) and later developed by Hotelling (1933), offers solution to this complex problem by transforming the original set of variables into a smaller set of linear combinations that account for most of the variability of the original set. In this technique, the total variation contained in a set of variables is considered, whereas factor analysis, also a data reduction technique, where no distributional assumption is required and interest centres on that part of variance which is shared by the common factors Godshalk and Timothy (1988). In view of the immense importance of principal component and factor analysis in plant breeding, these techniques were applied to 100

oat germplasm lines.

MATERIAL AND METHODS

The material consisted of 100 oat germplasm lines (Table 1) collected from different sources. Each genotype was accommodated in two rows plot of 4 m length with row to row and plant to plant spacing of 22.5 and 10 cm, respectively, in an augmented design with 10 blocks during rabi 2001-02. Ten different germplasm lines constituted a block with two checks (Kent and HJ 8) repeated in each block. All the recommended agronomical practices were followed to raise a good crop. Observations were recorded on five competitive plants from each genotype for 22 quantitative characters (Table 3).

In the present investigation, correlation matrix was used to extract the principal components. For deciding number of principal components to be retained, Kaiser's (1958) suggestion of dropping those principal components of correlation matrix with eigen roots less than one was followed. Principal factor analysis was

TABLE 1

List of genotypes and their sources used in the study

S. No.	Genotypes	Origin/Sources	S. No.	Genotypes	Origin/Sources	S. No.	Genotypes	Origin/Sources
1.	HFO 111	NBPGR, N. Delhi	35.	HFO 695	NBPGR, N. Delhi	69.	HFO 641	NBPGR, N. Delhi
2.	HFO 230	NBPGR, N. Delhi	36.	HFO 627	NBPGR, N. Delhi	70.	HFO 556	NBPGR, N. Delhi
3.	HFO 629	NBPGR, N. Delhi	37.	HFO 587	NBPGR, N. Delhi	71.	HFO 714	Haryana
4.	HFO 640	NBPGR, N. Delhi	38.	HFO 305	NBPGR, N. Delhi	72.	HFO 146	CCSHAU, Hisar
5.	HFO 348	IGFRI, Jhansi	39.	HFO 210	CCSHAU, Hisar	73.	HFO 454	GBPUAT, P. Nagar
6.	HFO 604	NBPGR, N. Delhi	40.	HFO 244	USSR	74.	HFO 717	Uttar Pradesh
7.	HFO 654	NBPGR, N. Delhi	41.	HFO 619	NBPGR, N. Delhi	75.	HFO 580	NBPGR, N. Delhi
8.	HFO 409	GBPUAT, P. Nagar	42.	HFO 591	NBPGR, N. Delhi	76.	HFO 157	CCSHAU, Hisar
9.	HFO 566	NBPGR, N. Delhi	43.	HFO 160	CCSHAU, Hisar	77.	HFO 110	NBPGR, N. Delhi
10.	HFO 333	IGFRI, Jhansi	44.	HFO 651	NBPGR, N. Delhi	78.	HFO 162	CCSHAU, Hisar
11.	HFO 469	GBPUAT, P. Nagar	45.	HFO 463	GBPUAT, P. Nagar	79.	HFO 55	NBPGR, N. Delhi
12.	HFO 147	CCSHAU, Hisar	46.	HFO 1	NBPGR, N. Delhi	80.	HFO 577	NBPGR, N. Delhi
13.	HFO 336	IGFRI, Jhansi	47.	HFO 563	NBPGR, N. Delhi	81.	HFO 105	NBPGR, N. Delhi
14.	HFO 287	NBPGR, N. Delhi	48.	HFO 161	CCSHAU, Hisar	82.	HFO 267	CCSHAU, Hisar
15.	HFO 274	NBPGR, N. Delhi	49.	HFO 638	NBPGR, N. Delhi	83.	HFO 264	CCSHAU, Hisar
16.	HFO 368	CCSHAU, Hisar	50.	HFO 226	NBPGR, N. Delhi	84.	HFO 513	NBPGR, N. Delhi
17.	HFO 562	NBPGR, N. Delhi	51.	HFO 550	NBPGR, N. Delhi	85.	HFO 722	CCSHAU, Hisar
18.	HFO 207	CCSHAU, Hisar	52.	HFO 460	GBPUAT, P. Nagar	86.	HFO 451	GBPUAT, P. Nagar
19.	HFO 637	NBPGR, N. Delhi	53.	HFO 402	GBPUAT, P. Nagar	87.	HFO 86	NBPGR, N. Delhi
20.	HFO 465	GBPUAT, P. Nagar	54.	HFO 437	GBPUAT, P. Nagar	88.	HFO 606	NBPGR, N. Delhi
21.	HFO 444	GBPUAT, P. Nagar	55.	HFO 208	CCSHAU, Hisar	89.	HFO 703	CCSHAU, Hisar
22.	HFO 61	NBPGR, N. Delhi	56.	HFO 716	Uttar Pradesh	90.	HFO 502	NBPGR, N. Delhi
23.	HFO 644	NBPGR, N. Delhi	57.	HFO 88	NBPGR, N. Delhi	91.	HFO 699	NBPGR, N. Delhi
24.	HFO 328	IGFRI, Jhansi	58.	HFO 33	NBPGR, N. Delhi	92.	HFO 14	NBPGR, N. Delhi
25.	HFO 552	NBPGR, N. Delhi	59.	HFO 364	CCSHAU, Hisar	93.	HFO 620	NBPGR, N. Delhi
26.	HFO 309	NBPGR, N. Delhi	60.	HFO 434	GBPUAT, P. Nagar	94.	HFO 467	GBPUAT, P. Nagar
27.	HFO 700	CCSHAU, Hisar	61.	HFO 127	IGFRI, Jhansi	95.	HFO 634	NBPGR, N. Delhi
28.	HFO 45	NBPGR, N. Delhi	62.	HFO 462	GBPUAT, P. Nagar	96.	HFO 236	NBPGR, N. Delhi
29.	HFO 138	CCSHAU, Hisar	63.	HFO 185	CCSHAU, Hisar	97.	HFO 630	NBPGR, N. Delhi
30.	HFO 517	NBPGR, N. Delhi	64.	HFO 8	NBPGR, N. Delhi	98.	HFO 625	NBPGR, N. Delhi
31.	HFO 505	NBPGR, N. Delhi	65.	HFO 125	NDRI, Karnal	99.	HFO 718	CCSHAU, Hisar
32.	HFO 595	NBPGR, N. Delhi	66.	HFO 70	NBPGR, N. Delhi	100.	HFO 617	NBPGR, N. Delhi
33.	HFO 569	NBPGR, N. Delhi	67.	HFO 122	NBPGR, N. Delhi			
34.	HFO 249	CCSHAU, Hisar	68.	HFO 632	NBPGR, N. Delhi			

carried out using principal component method, which does not require assumption of multivariate normal distribution of population (Jaiswal, 2000). As the initial factor loading was not clearly interpretable, the factor axes were rotated using varimax method of orthogonal rotation (Kaiser, 1958) which is the most popular method of which corresponded to spreading out of the squares of loading on each factor as much as possible. It made possible to obtain groups of large and negligible coefficients in different columns of the rotated factor loading.

RESULTS AND DISCUSSION

The utility of principal component depends upon the variability it accounts for. The principal components, characteristic roots (eigen values), contribution of

different principal components and their cumulative contribution to the total variation in 22 characters are presented in Table 2. The first six principal components had eigen value more than one and have explained 76.7% of the total variation. Each of the remaining principal components accounted for a small amount of the total variation. This indicated that these components are not of much practical value to the plant breeder. However, for more detailed study of the data, these components may provide good information. About 38.4% of the aggregate variability as measured by the sum of their variances was presented by the first principal component followed by 14.7% by second and so on.

TABLE 2

Total variance explained by different principal components

Principal components	Eigen values	Per cent variability	Cumulative % variability
1	8.448	38.401	38.401
2	3.252	14.783	53.184
3	1.851	8.413	61.597
4	1.193	5.423	67.021
5	1.127	5.122	72.143
6	1.009	4.587	76.730
7	0.885	4.021	80.752
8	0.732	3.326	84.077
9	0.622	2.827	86.905
10	0.567	2.578	89.482
11	0.499	2.268	91.750
12	0.446	2.025	93.775
13	0.321	1.460	95.235
14	0.284	1.292	96.527
15	0.178	0.809	97.336
16	0.157	0.713	98.048
17	0.131	0.595	98.644
18	0.103	0.469	99.112
19	0.077	0.352	99.465
20	0.056	0.258	99.723
21	0.044	0.201	99.924
22	0.016	0.075	100.000

Initially, the principal factor analysis was carried out without any rotation (Table 3) which revealed that 10 variables, viz. green fodder yield plant⁻¹, number of tillers plant⁻¹, flag leaf length and width, plant height, longest leaf width, longest internode length, dry matter yield plant⁻¹, number of nodes on main stem and stem thickness had very high loading on first factor, while seed yield panicle⁻¹ and spikelets plant⁻¹ were found to have high loading on second factor. Similarly, two variables, outer glume length and width on third and peduncle length on fourth factor. None of the variables was found to be highly loaded on fifth and sixth factors. The failure of principal factor analysis without rotation to draw sensible conclusions prompted to go for analysis with rotation. All the 22 variables showed high loading (Table 4) on different principal factors and none of them was left after rotation of the principal factor axes. Moreover, it clearly grouped the similar type of variables by loading them together on a common principal factor. The first principal factor (Table 4) was associated with green fodder yield and its component traits. Seed yield and its components were associated with second principal factor. The association of third principal factor was very high with outer glume length and width and 100-grain weight. However, florets spikelet⁻¹, days to maturity and peduncle length were correlated with fourth, fifth and sixth factors, respectively.

The clear cut grouping of similar type of variables

TABLE 3

Factor loadings of different characters with respect to different principal factors (unrotated)

Characters/Principal factors	PF 1	PF 2	PF 3	PF 4	PF 5	PF 6
Green fodder yield/plant	0.965*	-0.146	0.001	-0.032	0.044	0.011
Number of tillers/plant	0.959*	-0.139	-0.012	-0.066	0.073	0.017
Flag leaf length	0.947*	-0.113	-0.080	-0.061	0.018	-0.044
Plant height	0.946*	-0.171	-0.046	-0.064	0.068	0.004
Flag leaf width	0.924*	-0.172	-0.131	-0.075	0.035	-0.023
Longest leaf width	0.922*	-0.133	0.019	-0.019	-0.025	-0.075
Longest internode length	0.876*	-0.195	-0.072	-0.083	0.088	0.051
Dry matter yield/plant	0.775*	-0.186	-0.024	0.239	-0.051	0.038
Number of nodes on main stem	0.704*	-0.171	0.188	-0.115	-0.208	-0.053
Stem thickness	0.611*	0.307	-0.326	-0.151	0.079	0.007
Number of leaves/plant	0.468	-0.462	0.280	-0.053	-0.142	0.316
Longest leaf length	0.565	0.495	-0.213	-0.089	0.010	-0.122
Seed yield/panicle	0.375	0.751*	-0.201	0.104	-0.208	-0.028
Spikelets/panicle	0.175	0.713*	-0.205	0.125	-0.366	0.207
Panicle length	0.287	0.518	-0.385	0.154	0.094	0.367
Number of nodes/panicle	-0.180	0.576	-0.199	-0.455	0.123	0.385
Outer glume length	0.219	0.503	0.725*	-0.028	0.268	0.018
Outer glume width	0.330	0.575	0.647*	0.024	0.268	-0.034
100-grain weight	0.263	0.472	0.511	0.007	-0.091	0.096
Peduncle length	0.004	-0.262	0.052	0.756*	0.289	0.363
Florets/spikelet	0.087	0.114	-0.337	0.197	0.583	-0.445
Days to maturity	0.400	0.190	-0.016	-0.278	-0.067	0.440
Explained variability	8.448	3.252	1.851	1.193	1.127	1.009
Proportion of total (%)	38.401	14.783	8.413	5.423	5.122	4.587

PF - Principal factor.

by getting loaded on common principal factor elaborates the successful transformation of 22 interrelated variables into six independent factors explaining 76.7% of the variability of the original set. The relative contribution of various traits to the total variability has also been reported by Rao and Paroda (1982) in clusterbean, Mahajan and Prasad (1985) in rice and Singh *et al.* (1996) in fababean.

Principal factor scores were calculated for all the genotypes for all the six factors using Anderson-Rubin method and were utilized to find out genotypes superior for different factors, *i.e.* for all the characters

cumulatively ascribed to that factor. A high value of score of a particular genotype in a particular factor denotes high values for those variables in that genotype, which that factor is representing. Thus, the genotypes HFO 604, HFO 566, HFO 305, HFO 644 and HFO 552 which were having high score in PFI denotes that they are having high fodder yield potential. Similarly, genotypes HFO 138, HFO 717, HFO 244 and HFO 264 had high score in PF II, therefore, were better for seed yield. Likewise, genotypes HFO 336 and HFO 274 for PF III, HFO 640 and HFO 309 for PF IV, HFO 305 and HFO 161 for PF V and HFO 505 and HFO 226 for PF VI were found to have high score.

VARIABILITY IN OAT GERMPLASM

TABLE 4

Factor loadings of different characters with respect to different principal factors (Varimax rotation)

Characters/Principal factors	PF 1	PF 2	PF 3	PF 4	PF 5	PF 6
Green fodder yield/plant	0.963*	0.110	0.109	0.029	0.050	0.032
No. of tillers/plant	0.960*	0.113	0.108	0.044	0.007	0.015
Plant height	0.959*	0.097	0.061	0.054	0.012	0.014
Flag leaf length	0.940*	0.162	0.048	0.071	0.061	-0.033
Flag leaf width	0.940*	0.131	-0.020	0.075	0.022	-0.019
Longest leaf width	0.907*	0.125	0.100	0.040	0.140	-0.031
Longest internode length	0.904*	0.076	0.021	0.039	-0.047	0.032
Dry matter yield/plant	0.764*	0.093	0.007	-0.006	0.226	0.231
Number of nodes on main stem	0.713*	-0.020	0.135	-0.192	0.186	-0.144
Stem thickness	0.680*	0.141	0.113	0.227	-0.171	-0.168
Longest leaf length	0.632*	0.316	0.196	0.233	0.013	-0.202
Number of leaves/plant	0.575*	-0.285	0.041	-0.440	-0.020	0.158
Spikelets/panicle	-0.062	0.840*	0.116	-0.177	0.139	0.005
Seed yield/panicle	0.120	0.830*	0.216	0.081	0.187	-0.093
Number of nodes/panicle	0.124	-0.822*	0.007	0.110	0.067	-0.013
Panicle length	0.175	0.634*	-0.059	-0.033	-0.288	0.383
Outer glume length	0.045	0.061	0.945*	0.012	-0.035	-0.005
Outer glume width	0.144	0.127	0.907*	0.085	0.021	0.007
100-grain weight	0.077	0.296	0.654*	-0.190	0.106	-0.039
Florets/spikelet	0.056	0.051	-0.043	0.835*	-0.021	0.072
Days to maturity	0.269	0.249	0.131	0.251	0.583*	0.152
Peduncle length	0.019	-0.163	-0.013	0.026	0.096	0.905*
Explained variability	7.887	3.050	2.337	1.215	1.214	1.177
Proportion of total (%)	35.852	13.864	10.621	5.525	5.518	5.351

PF - Principal factor.

Further, all the genotypes were plotted on graph utilizing their scores based on two factors simultaneously. The genotypes which found place towards the better end of both the factors were found to be superior for those two factors and hence superior for all the characters, which are defined by these two factors. Thus, the genotypes HFO 604 (6), HFO 566 (9), HFO 305 (38), HFO 644 (23), HFO 552 (25) and HFO 717 (74) were found better for PF 1 and PF II (Fig.1), meaning hereby that they are superior for green fodder

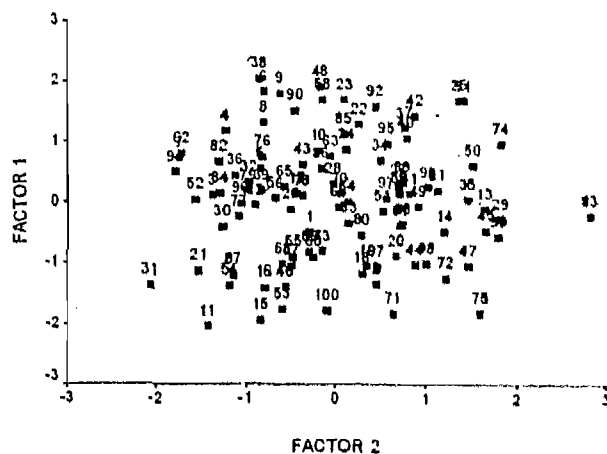


Fig. 1. Location of all entries based on PF scores w. r. t. factors 1 & 2.

Values in parentheses indicate the serial number of genotypes in graph.

yield and for seed yield as well. The results of the present study can be used as a stepping stone for evolving well defined approach based on evaluation and

characterization of genetic variation in oat and can be utilized in various breeding programmes to suit their specific objective.

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INFLUENCE OF IRRIGATION, SULPHUR AND SEED INOCULATION ON YIELD AND SOIL MOISTURE STUDIES OF LATE-SOWN CHICKPEA (*CICER ARIETINUM* L.)

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ABSTRACT

An experiment was conducted to study the effect of irrigation, sulphur and seed inoculation levels on yield and soil moisture studies of chickpea (*Cicer arietinum* L.) variety HC 1 under late sown conditions on sandy loam soil during the winter seasons (*rabi*) of 2000-01 and 2001-02. Two irrigations at pre-flowering and pod-development stages gave 16.4 and 7.4 per cent more seed yield over no irrigation and one irrigation given at pre-flowering stage, respectively. The consumptive water use (CWU) and moisture use rate increased with every additional irrigation level to a maximum of 232.56 and 1.69 mm day⁻¹ during 2000-01 and 240.88 and 1.73 mm day⁻¹ during 2001-02, respectively. The highest WUE (7.71 and 7.29 kg ha⁻¹ mm⁻¹) was recorded in no irrigation. Soil moisture extraction pattern showed that under unirrigated condition crop showed a tendency to extract more moisture from deeper soil layers (30-60 and 60-90 cm) as compared to irrigated conditions which extracted more water from upper layers (0-15 and 15-30 cm). Application of 40 kg S ha⁻¹ resulted in better yield, CWU and WUE than control and 20 kg S ha⁻¹. Inoculation with *Rhizobium*+PSB significantly increased seed yield and improved soil moisture use over single inoculation of *Rhizobium* or PSB and no inoculation.

Key Words : Chickpea, Irrigation, Sulphur, *Rhizobium*, PSB, Consumptive water use, WUE, Moisture use rate and Soil moisture extraction pattern.

The demand of pulses for vegetable proteins is increasing day by day in India. Thus, demand and supply had a bearing on its use in dietary. Due to sky rocketing prices of pulses, farmers are sowing chickpea crop under late conditions, after the harvest of cotton, even in December wherever irrigation facilities are available. It is grown almost as a rainfed crop and has been reported that it responds well to stored soil moisture or winter precipitation and application of irrigation under late sown conditions (Dumbre and Deshmukh, 1983). Continuous use of S-free fertilizers, intensification of agriculture with high yielding crop varieties and use of scarce amount of organics resulted into S-deficiency in crops. Sulphur plays an important role in the formation of S-containing essential amino acids (cysteine, methionine and cystine), synthesis of proteins and promotion of nodulation. Since chemical fertilizers are not only in short supply but also expensive,

hence there is need to supplement these with organic sources more particularly biofertilizers of microbial origin which are cheaper, pollution free and renewable (Mukherjee and Rai, 2000). Since information on the performance of chickpea in respect of optimum irrigation and sulphur levels with suitable seed inoculants under late sown conditions is meagre, the present investigation was undertaken.

MATERIAL AND METHODS

The field experiment was conducted for two consecutive *rabi* seasons of 2000-01 and 2001-02 at the Agronomy Research Farm of CCS Haryana Agricultural University, Hisar. The soil was sandy loam; low in organic carbon (0.34%), available nitrogen (197.5 kg N ha⁻¹) and sulphur (9.4 ppm); medium in available phosphorus (17.8 kg P₂O₅ ha⁻¹); high in available potassium (369.5 kg K₂O ha⁻¹) and slightly

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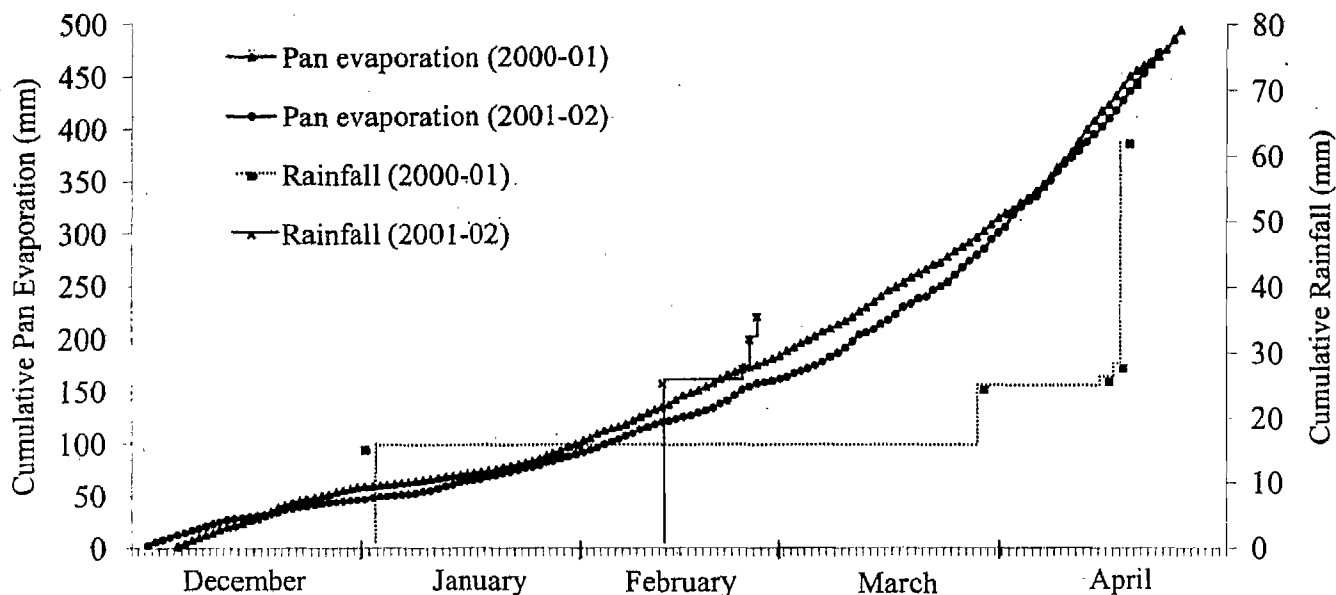


Fig. 1. Rainfall and pan evaporation of crop growth period during 2000-01 and 2001-02.

alkaline in reaction (pH 7.7). The physical constants of the soil have been given in Table 1. The experiment was laid out in split plot design with three replications. The treatments consisted of three irrigation levels, viz. no post-sowing irrigation (I_0), one irrigation at pre-flowering stage (I_1), and two irrigations at pre-flowering and pod-development stage (I_2) and three sulphur levels, viz. control (S_0), 20 kg S ha⁻¹ (S_1), and 40 kg S ha⁻¹ (S_2) in main plots while four seed inoculation levels, viz. no inoculation (B_0), seed inoculation with *Rhizobium* (B_1), seed inoculation with PSB-phosphorus solubilizing bacteria (B_2) and seed inoculation with *Rhizobium*+PSB (B_3) in sub-plots.

TABLE 1

Physical constants of the soil of the experimental site

Physical constants	Depth of soil profile (cm)			
	0-15	15-30	30-60	60-90
Field capacity (%)	22.07	21.13	20.83	20.61
Permanent wilting point (%)	8.53	7.90	7.70	7.34
Bulk density (g/cc)	1.41	1.44	1.45	1.46

Chickpea variety 'HC 1' was sown on 7 December, 2000 and 3 December, 2001 in rows 30 cm

apart by kera method using seed @ 50 kg ha⁻¹ and harvested on 24 April, 2001 and 21 April, 2002, respectively, during the two years. A measured quantity of 60 ha mm canal water was applied at each irrigation. Nitrogen (16 kg N ha⁻¹) and phosphorus (40 kg P₂O₅ ha⁻¹) were applied through DAP, while sulphur was applied through gypsum as per treatments as basal application. About 6 h before sowing, the seeds were inoculated with respective seed inoculants as per treatments. The other agronomic practices were followed as per recommendations. The total rainfall was 70.8 and 37.3 mm with 4 and 3 rainy days during two respective crop seasons, however, in first year most of rainfall was received at the end of crop season while in second year during mid of the crop season (Fig. 1). The cumulative pan evaporation for the crop growth period was 494.8 and 473.3 mm during 2000-01 and 2001-02, respectively.

RESULTS AND DISCUSSION

Effect on Seed Yield

Irrigation level I_2 gave significantly higher seed yield than I_1 and I_0 , while I_1 was significantly superior over I_0 during both the seasons. The increase in seed

TABLE 2.
Influence of irrigation, sulphur levels and seed inoculation on seed yield, consumptive water use and water-use efficiency of chickpea

Treatments	Seed yield (kg ha ⁻¹)	Consumptive water use (mm)										Water-use efficiency (kg ha ⁻¹ mm ⁻¹)		
		0-15 cm		15-30 cm		30-60 cm		60-90 cm		0-90 cm				
		2000-01	2001-02	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02		2000-01	2001-02
Irrigation levels														
I ₀	1379	1475	65.97	68.22	26.49	29.64	44.72	47.01	41.67	44.37	178.85	189.24	7.71	7.79
			(36.89)	(36.05)	(14.81)	(15.66)	(25.00)	(24.84)	(23.30)	(23.45)				
I ₁	1483	1611	95.49	92.92	42.32	45.66	37.84	40.27	33.57	35.72	209.22	214.57	7.09	7.51
			(45.64)	(43.31)	(20.23)	(21.28)	(18.09)	(18.77)	(16.04)	(16.64)				
I ₂	1595	1728	112.22	109.70	54.61	59.96	35.32	38.07	30.41	33.15	232.56	240.88	6.86	7.17
			(48.25)	(45.55)	(23.48)	(24.89)	(15.19)	(15.80)	(13.08)	(13.76)				
C. D. at 5%	77	87	-	-	-	-	-	-	-	-	-	-	-	-
Sulphur levels														
S ₀	1371	1481	89.70	89.15	39.86	43.73	38.05	40.16	34.03	36.47	201.64	209.51	6.80	7.06
			(44.48)	(42.55)	(19.77)	(20.87)	(18.87)	(19.17)	(16.88)	(17.41)				
S ₁	1496	1619	91.53	90.61	41.39	45.42	39.57	42.24	35.50	38.08	207.99	216.35	7.19	7.48
			(44.01)	(41.88)	(19.90)	(20.99)	(19.02)	(19.53)	(17.07)	(17.60)				
S ₂	1589	1714	92.45	91.08	42.17	46.11	40.26	42.95	36.12	38.69	211.00	218.83	7.53	7.83
			(43.81)	(41.62)	(19.99)	(21.07)	(19.08)	(19.63)	(17.12)	(17.68)				
C. D. at 5%	77	87	-	-	-	-	-	-	-	-	-	-	-	-
Seed inoculation														
B ₀	1441	1553	90.45	89.66	40.48	44.38	38.55	41.09	34.58	37.06	204.06	212.19	7.06	7.32
			(44.32)	(42.25)	(19.84)	(20.92)	(18.89)	(19.36)	(16.95)	(17.47)				
B ₁	1480	1598	91.19	90.25	41.12	45.04	39.28	41.71	35.23	37.75	206.82	214.75	7.16	7.44
			(44.09)	(42.03)	(19.88)	(20.97)	(18.99)	(19.43)	(17.04)	(17.58)				
B ₂	1474	1592	91.03	90.15	41.00	44.94	39.14	41.59	35.12	37.60	206.29	214.28	7.15	7.43
			(44.13)	(42.07)	(19.87)	(20.97)	(18.98)	(19.41)	(17.02)	(17.55)				
B ₃	1546	1676	92.22	91.05	41.99	45.98	40.20	42.73	35.95	38.60	210.36	218.36	7.35	7.68
			(43.84)	(41.70)	(19.96)	(21.06)	(19.11)	(19.57)	(17.09)	(17.67)				
C. D. at 5%	29	26	-	-	-	-	-	-	-	-	-	-	-	-

Figures in parentheses indicate the percentage consumptive water use of each layer from the total soil profile.

yield due to irrigation levels I_2 and I_1 over I_0 was 15.7 and 7.5 per cent during 2000-01 and 17.2 and 9.2 per cent during 2001-02, respectively (Table 2). Application of irrigation increased water availability, which in turn improved growth characteristics and these characteristics improved yield attributes, which ultimately resulted in significantly higher seed yield. Higher rate of consumptive use of water (Table 2) with increasing levels of irrigation also increased the seed yield. Youseti *et al.* (1997) recorded maximum seed yield of chickpea with two irrigations scheduled at pre-flowering and pod-filling stages which confirmed the results of present investigation.

Successive increase in sulphur levels increased the seed yield significantly over their preceding levels during both the years of investigation. Application of 40 and 20 kg S ha⁻¹ gave 218 and 125 kg ha⁻¹ in 2000-01 and 233 and 138 kg ha⁻¹ in 2001-02 more seed yield over control, respectively. The increase in yield due to sulphur application may be attributed to balanced nutrition and increased growth and yield parameters indicating that sulphur is crucial for achieving higher yields (Saraf *et al.*, 1997).

The seed inoculation with *Rhizobium* and PSB (B_3) significantly increased the seed yield over other levels of seed inoculation (B_2 , B_1 and B_0); however, the seed inoculation levels B_2 and B_1 were found to be statistically at par but significantly superior to B_0 in both the years of investigation. The per cent increase in seed yield due to B_3 , B_2 and B_1 over B_0 was 7.3, 2.3 and 2.7 per cent during 2000-01 and 7.9, 2.5 and 2.9 per cent during 2001-02, respectively. The favourable effect of seed inoculation on seed yield could be attributed to enhanced growth, nodulation and yield attributes. Similar beneficial effects of seed inoculation on yield of chickpea were reported by Solaiman (1999) and Meena *et al.* (2001).

Effect of Irrigation on Water Use

Increasing levels of irrigation resulted in increased consumptive water use (CWU) and decreased water-use efficiency (WUE) during both the

years (Table 2). The highest CWU of 232.56 and 240.88 mm was found in irrigation level I_2 during 2000-01 and 2001-02, respectively. A marked reduction in CWU was observed with corresponding decrease in number of irrigations from two in I_2 , one in I_1 and no post-sowing irrigation in I_0 . The CWU was more from upper soil layers (0-15 and 15-30 cm) by I_1 and I_2 , while it was more from deeper layers (30-60 and 60-90 cm) in case of I_0 . The increased CWU with increase in number of irrigations might be due to the fact that surface layers under higher frequency of irrigations remained wet for a longer duration thereby creating the condition for higher rate of evaporation as compared to the dry regimes. The application of irrigation increased soil moisture content, which in turn increased the loss of water from soil via plant to atmosphere. Lesser stomatal resistance in higher levels of irrigation increased transpiration rate of crop (Sinha and Singh, 1977). Further it appears that the increase in soil moisture status with I_2 resulted in more vegetative growth thereby increased loss of water by transpiration, which may be responsible for higher water use.

The water-use efficiency was highest (7.71 and 7.79 kg ha⁻¹ mm⁻¹) in I_0 followed by I_1 (7.09 and 7.51 kg ha⁻¹ mm⁻¹) and lowest in I_2 (6.86 and 7.17 kg ha⁻¹ mm⁻¹) in 2000-01 and 2001-02, respectively. The higher WUE associated with low soil moisture status (I_0) was due to proportionately greater increase in seed yield than the increase in water use because crop plants try to economise the water loss under limited water supply conditions (Yusuf *et al.*, 1980).

Upto 60 DAS there was almost no difference in moisture use rate due to irrigation treatments but during 61-90 DAS, I_1 and I_2 used equal water which was more than I_0 (Table 3). From 91 DAS onwards moisture use rate increased with increasing levels of irrigation. Moisture use rate over entire crop season (sowing-harvest) increased with increasing levels of irrigation. The increase in rate of water use was increased with increasing levels of irrigation due to increased CWU with irrigation levels. Similar results were also reported by Aujla and Cheema (1985).

TABLE 3
Influence of irrigation, sulphur levels and seed inoculation on moisture use rate (mm day⁻¹) of chickpea

Treatments	Sowing - 30 DAS		31-60 DAS		61-90 DAS		91-120 DAS		121 DAS-harvest		Sowing-harvest	
	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02
Irrigation levels												
I ₀	1.21	0.75	1.00	1.03	1.30	2.06	1.16	1.41	1.30	1.67	1.30	1.36
I ₁	1.19	0.75	1.01	1.03	1.74	2.46	1.60	1.84	1.44	1.69	1.52	1.54
I ₂	1.20	0.75	1.00	1.03	1.74	2.46	2.29	2.61	1.52	1.85	1.69	1.73
Sulphur levels												
S ₀	1.19	0.74	0.98	1.01	1.54	2.29	1.63	1.89	1.38	1.66	1.46	1.51
S ₁	1.20	0.75	1.00	1.03	1.60	2.34	1.70	1.97	1.43	1.76	1.51	1.56
S ₂	1.21	0.76	1.02	1.05	1.62	2.36	1.73	1.99	1.46	1.79	1.53	1.57
Seed inoculation												
B ₀	1.19	0.75	1.00	1.02	1.57	2.31	1.65	1.92	1.40	1.70	1.48	1.53
B ₁	1.20	0.75	1.00	1.03	1.59	2.33	1.68	1.95	1.42	1.73	1.50	1.54
B ₂	1.20	0.75	1.00	1.03	1.59	2.32	1.68	1.95	1.41	1.72	1.50	1.54
B ₃	1.21	0.76	1.02	1.04	1.62	2.36	1.72	1.99	1.45	1.78	1.52	1.57

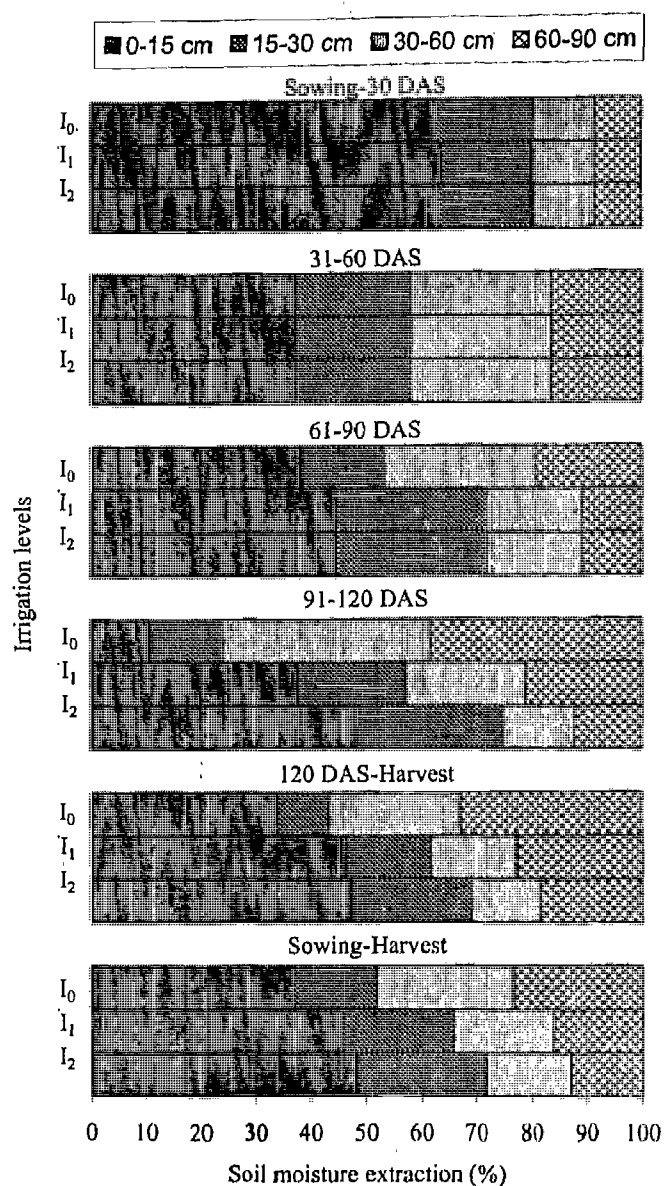


Fig. 2. Effect of irrigation levels on soil moisture extraction (%) from different soil layers by chickpea during 2000-01.

Effect of Irrigation on Soil Moisture Extraction

Upto 60 DAS there was almost no difference in soil moisture extraction pattern during both the years (Figs. 2 and 3). From 61 DAS onwards irrigation level I₂ extracted maximum soil moisture from upper soil layers (0-15 and 15-30 cm) followed by I₁ and lowest in I₀, while reverse trend was observed under deeper soil layers (30-60 and 60-90 cm); however, during 61-90 DAS I₂ and I₁ were almost identical. The trend

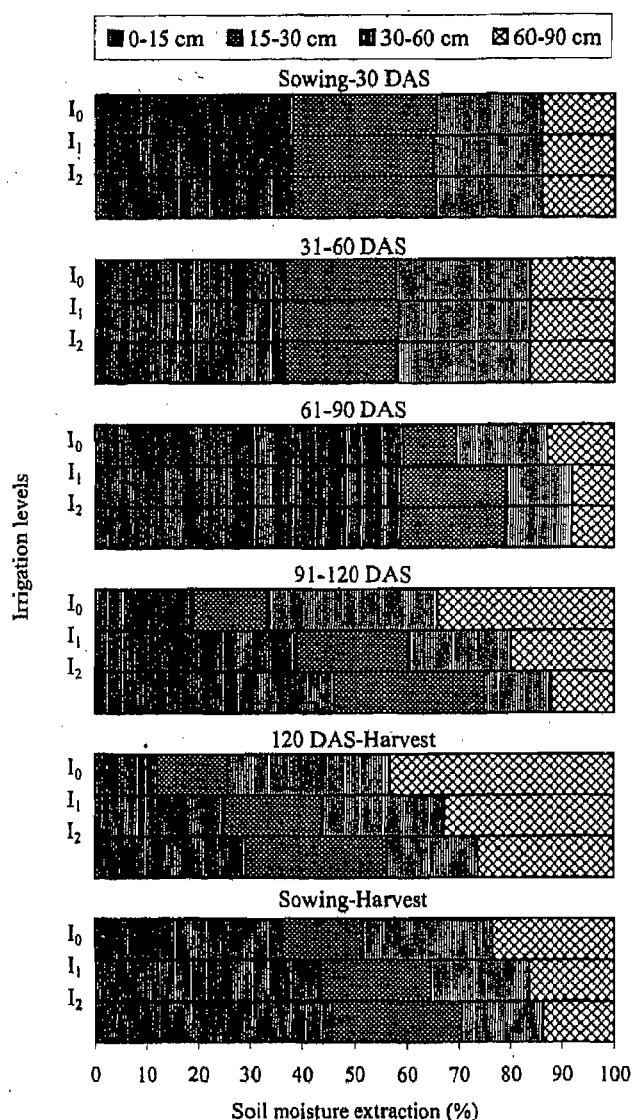


Fig. 3. Effect of irrigation levels on soil moisture extraction (%) from different soil layers by chickpea during 2001-02.

was similar in both the years. Soil moisture extraction pattern over entire crop season showed that under unirrigated condition (I_0) crop had a tendency to extract more moisture from deeper soil layers (30-60 and 60-90 cm) as compared to irrigated conditions (I_1 and I_2) which extracted more water from upper layers (0-15 and 15-30 cm). In general, the soil moisture extraction pattern revealed that per cent removal of water by the crop decreased with the increase in depth of soil profile under I_1 and I_2 , however, under I_0 extraction of water increased with increasing soil depth except in 15-30 cm soil layer where it was lowest. The

lowest extraction of water from 15-30 cm was due to two reasons. First, its depth was less (15 cm) as compared to lower 30-60 and 60-90 cm layers and secondly there was no contribution from rains in this layer when compared with top 0-15 cm layer where low intensity rains wetted the layer upto 15 cm. Higher moisture extraction from upper layers under high moisture regime (I_2 and I_1) may be attributed to more availability of water and better ramification of roots in the upper layers besides additive effects of higher transpiration from increased growth and more water loss from the soil surface through evaporation. As the quantity of water in upper most surface decreased by reducing the number of irrigations, the loss of water by evaporation and absorption by plants might have also been reduced and, therefore, the extraction of water from the lower layers increased due to more penetration of roots in the lower depth because moisture stress promotes extensive root growth in lower layers (Parihar, 1990).

Effect of Sulphur and Seed Inoculation on Water Use

Slight increase in the consumptive use of water and moisture use rate was observed with increasing levels of sulphur application for different crop stages as well as entire crop season during both the years of experimentation. Each successive increase in sulphur level increased the water-use efficiency over their preceding levels during both the years. Varying sulphur levels did not influence the soil moisture extraction pattern markedly during both the years, however, the crop showed a tendency to extract more moisture from deeper soil layers with increase in the levels of sulphur.

Various seed inoculation levels had almost identical effect on consumptive water use, moisture use rate and soil moisture extraction pattern from different soil layers at different crop stages as well as entire crop season in both the years. Highest water-use efficiency was obtained with B_3 level of seed inoculation followed by B_1 , B_2 and lowest with B_0 during both the years.

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EFFECT OF DIFFERENT FACTORS ON OXIDATION OF ELEMENTAL SULPHUR IN SOILS OF HARYANA

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ABSTRACT

Effect of soil type, levels of elemental S and organic matter on oxidation of sulphur were studied at constant temperature (30°C) and moisture (FC) in a series of laboratory experiments. The oxidation of elemental S initially increased at fast rate attaining peak on 18th day of incubation and thereafter slowed down. Comparatively, oxidation of S in sandy soil was faster than clay loam soil. Increasing doses of S application resulted in a significant decrease in S oxidation. Application of FYM increased the rate of oxidation of elemental S. The rate of S oxidation in sandy soil increased with increasing temperature from 5° to 35°C and thereafter decreased drastically at 45°C. The oxidation of S increased significantly with increasing water potential from -1.5 to -0.3 M pa and thereafter decreased with increase in water content $\mu\text{g pot}^{-1}$ upto saturation.

Key Words : Oxidation, Sulphur, Moisture, Temperature.

Now-a-days, sulphur is becoming a limiting nutrient in soils of north India particularly in the area of intensive cultivation. The response of sulphur application on legume and oil seed crops has been reported in Haryana soils and the response is very much clear in sandy soils having low organic matter (Dev and Kumar, 1982). Amongst different S sources, the elemental S and SSP have superiority over pyrite and gypsum. Elemental S is considered as an excellent source of sulphur and it should be applied before sowing so that it gets oxidized into sulphate well in time and becomes available maximum to the plants. The main factors affecting the S oxidation and its availability to plants are soil type, temperature, elemental S levels, water content and organic matter. Hence, the present experiment was conducted to study the effect of these factors on the oxidation of elemental S in different soils of Haryana.

MATERIAL AND METHODS

The experimental surface soils (0-15 cm) were collected from different agro-climatic zones of Haryana state. These soils were air-dried and sieved through 2 mm sieve and analyzed for different physico-chemical properties (Table 1). To study the effect of different factors on S oxidation, a series of laboratory experiments were conducted. To examine the effect of soil types on

S oxidation, different textured soils were treated with 200 ppm elemental S and incubated at constant temperature (30°C) and moisture (FC) for different periods. The effect of organic matter (0, 1 and 2 per cent w/w basis) on same S-levels (200 ppm) and effect of sulphur application (0, 100, 200 and 400 ppm S) on prescribed temperature and moisture were also studied only in Ludas sandy soil. The oxidation of sulphur under different water potentials (-1.5, -0.1, -0.03 and 0.00 M pa) at constant temperature (30°C) and under different temperatures (5°, 15°, 25°, 30°, 35° and 45°C) at constant moisture level (FC) was also studied in Ludas sandy soil. All these experiments were conducted in polyethylene bottles of capacity 125 ml carrying 20 g soil. After applying different treatments, mouths of bottles were covered with polyethylene sheet having small holes for aeration. Moisture level was maintained daily on weight basis. All these treatments were replicated four times and incubated for different intervals (6, 12, 18, 24, 36 and 48 days). After each incubation period, the treated soils were extracted with Morgan's reagent and analyzed for sulphate-S by turbid metric method as described by Chesnin and Yien (1950).

RESULTS AND DISCUSSION

The perusal of data in Table 2 indicated that the

TABLE 1

Physico-chemical properties of different experimental soils

Soil properties	Location of soils				
	Ludas	Hisar	Bohar	Karnal	Kaul
pH 1 : 2	8.2	7.9	8.4	8.1	7.9
EC _{1:2} (dSm ⁻¹)	0.26	1.05	1.2	0.21	0.39
CEC (C mol P ⁺ kg ⁻¹)	4.5	9.8	10.2	12.5	15.2
CaCO ₃ (%)	0.15	0.18	0.39	0.25	0.64
Field capacity (%)	12.5	17.1	16.1	18.6	23.0
Saturation (%)	25.0	33.0	31.8	37.5	45.0
Organic carbon (%)	0.05	0.32	0.28	0.41	0.37
Available N (ppm)	31.0	91.2	105	98.2	110
Available P (ppm)	4.6	9.7	12.5	14.6	9.2
Available K (ppm)	63.0	120	148	160	114
Available S (ppm)	8.0	21.5	14.5	18.0	25
Total S (ppm)	48.0	200	175	205	212
Classification	Typic Ustipsamment	Ustochreptic Camborthids	Typic Ustochrepts	Typic Ustochrepts	Acric Ochraqualfs
Sand (%)	93.2	75.7	72.1	55.5	44.8
Silt (%)	2.7	9.5	9.5	23.9	20.6
Clay (%)	4.1	14.8	18.4	20.6	34.6
Texture	Sandy	Sandy loam	Sandy loam	Loam	Clay loam

TABLE 2

Effect of soil type on sulphur oxidation in different soils

Soil type	Incubation period (days)					
	6	12	18	24	36	48
	SO ₄ -S (ppm)					
Sandy (Ludas)	51.4	84.8	115.7	129.9	154.6	173.2
Sandy loam (Bohar)	42.4	78.7	102.6	123.6	148.3	168.3
Sandy loam (Hisar)	49.7	83.3	108.3	127.8	151.5	170.4
Loam (Karnal)	40.7	76.9	100.3	124.5	146.7	165.4
Clay loam (Kaul)	38.8	70.6	98.3	118.3	142.3	162.5
LSD (0.05)	Days=1.84, Soils=1.68, Days x Soils=4.12					

oxidation of S decreased with increased clay content in soil. The overall trend of S-oxidation in different soils

was in order : sandy soil (Ludas) > sandy loam (Hisar) > Sandy loam (Bohar) > loam (Karnal) > clay loam (Kaul). At the end of 48 days study the oxidation of added S in sandy (Ludas), sandy loam (Hisar), sandy loam (Bohar), loam (Karnal) and clay loam (Kaul) was 86.6, 85.2, 84.1, 82.7 and 81.2 per cent, respectively. These results indicate that the S-oxidation was negatively correlated with clay content of soil. Similar results have also been reported by various workers (Singh and Kumar, 1982; Skiba and Wainwright, 1984).

The oxidation of added S increased with rise in temperature from 5° to 35°C and thereafter it decreased drastically with rise in temperature from 35° to 45°C (Table 3). The oxidation of elemental S was maximum during initial 18 days and thereafter it slowed down. At the end of 48 days study, the oxidation of added elemental-S at 5°, 15°, 25°, 30°, 35° and 45°C temperatures was about 22, 35, 69, 87, 90 and 36 per cent, respectively. The decrease in S-oxidation at high

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TABLE 3

Effect of temperature on sulphur oxidation in sandy soil

Temperature (°C)	Incubation period (days)					
	6	12	18	24	36	48
	SO ₄ -S (ppm)					
5	12.9	21.4	29.2	32.5	38.7	43.5
15	20.6	34.1	46.3	52.1	61.8	69.4
25	41.1	67.8	92.6	103.9	123.7	138.6
30	51.4	84.8	115.7	129.9	154.6	173.2
35	61.3	95.9	132.8	163.0	178.0	180.3
45	21.7	35.7	48.7	54.6	65.2	72.6

LSD (0.05) Days=1.56, Temperature=1.56,
Days x Temperature=3.84

temperature may be attributed to decrease in activity of oxidizing organisms. Nor and Tabatabai (1977) found 8.2 and 47 per cent mean oxidation of applied elemental S in five soils at 5° and 30°C, respectively. Skiba and Wainwright (1984) found highest rate of oxidation of elemental-S at 37°C and thereafter a sharp decrease was observed at 45°C. These findings are also corroborated with the results of Boswell *et al.* (1992) and Germida and Janzen (1993).

The effect of sulphur levels on its oxidation rate was erratic and was not found to follow any trend with increased level of S application (Table 4). The oxidation of applied-S at 100, 200 and 400 ppm S level at the end of 48 days incubation study was 87.8, 86.6 and 71.0 per

TABLE 4

Effect of elemental S on its oxidation in sandy soil

S-level (ppm)	Incubation period (days)					
	6	12	18	24	36	48
	SO ₄ -S (ppm)					
0	10.5	10.9	11.8	11.5	11.2	11.7
100	27.7	48.8	66.7	75.5	78.5	87.8
200	51.4	84.8	115.7	129.9	154.6	173.2
400	82.3	133.2	182.3	207.9	246.1	284.0

LSD (0.05) Days=1.91, S-levels=1.56,
Days x S-levels=3.82

cent, respectively. This indicated that the rate of sulphur oxidation did not increase with increasing level of applied S but significant increase was found with time of incubation. Singh and Kumar (1982) also found increase in oxidation of S with increasing levels of S in soils with time.

The oxidation rate of elemental S increased significantly with increase in water potential from -1.5 to -0.3 M pa and thereafter decreased at saturation level but was still higher than at -1.5 M pa (Table 5).

TABLE 5

Effect of water potential on sulphur oxidation in sandy soil

Water potential (M pa)	Incubation period (days)					
	6	12	18	24	36	48
	SO ₄ -S (ppm)					
-1.5	15.4	25.5	34.7	38.8	46.2	52.1
-0.1	36.1	59.8	81.2	90.8	107.9	120.8
-0.03	51.4	84.8	115.7	129.9	154.6	173.2
0.00	21.2	34.9	47.5	53.2	63.3	70.8

LSD (0.05) Days=2.99, Water potential=2.44,
Days x water potential=5.98

At the end of 48 days study, the oxidation of added S at -1.5, -0.1, -0.03 and 0 M pa water potentials was 26.8, 60.4, 86.6 and 35.5 per cent, respectively. This indicated that the rate of S oxidation with rise in water potential from -1.5 to -0.1 and -0.03 M Pa becomes almost double and triple, respectively. The field capacity moisture level (-0.03 M Pa) was found as the most suitable range of water potential for S oxidation. It may be due to the maximum activity of enzymes at such conducive conditions. Moreover, at field capacity the soil remains much aerobic and hence more oxidized condition probably supports highest S oxidation. Similar results were also reported by various workers (Singh and Kumar, 1982; Wainwright, 1984; Lee *et al.*, 1988; Germida and Janzen, 1993).

Addition of organic matter had little stimulatory effect on S oxidation over control, but increased FYM level from 1 to 2 per cent had non-significant effect on S-oxidation (Table 6). At the end of 48 days period, the

TABLE 6
Effect of organic matter on sulphur oxidation in sandy soil

Organic matter level (%)	Incubation period (days)					
	6	12	18	24	36	48
	SO₄-S (ppm)					
0	51.4	84.8	115.7	129.9	154.6	173.2
1	52.1	86.6	122.3	135.6	167.7	181.5
2	52.6	89.1	128.5	140.7	170.8	182.1

LSD (0.05) Days=3.95, Organic matter=2.79,

Days x Organic matter=6.85

increase in S oxidation over control (86.6%) due to

applied 1 and 2 per cent organic matter was 4.1 and 4.4 per cent, respectively. A positive effect of organic matter application on S oxidation may be due to the supply of various microbes in the soils, which hastened the process of S oxidation. Wainwright (1984) reported that although the process of oxidation of elemental S is mainly dependent on autotrophic bacteria belonging to thiobacillus group, but there are also heterotrophs including certain fungi, actinomycetes that can oxidize elemental S in soils. The positive effect of organic matter on S oxidation has also been reported by other workers (Janzen and Bettany, 1987; Skiba and Wainwright, 1984; Ghani *et al.*, 1992).

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EFFECT OF NITROGEN, FYM AND METRIBUZIN ON YIELD AND NITROGEN CONTENT OF WHEAT (*TRITICUM AESTIVUM* L.)

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ABSTRACT

Application of N significantly increased the wheat grain yield over control and the extent of increase was 9.18 g pot⁻¹ with 200 mg N kg⁻¹ soil over control. The highest response per unit N was observed at 150 mg N kg⁻¹ soil. Application of FYM (1%) significantly increased the grain yield of wheat over N alone at all levels of N application. The grain yield of wheat decreased significantly with the increasing levels of weedicide (200 to 400 a. i.) in both FYM and N treatments. The deleterious effect of weedicide was more pronounced in N₀ and FYM₀ treatments. Straw yield followed the similar trend as in case of grain yield. There was a significant and successive increase in N content of wheat grain and straw with the increase in N levels from 0 to 200 mg N kg⁻¹ soil with or without FYM. Nitrogen content in wheat grain was at par in 150 mg N kg⁻¹ soil and 100 mg N + FYM kg⁻¹ soil. N content in wheat straw was also at par in 200 mg N kg⁻¹ and 150 mg N kg⁻¹ + FYM treatments. With the increasing level of weedicide application, the N contents of wheat grain and straw decreased significantly at all the levels of N and FYM.

Intensive agriculture and use of chemical fertilizers to get maximum yields have led to the depletion of inherent soil fertility. The demand for nitrogenous fertilizers can be lowered down by supplementing the nutrients through organic manures. In addition to nutrients supply, organic manure may improve the physical condition of soil and availability of native nutrients in the soil. Among organic manures, FYM, green manuring and compost are commonly used. With the development in agricultural research, a large quantity of weedicides is being used to control weeds in wheat. In Haryana, *Phalaris minor* is the main weed which creates serious problem in wheat cultivation. Isoproturon is commonly used to control this weed. Due to resistance of *Phalaris minor* to isoproturon, metribuzin may also be used to control this weed. Therefore, this investigation was planned to study the effect of nitrogen and FYM on yield and nitrogen uptake by wheat in presence of weedicide (metribuzin).

MATERIAL AND METHODS

Pot experiment was conducted in the screen house. The soil used in pot experiment was sandy loam in texture, low in available N, pH (1 : 2) 7.7, EC

(1 : 2) 0.34 dSm⁻¹, NH₄-N and NO₃-N contents were 14.4 and 69.92 mg kg⁻¹ soil, respectively. Five levels of N (0, 50, 100, 150 and 200 mg kg⁻¹ soil through urea), two levels of FYM (0 and 1 per cent on dry weight basis) and three levels of weedicide metribuzin (0, 200 and 400 g a.i. ha⁻¹) were applied. A basal dose of P, K and Zn @ 60, 60 and 5 mg kg⁻¹ soil was added through SSP, MOP and ZnSO₄, respectively at sowing. Half of the N was applied at sowing and remaining half was applied 21 days after sowing. All the treatments were replicated thrice in CRD design. Four kg air dry soil was spread on a polythene sheet and required amount of fertilizers (solutions of N, P, K and Zn), FYM or in combination as per above treatments were thoroughly mixed. After applying different treatments the soil was shifted to polythene bags and these bags were put in the earthen pots. Ten seeds of wheat var. WH-542 were sown in each pot and after 12 days five plants were maintained in each pot. Weedicide was applied after 35 days of sowing. Interculture operations and irrigation with deionised water were done as per requirement. Crop was harvested at maturity. Grain and straw samples were collected and analyzed for total N.

RESULTS AND DISCUSSION

Grain Yield

Application of N significantly increased the grain yield of wheat and the magnitude of increase was 9.18 g pot⁻¹ with 200 mg N kg⁻¹ soil over control (Table 1). The highest response per unit N added was observed at 150 mg N kg⁻¹ soil over 100 mg N kg⁻¹ soil. The extent of increase in grain yield was low as the N application increased from 150 mg N kg⁻¹ soil (10.37 g pot⁻¹) to 200 mg N kg⁻¹ soil (11.16 g pot⁻¹). Similarly, application of N with FYM significantly increased the grain yield of wheat at all levels of N. The magnitude of increase was also similar between 150 and 200 mg

N kg⁻¹ soil. Application of FYM also increased the grain yield of wheat significantly over control (Table 1). Application of FYM in addition to N also increased grain yield of wheat at all levels of N. However, the effect of FYM was not as prominent as that of N application. These results indicate that the combined use of N and FYM had more beneficial effect than their individual use. Similar results were also reported by Ram (1996).

Grain yield of wheat decreased significantly with the increasing levels of metribuzin (200 and 400 g a.i. ha⁻¹) in both FYM and N treatments. Deleterious effect of metribuzin was more pronounced with FYM₀ and N₀

TABLE 1

Effect of different levels of nitrogen, FYM and metribuzin on grain and straw yields of wheat (g pot⁻¹)

Treatments	Nitrogen levels (mg N kg ⁻¹ soil)					Mean
	0	50	100	150	200	
Grain yield						
FYM (%)						
0	1.98	3.68	6.87	10.37	11.16	6.81
1	2.86	4.25	7.37	10.83	11.46	7.35
Mean	2.42	3.96	7.12	10.60	11.31	
C. D. (0.05)	N=0.11, FYM=0.07, N x FYM=0.16					
Metribuzin (g a.i. ha ⁻¹)						
0	4.27	5.89	8.68	14.32	14.76	9.58
200	2.45	3.61	6.63	9.62	10.36	6.53
400	0.55	2.41	6.06	7.86	8.81	5.14
Mean	2.42	3.97	7.12	10.60	11.31	
C. D. (0.05)	N=0.11, Weedicide=0.09, N x Weedicide=0.20					
Straw yield						
FYM (%)						
0	2.41	4.53	8.75	12.81	13.76	8.45
1	3.56	5.26	9.17	13.73	14.14	9.17
Mean	2.99	4.90	8.96	13.27	13.95	
C. D. (0.05)	N=0.21, FYM=0.13, N x FYM=0.27					
Metribuzin (g a.i. ha ⁻¹)						
0	5.25	7.34	10.96	17.85	18.40	11.96
200	2.97	4.31	8.24	11.77	12.78	8.01
400	0.74	3.04	7.69	10.18	10.67	6.46
Mean	2.99	4.90	8.96	13.27	13.95	
C. D. (0.05)	N=0.21, Weedicide=0.16, N x Weedicide=0.36					

TABLE 2

Effect of different levels of FYM and metribuzin on grain and straw yields of wheat (g pot⁻¹)

Treatments	Metribuzin (g a.i. ha ⁻¹)			Mean
	0	200	400	
Grain yield				
FYM (%)				
0	9.39	6.19	4.86	6.81
1	9.78	6.87	5.41	7.35
Mean	9.58	6.53	5.14	
C. D. (0.05)	FYM=0.07, Weedicide=0.09, FYM x Weedicide=0.36			
Straw yield				
FYM (%)				
0	11.71	7.60	6.05	8.45
1	12.21	8.42	6.88	9.17
Mean	11.96	8.01	6.47	
C. D. (0.05)	FYM=0.13, Weedicide=0.16, FYM x Weedicide=0.23			

treatments (Tables 1 and 2). At N₀, grain yield of wheat decreased upto the extent of about 95%, whereas in case of 200 mg N kg⁻¹ soil the loss was about 40% in presence of metribuzin 400 g a.i. ha⁻¹. However, FYM did not reduce the deleterious effect of metribuzin at the same extent as in case of N. In previous study Anderson (1986) and Schroeder (1989) also reported that yield decreased in wheat through metribuzin application.

Straw Yield

Application of N significantly increased the straw yield of wheat over control at all the levels of N (Table 1). Application of FYM also increased the straw yield of wheat at all the levels of N. As in case of grain yield, highest per unit response was observed at 150 mg N kg⁻¹ soil (12.81 g pot⁻¹) over 100 mg N kg⁻¹ soil (8.75 g pot⁻¹). These findings are similar to those of Patel *et al.* (1991).

Application of FYM significantly increased the straw yield of wheat at all N levels over control (Table 1). The straw yield of wheat was 8.45

g pot⁻¹ with N alone and increased to 9.17 g pot⁻¹ with the application of FYM in addition to N. The response of FYM was recorded at 0 and 50 mg N kg⁻¹ soil.

Straw yield of wheat decreased significantly with the increasing levels of metribuzin (200 to 400 g a.i. ha⁻¹), irrespective of N and FYM treatments (Tables 1 and 2). As in case of wheat grain yield, the deleterious effect of metribuzin was more pronounced at FYM₀ and N₀ treatments. The straw yield of wheat decreased from 5.25 to 2.97 g pot⁻¹ with metribuzin at 200 g a.i. ha⁻¹ and from 5.25 to 0.74 g pot⁻¹ at 400 g a.i. ha⁻¹ where no N was applied. Application of N @ 200 mg N kg⁻¹ soil in presence of metribuzin significantly increased the straw yield of wheat from 2.97 to 12.78 g pot⁻¹ with metribuzin at 200 g a.i. ha⁻¹ and from 0.74 to 10.67 g pot⁻¹ at 400 g a.i. ha⁻¹. Application of FYM also reduced the deleterious effect of metribuzin and straw yield of wheat increased significantly from 8.45 to 9.17 g pot⁻¹ over control in presence of metribuzin.

This indicated that deleterious effect of metribuzin on grain and straw yields of wheat could be reduced with the application of N and FYM.

Nitrogen Content in Wheat Grain

Nitrogen content in wheat grain significantly increased with the increasing levels of N from 0 to 200 mg N kg⁻¹ soil and the extent of increase was from 0.89 to 1.77 per cent over control (Table 3). Application of N also increased the N in wheat grain in presence of FYM at all the levels of N. Kumar *et al.* (1995) also reported the increase in N concentration with the N application in grain and straw of wheat. Application of FYM significantly increased the N concentration in wheat grain over control and the extent of increase was from 1.21 to 1.46 per cent. Bhatia *et al.* (1985) reported that N content in grain and straw of wheat increased significantly with FYM @ 10 t ha⁻¹. Nitrogen concentration in wheat grain at 150 mg N kg⁻¹ soil alone was at par with 100 mg N kg⁻¹ soil + FYM. The highest N concentration in wheat grain was observed in 200 mg N kg⁻¹ soil treatment.

TABLE 3

Effect of different levels of nitrogen, FYM and metribuzin on concentration of nitrogen (%) in grain and straw of wheat

Treatments	Nitrogen levels (mg N kg ⁻¹ soil)					Mean
	0	50	100	150	200	
Grain						
FYM (%)						
0	0.66	1.09	1.18	1.41	1.73	1.21
1	1.13	1.30	1.41	1.65	1.81	1.46
Mean	0.89	1.19	1.30	1.53	1.77	
C. D. (0.05)	N=0.04, FYM=0.02, N x FYM=0.05					
Metribuzin (g a.i. ha ⁻¹)						
0	1.22	1.32	1.41	1.62	1.84	1.48
200	0.96	1.16	1.26	1.50	1.75	1.33
400	0.51	1.12	1.23	1.48	1.73	1.22
Mean	0.89	1.19	1.30	1.53	1.77	
C. D. (0.05)	N=0.04, Weedicide=0.03, N x Weedicide=0.06					
Straw						
FYM (%)						
0	0.33	0.53	0.61	0.71	0.81	0.60
1	0.61	0.67	0.74	0.81	0.87	0.74
Mean	0.46	0.60	0.67	0.76	0.84	
C. D. (0.05)	N=0.04, FYM=0.02, N x FYM=0.06					
Metribuzin (g a.i. ha ⁻¹)						
0	0.59	0.67	0.74	0.84	0.91	0.75
200	0.53	0.58	0.66	0.75	0.82	0.66
400	0.29	0.56	0.64	0.70	0.80	0.60
Mean	0.46	0.60	0.67	0.76	0.84	
C. D. (0.05)	N=0.04, Weedicide=0.03, N x Weedicide=0.07					

Application of metribuzin significantly decreased the N concentration in wheat grain at all levels of N and FYM (Tables 3 and 4). With the application of metribuzin @ 200 g a.i. ha⁻¹ and 400 g a.i. ha⁻¹ N concentration at 0 mg N kg⁻¹ soil decreased significantly from 1.22 to 0.96 and 0.51 per cent, respectively. Nitrogen concentration in wheat grain at 100 mg N kg⁻¹ soil + 400 g a.i. ha⁻¹ metribuzin was almost similar to that of control (N and metribuzin at zero concentration). However, N concentration in wheat grain increased significantly with increasing N levels at both the levels of metribuzin. So, the effect of metribuzin was more pronounced at 0 and 50 mg N kg⁻¹ soil.

Thakre and Saxena (1972) also reported that lindane @ 30 ppm reduced the uptake of N.

Similarly, FYM application significantly decreased the phytotoxic effect of metribuzin (Table 4). Application of FYM increased the N concentration in wheat grain at both the levels of metribuzin and the increase was from 1.06 to 1.37 per cent in presence of metribuzin @ 400 g a.i. ha⁻¹.

Nitrogen Content in Wheat Straw

There was significant and successive increase in N content of wheat straw with increasing N levels

TABLE 4

Effect of different levels of FYM and metribuzin on concentration of nitrogen (per cent) in grain and straw

Treatments	Metribuzin (g a.i. ha ⁻¹)			Mean
	0	200	400	
Grain				
FYM (%)				
0	1.34	1.25	1.06	1.22
1	1.63	1.40	1.37	1.46
Mean	1.48	1.33	1.22	
C. D. (0.05)	FYM=0.02, Weedicide=0.03, FYM x Weedicide=0.04			
Straw				
FYM (%)				
0	0.65	0.61	0.51	0.59
1	0.84	0.70	0.68	0.74
Mean	0.75	0.66	0.60	
C. D. (0.05)	FYM=0.02, Weedicide=0.03, FYM x Weedicide=0.04			

from 0 to 200 mg N kg⁻¹ soil and this increase amounted to 0.38% over control (Table 3). Application of FYM

increased the N in wheat straw at all levels of N application. Nitrogen concentration at 200 mg N kg⁻¹ soil level was at par with 150 mg N kg⁻¹ soil+FYM treatment. However, highest N concentration (0.87%) in wheat straw was observed with 200 mg N kg⁻¹ soil+FYM.

The increasing levels of metribuzin decreased the N content of wheat straw significantly at all levels of N and FYM (Tables 3 and 4). Application of metribuzin @ 200 g a.i. ha⁻¹ and 400 g a.i. ha⁻¹ decreased the N content in wheat straw from 0.59 to 0.53 and 0.29 per cent, respectively. Nitrogen contents of wheat straw at 0, 50 and 100 mg N kg⁻¹ soil were almost at par with 50 mg N kg⁻¹ soil+200 g a.i. ha⁻¹ metribuzin, 100 mg N kg⁻¹ soil+200 g a.i. ha⁻¹ metribuzin and 150 mg N kg⁻¹ soil+200 g a.i. ha⁻¹ metribuzin, respectively. Application of FYM significantly increased the N concentration in wheat straw at both the levels of metribuzin and ranged from 0.61 to 0.70 per cent and 0.51 to 0.68 per cent at 200 g a.i. ha⁻¹ and 400 g a.i. ha⁻¹ metribuzin application.

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EFFECT OF IRRIGATION AND CHLORSULFURON ON WHEAT (*TRITICUM AESTIVUM* L.)

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ABSTRACT

The effect of irrigation and chlorsulfuron application on growth, yield attributes and yield of wheat was studied during two **rabi** seasons of 1998-99 and 1999-2000. Application of five irrigations (21, 45, 65, 85 and 105 DAS) improved the growth, yield attributes and yield of wheat compared to two (21 and 85 DAS) and three (21, 65 and 105 DAS) irrigations. Increase in the grain yield of wheat due to five and three irrigations over two irrigations was 20.3 and 16.2 per cent during 1998-99 and 23.9 and 18.9 per cent during 1999-2000, respectively. Application of chlorsulfuron at 20 and 30 g/ha resulted in better growth, yield attributes and yield of wheat. Maximum grain yield of wheat (4553 and 4849 kg/ha) was attained in the plots treated with chlorsulfuron at 30 g/ha, which was statistically at par with its lower dose (20 g/ha).

Key Words : Irrigation, Chlorsulfuron, Wheat, Weed control.

The new wheat production technology involves the use of high yielding varieties alongwith higher fertilizers and irrigations. These conditions stimulate the growth of crop as well as weeds, which compete with crop plants thereby reducing the yield. The reduction in grain yield of wheat due to unchecked growth of *Phalaris minor*, *Avena ludoviciana*, *Rumex retroflexus*, *Cirsium arvense* and *Chenopodium album* has been observed to the extent of 25 to 60 per cent and sometimes even more depending upon the intensity of weeds (Malik *et al.*, 1989). The sole dependence on germicides like fenoxaprop, clodinafop, isoproturon, metribuzin, diclofop-methyl, tralkoxydim, 2,4-D, fluroxypyris is leading to shift in weed flora in favour of broadleaf weeds (Balyan and Panwar, 1998). For controlling broadleaf weed flora in wheat, there is a need to evaluate some new herbicide (s) like chlorsulfuron, which has great potency against broadleaf weeds in cereals. Irrigation is one of the most important factors for assured crop production as it permits better utilization of all other production factors. Irrigation also affects the herbicide efficiency. In most parts of India, the supply of irrigation water in quantity, time and space falls short of its demand. Hence, there is an imperative need for efficient use of this available scarce resource.

Keeping above points in view, the present investigation was undertaken to evaluate the performance of chlorsulfuron under different irrigation levels in wheat.

MATERIAL AND METHODS

To evaluate the impact of irrigation and weed control methods on the performance of wheat, field experiments were conducted during **rabi** seasons of 1998-99 and 1999-2000 at Research Farm. The soil of the experimental field was sandy loam in texture, low in organic carbon (0.28%) and available nitrogen (187 kg/ha), medium in available phosphorus (18 kg/ha), high in available potash (375 kg/ha) and alkaline in reaction (pH 8.0) with electrical conductivity of 0.36 dS/m. The experiment comprising three irrigation levels (two irrigations at 21 and 85 DAS, three irrigations at 21, 65 and 105 DAS and five irrigations at 21, 45, 65, 85 and 105 DAS) in main plot and six weed control treatments (weedy control, chlorsulfuron at 20, 30, 45 and 60 g/ha and isoproturon @ 1000 g/ha) in sub-plots was laid out in split-plot design with four replications. Wheat variety WH 542 using 100 kg/ha seed was sown on 4th December during 1998 and 1st December during 1999. All the herbicides were sprayed at 30 DAS with knapsack sprayer fitted with flat fan nozzle using

625 l water/ha. All other package of practices were followed as per recommendations for wheat crop. Data on growth, yield attributes and yield were recorded.

RESULTS AND DISCUSSION

Effect on Growth

The growth attributes, viz. plant height and leaf area index increased significantly with increasing number of irrigations during both the years except LAI in 1999-2000 where level of five irrigations being statistically at par with three irrigations but was significantly higher than two irrigations (Table 1). Five irrigations raised dry matter accumulation of wheat to the tune of 10.3 and 16.3 per cent in 1998-99 and 5.1 and 13.7 per cent in 1999-2000 than three and two irrigations, respectively. These results are in close conformity with the findings of Hooda and Agarwal (1987). Application of chlorsulfuron 30 g/ha recorded highest LAI during both the years, while isoproturon 1000 g/ha resulted in maximum plant height. All the growth attributes remained significantly lowest in weedy plots except plant height which was minimum in plots treated with chlorsulfuron at 60 g/ha only during 1998-99 due to toxic effect.

Chlorsulfuron at 20 and 30 g/ha remained at par in respect of all the growth attributes of wheat (Table 1).

Effect on Weeds

Application of five irrigations resulted in significantly higher density and dry weight of weeds than two and three irrigations which were at par among themselves during both the years (Table 2). There were significantly lower density and dry weight of weeds in herbicidal treated plots and were minimum in chlorsulfuron (60 g/ha) treated plots. Both density and dry weight of weeds decreased (73-89 per cent) with the increase in concentration of chlorsulfuron during both the years of study. These results are in close conformity with those of Balyan *et al.* (2000).

Effect on Yield Attributes

Yield attributes (tillers/m.r.l., spike length and grains/spike) increased significantly with increasing number of irrigations from two to five (Table 3). The per cent increase in number of effective tillers/m.r.l. due to five irrigations over three and two irrigations was 14.8 and 22.1 per cent in 1998-99 and 14.5 and 19.7

TABLE 1

Effect of irrigation levels and weed control treatments on growth attributes of wheat

Treatments	Plant height (cm)		Leaf area index at 90 DAS	
	1998-99	1999-2000	1998-99	1999-2000
Irrigation levels				
Two (21 and 85 DAS)	80.67	81.87	4.55	4.65
Three (21, 65 and 105 DAS)	82.45	86.75	4.72	4.79
Five (21, 45, 65, 85 and 105 DAS)	84.12	89.58	5.05	5.12
C. D. at 5%	0.97	1.02	0.10	0.34
Herbicide dose (g/ha)				
Weedy control	81.53	84.33	4.57	4.65
Chlorsulfuron 20	83.53	87.53	4.86	4.94
Chlorsulfuron 30	82.93	86.67	4.90	4.97
Chlorsulfuron 45	81.53	85.20	4.77	4.84
Chlorsulfuron 60	80.93	84.70	4.73	4.80
Isoproturon 1000	83.93	87.76	4.82	4.91
C. D. at 5%	1.38	0.90	0.09	0.20

TABLE 2

Effect of irrigation levels and weed control treatments on density and dry weight of weeds in wheat

Treatments	Weed density at 90 DAS (Number/m ²)		Dry matter of weeds at 90 DAS (g/m ²)	
	1998-99	1999-2000	1998-99	1999-2000
Irrigation levels				
Two (21 and 85 DAS)	8.60 (74.5)	8.96 (80.6)	65.98	74.02
Three (21, 65 and 105 DAS)	8.76 (75.2)	9.18 (84.1)	67.12	76.0
Five (21, 45, 65, 85 and 105 DAS)	8.93 (79.9)	9.57 (89.5)	72.48	81.24
C. D. at 5%	0.24	0.28	1.31	2.04
Herbicide dose (g/ha)				
Weedy control	13.53(181.5)	13.43(180.8)	107.40	116.28
Chlorsulfuron 20	7.58 (57.2)	7.90 (61.7)	63.83	72.30
Chlorsulfuron 30	7.39 (53.6)	7.74 (59.2)	59.43	67.58
Chlorsulfuron 45	7.28 (52.5)	7.66 (57.3)	56.50	62.17
Chlorsulfuron 60	7.07 (48.8)	7.49 (55.6)	51.80	56.53
Isoproturon 1000	8.09 (63.7)	9.73 (93.9)	72.20	87.67
C. D. at 5%	0.31	0.40	1.37	2.42

Original values given in parentheses were subjected to square root transformation $\sqrt{X+1}$ before analysis.

per cent in 1999-2000, respectively. The corresponding values for number of grains/spike were 6.8 and 5.5 per cent in 1998-99 and 12.7 and 9.5 per cent in 1999-2000, respectively. Kumar *et al.* (1994) also recorded improved yield attributes with frequent irrigations. Chlorsulfuron at 30 and 20 g/ha being statistically at par recorded significantly higher number of effective tillers/m.r.l., spike length and grains/spike than rest of weed control treatments. However, chlorsulfuron 20 g/ha and isoproturon 1000 g/ha were statistically at par in case of grains/spike. Application of chlorsulfuron at 20 and 30 g/ha also resulted in bolder grains, however, the differences in 1000-grain weight were non-significant among irrigation levels as well as chlorsulfuron doses.

Effect on Crop Yield

Grain as well as straw yield of wheat increased significantly with increasing number of irrigation

during both the years (Table 3). Increase in grain yield due to five and three irrigations over two irrigations was 20.3 and 16.2 per cent during 1998-99, and 23.9 and 18.9 per cent during 1999-2000, respectively. Both grain and straw yield were significantly higher in plots treated with chlorsulfuron at 30 and 20 g/ha as compared to chlorsulfuron 45 or 60 g/ha, isoproturon 1000 g/ha, and weedy control plots during both the crop seasons. The maximum grain yield (4553 and 4849 kg/ha) was obtained in the plots treated with chlorsulfuron at 30 g/ha, which was statistically at par with chlorsulfuron 20 g/ha. This might be due to the fact that grain yield of wheat was dependent on the spectrum of weed flora and efficiency of herbicides against the existing weed flora. Increase in yield with chlorsulfuron at 20 and 30 g/ha could be attributed to the improved yield attributes of wheat. Bhushan and Kumar (1999) and Malik *et al.* (1999) also reported similar results.

TABLE 3
Effect of irrigation levels and weed control treatments on yield attributes and yield of wheat

Treatments	Number of effective tillers/m.r.i.		Length of spike (cm)		Number of grains/spike		Grain yield (kg/ha)		Straw yield (kg/ha)	
	1998-99	1999-2000	1998-99	1999-2000	1998-99	1999-2000	1998-99	1999-2000	1998-99	1999-2000
Irrigation levels										
Two (21 and 85 DAS)	66.87	74.38	9.88	10.70	43.88	50.66	3705	3788	5568	5732
Three (21, 65 and 105 DAS)	73.11	79.20	10.23	11.13	46.87	52.86	4422	4672	6594	7105
Five (21, 45, 65, 85 and 105 DAS)	85.85	92.63	10.66	11.38	50.27	55.96	4649	4976	6983	7458
C. D. at 5%	1.53	1.07	0.08	0.22	0.86	0.16	105	138	174	139
Herbicide dose (g/ha)										
Weedy control	70.02	75.23	9.28	10.00	42.33	49.80	3677	3909	5543	5998
Chlorsulfuron 20	78.03	85.63	10.77	11.63	48.96	54.22	4491	4797	6756	7125
Chlorsulfuron 30	78.80	87.23	10.84	11.63	49.33	54.72	4553	4849	6759	7221
Chlorsulfuron 45	75.17	81.26	10.13	11.11	46.93	53.35	4281	4446	6420	6741
Chlorsulfuron 60	73.73	80.23	10.03	11.03	46.33	52.81	4207	4307	6283	6568
Isoproturon 1000	75.90	82.83	10.49	11.03	48.13	53.96	4343	4565	6530	6937
C. D. at 5%	2.66	1.28	0.10	0.39	1.01	0.56	151	142	161	139

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RESIDUAL EFFECTS OF SULFONYLUREA HERBICIDES APPLIED IN WHEAT ON SUCCEEDING CROP OF SORGHUM (*SORGHUM BICOLOR* L.) AND COTTON (*GOSSYPIUM HIRSUTUM* L.)

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Chlorsulfuron, sulfosulfuron, metsulfuron, mesosulfuron and iodosulfuron belonging to sulfonyl urea group of herbicides have been found effective for control of weeds in wheat. These herbicides are very effective even at low application rates but persist in the soil for more than one growing season and may cause toxicity to rotational crops (Peterson and Arnold, 1985; Beyer *et al.*, 1988; Kotoula-Syaka *et al.*, 1993). Keeping this in view, residual effect of these herbicides applied in wheat on the succeeding crop of sorghum and cotton was investigated.

A field experiment was conducted on Research Farm of CCS Haryana Agricultural University, Hisar during 2002-03. The experiment consisted of eight herbicidal treatments, *viz.* Chlorsulfuron at 30 and 60 g/ha, sulfosulfuron at 25 and 50 g/ha, metsulfuron at 4 and 8 g/ha and meso+iodosulfuron at 12+2.4 and 24+4.8 g/ha and were compared with untreated check in a randomized block design replicated thrice. The plot size was 16 x 4.0 m², wheat variety PBW 343 was sown on 10 December 2002 and harvested on 19 April 2003. All the herbicides were applied with knapsack sprayer fitted with flat fan nozzle using 375 litres of water ha⁻¹ at 35 days after sowing (DAS). The data on growth and yield attributes of wheat were recorded in order to study the adverse effects of these herbicides, if any.

After wheat harvest, the layout was kept undisturbed and the plots were divided into two equal parts length-wise finding plot size of 8.0 x 4.0 m² to accommodate two succeeding crops (sorghum and cotton) per plot. After preparing the field manually,

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sorghum variety 'HC-136' and cotton variety 'HS-1117' were sown on 18 May 2003. The data on various growth parameters were recorded in relation to both of these crops upto 35 DAS only. All other recommended package of practices was adopted for wheat, sorghum and cotton from time to time.

Effect on Wheat

The data in Table 1 reveal that all growth and yield attributes except spike length, 1000-grain weight and number of grains per spike varied significantly among themselves. Higher dose of chlorsulfuron, sulfosulfuron and meso+iodosulfuron caused suppression in growth of wheat resulting in significantly less plant height and number of tillers per plant at 45 and 90 DAS as compared to their lower dose. The suppression in growth parameters in these treatments was translated into poor grain and straw yield. Maximum grain yield was obtained in weed-free untreated check which was at par with chlorsulfuron at 30 g/ha, sulfosulfuron 25 g/ha, metsulfuron 4 and 8 g/ha and meso+iodosulfuron at 12+2.4 g/ha.

Effect on Sorghum

Germination of sorghum was normal under all treatments but 2-3 days after germination residues of chlorsulfuron (60 g/ha), sulfosulfuron (25 and 50 g/ha) caused stunting and mortality of sorghum plants and plant population in these treatments at 20 DAS was significantly lower than untreated check (Table 2). Similarly residual effect of these herbicides was observed on growth parameters such as number of leaves/plant, shoot dry matter accumulated per plant and green fodder yield at 35 DAS. Maximum number of leaves

TABLE 1
Effect of herbicides on growth, yield and yield attributes of wheat

Herbicide	Dose (g/ha)	Plant height at harvest (cm)	Number of tillers per m. r. l.		Spike length (cm)	Number of grains per spike	1000-grain weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)
			45 DAS	90 DAS					
Chlorsulfuron	30	92.6	62	94	9.0	52	44.5	4560	5920
Chlorsulfuron	60	92.0	60	92	9.1	53	43.5	4492	5884
Sulfosulfuron	25	94.0	64	95	9.0	54	44.1	4600	6040
Sulfosulfuron	50	92.0	61	92	9.2	52	42.9	4440	5720
Metsulfuron	4	93.0	64	94	9.2	54	44.2	4560	5900
Metsulfuron	8	93.2	67	94	9.1	54	43.8	4520	5824
Meso+iodosulfuron	12+2.4	93.0	64	93	9.2	52	44.0	4545	5860
Meso+iodosulfuron	24+4.8	92.1	62	91	9.1	53	42.9	4400	5680
Untreated weed-free check	-	94.0	64	95	9.0	54	43.7	4620	6000
C. D. at 5%		0.4	1.6	1.4	NS	NS	NS	122	131

TABLE 2
Residual effect of herbicides applied in wheat on growth parameters of sorghum

Herbicide	Dose (g/ha)	Plant population at 20 DAS	Number of leaves per plant at 35 DAS	Shoot length at 35 DAS (cm)	Dry matter per plant at 35 DAS (kg/ha)	Green fodder yield at 35 DAS (kg/ha)
Chlorsulfuron	30	6.2	4.1	26.2	1.2	3680
Chlorsulfuron	60	2.0	4.0	18.4	0.9	2208
Sulfosulfuron	25	11.2	6.4	35.6	1.8	6270
Sulfosulfuron	50	8.4	4.2	34.0	1.6	3840
Metsulfuron	4	14.0	8.2	52.8	2.9	9520
Metsulfuron	8	13.6	8.0	53.3	2.6	9380
Meso+iodosulfuron	12+2.4	15.2	7.6	55.0	2.9	9484
Meso+iodosulfuron	24+4.8	14.8	8.2	54.2	2.7	9360
Untreated weed-free check	-	15.2	8.2	55.0	2.8	9450
C. D. at 5%		3.6	0.7	3.9	0.3	245

(8.2) was obtained in untreated weed-free check and meso+iodosulfuron at 24+2.4 g/ha which were significantly higher than chlorsulfuron at 30 and 60 g/ha and sulfosulfuron at 25 and 50 g/ha. Minimum shoot height/plant (18.4 cm) was recorded with chlorsulfuron at 60 g/ha which was 66.5% less than untreated check. However, residual toxicity of chlorsulfuron on the succeeding crop of maize has

been reported by Amarjeet (2002).

Effect on Cotton

As in sorghum, residues of chlorsulfuron applied in wheat caused significant reduction in plant population, number of leaves, shoot length, dry matter accumulated per plant and seed cotton yield as compared to untreated check (Table 3). All growth parameters

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TABLE 3

Residual effect of herbicides applied in wheat on growth parameters of cotton

Herbicide	Dose (g/ha)	Plant population at 20 DAS	Number of leaves per plant at 35 DAS	Shoot length at 35 DAS (cm)	Dry matter per plant at 35 DAS (kg/ha)	Seed cotton yield (kg/ha)
Chlorsulfuron	30	2.2	3.4	7.2	2.8	320
Chlorsulfuron	60	1.8	3.2	5.6	2.3	256
Sulfosulfuron	25	7.9	14.2	34.9	11.8	1828
Sulfosulfuron	50	7.2	10.4	32.2	12.0	1650
Metsulfuron	4	8.0	13.8	34.2	11.7	1965
Metsulfuron	8	7.6	14.2	33.7	12.0	1936
Meso+iodosulfuron	12+2.4	8.2	14.0	33.5	11.8	1890
Meso+iodosulfuron	24+4.8	8.0	12.9	34.0	11.9	1872
Untreated weed-free check	-	8.0	12.0	34.1	12.4	1836
C. D. at 5%		0.9	3.4	2.6	1.7	326

and seed cotton yield were at par with untreated weed-free check in sulfosulfuron, metsulfuron and meso+iodosulfuron treated plots. Seed cotton yield in untreated weed-free check was 473 and 617 per cent higher than chlorsulfuron at 30 and 60 g/ha.

So, it can be concluded that sorghum crop should not be planted after harvest of wheat treated with chlorsulfuron and sulfosulfuron. Metsulfuron and pre mix formulation of meso+iodosulfuron (Atlantis) are safe both for sorghum and cotton.

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ROLE OF ECOLOGICAL FACTORS IN CONCEPT DEVELOPMENT OF PRE-SCHOOLERS

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ABSTRACT

The study was carried out in rural areas of Hisar district of Haryana state. Various crucial factors, which might have an impact on child's conceptual development, were identified. To examine the role of ecological factors in the concept development of pre-schoolers, the ecological profile of rural pre-schoolers at micro, meso and exo level was assessed using an interview schedule. Boehm Test of Basic Concepts was used to know the concept development level of children. The coefficient of correlation between ecological factors at all the three levels and the scores of children on concept development revealed that with increasing age, parents are not enthusiastic in stimulating their children. Parent's education and occupation have a positive bearing on child's development. It was further observed that children from nuclear and small families performed better on concept development as compared to their counterparts from joint and large size families. Size of land holding was another important factor contributing towards the conceptual performance of children. Similarly, the role of exo level factors in ecological profile of children has a bearing on child's conceptual performance as the developmental potential of children was found to be enhanced by the existence of supportive links with external settings.

Key Words : Ecological, Micro level, Meso level, Exo level, Concept development.

The ecological perspective suggests that human development is a product of interaction between the growing human organism and its environment. The developing person is viewed not merely as an individual on whom the environment makes its impact, but as a growing dynamic entity that progressively moves and restructures the milieu in which it resides. Ecological environment is conceived as extending far beyond the immediate situation directly affecting the developing person – the objects to which he responds or the people with whom he interacts on a face-to-face basis. Regarded as of equal importance in ecological environment are connections between other persons present in the setting, the nature of these links and their indirect influence on the developing person through their effect on those who deal with him directly. Many research findings highlight the developmental significance of various ecological factors for the children. The home environment characterized by socio-economic status and parent-child relationship is of primary

importance for development of the child. The results have shown that children belonging to parents with low education and occupational status exhibited poor development. Similarly, children from large families and low caste revealed lower level of cognition. Sigman *et al.* (1991), Dalal (1991), Richer and Grieve (1991) and Devi (1994) also provided supporting evidences in their studies and concluded that home environment, parental socio-economic status and parental education level tend to bear impact on learning environment of the family and thus on the development of children. Effect of socio-economic and family factors in determining the level of cognitive development of children has been established by Bradley *et al.* (1989). Thus, the early opportunities provided to children by their parents in the socio-cultural contexts of the home and community establish much of what may be cognitive development and how it will be used for further interaction in the social world. Consideration of the home environment is basic for understanding of the development of the child. Family

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lays the groundwork for basic personality structure. Parental attitudes, behaviour and relationship all determine the child's personality and behaviour. The findings of the study focused that parent-child relationship characterized by warm, supportive and communicative environment in the family are likely to produce a number of cognitive skills and tend to account for a substantial proportion of variance in the performance of the children.

METHODOLOGY

A survey of 10 villages was carried out to get the baseline information of the villages. Four villages were found matching up to maximum in their profile. A sample of 120 children between 3-5 years was drawn at random from four villages of Hisar district of Haryana state in 2001. The ecological profile of the children was assessed using a duly pretested interview schedule. The parents of the selected children were also interviewed to get the information on ecological profile. The interview schedule had the ecological variables at three levels – micro, meso and exo. Micro level variables included information related to child's personal and individual aspects, whereas meso level variables deal with child's familial aspects and exo level variables collected information on the environment of the child that have indirect bearing on child's development. To assess the concept development level of children, Boehm Test of Basic Concepts (Boehm, 1986) was used. Form 'C' of BTBC deals with the basic concepts and 'Applications' relatively deal with relational concepts. The data thus collected on both the aspects were pooled and analyzed. Computing correlations carried out the analysis of impact of ecological factors on conceptual performance of children.

RESULTS AND DISCUSSION

The coefficient of correlation between ecological factors at micro, meso and exo level and scores of children on concept development were computed separately.

Micro Level Factors and Concept Development

Data in Table 1 reveal the correlation of micro level factors and scores on concept development (From 'C' as well as 'Applications') among children. The ordinal position of the child was found to have insignificant correlation with the concept development, value being 0.08 on Form 'C', whereas a marginally negative correlation existed, $y = 0.14$ with 'Applications'. The data reveal the correlations of physical development of children and the scores of children on concept development. The physical development of child was found to be significantly and positively correlated with the concept development, y values being 0.27 and 0.22, confirming the old adage of 'Healthy Mind in Healthy Body'. Importantly, number of adults and children was not found significantly correlated with children's scores on concept development. Rather a negative trend of correlations was observed with number of children in family and their concept development.

TABLE 1

Correlation between micro level factors and concept development

(N=120)

S. No.	Factors	Components of BTBC	
		Form 'C'	'Applications'
1.	Ordinal position	-0.14	-0.12
2.	Physical development of child	0.27*	0.22*
3.	Adults in family	0.09	0.09
4.	Children in family	-0.14	-0.11

*Significant at $P < 0.05$.

Thus, it can be concluded that as the ordinal position and number of siblings increased, the performance of children on concept development decreased. This may be due to the reason that parents with larger number of children might not be able to give more time to their children. Kumari (1994) also reported that birth order and number of siblings were significantly associated with cognitive abilities of children. She further revealed that most of the children who had high

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level of cognitive abilities had one to three siblings and who had more siblings had low level of cognitive abilities. The reason for negative correlation might be that with limited resources, parents are unable to provide an enriched environment for the development of more number of children. Similar findings are corroborated by Kuntala (1996) who concluded that if number of siblings was more, it becomes difficult for parents to provide material goods as well as rich stimulating environment for child's overall development.

Meso Level Factors and Concept Development

Meso level factors included parental age, education, occupation and other familial factors. As revealed in Table 2, age of father was marginally negatively correlated with concept development scores (-0.16) and (-0.18) for Form 'C' and 'Applications', respectively. The data in Table 2 also depict coefficients of correlation between children's scores of concept development and maternal age. It is evident from the data that there was marginal negative relationship

between children's scores and maternal age, y value range being -0.14 and -0.17 for Form 'C' and 'Applications', respectively. With respect to relationship with father's education, it can be seen that it was moderately positively correlated with children's scores, as the value was 0.24 and 0.39 on Form 'C' and 'Applications', respectively. Similarly, the computations made for mother's education and concept development proved to be marginally correlated as $y=0.21$ and 0.19 on Form 'C' and 'Applications', respectively. Father's occupation is another factor important for the concept development of children. The data reveal that father's occupation and children's scores on Form 'C' and 'Applications' were moderately positively related with each other, value being 0.20 and 0.46, respectively. With respect to relationship between mother's occupation and children's scores, y values were 0.21 and 0.29 on Form 'C' and 'Applications', respectively indicating marginal to moderate positive correlation between the two. Family size, which is another important ecological factor, was found to be significantly negatively correlated with children's scores for concept development on Form 'C' as well as 'Applications', values being -0.30 to -0.46. With respect to the relationship between type of family and scores of conceptual development, it appears from the data that a marginal negative correlation emerged for Form 'C' and 'Applications' as the values were -0.20 and -0.23, respectively. It is evident from the data that caste was significantly positively correlated with scores of children on Form 'C' and 'Applications' as revealed by y values, which were 0.36 to 0.39 on Form 'C' and 'Applications', respectively. The data also depict coefficients of correlation between children's scores of concept development and type of house. There was a marginally positive correlation between children's scores on Form 'C' and 'Applications' and type of house as y values fell to 0.13 and 0.18, respectively. However, land holding and the concept development score was moderately positively correlated, y values being 0.39 and 0.28 on Form 'C' and 'Applications', respectively. Similarly, the material possessions possessed by the family were also found to be moderately positively

TABLE 2
Correlation between meso level factors and concept development

S. No.	Factors	(N=120)	
		Components of BTBC	
		Form 'C'	'Applications'
1.	Father's age	-0.16*	-0.18*
2.	Mother's age	0.14	0.17*
3.	Father's education	0.24*	0.39*
4.	Mother's education	0.21*	0.19*
5.	Father's occupation	0.20	0.46*
6.	Mother's occupation	0.21*	0.29*
7.	Size of family	-0.30*	-0.46*
8.	Type of family	0.20	-0.23*
9.	Caste	0.36*	0.39*
10.	Type of house	0.13	0.18
11.	Size of house	0.21	0.14
12.	Land holding	0.39*	0.28*
13.	Milch animals	0.08	0.10
14.	Material possessions	0.22	0.49*

*Significant at $P<0.05$.

correlated with the performance of children on Form 'C' and 'Applications', r values being 0.22 and 0.49, respectively. Insignificant correlation was seen between size of house and milch animals and children's performance on Form 'C' and 'Applications'. The results of present study reveal that with increasing age, parents are not much interested and enthusiastic in children's development. Young parents being more enthusiastic, get involved in children activities more than what the older parents do. The above findings reveal that parents' education and occupation have a positive bearing on child's development. Similar results have been reported in literature indicating that maternal education and family demographic factors were linked to cognitive and intellectual development of children. These results make it clear that educated parents provide better facilities to their children for overall development. They better understand the needs and requirements of their children and accordingly provide the stimulation for satisfying their needs and requirements. Sometimes, parents have resources but due to lack of education are unable to provide enriched environment to their children.

Similar findings were reported in the work of Masud *et al.* (1994) who reported that mothers who were better educated, had spouses in prestigious position, had small number of children and derived satisfaction from outside job provided higher quality care to their children. Buttler *et al.* (1995) found that father's education has got much impact on academic performance of children. It may be due to their constant contact with the rich literature. Mother's educational level was influenced in their children's educational attainment, especially in low status group (Willerman, 1979). They revealed that highly educated parents are more capable of comprehending the needs and aspirations of children, hence provide more conducive environment to their young ones for their optimal development as compared to the less educated parents. The findings of present study disclosed that children from nuclear families and small families performed better on concept development as compared

to children from joint and large families. In nuclear and small size families, the interaction and interpersonal relationship among family members are warm, supportive and strong. Besides this, better opportunities for the development are accessible to each member of the family. These findings get support from research work of Usha Rani (2001) who while examining the impact of demographic factors on cognitive development of pre-schoolers revealed that children belonging to nuclear and small families scored higher on all aspects of cognition than did those belonging to joint and large families.

It was further revealed that caste-wise hierarchy was maintained even in the conceptual development of children. The human ecological theory also postulates the impact on children by class, ethnicity and socialization practices (Bronfenbrenner, 1979). Hudson (1991) while studying social cognition of children revealed significant association between caste factor and social cognition of pre-school children. As agriculture is still the predominant source of livelihood in rural areas, so the size of land holding continues to be an important factor contributing for the availability of resources in the family, which in turn enable parents to provide enriched environment to their children. That is why the material possessions possessed by the family also contribute for the development of children. Parents can provide an opportunity of exploring to their children through resources and provide more conducive environment for the development of their children. The results of the study are in line with various researches as Mishra and Tiwari (1990) emphasized that parental educational level and family income contributes a lot in cognitive and language development of children.

Exo Level Factors and Concept Development

The results of working of coefficients of correlation between exo level factors and scores of concept development are presented in Table 3. It is evident that substitute care was marginally positively correlated with the performance of children on Form 'C' and 'Applications', r values ranging from 0.49 and

TABLE 3
Correlation between exo level factors and concept development
 (N=120)

S. No.	Factors	Components of BTBC	
		Form 'C'	'Applications'
1.	Substitute care	0.49*	0.27*
2.	Mass media exposure	0.52	0.27
3.	Community participation	0.46*	0.24

*Significant at P<0.05.

0.27, respectively. The computations were also made for correlation between media exposure and scores of concept development. The data reveal that moderate positive correlation existed between the two as indicated by y values, which were ranging from 0.52 and 0.27 on Form 'C' and 'Applications'.

The data also depict coefficients of correlation between children's scores of concept development and community participation. It is evident from the data that marginal to moderate positive correlation existed between scores of children on Form 'C' and 'Applications' and community participation in both the study groups as the values ranged from 0.46 and 0.24, respectively.

The findings further reveal that child's exosystem tends to exert a significant influence on conceptual development of the children. Exosystem consists of one or more settings that do not involve the developing persons as an active participant but in which events occur that affect, or affected by what happens in the settings. The developmental potential of a setting is enhanced by the existence of supportive links with external settings (Bronfenbrenner, 1979). Community or neighbourhood setting is also a primary setting in which children spend unstructured time. Children develop skills through daily interactions in neighbourhood. Characteristics of a neighbourhood influence a child by presenting a certain array of sensory stimuli and resources. So, the type of community participation directly or indirectly affects the development of cognitive

competencies of the child. Among exo level factors, media exposure was another important factor as this was moderately positively correlated with the performance of children. The reason might be that when parents provide better facilities in the form of literature, play material, etc. to their children and thereby stimulate them through enriched environment and the development of children is enhanced. These results get support from the study conducted by Kaliramana (1999). She found that parents who provide opportunities to the children stimulated the cognitive development of their children.

While home environment receives primary importance in the studies of child development, the factors like neighbourhood environment, developmental facilities in the neighbourhood, social interaction networks of the family and the exposure to the mass media are lagged behind. Although some of these ecological variables do not bear direct influence on child's cognitive development, indirect influences are very strong. Directly or indirectly, these factors influence the microsystem of the child, which comprises the immediate social settings. The results of the study have focused on the relative importance of these factors to child's social cognition. The findings reported by Sarmah (1997) reveal the significant impact of neighbourhood environment, social interaction patterns of adolescents and exposure to mass media on metacognitive abilities of adolescents. The parents' strategies of care giving may be influenced by the work they do, their own education, or the particular style of parenting they experienced in their childhood. Finally, the family constellation including the sibling groups, the type of family and the age of parents may influence the severity of discipline that is used, the amount and diversity of interactions and the presence of various role groups. All these aspects of the environment have the consequences for the child's cognitive growth. Thus, the whole ecological environment is a nested structure consisting of the various systems, namely, micro, meso and exo, which affect the cognitive development of the child.

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MATERNAL INTERACTION STRATEGIES AND THEIR RELATION WITH EDUCATION, INCOME AND LIFE SATISFACTION

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ABSTRACT

The study was conducted in Hisar city in the state of Haryana on a sample size of 90 mothers of 45 male and 45 female children in the age group of 4-5 years in 2004. Self-structured interview schedule was used to gather information on various interactional strategies adopted by the mothers. The findings portrayed that mothers generally used encouraging, praise, observing, physical affection and reward power more as compared to other strategies. The less used strategies were physical punishment, threatening/fear, criticising, refuse/neglect or physical restraints. Education, income and life satisfaction were important in selection of interactional strategies.

Key Words : Responsivity, Enquiry, Interaction strategy, Life satisfaction.

The intellectual development of the young child is of prime interest these days. Many studies have reported that child has interactive right from the birth. Environment influences him the most. Among all the persons that come in contact with the child, mother is the closest one. Her behaviour, actions, personality and everything of her will influence the child in many ways. Since intellectual and personality growth are very important, it is essential that mothers/caretakers should be active, alert and sensitive while dealing with the child to act as a facilitator for children's intellectual and other developments. Pre-school age is especially important when child actively seeks knowledge and lays the foundation for the models of thinking.

Vygotsky (1978) emphasized on assisted discovery that teachers or mothers should guide children's learning with explanation, demonstration and verbal prompts, careful tutoring and should concentrate their efforts to teach child in zone of proximal development. For cognitive, mental, or personality development the early childhood experiences are most crucial. The home is the first environment that a child gets; interaction within home will determine mental and behavioural outcomes.

Within family, mother is the most crucial person who comes in contact with a child for most of the time

and for most of the activities. She satisfies his all physical, psychological and social needs; she socializes the child; and also teaches the child through direct instructions, modeling or through providing appropriate home setting. Home settings provide opportunities for child for self-direction and explorations as in terms of Piaget 'Mother's active involvement provides scaffolding to support, to advance the development'. Parent-child interactions are important to child's developing literacy abilities also.

Strategies are conscious or unconscious behavioural activities that are used to enhance mental performance. Some activities may be effective others ineffective. The quality of parent-child interaction determines the quality of child's development. Parents by virtue of their great physical strength, complete control over the child's material and emotional supplies have a great influencing power in all areas of the child's life. Laosa (1977) empirically tested a causal model of family as facilitator in child's intellectual development. Bromwich and her colleagues (1978) specified parent-infant interaction by six level hierarchies. Baumrind (1967) empirically tested causal model of family interaction and child's personality development. Philip Jackson (1955) worked on models of mothers' verbal solutions to child's problem behaviour.

There is no dearth of studies, which highlight the effect of various factors on use of interactional strategies. The economic status and the education of parents may be important in the choice of interactional strategies. The present study aims at investigating the pattern of interactional strategies adopted by mothers while dealing with their children. The strategies have been categorized into four types – relational strategies, thinking facilitating strategies, change affecting strategies (positive) and change affecting strategies (negative).

METHODOLOGY

The study was conducted on 90 mothers of 45 boys and 45 girls of 4-5 years old children in Hisar city during January-March, 2004. The respondents, consisting of equal number from each of the three income groups, *i.e.* low, middle and high were interviewed personally with the help of interview schedule which comprised number of questions related to various interactional strategies with three response categories – most of the time, sometimes and never. Their responses were converted into scores giving appropriate weightage. The highest possible score was six and lowest was zero for each of the strategy.

RESULTS AND DISCUSSION

Data in Table 1 reveal that mothers generally used observing strategy more than others from the pool of relational strategies. The mean score of physical affection was very close to the observing strategy. Responsivity which is essential in establishing good relation between mother and child and which paves way for mental and social-emotional development of children was also less used. So is the case regarding involvement strategy. However, the negative strategies like refusing, neglecting or rejecting the child were less used but its presence with 2.2 mean score was the cause of concern. Thus, it was evident that parents showed love and affection but instead of getting involved with them, they used to leave their children on their own and observed/supervised their activities from distance. Howes and others (1988) reported that

TABLE 1
Mean scores on parental interactional strategies

Attributes	Total N=90
Relational strategies	
Responsivity	3.9
Involvement	3.4
Physical affection	4.5
Observing/Supervising	4.6
Refuse/neglect/rejection	2.2
Thinking facilitating strategies	
Enquiry	3.7
Propose alternatives/suggestions	3.7
Elaboration/explaining/demonstration/modeling	3.5
Helping on demand	3.6
Change affecting positive strategies	
Reward power	4.2
Comply/agree	3.9
Encouraging	5.4
Praise/appreciation	4.8
Instruction	3.4
Change affecting negative strategies	
Criticizing	2.8
Physical punishment	3.1
Threatening/fear	2.9
Physical restraints	1.9

caregivers who work in high quality child-care settings can be more responsive and sensitive to the infants in their care than caregivers who were working in less desirable conditions. Infants and toddlers in high quality child care are more likely than children in low quality care to be securely attached to caregivers, to engage in competent social interaction with adults and peers to self regulate, and to have high language and cognitive scores. Kellaghan *et al.* (1999) highlighted that parent/family involvement has a significant positive impact on students outcome throughout the elementary, middle and secondary school years.

Thinking facilitating strategies are essential for

MATERNAL INTERACTION STRATEGIES

TABLE 2

Rank order of strategies adopted by mothers

Attributes	Rank order (N=90)
Encouraging	1
Praise/appreciation	2
Observing/supervising	3
Physical affection	4
Reward power	5
Comply/agree	6.5
Responsivity	6.5
Propose alternatives	8.5
Enquiry	8.5
Helping on demand	10
Explaining/modeling	11
Involvement	12.5
Instruction	12.5
Physical punishment	14
Threatening/fear	15
Criticizing	16
Refuse/neglect/rejection	17
Physical restraints	18

mental development of the child. Data in Table 1 further show that all such strategies were sufficiently used by the mothers. Among the four listed strategies enquiry and propose alternatives were more used than elaboration or helping on demand.

To affect any change in child's behaviour, parents used variety of positive strategies. Encouraging strategy tops the list with 5.4 average mean score followed by praise and appreciation. Direct instructions were less used. Many parents used those strategies which were negative. Data in Table 1 further show that among the negative strategies physical punishment was used quite frequently followed by threatening/fear and criticizing. These strategies though convenient in affecting change but their after effects are negative as they may cause behavioural problems in children in later life. Clarke-Stewart (1977) suggested that the child's most valuable intellectual experiences during early childhood occur

through interaction with another person who explains, teaches, reasons with, helps, entertains, converse with, praises, shares and expands the child's activities. These kinds of maternal behaviour as well as maternal warmth seem to be more beneficial for intellectual development than are child-rearing practices characterized by strict control, coaxing, commands threats and punishment.

While combining all the strategies it was observed (Table 2) that positive strategies were used more than negative ones. Encouraging, praise/appreciation, observing, physical affection and reward power scored high ranks, whereas low ranks were obtained by the

TABLE 3

Association between predictor variables and interactional strategies

Strategies	Mother education	Income	Life satisfaction
Relational strategies			
Responsivity	1.52	6.39*	2.31
Involvement	12.13*	16.57*	5.12
Physical affection	0.96	4.03*	0.60
Observing/Supervising	13.35*	17.23*	2.68
Refuse/neglect/rejection	9.41*	35.54*	3.13
Thinking facilitating strategies			
Enquiry	1.32	0.27	6.90*
Propose alternatives/suggestions	3.24	37.45*	6.62*
Elaboration/explaining/demonstration/modeling	1.06	1.41	1.94
Helping on demand	4.07*	0.47	7.17*
Change affecting positive strategies			
Reward power	1.00	11.50*	0.07
Comply/agree	5.22	2.51	0.29
Encouraging	0.00	47.06*	3.92
Praise/appreciation	3.72	12.19*	1.43
Instruction	1.84	0.07	5.93
Change affecting negative strategies			
Criticizing	8.95*	0.41	0.06
Physical punishment	5.37*	13.59*	3.34
Threatening/fear	12.64*	12.43*	11.98*
Physical restraints	3.03	12.17*	5.25

Level of significance=0.05.

negative strategies, e.g. physical punishment, threatening/fear, criticizing, neglect/rejection and physical restraints. Though, it is a good sign that mothers love their children and do not use negative strategies still they need to be informed about the importance of thinking facilitating strategies which help in development of mental processes.

Further, data in Table 3 depict the association between strategies and economic, educational and psychological variables. Among relational strategies responsiveness and physical affection were significantly associated with the family income, whereas involvement, observing and neglect/rejection were found associated with the mother's education and family income. This shows that family income is very important factor to generate resources and provide better facilities and educated mother is more responsible and more caring. Belsky *et al.* (1988) reported that infants of full-time employed mothers were more likely to exhibit an increase in maternal attachment relationship than infants of part-time employed and non-employed mothers. It is important to recognize that even though more infants of full-time employed mothers were classified as insecure, well over half of the infants of full-time employed mothers were classified as securely attached. *Employed mothers may be more resourceful and provide better quality care in short span.*

In thinking facilitating strategies enquiry, suggestion

and helping on demand have been found associated with life satisfaction. Suggestion strategy was statistically significant with family income, whereas helping on demand with mother's education. This means if they were more satisfied they were happy, they can spare more time and get involve with the child in various intellectual activities. Mothers from higher income group spent time on listening to child explanations and suggest alternatives to problem situations. Shaver and Walls' (1998) stated that parent/family involvement improves student outcomes. Variations have been found according to students' family cultures, ethnicity, and socio-economic backgrounds.

In change affecting positive strategies reward power, comply, encouraging, praise/appreciation have been found associated with family income. This shows where income was high they praised and appreciated their children for good conduct to effect the change in children's behaviour. Under change affecting negative strategies criticizing, physical punishment, threatening/fear have been found associated with the family income, whereas only threatening strategy had been found significantly associated with the life satisfaction only. This shows that if mothers are more educated they should neither create fear in their children, nor give physical punishment or criticize their children. If mothers are more satisfied with their life they may avoid physical restraints also.

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IMPACT ASSESSMENT OF INSTITUTIONAL TRAININGS FOR IN-SERVICE FACULTY

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ABSTRACT

A study undertaken to find out the motivational factors, seriousness and interest, opinion regarding facilities provided and overall impact of the trainings offered for in-service faculty at AAREM, CCS Haryana Agricultural University reveals that the trainees joining these courses were highly motivated, the seriousness and interest remained fairly high during the four week course, majority rated the physical facilities, logistics, boarding and lodging facilities, learning environment, study tour and training manual provided between good to excellent. The overall impact was high for most of the parameters. This speaks high of the satisfaction of trainees as well as the contents covered and the organization of these courses.

Training has gained wide acceptability as a development strategy for upgrading the professional competence of the work force. It has been widely accepted that this yields high returns on investment. The basic ethos and modes of training consist partly of an inheritance from 18th and 19th century France and Prussia on which are superimposed the new techniques devised by American management in the twentieth century (Subramanian, 1988). Training has been described as an overt process, a sequence of experiences, and a series of opportunities to learn, in which the trainee is exposed in some more or less systematic way to certain materials or events. Training is a sequential activity demanding systematic planning, execution and follow-up (Kumar and Hansra, 2000). Broadly training aims at maintaining and increasing the employee's effectiveness in his present job, preparing him for promotion, stimulating his potentials and developing his skills and knowledge for greater organizational effectiveness (Chaturvedi, 1979). Whenever a person's ability to perform a job is limited by lack of knowledge or skill, this gap can be narrowed by providing him an opportunity to upgrade the same through training. The International Labour Organization (1980) defines training as activities, which essentially aim at providing the necessary skills, knowledge and attitudes required for employment in a particular

occupation.

The key to effective training is how the learning activities are designed and imparted alongwith how motivated the trainees are to acquire the same during training and transfer the same on their return to the organization. It is a recognized fact that employees must be trained on a regular basis so as to be abreast with the fast changes. Training is an expensive activity and, therefore, the institutions imparting training and the organizations deputing employees both need to be cautious. Various Commissions and Committees that have reviewed Indian education have stressed the need to maintain quality and upgrade knowledge, skills, potentialities and capabilities of teachers. The need for quality education has also come into focus on account of recent advances in technology, knowledge explosion, information systems, globalization and liberalization. In this changing scenario, continuous training of teachers and scientists is all the more important as they are engaged in a profession that demands them to be updated and deliver education and information in a professional manner. The teachers in universities have a strong academic base, as they join after obtaining degrees in higher education. However, as they man the highest seats of learning it is essential that they are trained and updated on latest state-of-art in their subject matter area as well as educational delivery

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techniques and allied areas. Under the new education policy, faculty in State Agricultural Universities (SAUs)/ Indian Council of Agricultural Research (ICAR) institutes/University Grants Commission supported colleges have to complete 56 days training for every promotion. The agricultural universities are charged with the responsibility of preparing the manpower to take up education, research, extension and other responsibilities in the agriculture and allied sector. Training plays an important role in bridging this technological gap and is an investment for the future (AAREM, 2001).

CCS Haryana Agricultural University, Hisar is the only agricultural university in the country that has an Academy of Agricultural Research and Education Management (AAREM) which offers in-service training to teachers, researchers and extension personnel. Since inception in 1994 under the Agricultural Human Resource Development (AHRD) Project this is regularly offering a range of training courses, some of common use and others more specific to various disciplines. The present study was undertaken with the objective of investigating the profile, motivational factors, seriousness and interest of trainees, opinion regarding facilities provided and the impact of the AAREM trainings.

METHODOLOGY

All the in-service teachers who attended four weeks training at AAREM, CCS Haryana Agricultural University, Hisar during the period April 2000 - March 2001 constituted the sample of the study. This covered trainees of eight courses. The total sample consisted of 225 trainees. A duly pre-tested questionnaire was used to elicit desired information from the trainees on various aspects. The information gathered was coded and analyzed as per standard procedure.

RESULTS AND DISCUSSION

The eight four week trainings that were offered at AAREM during the year under study were : Faculty Development Programme in Educational Technology, Induction Training Course, Language Skills and Technical

Writing, Communication and Reporting Skills, Microbes in Integrated Nutrient Management, Post Harvest Technology in Fruits, Designing and Analysis of Field Experiments, and Faculty Development Programme in Research Management. The circular for these trainings was sent much in advance to various SAUs and ICAR organizations throughout the country. The number of trainees in these courses ranged between 25-30 per course.

The profile of the in-service teachers who were deputed by various organizations to attend training at AAREM revealed that 51.11 and 48.89 per cent were in the rank of Assistant Professor and Associate Professor, respectively; 42.2, 41.3, 13.3 and 3.2 per cent were working in teaching, research, extension and other schemes, respectively; 84.0, 12.44 and 3.56 per cent came from university, government departments, and other organizations, respectively; 79.56 and 20.44 were male and female respectively; 48.45, 24.89 and 26.66 per cent had 10-20 years, 20+ and upto 10 years experience, respectively; 58.22 and 18.67 were in the age group 35-45 and 45-55 years, respectively; 31.11, 24.89, 20.00, 16.00 and 7.11 had attended 1, 2, nil, 3 and 4 trainings, respectively.

Details of motivational factors of the trainees have been presented in Table 1. It is evident that out of the 19 motivational statements, the statement to upgrade technical knowledge and skill obtained the highest MS 3.5/4.0 (rank I) and fell in the 'very high' motivational category followed by next factors in descending order in 'high' category as, to fulfil training requirement for promotion (MS 3.39, rank II), opportunities for training from a reputed organization (MS 3.03, rank III), relevant title, objectives and contents of the course as per course circular (MS 3.02, rank IV), and to interact with professionals (MS 3.01, rank V). The factors that came under 'medium' motivational category were seven in number, with range between MS 2.39 to 2.92, while there were four factors in the 'low' category with range of MS between 1.19 to 1.90 and three factors in the 'very low' category with MS between 0.46 to 0.87.

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TABLE 1

Motivational factors for attending training at AAREM

(n=225)

S. No.	Motivational factor	Wt. mean score	Rating	Rank
1.	To upgrade technical knowledge and skill	3.50	Very high	I
2.	To fulfil training requirement for promotion	3.39	High	II
3.	Opportunity for training from a reputed organization	3.03	High	III
4.	Relevant title, objectives and contents of the course as per course circular	3.02	High	IV
5.	To interact with professionals	3.01	High	V
6.	To be familiar with new training methodologies	2.92	Medium	VI
7.	Gain information on planning of courses and projects	2.85	Medium	VII
8.	To find solutions to technical problems	2.81	Medium	VIII
9.	To develop professional ties with trainees	2.66	Medium	IX
10.	To develop professional ties with trainers	2.60	Medium	X
11.	Revision of earlier learnt concepts	2.60	Medium	XI
12.	Attractive title of the course	2.39	Medium	XII
13.	Deputed by organization	1.90	Low	XIII
14.	Joined out of inquisitiveness	1.47	Low	XIV
15.	To visit CCSHAU Campus	1.24	Low	XV
16.	Tourist attraction of visiting north India	1.19	Low	XVI
17.	To be away from work place	0.87	Very low	XVII
18.	To be away from routine duties	0.52	Very low	XVIII
19.	To visit friends and family	0.46	Very low	XIX

TABLE 2

Seriousness and interest during training

(n=225)

S. No.	Attribute	Category	Number	%
1.	Seriousness	High	183	81.33
		Medium	37	16.4
		Low	5	2.22
2.	Interest	High	159	70.67
		Medium	63	28.00
		Low	3	1.33

From data in Table 2, on seriousness during training it is evident that majority of the trainees (81.33%) were in the high category. This may be so as majority of them were fairly senior teachers, had high motivation and interest to complete the course. Another reason could be that all trainees had to clear a written exam conducted at the end of the course and

only those who successfully cleared the examination requirement were offered a certificate of completing the course. Since they had been deputed by their respective organizations they were in need of such a certificate while this was also required for their promotion under the prevalent promotion scheme. On the parameter of interest it is noted that this remained high for majority of participants (70.67%) followed by a small minority (28%) in the medium category and an almost insignificant number (1.33%) in the low category. It could thus be concluded that the interest of the trainees on the whole remained high, and this may be on account of the fact that the topics being covered were relevant and being delivered in an efficient manner by the experts, while the training environment was found to be congenial to learning.

Opinion of trainees regarding infra-structural

TABLE 3
Opinion regarding infrastructural facilities and logistics

(n=225)

S. No.	Attribute	Category	Number	%
1.	Physical facilities	Excellent	126	56.00
		Good	84	37.33
		Fair	10	4.45
		Poor	5	2.22
2.	Logistics	Excellent	69	30.67
		Good	126	56.00
		Fair	29	12.89
		Poor	1	0.44
3.	Boarding and lodging	Excellent	63	28.00
		Good	126	56.00
		Fair	33	14.67
		Poor	3	1.33
4.	Learning environment	Excellent	101	44.89
		Good	101	44.89
		Fair	22	9.73
		Poor	1	0.4
5.	Study tour	Excellent	88	39.11
		Good	79	35.11
		Fair	30	13.3
		Poor	28	12.44
6.	Training manual	Excellent	99	44.00
		Good	99	44.00
		Fair	18	8.00
		Poor	9	4.00

facilities and logistics including aspects of physical facilities, boarding and lodging, learning environment, study tour and training manual provided has been given in Table 3. It is evident that for physical facilities 56.0 and 37.33 per cent rated these as excellent and good, respectively, 56.0 and 30.67 per cent rated logistics as good and excellent, respectively, 56.0 and 28.0 rated boarding and lodging facilities as good and excellent, respectively, 39.11 and 35.11 per cent rated study tour as excellent and good and the training manual provided to all the participants was rated by 44% each in

excellent and good category, respectively. On the whole all the parameters were in the 'good' to 'excellent' category.

Regarding overall impact of the trainings (Table 4) three parameters were rated in very high category, viz. improvement in team work skills (MS 3.595, rank I), time adherence (MS 3.569), and learning new topics/areas (MS 3.528, Rank III). The parameters that were in the high category with MS ranging between 3.0 and 3.5 and ranks from IV to XIX were confidence to organize similar trainings, improvement in socialization skills, improved self esteem, updating of concepts, confidence building, enhanced organizational and managerial skills, strengthening of professional linkages, improvement in leadership skills, confidence to deliver expert lectures, improvement in presentation skills, improvement in project preparation skills, exposure to new topics in curriculum, improvement in evaluation skills, improvement in communication skills, better understanding of educational processes, and exposure to organize similar trainings.

It is concluded that AAREM, CCS Haryana Agricultural University is doing a useful service by organizing effective trainings of four weeks duration for in-service faculty. There is a heavy rush for various specialized trainings offered for them. The trainees joining these courses are highly motivated to join these for various reasons while the seriousness and interest remain fairly high during the four week course. Further, as majority of the trainees rate the physical facilities, logistics, boarding and lodging facilities, learning environment, study tour and training manual provided between good to excellent. This speaks high of the training contents, the methodology and overall organization. Regarding overall impact this is high for a number of parameters and highlights the usefulness of the courses offered.

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TABLE 4
Overall impact of trainings

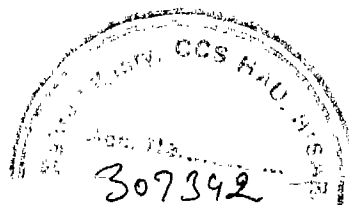
(n=225)

S. No.	Impact statements	Total score	Wt. mean score	Rating	Rank
1.	Improvement in team work skills	701	3.595	Very high	I
2.	Time adherence	696	3.569	Very high	II
3.	Learn new topics/areas	688	3.528	Very high	III
4.	Confidence to organize similar trainings	671	3.441	High	IV
5.	Improvement in socialization skills	668	3.426	High	V
6.	Improved self-esteem	665	3.410	High	VI
7.	Updating of concepts	661	3.389	High	VII
8.	Confidence building	660	3.385	High	VIII
9.	Enhanced organizational and managerial skills	651	3.338	High	IX
10.	Strengthening of professional linkages	642	3.292	High	X
11.	Improvement in leadership skills	638	3.272	High	XI
12.	Confidence to deliver expert lectures	626	3.210	High	XII
13.	Improvement in presentation skills	625	3.205	High	XIII
14.	Improvement in project preparation skills	623	2.195	High	XIV
15.	Exposure to new topics in curriculum	620	3.179	High	XV
16.	Improvement in evaluation skills	613	3.144	High	XVI
17.	Improvement in communication skills	605	3.103	High	XVII
18.	Better understanding of educational process	593	3.041	High	XVIII
19.	Exposure to organize similar trainings	589	3.021	High	XIX
20.	Undertake consultancy work	574	2.944	Medium	XX
21.	Exposure to new training methods	572	2.933	Medium	XXI
22.	Enhanced creative thinking	564	2.892	Medium	XXII
23.	Enhanced confidence in preparation and use of A.V. aids	563	2.887	Medium	XXIII
24.	Enhancement in computer skills	502	2.574	Medium	XXIV
25.	Exposure to new equipments	492	2.523	Medium	XXV

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VARIABILITY IN PHYSICO-CHEMICAL PROPERTIES AND CHEMICAL COMPOSITION OF NEWLY RELEASED GREEN GRAM CULTIVARS

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ABSTRACT

Physico-chemical properties and chemical analysis of some high yielding varieties of green gram (*Vigna radiata* L.) were studied. The seed density, swelling capacity, swelling index, hydration capacity, hydration index and cooking time varied significantly from 1.21 to 1.65 g/ml, 0.10 to 0.12 ml/seed, 0.99 to 1.15, 0.14 to 0.20 g/seed, 0.42 to 0.99 and 30 to 38 min, respectively in all the 11 cultivars of green gram. The cultivar MH1K-25 had maximum value of hydration capacity, hydration index, swelling capacity and swelling index, which resulted in less cooking time, i.e. 30 min. Whereas Pusa -9531 had minimum hydration capacity, hydration index, swelling capacity and swelling index which might have contributed towards more cooking time, i.e. 38 min. MH1K-25 cultivar also manifested higher contents of protein and fat, whereas Asha cultivar had maximum sugar contents. Significant differences were found among all the cultivars.

Key Words : Cultivars, Physico-chemical properties, Proximate composition, Sugars.

India is the largest pulse-growing country in the world, in terms of both area (43.3%) and production (35.15%) (Saharan *et al.*, 2002). Although a number of pulse crops are grown in India, the most important of these are green gram, chickpea, pigeonpea, black gram, moth bean, lentils, pea, cowpea, etc. Green gram (*Vigna radiata* L.) is one of the most important food legumes grown and consumed in India. A significant role of legumes in the diets of people in many developing countries is restricted because of their high cost and certain defects in their nutritional and food use qualities. Biological utilization of pulses is limited due to deficiencies in sulphur-containing amino acids and presence of antinutritional factors (Jood *et al.*, 1998a, b). Low utilization of legume grains has also been partially attributed to the presence of beany flavours, prolonged preparation and cooking prior to consumption (Punia and Chauhan, 1998).

To evolve high yielding crop varieties is one of the most important strategies to fill up the gap between demand and supply of food legumes and also to improve the nutritional status of the population consuming such

diets. New varieties may not always be different in their nutritive value from the traditional varieties. Hence, it is imperative to constantly monitor the nutritive value of new varieties and those found inferior may be discarded from general cultivation. The efforts put in by plant breeders in evolving a high yielding and nutritionally superior variety may be of little significance if it does not fit in the consumer preferences regarding its physical acceptability and cookability. The present study was, therefore, undertaken to determine the physico-chemical properties and chemical composition of unprocessed seeds of green gram.

MATERIAL AND METHODS

Eleven high yielding varieties of green gram, namely, MH 96-1, MH 98-1, MH 98-1 (D), MH 98-5, MH 98-6, MH 98-7, Asha, Pusa-9531, MH1K-23, MH1K-24 and MH1K-25 were procured in single lot from the Department of Plant Breeding of the University. The seeds were cleaned, made free of dust, dirt and foreign material.

Physico-chemical Properties

Unprocessed seeds of green gram were analysed

*Department of Plant Breeding.

for the following physico-chemical properties (AOAC, 1995).

(a) Seed weight

One hundred seeds were weighed for calculating seed weight.

$$\text{Seed weight} = \frac{\text{Weight of 100 seeds}}{100}$$

(b) Density

Fifty g seeds were transferred to measuring cylinder. Then 50 ml distilled water was added to it. Seed volume was recorded by subtracting 50 ml from the total volume (ml). Density was recorded as g/ml.

(c) Hydration capacity

Seeds weighing 50 g were counted and transferred to a measuring cylinder and to this water was added. The cylinder was covered with aluminium foil and left overnight at room temperature. Next day seeds were drained, superfluous water removed with filter paper and swollen seeds were weighed. Hydration capacity per seed was determined by using the following formula :

$$\text{Hydration capacity (per seed)} = \frac{\text{Weight of soaked seeds} - \text{Weight of seeds before soaking}}{\text{Number of seeds}}$$

(d) Hydration index

$$\text{Hydration index} = \frac{\text{Hydration capacity per seed}}{\text{Weight of one seed (g)}}$$

(e) Swelling capacity

Seeds weighing 50 g were counted, their volume noted and soaked overnight. The volume of the soaked seeds was noted in a graduated cylinder. Swelling capacity per seed was determined by using the following formula :

$$\text{Swelling capacity} = \frac{\text{Volume after soaking} - \text{Volume before soaking}}{\text{Number of seeds}}$$

(f) Cooking time

Seeds (100 g) were taken in beakers of crude fibre apparatus, water was added in a ratio of 1 : 3 (w/v). Beakers were connected with condensers to avoid evaporation of water during boiling. Samples were stirred at 2 min interval. After 45 min, one seed was withdrawn without interrupting the boiling. Degree of cooking was tested by pressing seeds between fingers. If seeds were felt uncooked, one seed was again tested after 5 min. This procedure continued until five seeds tested were found cooked. At this time, total cooking time was recorded.

Preparation of Samples

All the samples were dried in hot air oven at 60°C to a constant weight. The dried samples were ground in an electric grinder using 0.5 mm sieve size and kept in airtight plastic containers at room temperature for further chemical analysis.

Chemical Analysis

Proximate composition (moisture, crude protein, crude fat, ash and crude fibre) was estimated by standard methods of analysis (AOAC, 1995). Crude protein was estimated by using the micro-Kjeldhal method. A factor of 6.25 was applied to convert the amount of nitrogen to crude protein. Total carbohydrate was calculated from the sum of moisture, protein, crude protein, crude fat, ash and crude fibre and subtracted it from 100.

Total soluble and reducing sugars were estimated according to the method of Hulme and Narain (1931). The amount of non-reducing sugars was calculated as the difference between total soluble sugars and reducing sugars. Starch from the sugar free pellet obtained after centrifugation was estimated by the method of Clegg (1956). The starch was extracted in 52% perchloric acid and then centrifuged. It was calculated as starch = Glucose × 0.9.

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Statistical Analysis

The data were statistically analysed for analysis of variance to determine the critical difference (CD) among cultivars. The difference of two means between the cultivars exceeding this value is significant (Panse and Sukhatme, 1978).

RESULTS AND DISCUSSION

The physico-chemical characteristics of selected green gram varieties are presented in Table 1.

Density of selected 11 cultivars of green gram varieties varied from 1.21 to 1.65 g/ml, highest being in cultivar MH1K-25 and lowest in cultivar Pusa-9531. Sinha (1999) observed the density of cowpeas ranging from 1.13 to 1.21 g/ml, whereas a range of 0.91 to 0.28 g/cm³ was reported by Latunde-Dada (1993). Seed weight of all the 11 varieties ranged from 2.78 to 3.56. Hydration capacity of different green gram cultivars ranged from 0.14 to 0.20 g/seed. Cultivar Pusa-9531 had the lowest hydration capacity, whereas MH1K-25 had the highest. MH 98-7 and Asha cultivars had almost similar hydration capacity, Pusa-9531, which

had lowest hydration capacity, had the minimum hydration index too. Significant differences were observed between all the varieties.

Among cultivars, MH1K-25 had maximum swelling capacity as well as swelling index, whereas minimum swelling capacity and swelling index were observed for Pusa-9531. Swelling capacity of all the cultivars differed significantly from each other, however, Asha, MH1K-23 and MH1K-24 had almost similar swelling index. According to Latunde-Dada (1993), swelling capacity of different varieties of cowpea ranged from 56-183.99, 77-123.5 and 43.9-94.5 per cent, respectively. He reported that legumes having the higher hydration and swelling capacity require less cooking time, hence are procured by the consumers and processors.

Cooking time is of paramount importance as most of legumes require a long period for cooking. Cooking time of the green gram cultivars studied varied between 30 min for MH1K-25 and 38 min for Pusa-9531 (Table 1). Whereas, Sinha (1999) and Saharan *et al.* (2002) reported higher cooking time in cowpea

TABLE 1

Physico-chemical properties of selected cultivars of green gram

Cultivar	Density (g/ml)	Seed weight (g)	Hydration capacity (g/seed)	Hydration index	Swelling capacity (ml/seed)	Swelling index	Cooking time (min)
MH 96-1	1.48±0.01	2.97±0.02	0.19±0.00	0.75±0.00	0.12±0.00	1.06±0.00	34±1.52
MH 98-1	1.41±0.01	2.81±0.01	0.17±0.00	0.65±0.00	0.11±0.00	1.03±0.00	33±1.52
MH 98-1 (D)	1.22±0.02	3.14±0.01	0.15±0.00	0.46±0.00	0.10±0.00	0.99±0.00	38±1.52
MH 98-5	1.53±0.03	2.82±0.01	0.20±0.00	0.84±0.00	0.12±0.00	1.12±0.00	32±0.57
MH 98-6	1.34±0.04	2.95±0.01	0.17±0.00	0.65±0.00	0.11±0.00	1.04±0.00	33±0.57
MH 98-7	1.45±0.02	2.99±0.01	0.19±0.00	0.70±0.00	0.12±0.00	1.08±0.00	33±0.50
Asha	1.53±0.02	2.82±0.01	0.19±0.01	0.82±0.01	0.12±0.00	1.10±0.00	32±1.00
Pusa-9531	1.21±0.02	3.56±0.03	0.14±0.00	0.42±0.00	0.10±0.00	0.95±0.00	38±0.57
MH1K-23	1.44±0.03	2.96±0.03	0.18±0.00	0.73±0.00	0.12±0.00	1.10±0.00	33±0.05
MH1K-24	1.34±0.05	3.10±0.01	0.16±0.00	0.58±0.00	0.10±0.00	1.10±0.00	35±0.50
MH1K-25	1.65±0.01	2.78±0.02	0.20±0.00	0.99±0.00	0.12±0.00	1.15±0.02	30±0.50
CD (P≤0.05)	0.04	0.03	0.01	0.01	0.01	0.02	1.55

Values are mean ±S. E. of three independent determinations.

(55-68 min) cultivars, rice bean (87 min) and fababean (108 min).

The cooking time was found to be significantly ($P < 0.05$) negatively correlated with the density, hydration capacity, swelling capacity, hydration index and swelling index (Table 2). Among the cultivars, MH1K-25 had more hydration capacity, hydration index, swelling capacity and swelling index, it required less cooking time. The results of the present study are consistent with those mentioned by previous workers

TABLE 2

Correlation of cooking time with physico-chemical characteristics of selected cultivars of green gram

Physico-chemical characteristics	Cooking time
Density	-0.49058*
Hydration capacity	-0.96890**
Hydration index	-0.95606**
Swelling capacity	-0.9220**
Swelling index	-0.54267*

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

for cowpea, rice bean and faba bean cultivars (Sinha, 1999; Saharan *et al.*, 2002). They also reported a significant negative correlation between the swelling capacity and cooking time of legumes.

Chemical Analysis

(a) Proximate composition

Moisture content of green gram cultivars ranged from 7.20 to 8.26 per cent. Similarly, Sharma *et al.* (1991) reported that the moisture content of green gram varieties ranged from 8.20 to 8.90 per cent. Crude protein content of green gram cultivars ranged from 21.30 to 26.93 per cent. Significant differences were observed among moisture content of different cultivars of green gram. The results of crude protein of the present study are in consistent with those mentioned by previous workers (Hira *et al.*, 1988; Jood *et al.*, 1998b). Fat content of green gram cultivars ranged from minimum of 1.16% in cultivar MH 98-6 to maximum of 2.26% in Asha (Table 3). Significant differences were found among all the varieties. The fat contents obtained in green gram cultivars were close to that reported by Sharma *et al.* (1991) and Jood *et*

TABLE 3

Proximate composition of selected cultivars of green gram (g/100 g)*

Cultivar	Moisture	Protein	Fat	Ash	Crude fibre	Total carbohydrate
MH 96-1	7.20±0.20	22.20±0.20	1.33±0.20	3.66±0.15	2.43±0.05	63.18
MH 98-1	8.26±0.30	23.13±0.15	1.33±0.05	3.63±0.15	2.06±0.05	61.59
MH 98-1 (D)	7.56±0.20	22.70±0.15	1.53±0.15	3.00±0.10	2.13±0.20	63.08
MH 98-5	7.96±0.15	23.50±0.20	2.20±0.20	3.93±0.20	1.76±0.15	60.65
MH 98-6	7.56±0.15	22.63±0.15	1.16±0.15	3.53±0.05	1.80±0.10	63.32
MH 98-7	7.50±0.10	22.70±0.30	1.60±0.10	3.76±0.05	1.70±0.10	62.74
Asha	8.23±0.15	25.26±0.20	2.26±0.28	3.83±0.05	2.70±0.10	57.72
Pusa-9531	7.23±0.20	21.30±0.70	1.86±0.05	3.56±0.05	2.03±0.15	64.02
MH1K-23	7.23±0.15	22.43±0.15	1.83±0.15	3.60±1.0	1.76±0.15	63.15
MH1K-24	7.63±0.15	21.40±0.40	2.00±0.10	3.66±0.05	1.76±0.15	63.55
MH1K-25	8.10±0.10	26.93±0.54	2.40±0.10	3.66±0.05	2.30±0.10	56.61
CD (P<0.05)	0.30	0.54	0.28	0.18	0.21	0.60

*On dry matter basis.

Values are mean ±S. E. of three independent determinations.

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TABLE 4
Sugar contents of selected cultivars of green gram*

Cultivar	Total soluble sugar (g/100 g)	Reducing sugar (mg/100 g)	Non-reducing sugar (g/100 g)
MH 96-1	7.83±0.05	331.23±0.25	7.49±0.50
MH 98-1	8.03±0.05	432.76±0.66	7.59±0.05
MH 98-1 (D)	8.00±0.10	416.30±0.26	7.58±0.10
MH 98-5	8.16±0.15	422.53±2.13	7.73±0.15
MH 98-6	8.23±0.20	345.70±1.55	7.88±0.20
MH 98-7	8.03±0.15	402.36±3.35	7.62±0.15
Asha	8.76±0.15	504.96±0.83	8.24±0.18
Pusa-9531	8.40±0.10	366.23±0.90	8.03±0.10
MH1K-23	8.33±0.15	481.36±1.18	7.84±0.14
MH1K-24	7.90±0.10	373.83±5.30	7.52±0.95
MH1K-25	8.83±0.11	500.56±0.81	8.32±0.10
CD (P<0.05)	0.22	3.62	0.44

*On dry matter basis.

Values are mean ±S. E. of three independent determinations.

al. (1998b). Ash content of green gram cultivars ranged from 3.00 to 3.93 per cent. Similar results were obtained in cowpea by Akinyele (1989) and Farine and Ingraio (1991). Crude fibre content in green gram cultivars ranged from 1.70 to 2.43 per cent. Total carbohydrate contents of 11 green gram cultivars ranged from 56.61 to 64.02 per cent.

(b) Sugars and starch

Significant differences in the total, reducing and non-reducing sugars were observed among different cultivars. Total, reducing and non-reducing sugars in cultivars were in the range of 7.83 to 8.33 g/100 g, 331.23 to 504.98 mg/100 g and 7.49 to 8.32 g/100 g, respectively (Table 4). Similar values of total, reducing and non-reducing sugars were reported by Kataria (1986) where total, reducing and non-reducing sugars

among amphidiploids and parents (green gram and black gram) ranged from 7.6 to 9.6, 0.311 to 0.516, 7.2 to 8.9 g/100 g, respectively.

Conclusion

It may be concluded from the present study that 11 cultivars of green gram investigated differed in their physical and chemical characteristics. MH1K-25 cultivar had superior physico-chemical characteristics hence required less cooking time. Therefore, it is imperative to constantly monitor the nutritive value of newly evolved cultivars and those found inferior may be discarded from general cultivation. This would be helpful in improving the nutritional status of the general population of developing countries.

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FOOD CONSUMPTION PATTERN AND NUTRIENT INTAKE OF PRE-SCHOOL CHILDREN (3-4 YEARS) OF KAITHAL DISTRICT OF HARYANA

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ABSTRACT

Data on food intake of pre-school children (3-4 years) of Kaithal district of Haryana state revealed that the subjects were consuming less amount of various foods, viz. cereals, pulses, milk and milk products, green leafy vegetables, and fats and oils when compared with the recommended dietary intake. The daily mean intake of energy, iron and vitamin C was significantly lower as compared to RDA.

Key Words : Nutrient intake, Food groups, Food intake.

Pre-school stage is the most critical period which involves drastic changes among children. At this age, they have special nutritional needs because of the rapid growth and development which is dependent on the adequacy of diet consumed by them. Prolonged subsistence on inadequate diets may lead to many ill-effects, high rates of morbidity and even to mortality.

Pre-school age is one of the most vulnerable period mainly due to easy susceptibility to malnutrition and infection. Taking growth retardation (weight for age deficit) as an indicator of nutritional status, almost 85% of the pre-school children from the Indian sub-continent are regarded as under-nourished, with about 15-35 per cent being moderate to severely malnourished. Ninety per cent Indian children (1-3 years) are reported to be under weight for their age and approximately half of them are also anaemic (Desai and Choudhary, 1993).

Available evidences indicate that severe malnutrition experienced during critical phase of life (usually in infancy and early childhood) affects not only the expression of genetic potential for physical growth and development but also the intellectual development and personality. It is recognized that rapid physical, mental and emotional growth of children takes place in early childhood. To obtain optimum nutritional status, proper nutrition is of great importance.

An adequate intake of nutrients and maintenance

of good health must be ensured during childhood. Studies undertaken at National Institute of Nutrition (NIN), Hyderabad have confirmed that pre-school children who received supplements which provided about 300 calories and 3-4 g of protein a day showed a very satisfactory growth rate. The low diet and nutrient intake lead to poor nutritional status and many deficiency diseases in children.

MATERIAL AND METHODS

Rural areas of Kaithal district of Haryana state were selected purposively as the locale of present investigation for the sake of convenience. The present study envisaged the selection of two blocks, i.e. Pundari and Kalayat by simple random sampling. A list of villages of these two blocks was obtained from the Block Development Office. From this list, four villages, i.e. Fatehpur, Solumajra, Batta and Kailram were selected by simple random sampling technique. In each village, a list of pre-school children in the age group of 3-5 years was prepared and every third child was selected for the study at random and in this way total 300 (male 150, female 150) pre-school children in the age group of 3-5 years were selected. The present study was conducted on 109 pre-school children of 3-4 years age group. The study was conducted in the months of April and May, 2002.

A well-structured interview schedule was

prepared which was pretested initially. Based on the responses obtained and difficulties realised, modifications were made to make the interview schedule more functional.

Interview schedule consisted of questions to gather information on various aspects as general background, socio-economic status, dietary habits and food and nutrient intake.

To assess socio-personal and economic profile of respondents, various socio-economic status scales were used. The children were categorized into two age groups, *i.e.* 3-4 years and 4-5 years according to RDA (Recommended Dietary Allowances) pattern recommended by ICMR (Gopalan *et al.*, 1989). Family type and education of mothers were operationally measured by socio-economic status scale (Kulshrestha, 1980). The income categories were made by adopting the income range of all the respondents' families. Caste was measured by modified SES scale of Trivedi (1963).

Dietary assessment

Information regarding the intake of food for three consecutive days was collected from the respondents' mothers using 24-hour recall method. Data were collected by the method of National Nutrition Monitoring Bureau (NNMB, 1980). Standard measures including katories, spoons and glasses of various sizes were shown to the mothers to help them in estimating the amount of food consumed. Cooked food consumed was converted into its raw equivalents.

Diet intake

The mean daily food intake was calculated by taking the mean of three days intake. The food groups included cereals, pulses, fruits, green leafy vegetables, roots and tubers, other vegetables, milk and milk products, sugar and jaggery and fats and oils. Average intake of the subjects was compared with the Recommended Dietary Intake of ICMR (NIN, 1998).

Nutrient intake

Nutrients, namely, energy, protein, fat, calcium,

iron, β -carotene, thiamine, riboflavin, nicotinic acid, ascorbic acid, folic acid and vitamin B₁₂ were calculated using the MSU Nutriguide (Song *et al.*, 1992) from the raw foods consumed by the subjects. Nutrient intake of three consecutive days was added and mean was taken out. The results of mean nutrient intake were compared with the Recommended Dietary Allowances of ICMR (Gopalan *et al.*, 1989).

RESULTS AND DISCUSSION

Data regarding socio-personal and economic profile of respondents are presented in Table 1. Out of the children selected 55 (50.45%) were males and 54 (49.54%) were females. Almost half of the subjects were from low income group and rest of subjects belonged to middle income group and high income

TABLE 1
Socio-personal and economic profile of respondents

Characteristics	Frequency	Percentage
Age		
3-4 years	109	36.33
Sex		
Male	55	50.45
Female	54	49.54
Type of family		
Nuclear	72	66.05
Joint	37	33.94
Caste		
Lower	12	11.00
Middle	40	36.69
Upper	57	52.29
Education of mother		
Illiterate	64	58.71
Primary	26	23.85
Middle	14	12.84
Matric	5	4.58
Graduate	-	-
Monthly income (Rs.)		
1000-5000	54	49.54
5000-8000	36	33.02
Above 8000	19	17.43

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group. Sixty-six per cent of the subjects were from nuclear families. Mothers of almost half of the subjects were illiterate and remaining were educated upto primary, middle and matric level.

Food Intake

The quantitative consumption of food items from all the food groups by the subjects has been summarized in Table 2. Mean daily intake of cereals in boys and girls was 109.82 g and 112.78 g, respectively and was slightly lower than RDI. A non-significant difference was observed in intake of cereals between boys and girls.

As depicted in Table 2, mean daily intake of pulses and green leafy vegetables was significantly lower than RDI. When compared sex-wise, almost similar intake was observed among boys and girls. Low

intake of pulses and green leafy vegetables in the diet of pre-school children has been reported earlier by various research workers, viz. Singh *et al.* (1997), Vijayaraghavan and Rao (1998) and Khosla *et al.* (2000).

Among the respondents surveyed, mean daily intake of fruits was merely 4.76 g in boys and 4.52 g in girls, which was significantly lower than RDI. Daily mean intake of milk in boys and girls was 399 and 380 ml, respectively, which was 79.8 and 76.0 per cent of RDI, respectively. The data indicated that boys were taking slightly higher amount of milk and milk products.

Average intake of roots and tubers, other vegetables and fats and oils were slightly lower than RDI but variation was statistically non-significant. The intake of sugar and jaggery was found to be almost equal to RDI.

TABLE 2
Mean daily food intake of pre-school children of 3-4 years

Foodstuffs	RDI (g)	Mean daily intake (g)		Z value		'Z ₁ ' value Boys-Girls
		Boys (n=55)	Girls (n=54)	Boys	Girls	
Cereals	120	109.82±23.9 (91.5)	112.78±20.7 (93.9)	0.43	0.35	0.69
Pulses	30	11.80±5.6 (39.3)	12.56±9.5 (41.9)	3.24*	2.83*	0.50
Roots and tubers	50	40.64±36.5 (81.3)	35.13±24.1 (70.3)	0.26	0.61	0.93
Other vegetables	50	24.53±32.64 (49.0)	22.39±26.3 (44.8)	0.78	1.0	0.38
Green leafy vegetables	50	7.42±9.4 (14.8)	5.40±7.2 (10.8)	4.53*	6.18*	1.25
Fruits	100	4.76±2.2 (4.8)	4.52±2.2 (4.5)	44.09*	43.83*	0.59
Milk and milk products	500	399.09±201.3 (79.8)	380.00±156.0 (76.0)	0.50	0.70	0.55
Fats and oils	20	14.18±5.6 (70.9)	14.78±4.7 (73.8)	1.04	1.10	0.60
Sugar and jaggery	25	25.90±10.0 (103.6)	26.56±9.2 (106.2)	0.09	0.16	0.35

*Significant at 5% level.

Values are mean ± SD.

Figures in parentheses indicate per cent RDI.

RDA - Recommended dietary allowances (NIN, 1998).

Z values show comparison of intake and RDI.

Z₁ values indicate comparison of food intake of boys and girls.

Nutrient Intake

Data in Table 3 reflect mean daily nutrient intake of the pre-school children of 3-4 years. Mean daily intake of energy, iron and vitamin C was significantly lower than RDA. On comparing sex-wise, it was found that difference among these nutrients was non-significant. Lower intake of iron and vitamin C may be due to low intake of green leafy vegetables and other iron rich foods and fruits especially citrus fruits in the diet of rural pre-school children. Similarly, inadequate intake of energy, iron and vitamin C by pre-school children has been reported by Takyi (1999).

Mean daily intake of protein, fat, calcium, vitamin

A and folic acid of both girls and boys was slightly higher than RDA. However, non-significant difference was observed in intake of these nutrients between boys and girls.

As is evident from the results, consumption of pulses, green leafy vegetables and fruits was very low in the children's diet, therefore, enrichment of daily diet with these food stuffs should be encouraged. Emphasis should be laid on growing of green leafy vegetables in their fields so that they can consume these vegetables and get valuable vitamins and minerals in sufficient amount for the improvement of children's nutritional status.

TABLE 3
Mean daily nutrient intake of pre-school children of 3-4 years

Nutrients	RDA (g)	Mean nutrient intake/day		Z value		'Z ₁ ' value Boys-Girls
		Boys (n=55)	Girls (n=54)	Boys	Girls	
Energy (Kcal)	1240	989.00±93.2 (77.7)	987.83±103.0 (79.6)	2.6*	2.4*	0.0
Protein (g)	22	29.52±5.8 (134.1)	29.48±5.6 (133.9)	1.3	1.3	0.0
Fat (g)	25	33.65±8.2 (134.6)	33.86±8.5 (135.5)	1.1	1.0	0.1
Calcium (mg)	400	640.87±298.5 (160.2)	632.53±257.9 (158.1)	0.8	0.9	0.2
Iron (mg)	12	8.40±2.2 (69.9)	8.14±1.9 (67.9)	2.0*	1.6*	0.6
Vitamin A (µg)	400	425.14±213.5 (106.3)	402.35±207.9 (100.6)	1.1	1.0	0.6
Vitamin C (mg)	40	16.63±5.3 (41.6)	16.52±6.3 (41.3)	4.4*	3.7*	0.0
Thiamine (mg)	0.6	0.77±0.1 (128.5)	0.71±0.1 (128.0)	1.8	1.7	0.2
Riboflavin (mg)	0.7	0.54±0.2 (77.5)	0.53±0.2 (75.3)	-0.9	1.0	0.5
Nicotinic acid (mg)	8	7.95±0.9 (99.3)	8.00±0.9 (100.0)	0.1	0.0	0.3
Folic acid (µg)	30	84.91± 31.8 (283.0)	79.33±20.9 (264.4)	2.4*	1.7	1.0
Vitamin B ₁₂ (µg)	0.2-1.0	0.28±0.17 (137.7)	0.30±0.16 (149.3)	0.4	0.6	0.7

*Significant at 5% level.

Values are mean ± SD.

Figures in parentheses indicate per cent RDA.

RDA – Recommended dietary allowances (Gopalan *et al.*, 1989).

Z values show comparison of intake and RDA.

Z₁ values indicate comparison of nutrient intake of boys and girls.

NUTRIENT INTAKE OF PRE-SCHOOL CHILDREN

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CREATIVE DESIGNS FOR ADOLESCENT TOP USING DART MANIPULATION

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Clothes are so intimate, obvious and omnipresent part of our personality that no other expenditure of equal amount can contribute so much to the satisfaction of our deep desire for personal recognition and to the sense of personal security. Clothing requirements of different individuals vary at different stages. These variations are due to the difference in age, personality, gender and role by individual to be played. Among all the stages of life, adolescents are considered to be the most conscious about their clothing. Change in body figure is one of the factors which affect their clothing selection. Due to change in body curves there is immense need for fullness in the garment. Therefore, proper fit in garment is very essential. Designing garments for an adolescent is very skillful job. Designs should be such that they can fulfil their needs. Designing through dart manipulation can solve the purpose as number of designs can be created by converting darts into princess line, tucks, gathers, style line and panels. These designs can provide fullness and can be used for decorative purposes. Tops have been observed as an important garment of the adolescent girl's wardrobe as these can be matched and worn with skirts as well as jeans or pants.

Total 15 designs for top were sketched using dart manipulation techniques. Darts were manipulated into princess line, tucks, gathers, panels and in style lines. From these 15 designs five most preferred designs based on princess line and style line were selected by a panel of experts as well as adolescent girls (Fig. 1). For stitching of tops standardized measurements of size 32 inches round bust were used. On the basis of respondents preferences pink coloured blend (lizzy-buzy) fabric was selected. Constructed tops were given to the respondents to wear and were assessed by experts and respondents themselves on three-point rating scale.

It is evident from Table 1 that cotton blend was ranked first (3.37), followed by cotton (3.05). Third rank was earned by Denim (1.97). Least preferred fabric for top was synthetic (1.62). Sethi (1989) and Sandhu (1991) also reported preferences for cotton fabric by the adolescent girls because of comfort.

TABLE 1

Preferential order for selection of fabric

(N=60)			
S. No.	Material	Weighted mean	Rank
1.	Cotton	3.05	II
2.	Cotton blend	3.37	I
3.	Denim	1.97	III
4.	Synthetic	1.62	IV

The data in Table 2 indicate that while selecting fabric for garments, comfortable was ranked first (4.80), followed by attractiveness (4.25). Third rank was earned by climatic conditions (3.55) followed by cost of fabric (3.35) and durability (2.53), easy care of fabric was ranked least (2.45). Sushila Devi (1995) also stated attractiveness (94.44%) and comfortability (85.56%) as reasons for the selection of fabric on the basis of study on Home Science girls.

TABLE 2

Reasons for fabric selection

(N=60)			
S. No.	Response	Weighted mean	Rank
1.	Comfortable	4.80	I
2.	Attractiveness	4.25	II
3.	Durability	2.53	V
4.	Easy care	2.45	VI
5.	Cost of fabric	3.35	IV
6.	Climatic conditions	3.55	III

The data in Table 3 show that pink coloured fabric was ranked first by the respondents (80.00%) followed by sky-blue (56.67%), white colour was ranked third (51.67), fourth rank was given to lemon (28.33%), fifth rank was obtained by red (26.67%), sixth rank was given to orange (18.33%), seventh and eighth ranks were given to black (13.33%) and peach (10.00%) by the respondents. Similar results were

reported by Chopra (1997) and Sangeeta (1981) that girls prefer pink colour being most attractive and soothing for their dresses. Duggal (1976) reported that girls with whitish complexion preferred more of blue, pink and yellow colours in their garments.

The results presented in Table 4 show that design No. 7 was assessed for placement of princess line and overall appearance of the design. The design was ranked first both by the respondents as well as experts with weighted mean score 2.85 and 2.80, respectively. The main feature of this design was placement of princess line by shifting side seam dart into arm side and overall appearance of the design.

The design No. 5 was assessed on the basis of included features, which are shape and length of yoke, placement of princess line and overall appearance of the design. The design was ranked second both by respondents and experts with weighted mean score 2.83 and 2.75, respectively. This design includes shifting of side seam dart to waist dart converted into princess line. Arm scye dart was converted into yoke line.

TABLE 3

Preference for the material colour

(N=60)

S. No.	Material colour	Respondents		Rank
		Frequency	Percentage	
1.	Pink	48	80.00	I
2.	Sky blue	34	56.67	II
3.	White	31	51.67	III
4.	Lemon	17	28.33	IV
5.	Red	16	26.67	V
6.	Orange	11	18.33	VI
7.	Black	08	13.33	VII
8.	Peach	06	10.00	VIII

TABLE 4

Assessment of the constructed tops in relation to constructional features

S. No.	Design No.	Features of design	Respondents			Experts		
			Mean score	Weighted mean score	Rank	Mean score	Weighted mean score	Rank
1.	7	(i) Placement of princess line	2.85	2.85	I	2.80	2.80	I
		(ii) Overall appearance of design	2.85			2.80		
2.	5	(i) Shape of yoke	2.45	2.83	II	2.30	2.75	II
		(ii) Length of yoke	2.15			2.20		
		(iii) Placement of princess line	2.70			2.60		
		(iv) Overall appearance	2.45			2.30		
3.	15	(i) Placement of princess line	2.60	2.73	III	2.60	2.65	III
		(ii) Overall appearance	2.85			2.70		
4.	8	(i) Shape of yoke	2.45	2.44	IV	2.30	2.35	IV
		(ii) Symmetry of yoke	2.15			2.20		
		(iii) Placement of princess line	2.70			2.60		
		(iv) Overall appearance	2.45			2.30		
5.	9	(i) Placement of style line	2.35	2.43	V	2.30	2.30	V
		(ii) Overall appearance	2.58			2.30		

CREATIVE DESIGNS USING DART MANIPULATION

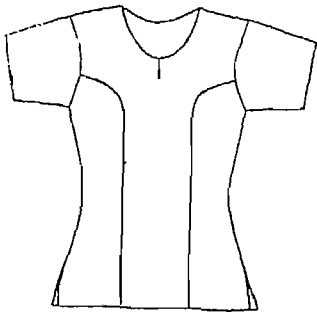
The design No. 15 includes placement of princess line and overall appearance of the design. Data depict that third rank was given to this design by the respondents as well as experts (2.73 and 2.65, respectively). By shifting side seam dart and arm scye dart into shoulder line and converted into princess line with the waist dart.

The design No. 8 was assessed on the basis of included features, viz. shape and symmetry of the yoke, placement of princess line. This design earned fourth

rank by the respondents as well as experts with scores 2.44 and 2.35, respectively.

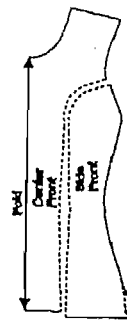
Data show that design No. 9 was assessed on the basis of placement of style line and overall appearance of the design. It was ranked fifth both by respondents as well as experts with scores 2.43 and 2.30, respectively. In this design waist dart is partially shifted to arm scye dart and shoulder dart forming a style line which passes through bust apex ending at side seam.

Design No. 7

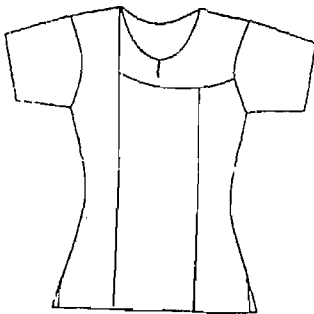


SPECIFICATIONS

- Side seam dart shifted to arm scye dart.
- Waist dart manipulated to princess line.

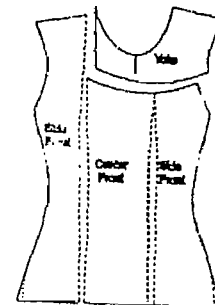


Design No. 8

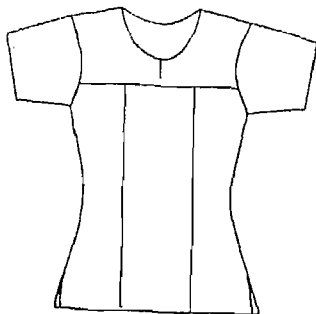


SPECIFICATIONS

- Side seam dart in arm scye dart shifted to shoulder line.
- Waist dart and shoulder dart manipulated to princess line.

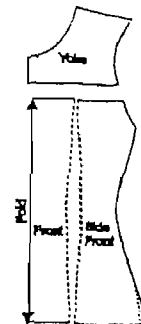


Design No. 5



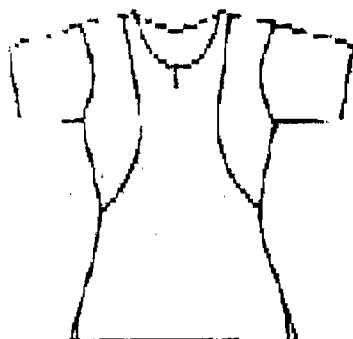
SPECIFICATIONS

- Side seam dart shifted to waist dart.
- Waist dart converted into princess line.
- Arm side dart converted into yoke line joint to princess line.

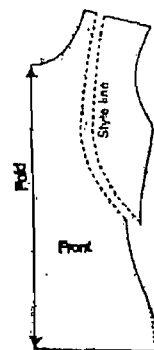


Design No. 9

SPECIFICATIONS

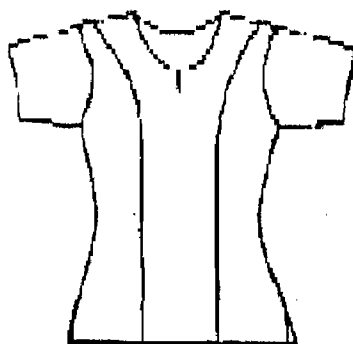


- Waist dart shifted to side seam dart and shoulder dart.
- Arm scye dart shifted to shoulder dart.
- Shoulder dart and side seam dart converted to style line.

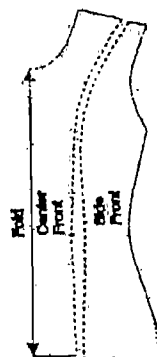


Design No. 15

SPECIFICATIONS



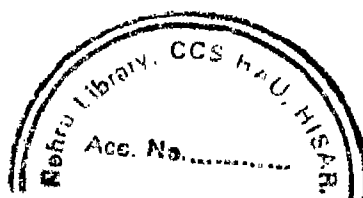
- Side seam dart and arm scye dart shifted at shoulder.
- Waist dart manipulated into princess line.



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RELATIVE EFFICIENCY OF INCOMPLETE BLOCK DESIGN IN SESAME (*SESAMUM INDICUM*)

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ABSTRACT

A uniformity trial on sesame was conducted at the CCS Haryana Agricultural University, Hisar during 1999-2000. The relative efficiencies of confounded designs and lattice designs were compared with randomized block design. The confounding in 12-plot block increased the efficiency by 7.31% over 24-plot block. This gain in efficiency was 14.45% more when block size was further reduced to 8-plot blocks. The relative efficiencies of simple lattice, triple lattice, balanced lattice and lattice square design with two different plot sizes and with number of varieties 25, 49, 81 and with and without recovery of inter-block information were computed. The average relative efficiency of lattice design with recovery of inter-block information was 135.91%, while without recovery of inter-block information was 127.55 per cent. The gain in efficiency with recovery of inter-block was always more in comparison to without recovery of inter-block information in all lattice designs, for all the varieties of sesame in different plot sizes. The average gain in efficiency of lattice design over randomized block design was 31.74 per cent. This efficiency further increased with increase in plot size. The relative efficiencies of simple, triple, balanced and lattice square with respect to randomized block design were 127.17, 131.26, 135.59 and 128.01 per cent, respectively. The average relative efficiency of square and triple lattice for 25 varieties were 132.75 and 137.50 per cent. Thus, lattice square design did not cause any additional gain in efficiency. Similarly, lattice square design was compared with simple lattice in case of 49 varieties and it was found to be less efficient. Balanced lattice design proved more efficient in most of the cases.

The incomplete block design (IBD) developed by Yates (1936) is generally recommended for experiments with larger number of treatments because of the fact that a block accommodating a complete replicate might not be sufficiently homogenous and the precision of the treatment comparison may suffer. This reduction in block size is achieved by confounding by sacrificing all or part of the information on certain treatment comparisons or by the use of other incomplete block designs like lattice designs. The objective of the present investigation was to determine the efficiency of confounding by the use of lattice and lattice square design by superimposing on a uniformity trial data.

MATERIAL AND METHODS

A uniformity trial in sesame was conducted during 1999-2000. The crop was sown with a row to row spacing of 30 cm and plant to plant spacing of 15

cm. Variety HT-1 was sown and uniform agronomic practices like irrigation, fertilization, etc. were followed for all the plots. The whole field was harvested in 576 units each of dimension 1 m². The relative efficiency (RE) of confounded design was worked out by calculating the ratio of variance obtained with confounding in 24 plot blocks to that with confounding in (i) 12 plot blocks and (ii) 8 plot blocks. Simple lattice (with four replications), triple lattice (three replications), balanced lattice (K+1 replication) and lattice square [with (K+1)/2 replications] with 25, 49 and 81 varieties in two different plot sizes of 1×1 m² and 1.5×1.5 m² were calculated. The RE of these different designs as compared to RBD have been calculated both with and without recovery of inter-blocks information. The RE in case of recovery with inter-block information has been worked out by methods as used by Shukla (1966), and without recovery of inter-blocks information has

been computed by utilizing the efficiency factor given by Yates (1936). RE of any IBD with respect to RBD was obtained by the formula :

$$\text{RE (in percentage)} = (V_R/V_I) \times 100$$

Where, V_R is EMS for RBD, V_I is the EMS for IBD obtained by multiplying EMS for IBD by the respective efficiency factor 'f'. The efficiency factor 'f' has been calculated as given below :

Efficiency factor (f) for different lattice designs

Design	With recovery of IBI	Without recovery of IBI
	Cochran (1941)	Yates (1936)
K×K simple lattice	$1 + [4/(K+1)] [(B-E)/(2B+E)]$	$(K+1)/(K+3)$
Triple lattice	$1 + [3/2 (K+1)] [(B-E)/B]$	$(K+1)/(K+2\frac{1}{2})$
Lattice square	$1 + [1/(K-1)] \{[(R-E)/R] + [(C-E)/C]\}$	$(K+1)/(K-1)$

Where :

B=MS for blocks within replication

R=MS for rows within replication

C=MS for columns within replication

E=MS for error within replication

For comparing the efficiencies of different lattice designs among themselves, designs which cover the same number of replications were considered.

RESULTS AND DISCUSSION

Based on the previous studies on uniformity trials, Kaushik *et al.* (1977a, b) and Hasija *et al.* (1985) have concluded that it will not be desirable to test more than 20 varieties in a RBD and thus it was considered necessary to estimate the gain in efficiency of IBD over RBD in case of sesame which is an important crop in Haryana.

The RE of confounded design was worked out and the results are given in Table 1.

The confounding results in gain of efficiency varied from 2.51 to 18.96 per cent with an average of

TABLE 1
Efficiency of confounding

Experiment No.	12-plot block	8-plot block
1	105.33	108.31
2	106.84	125.34
3	106.99	118.56
4	118.96	123.33
5	103.21	106.21
6	102.51	104.93
Average	107.31	114.45

7.31 in case of 12 plot blocks. The efficiency of confounding increased when the block size was further reduced from 12 to 8. With 8 plot blocks the gain in efficiency due to confounding varied from 4.93 to 25.34 with an average gain of 14.45.

The RE of various designs with respect to RBD for different plot sizes and with different number of varieties have been calculated and are given in Table 2. On an average, the RE was always more with recovery of inter-block information (135.92%) than without recovery of inter-block information (125.10%). Though, the efficiencies of different designs with different number of varieties of sesame were not directly comparable among themselves, unless they occupy the same experimental area and number of replications, yet, on an average, it can be safely concluded that the gain in efficiency of balanced lattice over RBD was more than any other design. The relative efficiencies of double lattice and triple lattice, on an average, are almost equal (133.17 and 134.17) in case of recovery of inter-block information which is in agreement with the results obtained by Sardana *et al.* (1967) but in case of without recovery of inter-block information, the gain in efficiency was more in triple lattice design as compared to simple lattice. It was also observed by Abraham and Vachhani (1964) in case of rice crop.

The average gain in efficiency obtained by the use of lattice designs over RBD is 30.88 per cent. While Kaushik *et al.* (1977) reported the gain as 29%

TABLE 2

Relative efficiencies of various lattice designs as compared to RBD

Size	No. of varieties	Simple lattice		Triple lattice		Balanced lattice		Lattice square		Average
		With recovery	Without recovery	With recovery	Without recovery	With recovery	Without recovery	With recovery	Without recovery	
1 × 1 m ²	25	131	114	129	122	131	109	138	117	
	49	124	114	126	119	138	125	131	114	
	81	123	113	123	119	124	121	123	113	
Average		126	113.67	126	120	131	118.33	130.67	114.67	122.54
1.5 × 1.5 m ²	25	143	134	153	146	157	153	149	127	
	49	154	138	145	139	141	135	141	127	
	81	124	114	129	125	-	-	136	120	
Average		140.33	128.67	142.33	136.67	149	144	142	124.67	138.46
Average		133.17	121.17	134.17	128.34	140	131.2	136.34	119.67	
Average		127.17		131.26		135.59		128.01		

in mustard, Shukla (1966) reported the gain as 22% in case of jute, and Zubar (1942) observed 36% gain in case of corn. The RE of different designs varied with number of varieties and plot sizes. The gain in efficiency over RBD was more with bigger plot size, when the plot size was increased from 1×1 m² to 1.5×1.5 m² the average gain in efficiency of lattice designs over RBD increased by 21.5 per cent. With two plot sizes and number of varieties as 25, 49 and 81, the average efficiency of simple, triple, balanced and lattice square were 127.17, 131.26, 135.59 and 128.01 per cent. There was not much difference in the efficiencies, yet the balanced lattice was slightly superior.

For comparing the efficiency of different lattice

designs among themselves, designs which covered the same area and the same number of replications were considered. The comparison of lattice square and triple lattice was made in case of 25 varieties. The average efficiencies of triple and square lattice were 137.50 and 132.75, respectively, indicating thereby that lattice square design was less efficient than triple lattice which may be due to the fact that there may not be two directional fertility gradients in the soil. Similarly, lattice square was compared with simple lattice in case of 49 varieties and average efficiencies were found to be 128.25 and 132.5, respectively, indicating that lattice square is also less efficient than simple lattice.

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CHEMICAL CONSTITUENTS OF BARK OF *CRATAEVA NURVALA* (BUCH - HAM)

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ABSTRACT

Four compounds have been isolated and characterized from bark of *Crataeva nurvala* : 7-tridecanone, lupeol, 14-heptacosanone and E-Sitosteryl-E-D-glucoside. Of these 7-tridecanone and 14-heptacosanone are being reported for the first time from this plant.

Key Words. : *Crataeva nurvala*, Capparidaceae, Chemical components, Spectral data.

Crataeva nurvala belongs to the family Capparidaceae. It is used to treat hypercrystalluria, hyperoxaluria and hypercalciuria. The plant is also known to possess antipyretic, diuretic, demulcent, laxative, antilithic, antihelminthic and anti-inflammatory activities (Singh and Kapoor, 1991; Singh *et al.*, 1997). It is used as stomachic, alternative tonic in chest and blood diseases and is widely used to treat urinary stones (Prabhakar and Kumar, 1990). It decreases urinary and renal tissue oxalate levels and also decreases stone formation (Varalakshmi *et al.*, 1990). Main constituents reported from the plant are terpenoids (Lakshmi and Chauhan, 1975). A major component isolated from the plant is lupeol. It is reported mainly from the bark. Lupeol is known to possess antiurolithiasis activity (Anand *et al.*, 1993).

MATERIAL AND METHODS

The melting points were determined on Ganson electrical melting point apparatus. ¹H NMR spectra were recorded on Bruker AC-300F 300 MHz NMR spectrometer in CDCl₃ using TMS as internal standard. IR spectra were recorded on Hitachi 570 Infrared spectrophotometer. Mass spectra were recorded on VG-70S 11-250J GC-MS-DS mass spectrometer.

Plant material : Bark of the plant was obtained from the Landscape Department of the University.

Extraction and isolation : Bark of *Crataeva nurvala* (5 kg) was chopped into small pieces and air-

dried. The extraction was carried out by refluxing with hot methanol for six hours. The solvent was removed to obtain the extractives. With the given plant material, the process of extraction was repeated four times. The viscous mass thus obtained was mixed with silica gel (60 - 120 mesh), dried over water bath and subjected to silica gel (60 - 120 mesh) column chromatography and afforded four compounds (A - D).

RESULTS AND DISCUSSION

Compound A (7-Tridecanone, 1)

It was obtained on elution with benzene-petroleum ether (1 : 9) and crystallized from benzene as white solid, 7 mg, m.p. 197° (lit mp 198-200°, Heilbron *et al.*, 1965). IR Θ_{\max} (K Br): 760, 802, 1026, 1096, 1260, 1378, 1494, 1733, 2852. ¹H NMR (δ , CDCl₃): 2.22 (4H, t, J 7.0Hz, 2 x -CH₂CO-), 1.58 (4H, m, 2 x -CH₂CH₂CO-), 1.25 (12H, br, 6 x -CH₂-), 0.88 (6H, t, J 7.0 Hz, 2 x -CH₃). GC-MS (m/z): 197 (M⁺ - 1), 185, 157, 152, 129, 115, 101, 98, 84. A comparison with literature data (Heilbron *et al.*, 1965) confirmed the compound A to be 7- tridecanone (1). It is the first report of the isolation of 7-tridecanone (1) from *C. nurvala* bark.

Compound B (Lupeol, 2)

It was obtained on elution with benzene-petroleum ether (1 : 3) and crystallized from methanol, 100 mg, m.p. 216° (lit. m.p. 214 - 216°, Sukhdev, 1989). It gave violet colour with Ac₂O/H₂SO₄. IR Θ_{\max} (K Br) : 667,

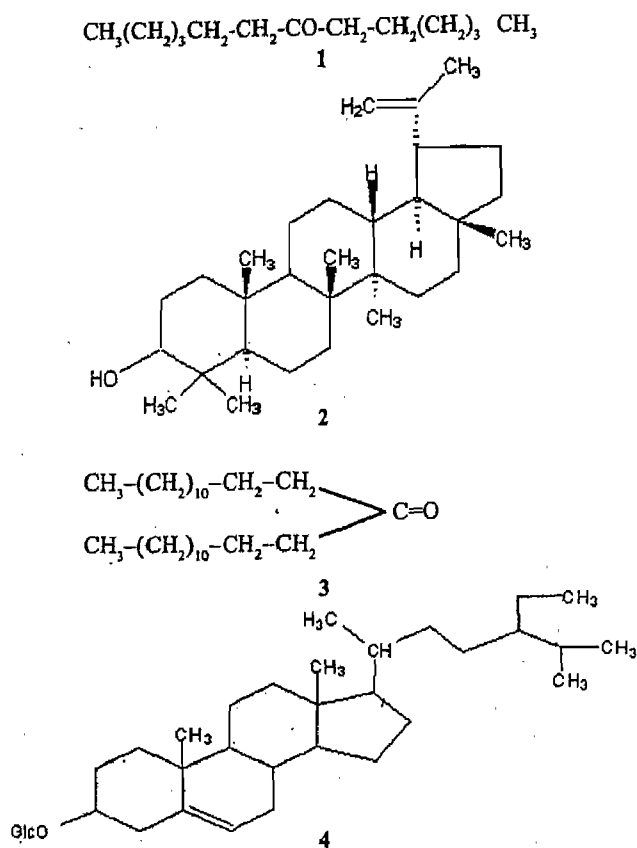


Fig. 1.

882, 1014, 1093, 1216, 1380, 1459, 2872, 3067, 3322. $^1\text{H NMR}$ (δ , CDCl_3): 4.68 (1H, m, $>\text{C}=\text{CHH}$), 4.56 (1H, m, $>\text{C}=\text{CHH}$), 3.19 (1H, m, $-\text{CHOH}$), 1.64 - 2.41 (25H, m, 10 x $-\text{CH}_2-$, 5 x $>\text{CH}-$), 1.70 (3H, s, $-\text{CH}_3$), 1.04 (3H, s, $-\text{CH}_3$), 0.96 (3H, s, $-\text{CH}_3$), 0.95 (3H, s, $-\text{CH}_3$), 0.84 (3H, s, $-\text{CH}_3$), 0.79 (3H, s, $-\text{CH}_3$), 0.76 (3H, s, $-\text{CH}_3$). GC-MS (m/z): 446 (M^+), 428, 318, 266, 222, 207, 136, 119 and 105. These data fully agreed with literature data (Sukhdev, 1989) of lupeol (2). The compound B was therefore characterized as lupeol (2).

Compound C (14- Heptacosanone, 3)

The compound was obtained on elution with benzene - petroleum ether (1 : 1) and crystallized from methanol, 7 mg, m.p. 80° (lit. m.p. $78 - 80^\circ$, Heilbron *et al.*, 1965). IR Θ_{max} (K Br) : 800, 1093, 1260, 1456, 1736, 2960. $^1\text{H NMR}$ (δ , CDCl_3) : 2.35 (4H, t, J 7.0 Hz, 2 x $-\text{CH}_2\text{CO}-$), 1.67 (4H, m, 2 x $-\text{CH}_2\text{CH}_2\text{CO}-$),

1.26 (40H, br, 20 x $-\text{CH}_2-$), 0.88 (6H, t, J 7.0, 2 x $-\text{CH}_3$). GC-MS (m/z) : 394 ($\text{M}^+ + 2$), 281, 208, 207, 169, 161, 149, 121, 97, 85. A comparison of the data of the compound C with the literature data (Heilbron *et al.*, 1965) for 14 - heptacosanone/myrestone (3) confirmed the compound C to be 14- heptacosanone/myrestone (3). It is the first report of the isolation of 14 - heptacosanone (3) from *C. nurvala* bark.

Compound D (E-Sitosteryl-E-D-glucoside, 4)

It was obtained on elution with ethyl acetate : benzene (1:1) and crystallized from ethyl acetate, 50 mg, m.p. 281°C (lit. m.p. $283-286^\circ\text{C}$, Heilbron *et al.*, 1965). It gave positive Liebermann-Burchard reaction. It responded to Molisch test. IR Θ_{max} (K Br) : 625, 895, 1026, 1075, 1258, 1373, 1466, 3395. Acetate (Compound D + Acetic anhydride + pyridine, m.p. 170°C , lit. m.p. 171°C , Heilbron *et al.*, 1965); $^1\text{H NMR}$ (Γ , CDCl_3) : 0.67 (3H, s, $-\text{CH}_3$), 0.82 (3H, s, $-\text{CH}_3$), 0.86 (3H, s, $-\text{CH}_3$), 0.98 (3H, s, $-\text{CH}_3$), 1.25 (6H, s, 2 x $-\text{CH}_3$), 1.4-1.87 (29H, m, 7 x $>\text{CH}-$, 11x $-\text{CH}_2-$), 2.00 (3H, s, $-\text{OAc}$), 2.02 (3H, s, $-\text{OAc}$), 2.05 (3H, s, $-\text{OAc}$), 2.08 (3H, s, $-\text{OAc}$), 3.85 - 5.24 (8H, m, H - 3, sugar protons), 5.35 (1H, br, H-6). GC-MS (m/z) : 326 (M^+), 395, 281, 269, 207, 174, 161, 149, 122, 94.

Hydrolysis

The compound D (8 mg) was mixed with one ml of Kiliani mixture (glacial acetic acid : HCl : H_2O : 3.5 : 1.0 : 5.5) and heated in a sealed tube on water bath for six hours to hydrolyze the sugar component and get the aglycone. The aglycone was then extracted with diethyl ether and compared with authentic sample of E-sitosterol (Kalidhar, 1982) using TLC. The remaining reaction mixture was concentrated and then examined for free sugar by paper chromatography and was found to be glucose on direct comparison with an authentic sample of glucose.

The identity of the compound D as E-sitosteryl-E-D glucoside (4) was confirmed by direct comparison of the compound D with the authentic sample (Kalidhar, 1982) of E-sitosteryl-E-D-glucoside (4).

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ESTIMATION OF AREA AND PRODUCTION OF COTTON IN HARYANA

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ABSTRACT

The growth rates of area, production and yield of cotton crop in Haryana for a period of 40 years (1966-67 to 2005-06) were found highly significant. Area and its interaction with yield were main components to increase its production. An estimate of area, production and yield of cotton in Haryana for next two years was also worked out.

Key Words : Regression coefficient, Compound growth rate, Variability.

Cotton is the main commercial crop of **kharif** season in Haryana. Its contribution, which was 5.79% during 1966-67, has shot upto 10.2% during 2003-04 in the total production of cotton in India. Its area and production in Haryana have increased tremendously, 343 thousand hectares and 1102 thousand bales, respectively, in a span of 38 years. The demand of cotton is going to increase in the times to come and hence the estimate of area and production may be helpful to the farmers, industrialists and agriculturalists to take appropriate decision about the production of the crop. Narayanan (1994) has studied the prospects of cotton production in India. Bhatnagar (2004) has also studied the trend for sunflower as well as oilseed in Haryana.

An attempt has been made to analyze the growth performance and to estimate the area and production of cotton in Haryana.

METHODOLOGY

The study is based on the secondary data of area, production and yield of cotton (American and Desi) in Haryana for the period of 40 years from 1966-67 to 2005-06 which was collected from Statistical Abstract of Haryana. The whole study period has been divided into two phases, *i.e.* 1966-67 to 1988-89, and 1989-90 to 2005-06 as there was a breakthrough in cotton production technology in Haryana.

Basically any change in production of a crop

depends on the change in its area and yield. If the production, yield and area are denoted by Q_n , Y_n and A_n for the current period and Q_0 , Y_0 and A_0 for the base period, the increase in production $Q=(Q_n-Q_0)$ in n years over base period is a function of change in area $A=(A_n-A_0)$ and yield $Y=(Y_n-Y_0)$.

Sharma (1977) suggested the formation to measure the relative contribution of area, yield and their interaction in increase of crop production.

Production in base year is given by

$$Q_0 = A_0 \times Y_0$$

Similarly, production in n year is given by

$$Q_n = A_n \times Y_n$$

Also,

$$Q_n = Q_0 + Q, A_n = A_0 + A \text{ and } Y_n = Y_0 + Y$$

Therefore,

$$(Q_0 + Q) = (A_0 + A) (Y_0 + Y)$$

$$Q = A_0 Y + Y_0 A + AY \tag{2.1}$$

Where,

$A_0 Y$ = Yield effect,

$Y_0 A$ = Area effect and

AY = Interaction between area and yield.

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

To analyze the time series data following two functions were fitted. The linear function is

$$Y_t = a + bt \quad (2.2)$$

Where,

Y_t = Area/ Production/ Yield of cotton in Haryana in t th year,

a = Constant,

b = Regression coefficient and

t = Time variable in years (1, 2, —, 40).

The exponential function is

$$Y_t = AB^t \quad (2.3)$$

Where,

A = Constant and

$B = (1+r)$ with r as compound growth rate.

It is in the log form as

$$\log Y_t = \log A + t \log B \quad (2.4)$$

which is similar to linear equation (2.2).

The compound growth rate (C. G. R.) has been calculated as

$$\text{Compound growth rate (\%)} = (\text{Anti log } B - 1) \times 100.$$

RESULTS AND DISCUSSION

Cotton area in Haryana has increased 400 thousand hectares, whereas its production has increased 1194 thousand bales of 170 kg each during 1966-67 to 2005-06. But the average yield of cotton has increased only 154 kg per hectare in this period.

According to data in Table 1, average area of cotton in Haryana has shot up from 212 to 577 thousand hectares, i.e. 172.17% more area was captured by

TABLE 1

Average area, production and yield of cotton in Haryana for the triennium 1966-69 as base period and 2003-06 as current period

Variable	Base period	Current period	Change (%)
Area ('000 hectare)	212	577	172.17
Production ('000 bales)	353	1660	370.25
Yield (kg/ha)	283	489	72.79

cotton crop in a span of 40 years by taking the triennium 1966-69 as base period and the triennium ending 2006 as current period. Average production of cotton has also increased from 353 to 1660 thousand bales showing an appreciable rise of 370.25 per cent. Similarly, the average yield of cotton has gained 72.79% as yield has increased from 283 to 489 kg per hectare in this period. There is a remarkable increase in area and production of cotton in Haryana.

For comprehensive study, the span of 40 years from 1966-67 to 2005-06 has been divided into two phases according to the breakthrough in production technology, i.e. Phase I (1966-67 to 1988-89) and Phase II (1989-90 to 2005-06). As depicted in Table 2, average area of cotton has increased 93.40% from 212 to 410 thousand hectares in 23 years by taking the triennium 1966-69 as base period and the triennium ending 1989 as current period for Phase I. For Phase II, the area of cotton has increased only 18% from 489 to 577 thousand hectares in duration of 17 years by taking the triennium 1989-91 as base period and the triennium ending 2006 as current period. Average cotton production has amazingly increased from 353 to 813 thousand bales showing a significant increase of 130.31% during Phase I, whereas it has increased only 35.07% from 1229 to 1660 thousand bales in Phase II. Average yield of cotton has gained 19.08%, i.e. from 283 to 337 kg per hectare in Phase I and 14.52% increase from 427 to 489 kg per hectare during Phase II. So, area and production of cotton have increased significantly in Phase I than Phase II.

TABLE 2

Average area, production and yield of cotton in Haryana for the triennium 1966-69 as base period and 1986-89 as current period for Phase I and 1989-91 as base period and 2003-06 as current period for Phase II

Variable	Phase	Base period	Current period	Change (%)
Area ('000 hectare)	I	212	410	93.40
	II	489	577	18.00
Production ('000 bales)	I	353	813	130.31
	II	1229	1660	35.07
Yield (kg/ha)	I	283	337	19.08
	II	427	489	14.52

Increase in production of cotton has been decomposed into components, viz. yield effect, area effect and the effect of their interaction (Table 3). For whole study period, the production of cotton has increased 19.7% due to yield effect and 46.5% due to area effect. The interaction between area and yield has contributed 33.8% to increase the production of cotton. Thus, area and its interaction with yield are the main factors to increase the production of cotton in Haryana. During Phase I the production of cotton has increased 71.7% mainly due to area effect, whereas it increased 14.6% due to yield and 13.7% due to interaction between area and yield. The production of cotton has increased 41.4% due to yield and 51.3% due to area effect which are the main contributing factors during Phase II, whereas the contribution of their interaction is only 7.3 per cent.

TABLE 3

Contribution of area, yield and their interaction on production of cotton in Haryana

Variable effect	Period		
	Phase I	Phase II	Whole period
Yield	14.6%	41.4%	19.7%
Area	71.7%	51.3%	46.5%
Interaction between area and yield	13.7%	7.3%	33.8%

The trend/pattern of growth in area, production and yield of cotton in Haryana during 1966 to 2006 have been presented in Table 4. Area of cotton has increased with highly significant compound growth rate of 3.32%, i.e. a simple increase of 12.34 thousand hectares every year. Similarly, the production of cotton has increased with highly significant rate of 4.06% giving an annual increase of 31.99 thousand bales. Average yield of cotton has also increased with highly significant rate of 0.72%, which means an increase of 2.90 kg per hectare per year. So, the production of cotton has increased at a higher rate than area and yield. The variability in area, production and yield of cotton in Haryana has also been worked out in Table 4. The production of cotton has shown maximum variability of 49.80 per cent. The variability for area of cotton is 37.50%, whereas for yield it is only 20.21 per cent.

TABLE 4

Pattern of growth and variability in cotton in Haryana for the period 1966-67 to 2005-06

Variable	Regression coefficient (b)	Compound growth rate (%)	Coefficient of variation (%)
Area	12.34**	3.32**	37.50
Production	31.99**	4.06**	49.80
Yield	2.90**	0.72**	20.21

**Significant at 1%.

TABLE 5

Estimated trend values of area, production and yield of cotton in Haryana

Year	Area ('000 hectare)	Production ('000 bales)	Yield (kg/ha)
	$Y_t = 193.86 (1.03316)^t$	$Y_t = 337.76 (1.04058)^t$	$Y_t = 296.01 (1.0072)^t$
2006-07	739	1726	397
2007-08	763	1796	400

The compound growth rate is found best fit for the area and production of cotton. An estimate of area, production and yield of cotton in Haryana has been

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worked out by using the equation 2.3 and presented in Table 5 for the next two years. It is estimated that area of cotton in Haryana will be 739 and 763 thousand hectares for the years 2006-07 and 2007-08,

respectively. The production of cotton is expected to be 1726 and 1796 thousand bales in these years, respectively. Average yield of cotton is also estimated to be 397 and 400 kg per hectare for respective years.

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NPK CONTENT AND UPTAKE AS AFFECTED BY PLANTING SYSTEMS, SEED RATES AND N LEVELS IN WHEAT (*TRITICUM AESTIVUM* L.)

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ABSTRACT

A field experiment was conducted during winter seasons to study the effect of different planting methods, seed rates and nitrogen levels on the nutrient content and uptake pattern of wheat. The two planting systems, viz. bed planting and conventional sowing did not have their significant effect on growth, yield attributes, grain yield, NPK content, NPK uptake and protein content. Each increase of 25 kg seed rate starting from 50 kg ha⁻¹ and ending with 100 kg ha⁻¹ brought about a significant increase in grain yield. NPK uptake increased significantly with increasing seed rate upto 100 kg ha⁻¹ during both the years. With each successive level of nitrogen upto 150 kg ha⁻¹ the spikes/m, grains/spike and grain yield improved significantly in both the years. The N content in grain increased with enhancing fertility levels upto 150 kg N ha⁻¹, whereas P and K content did not vary during both the years. The K content in straw enhanced significantly with each successive level of N. The uptake of N and P and protein content in grain increased significantly with successive increase in N level upto 150 kg ha⁻¹.

Key Words : Planting system, Seed rate, Nitrogen level, Bed planting, Conventional planting.

The present scenario of high fuel and energy costs with increasing cost of inputs like seeds and fertilizers has forced the researchers to think about a system that can help in efficient use of these inputs without any adverse effect on environmental sustainability and productivity. To exploit the yield potential of a genotype the prerequisite is the planting system. Increasing plant densities by higher seed rates have been visualized as one of the ways to increase the yield. Fertilization especially nitrogen is required in large amounts by high yielding dwarf genotypes and is often the most limiting plant nutrient in soil for optimum crop yield. The information on nutrient content and uptake studies in wheat as affected by planting system, seed rates and N fertilization is meagre. The present investigation was aimed at studying the yield behaviour, NPK content and uptake as affected by planting system, seed rates and N levels in bread wheat.

MATERIAL AND METHODS

The field experiment was conducted during rabi seasons at the Crop Research Farm of CCS Haryana

Agricultural University, Hisar. The soil was sandy loam (Typic Ustochrept) in texture, slightly alkaline in reaction (pH 8.0), poor in available nitrogen (161 kg N ha⁻¹); and medium in phosphorus (9.2 kg P₂O₅ ha⁻¹) and potassium (264 kg K₂O ha⁻¹). The experiment was laid out in split plot design with three replications and 24 treatment combinations consisting of two planting systems (bed planting and conventional sowing), three seed rates (50, 75 and 100 kg/ha) in main plots and four levels of nitrogen (90, 120, 150 and 180 kg/ha) in sub-plots. After applying pre-sowing irrigation, cultivar PBW 343 was sown on November 28 and 24 in 1997 and 1998, respectively. Nitrogen as per treatment was applied in two equal splits at the time of sowing and CRI stages, while the common based application of 60 kg P₂O₅, 30 kg K₂O and 25 kg ZnSO₄ per ha was made in all the plots at the time of sowing. Crop received five irrigations each at CRI, late tillering, jointing, flowering and dough stages during both the years. The crop was harvested on April 22, 1998 and April 25, 1999 during first and second year, respectively.

NPK content in grain and straw at harvest was

determined. For analysis of NPK oven dried plant material (grain and straw at harvest) from each plot was grinded separately. Nitrogen (Nessler's reagent method), phosphorus (Vanadomolybdo-phosphoric acid yellow colour method) and potassium (Flame photometer method) contents in samples were analyzed. The uptake of each nutrient was computed by multiplying per cent content by yield and dividing by 100. Protein content in grain was calculated from estimation of nitrogen in grain. The nitrogen content thus obtained was multiplied by 6.25 to calculate the protein content.

RESULTS AND DISCUSSION

Effect of Planting Systems

Planting systems did not differ significantly in respect of NPK concentration and uptake, protein content and grain yield of wheat (Tables 1 and 2). Further the data relating to yield contributing characters also indicate that two methods of planting failed to effect any remarkable increase in these parameters during two years of experimentation. Similarly, no

significant variation in grain yield of wheat due to planting systems was observed by Mascagni *et al.* (1995).

Effect of Seed Rates

Each increase in seed rate from 50 to 100 kg/ha brought about a significant increase in grain yield of wheat in both the years (Table 1). Similarly, with enhancing seed rate level, the spikes/m and grains per spike improved significantly during two consecutive years of study, with maximum number obtained with 100 kg/ha. However, the increasing seed rate failed to affect the 1000-grain weight during both the years of study. The results corroborate the findings of Parihar and Singh (1995). The varying seed rate failed to cause significant variation in NPK content in grain and straw at harvest during both the years.

NPK uptake in grain and straw followed trend similar to grain yield of wheat. With successive increase in levels of seed rate, the uptake of all the three nutrients in grain and straw showed a significant

TABLE 1

Effect of planting systems, seed rates and nitrogen levels on growth, yield attributes and yield of bread wheat

Treatment	Spikes/metre row		Grains/spike		1000-grain weight (g)		Grain yield (t/ha)		Pooled mean
	1997-98	1998-99	1997-98	1998-99	1997-98	1998-99	1997-98	1998-99	
Planting systems									
Bed	70.25	71.62	42.55	44.01	42.21	42.51	4.05	4.19	4.12
Conventional	69.43	71.91	42.15	43.81	42.10	43.01	4.02	4.20	4.11
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Seed rates (kg/ha)									
50	63.96	67.88	39.01	42.31	41.64	42.43	3.67	3.90	3.79
75	71.43	71.28	43.30	43.90	41.97	42.78	4.13	4.28	4.11
100	74.12	76.14	44.78	45.53	42.02	42.79	4.30	4.45	4.38
CD (P=0.05)	1.52	2.15	1.29	1.31	NS	NS	0.13	0.14	0.14
Nitrogen levels (kg/ha)									
90	64.93	65.93	39.48	40.96	41.45	42.22	3.73	3.92	3.83
120	69.41	70.89	42.40	43.43	42.29	42.99	4.01	4.20	4.11
150	72.35	74.72	43.82	45.15	42.40	43.18	4.19	4.33	4.26
180	72.66	75.51	43.85	46.11	42.45	43.23	4.20	4.34	4.27
CD (P=0.05)	1.93	1.52	1.49	1.33	NS	NS	0.15	0.11	

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improvement. The maximum uptake of 73.49 and 80.17 kg N, 13.32 and 13.39 kg P and 19.77 and 19.19 kg K/ha was recorded with seed rate of 100 kg/ha. The protein content in grains of wheat did not show any appreciable variation with altering seed rate levels during both the seasons. Similar findings have been reported by Chauhan *et al.* (2000).

Effect of Nitrogen Levels

Each successive increase in nitrogen level from 90 to 150 kg/ha enhanced the grain yield significantly in both the years. Similar trend was recorded on the basis of pooled data. However, the further increase in nitrogen level beyond 150 kg ha⁻¹ failed to show any significant response during first as well as second year of study. Similar to yield trend the response of N was significant upto 150 kg/ha. However, the N fertilization failed to affect 1000-grain weight during both the years of study. Higher grain yield with higher doses of nitrogen application was also reported by Tomar *et al.* (1997). The successive increment of N

upto 150 kg/ha significantly enhanced the N content in grain and K content in straw during both the years. It was observed that N content in grain was 13.2, 5.5 and 14.0, 7.5 per cent higher over 90 and 120 kg N/ha during 1997-98 and 1998-99, respectively. The N and P uptake in grain as well as in straw and K uptake in grain with progressive increase in N level increased significantly upto 150 kg N/ha during both the years. K uptake in straw improved significantly with each increase in nitrogen upto 180 kg N per ha during two consecutive years.

Uptake of nutrients is the function of yield and their concentration. Increase in yield and nutrient content with N application also enhance their uptake. The increase in NPK uptake by fertilizer application has also been reported by Patel and Upadhyay (1993). The protein content in grain of wheat influenced significantly upto 150 kg N/ha (11.22%). This is attributed mainly due to increment in N content in grain with the application of nitrogen upto 150 kg/ha.

TABLE 2

Effect of planting systems, seed rates and nitrogen levels on NPK concentration, uptake and protein content in grain and straw of bread wheat (pooled mean for 1997-98 and 1998-99)

Treatment	Concentration (%)						Uptake (kg/ha)						Protein content (%)
	Nitrogen		Phosphorus		Potassium		Nitrogen		Phosphorus		Potassium		
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	
Planting systems													
Bed	1.78	0.48	0.31	0.044	0.43	1.68	73.57	29.87	12.77	2.74	17.92	103.78	11.12
Conventional	1.73	0.47	0.31	0.044	0.44	1.70	71.37	29.82	12.76	2.76	18.08	106.72	10.84
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Seed Rates (kg/ha)													
50	1.73	0.47	0.30	0.044	0.43	1.69	65.76	27.66	11.56	2.55	16.26	98.31	10.84
75	1.75	0.47	0.31	0.045	0.43	1.70	73.85	29.79	13.13	2.78	18.23	106.46	11.06
100	1.75	0.48	0.31	0.045	0.44	1.70	76.83	31.79	13.62	2.99	19.48	111.87	10.97
CD (P=0.05)	NS	NS	NS	NS	NS	NS	2.80	1.85	0.45	0.17	0.72	5.15	NS
Nitrogen levels (kg/ha)													
90	1.58	0.45	0.30	0.041	0.42	1.53	60.43	26.35	11.49	2.40	16.05	88.75	9.87
120	1.68	0.47	0.31	0.044	0.43	1.64	69.26	28.69	12.74	2.71	17.85	100.36	10.53
150	1.79	0.48	0.31	0.046	0.44	1.76	76.60	31.18	13.44	2.97	18.86	111.75	11.22
180	1.83	0.49	0.32	0.047	0.44	1.82	78.46	32.73	13.67	3.11	18.93	120.66	11.46
CD (P=0.05)	0.09	NS	NS	NS	NS	0.10	3.82	1.70	1.02	0.22	0.84	7.75	0.50

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GENETIC CORRELATION AND PATH COEFFICIENT STUDIES FOR FASCICULATED ROOT YIELD IN SATAVAR (*ASPARAGUS RACEMOSUS* WILLD.)

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ABSTRACT

Eight accessions of *Asparagus racemosus* were evaluated for dry fasciculated root yield per plant and its component characters. The accessions exhibited significant differences for all the traits. Dry fasciculated root yield per plant, plant height, fasciculated roots per plant and root length exhibited very high heritability coupled with relatively high genetic gain. Dry fasciculated root yield per plant showed significant phenotypic and high genotypic correlation with fasciculated roots per plant and fresh fasciculated root yield per plant. Similarly, fresh fasciculated root yield per plant showed positive and high correlation with fasciculated root per plant but negative and significant correlation with fasciculated root length. Fresh fasciculated root yield per plant showed maximum direct effect followed by plant height and diameter of fasciculated root canopy.

Key Words : *Asparagus racemosus*, Correlation, Fasciculated root, Path coefficient, GCV, PCV.

Asparagus racemosus Willd (Satavar), belonging to Liliaceae family, is an important medicinal plant; root of which constitutes the drug of commerce. It is found in tropical and sub-tropical parts of India including Andaman and ascending in the Himalayas upto an altitude of 1500 m. The Satavar roots are the source of the drug 'shatawar' which is used in indigenous medicine as a tonic and as ingredient in several medicinal preparations. The fresh roots are taken out from forest in an unscientific way by the users. Due to its huge demand in the pharmaceutical industries National Medicinal Plants Board has considered it in the list of 32 medicinal plants recommended for cultivation by farmers. Perusal of literature reveals that no improvement programme has been carried out on Satavar, hence the present investigation was conducted to know the magnitude and type of genetic variation and direction of association among different characters and to suggest measures for improving fasciculated root yield.

MATERIAL AND METHODS

Eight accessions, namely, HAR-1, HAR-2, HAR-

3, HAR-4, HAR-5, HAR-6, HAR-7 and HAR-8 collected from different parts of Haryana were evaluated in randomized complete block design with three replications during 2002-04 at Research Farm of the University. Seeds of different accessions were sown on June 15, 2002 in the nursery and after 50 days the plants were transplanted in the field. Each plot consisted of 4 rows of 3.6 m length spaced 90 cm apart. A spacing of 90 cm between plants was maintained. After 24 months of transplantation, five randomly selected plants from each plot were taken from each entry and replication; and observations were recorded on plant height (cm), green herb yield (kg), fasciculated root length and diameter (cm), number of fasciculated roots per plant, diameter of fasciculated root canopy (cm), and fresh and dry fasciculated root yield per plant (g). Data obtained were subjected to analysis of variance and covariance followed by estimation of variation components as well as phenotypic and genotypic correlations as suggested by Singh and Chaudhary (1996) and path coefficient as described by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The analysis of variance (ANOVA) for eight characters indicates that there was considerable variation in respect of all the characters studied. However, absolute variability in different characters cannot be the criteria for deciding as to which character is showing the highest degree of variability. For this, phenotypic and genotypic coefficients of variance (PCV and GCV), heritability in broad sense (h^2) and genetic advance as per cent of mean (GA) were calculated and have been given in Table 1.

The results reveal that dry fasciculated root yield per plant exhibited the highest variation (GCV and PCV), followed by number of fasciculated roots per plant, green herb yield, fasciculated root length and plant height both at genotypic and phenotypic levels. In the present study the difference between GCV and PCV was less for all the characters indicating least influence of environment on their expression. On the basis of GCV alone, it was not possible to determine the amount of heritable variation. It can be found out with greater degree of accuracy when heritability in conjunction with genetic advance is studied (Dudley and Moll, 1969). Hence, both heritability and genetic advance were determined to study the scope of improvement in various characters through selection. The heritability estimation ranged from 44.81 (fresh fasciculated root yield per plant) to 99.07 per cent (dry

fasciculated root yield per plant). High heritability values were observed for dry fasciculated root yield per plant, plant height, number of fasciculated roots per plant and fasciculated root length, indicating less influence of environment on these characters. Moderate to low heritability for other characters indicates that environmental effect constitutes a major portion of the total phenotypic variation and selection for these characters will be less effective.

Expected genetic advance and its estimated percentage mean for various characters reveal that the dry fasciculated root yield per plant and fasciculated root per plant exhibited the highest genetic advance. Though characters like green herb weight, fasciculated root length and diameter, plant height, and fresh fasciculated root yield per plant exhibited moderate to low heritability values, their GCV was comparatively less resulting in less genetic advance. The characters like dry fasciculated root yield per plant and number of fasciculated roots per plant possessing high GCV, heritability and genetic advance could be effectively used in selection as it has been suggested that characters with high heritability coupled with high genetic advance would respond to selection better than those with high heritability and low genetic advance.

Correlation among dry fasciculated root yield per plant and its component characters was worked out and results are presented in Table 2. Plant height had

TABLE 1

Estimates of mean, range, genotypic (GCV) and phenotypic coefficient of variation (PCV), heritability (h^2) and genetic advance as per cent of mean (GA) for different characters in Satavar

S. No.	Characters	Mean	Range	GCV (%)	PCV (%)	h^2 (b. s., %)	GA (%)
1.	Plant height (cm)	231.21	208.33-288.33	11.31	11.64	94.46	22.65
2.	Green herb yield/plant (kg)	1.22	1.066-1.500	13.08	14.86	77.42	23.71
3.	Fasciculated root length (cm)	37.85	29.66-44.33	12.68	14.02	81.84	23.63
4.	Fasciculated root diameter (cm)	1.53	1.27-1.77	9.39	10.70	76.72	16.93
5.	Fasciculated roots/plant	318.29	210.00-456.67	23.21	24.22	91.83	45.82
6.	Fresh fasciculated root yield/plant (kg)	4.27	3.616-4.533	5.928	8.84	44.81	8.16
7.	Diameter of fasciculated root canopy (cm)	100.96	94.333-105.333	3.11	5.12	58.30	6.15
8.	Dry fasciculated root yield/plant (kg)	0.91	0.568-1.386	30.62	30.16	99.07	62.78

TABLE 2
Estimates of genotypic correlation coefficients between different traits in Satavar

Character	Plant height	Green herb yield/plant	Fasciculated root length	Fasciculated root diameter	Fasciculated roots/plant	Fresh fasciculated root yield/plant	Diameter of fasciculated root canopy	Dry fasciculated root yield/plant
Plant height	1.000	0.898*	-0.049	0.012	0.135	-0.054	0.181	0.037
Green herb yield/plant		1.000	-0.458	-0.020	0.291	0.169	0.440	0.382
Fasciculated root length			1.000	0.073	-0.629	-0.848*	-0.013	-0.837*
Fasciculated root diameter				1.000	-0.677	-0.094	0.083	-0.359
Fasciculated roots/plant					1.000	0.734*	-0.144	0.710*
Fresh fasciculated root yield/plant						1.000	-0.137	0.887*
Diameter of fasciculated root canopy							1.000	0.270
Dry fasciculated root yield/plant								1.000

TABLE 3
Path coefficient analysis indicating direct and indirect effects of different traits on fresh fasciculated root yield per plant in Satavar

Character	Plant height	Green herb yield/plant	Fasciculated root length	Fasciculated root diameter	Fasciculated roots/plant	Fresh fasciculated root yield/plant	Diameter of fasciculated root canopy	Correlation with DFRY (r)
Plant height	0.932	-0.776	0.038	-0.016	-0.228	-0.087	0.100	-0.037
Green herb yield/plant		0.837	0.355	0.027	-0.490	0.271	0.242	0.381
Fasciculated root length			0.046	-0.099	-1.060	-0.364	-0.007	0.837
Fasciculated root diameter				0.011	1.141	-0.151	0.045	-0.359
Fasciculated roots/plant					0.126	1.181	-0.079	0.705
Fresh fasciculated root yield/plant						0.051	-0.072	0.887
Diameter of fasciculated root canopy							0.551	0.270

DFRY - Dry fasciculated root yield per plant.

positive and significant association with green herb yield per plant (0.898). Fasciculated root length was found significantly and negatively associated with fresh (-0.848) and dry (-0.837) fasciculated root yield per plant. Fasciculated roots per plant showed positive and significant association with fresh (0.734) and dry (0.710) fasciculated root yield per plant. Similarly, fresh fasciculated root yield showed positive and significant correlation with dry fasciculated root yield (0.887).

In path analysis seven different fasciculated root yield component characters were considered as casual variables and only dry fasciculated root yield per plant was taken as dependent variable. The direct and indirect effects of various characters were worked out at genotypic level and are presented in Table 3. The direct positive effects of various characters on dry fasciculated root yield per plant can be arranged in a

descending order, fresh fasciculated root yield (1.607), plant height (0.932), diameter of fasciculated root canopy (0.551), while direct negative effects were found with fasciculated root length (-0.775), green herb weight (-0.863), fasciculated root diameter (-1.366), fasciculated roots per plant (-1.685). Fasciculated root length had indirect effect via fresh fasciculated root yield per plant, number of fresh fasciculated roots per plant and green herb weight.

The correlation and path coefficient analysis, thus showed that fasciculated roots per plant, root length and fresh fasciculated root yield had positive significant correlation and also having high direct and positive influence on dry fasciculated root yield per plant. Therefore, these characters could be taken as an indicator to improve the dry fasciculated root yield per plant through selection.

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ECONOMICS OF PEARL MILLET - LEGUME ASSOCIATION AS INFLUENCED BY INTERCROPPING AND STRIPCROPPING SYSTEMS IN SANDY LOAM SOILS

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ABSTRACT

An investigation was undertaken to assess the economics of pearl millet - legume association as influenced by inter and stripcropping systems. The field experiment consisting of 17 treatments was laid out in randomized block design. During both the years of study (pooled data for the years 2002 and 2003), net returns and B : C ratios were highest with stripcropping of pearl millet + clusterbean (6 : 3). Stripcropping of pearl millet + blackgram (4 : 2) recorded highest LER (1.57).

Key Words : Economics, Land equivalent ratio, Pearl millet - legume association, Intercropping, Stripcropping.

In order to maximize the production per unit area per unit time, the intercropping/stripcropping pearl millet with legumes augments the utilization of available light, moisture and nutritional factors with reference to space and time. This practice assumes a great importance and is an important paying system of crop production under rainfed conditions (Kumar and Gautam, 1993). It is one of the most recognized systems of cropping to increase the cropping intensity and production per unit area, time and inputs by growing two or more component crops in appropriate geometry. There is no yield reduction of main crop if legume crops like cowpea, greengram, clusterbean, etc. are grown in additional available space. Besides the above considerations, intercropping/stripcropping is also aimed at augmentation of economic returns (Yadav *et al.*, 1994). Hence, the present investigation was undertaken to study the economics of intercropping and stripcropping systems of pearl millet-legume association in sandy loam soils of Haryana.

MATERIAL AND METHODS

The field experiment was conducted during kharif seasons of 2002 and 2003 at the Crop Research Farm, on a well drained sandy loam soil, pH 8.10, organic carbon 0.18%, with available nitrogen 117 kg ha⁻¹, phosphorus 17.5 kg ha⁻¹, and potash 275

kg ha⁻¹. The experiment was laid out in randomized block design comprising 17 treatments replicated thrice and having net plot size 32.4 m² (8.1 m x 4.0 m), with a gross plot size of 45.0 m² (9.0 m x 5.0 m). The details of the treatments were : T₁ - Pearl millet sole (cv. HHB-67), T₂ - Clusterbean sole (cv. HG-365), T₃ - Mungbean sole (cv. Asha), T₄ - Cowpea sole (cv. GC-3), T₅ - Blackgram sole (cv. T-9), T₆ - Intercropping (2 : 1) of Pearl millet + Clusterbean, T₇ - Intercropping (2 : 1) of Pearl millet + Mungbean, T₈ - Intercropping (2 : 1) of Pearl millet + Cowpea, T₉ - Intercropping (2 : 1) of Pearl millet + Blackgram, T₁₀ - Stripcropping (4 : 2) of Pearl millet + Clusterbean, T₁₁ - Stripcropping (4 : 2) of Pearl millet + Mungbean, T₁₂ - Stripcropping (4 : 2) of Pearl millet + Cowpea, T₁₃ - Stripcropping (4 : 2) of Pearl millet + Blackgram, T₁₄ - Stripcropping (6 : 3) of Pearl millet + Clusterbean, T₁₅ - Stripcropping (6 : 3) of Pearl millet + Mungbean, T₁₆ - Stripcropping (6 : 3) of Pearl millet + Cowpea and T₁₇ - Stripcropping (6 : 3) of Pearl millet + Blackgram. The recommended doses of fertilizers, in the sole stands of pearl millet and legumes were applied as 120 kg N + 60 kg P₂O₅ and 20 kg N + 40 kg P₂O₅ ha⁻¹, respectively. The amount of nutrients in intercrops and stripcrops was computed as per their row ratios. The P₂O₅ was applied before sowing, whereas N was applied in two equal splits (half at sowing and remaining half at three week stage of

the crop). The sowing of five crops was done manually in flat beds after layout with the help of a hand plough in rows 45 cm apart. The sowing was done at a depth of 2 cm (pearl millet) and 5 cm (legumes) using 5, 15, 15, 20 and 25 kg seed ha⁻¹ for pearl millet, mungbean, blackgram, clusterbean and cowpea, respectively. The sowing of crops was done on July 12, 2002 and June 24, 2003 during first and second year, respectively. At maturity crops were harvested manually, pearl millet on October 2, 2002 and legumes on October 17, 2002 during first year and during second year the harvesting was done on 17 September 2003 and 9 October 2003 for pearl millet and legumes, respectively.

To find out the most profitable treatment, economics of different treatments was worked out in terms of net returns (Rs. ha⁻¹) by taking into account the cost of cultivation and gross returns per hectare. The cost of cultivation and gross returns of the crop were calculated on the basis of the approved market rates for inputs and outputs. B : C ratio, LER and PM equivalent yield were calculated as follows :

- (i) **Benefit : Cost (B : C) ratio** = Gross returns (Rs. ha⁻¹) / Cost of cultivation (Rs. ha⁻¹).
- (ii) **Land Equivalent Ratio (LER)** = $\sum_{i=1}^n (Y_i / Y_{ij})$
Where, Y_i is the yield of ith component from a unit area grown as intercrop and Y_{ij} is the yield of ith component grown as sole crop over the same area.
- (iii) **Pearl Millet Equivalent Yield (PEY)** = $\sum_{i=1}^n (y_i \cdot e_i)$ Where, y_i is yield of ith component and e_i is equivalent factor of ith component or price of ith crop (pearl millet).

RESULTS AND DISCUSSION

Grain and Stover Yield

Pearl millet

Grain and stover yields of pearl millet were observed to be significantly higher in sole system over inter and strip cropping systems. Pearl millet sole crop

was found to produce 17.2, 14.8, 20.0 and 13.4; 30.2, 25.9, 20.2 and 12.9 per cent higher grain and stover yields than intercroppings of pearl millet + clusterbean (2 : 1), pearl millet + mungbean (2 : 1), pearl millet + cowpea (2 : 1) and pearl millet + blackgram (2 : 1), respectively based on two years pooled data (Table 1). Similarly, pearl millet sole resulted in 0.9, 24.3, 26.5 and 21.0 per cent higher grain yield than stripcroppings of pearl millet + clusterbean, pearl millet + cowpea, pearl millet + mungbean and pearl millet + blackgram (6 : 3), respectively. Mishra (1996) reported similar reduction in grain yield of base crop in intercropping treatments thereby corroborating the present findings. Contrary to this, Singh and Joshi (1994) did not observe reduction in base crop yield under intercropping systems.

Intercrop

Sole crops (clusterbean, mungbean, cowpea and blackgram) recorded 196.7 and 78.1; 338.6 and 181.3; 261.6 and 107.4; and 297.3 and 120.0 per cent higher grain yield than respective inter (2 : 1) and strip (6 : 3) cropping systems [pearl millet + clusterbean (2 : 1) and pearl millet + clusterbean (6 : 3), pearl millet + mungbean (2 : 1) and pearl millet + mungbean (6 : 3), pearl millet + cowpea (2 : 1) and pearl millet + cowpea (6 : 3) and pearl millet + blackgram (2 : 1) and pearl millet + blackgram (6 : 3)]. However, corresponding increase in mean stover yield was 117.6 and 56.9; 215.2 and 121.2; 330.5 and 163.9; and 436.1 and 151.2 per cent, respectively (Table 1). Sharma and Gupta (2001), also reported decrease in the yield attributes, grain and stover yield of inter crops as compared to sole crop systems.

Land Equivalent Ratio (Systems)

The highest LER under the pearl millet - legume system was recorded in pearl millet + blackgram (4 : 2). However, it was at par with pearl millet + clusterbean at 4 : 2 and 6 : 3 and pearl millet + cowpea at 6 : 3. Lowest LER was, however, recorded under intercropping of pearl millet + mungbean (2 : 1) which being at par with intercropping of pearl millet + cowpea

TABLE 1
Seed and stover yield, land equivalent ratio (LER) and economics of pearl millet and grain legumes as affected by various treatments (pooled data for the years 2002 and 2003)

Treatment	Seed yield (kg ha ⁻¹)		Stover yield (kg ha ⁻¹)		Land equivalent ratio (LER)		Cost of cultivation (Rs.)	Net returns (Rs.)	B : C ratio (Rs. Re ⁻¹ invested)
	Pearl millet	Legumes	Pearl millet	Legumes	Pearl millet	Legumes			
T ₁ [Pearl millet (PM) sole]	4075	-	5784	-	-	-	12666	14947	2.18
T ₂ [Clusterbean (CB) sole]	-	1760	-	3017	-	-	11154	12004	2.08
T ₃ [Mungbean (MB) sole]	-	1373	-	3903	-	-	11229	11999	2.07
T ₄ [Cowpea (CP) sole]	-	915	-	2885	-	-	11729	422	1.04
T ₅ [Blackgram (BG) sole]	-	902	-	2638	-	-	11304	4162	1.37
T ₆ [PM+CB (2 : 1)]	3475	593	4440	1386	0.690	0.330	11481	15653	2.39
T ₇ [PM+MB (2 : 1)]	3547	313	4591	1238	0.783	0.230	12506	14593	2.17
T ₈ [PM+CP (2 : 1)]	3395	253	4809	670	0.750	0.277	12673	11895	1.94
T ₉ [PM+BG (2 : 1)]	3591	227	5123	492	0.803	0.257	12531	13899	2.11
T ₁₀ [PM+CB (4 : 2)]	3672	773	4365	1628	0.677	0.857	11481	17211	2.54
T ₁₁ [PM+MB (4 : 2)]	3016	457	4414	1472	0.627	0.823	12506	13349	2.07
T ₁₂ [PM+CP (4 : 2)]	2816	328	4773	903	0.590	0.777	12673	9484	1.75
T ₁₃ [PM+BG (4 : 2)]	3242	319	4830	785	0.670	0.897	12531	12506	2.00
T ₁₄ [PM+CB (6 : 3)]	4037	988	4837	1922	0.723	0.827	11481	21695	2.94
T ₁₅ [PM+MB (6 : 3)]	3276	488	4745	1764	0.670	0.753	12506	15328	2.23
T ₁₆ [PM+CP (6 : 3)]	3220	441	4921	1093	0.667	0.860	12673	12693	2.00
T ₁₇ [PM+BG (6 : 3)]	3367	410	5113	1050	0.697	0.753	12531	14919	2.19
SEm±	58	31	98	50	0.014	0.025	-	488	0.04
CD (P=0.05)	170	90	288	146	0.041	0.073	-	1412	0.12

(2 : 1), differed significantly from various treatments except intercropping of pearl millet + clusterbean (2 : 1) and of pearl millet + blackgram (2 : 1). Singh and Joshi (1994) corroborate the present findings.

Economics

Net return (Rs. 21695) was the highest with stripcropping of pearl millet + clusterbean (6 : 3). Benefit : cost ratio also followed almost identical trend to that observed for net returns. The increase in net return and benefit : cost ratio might be due to higher grain yields of component crops and pearl millet equivalent yield as well (Table 1). While comparing sole, inter and stripcropping treatments, cowpea sole recorded lowest net returns (Rs. 422) and benefit : cost ratio (1.04). On an average, all the cropping system treatments involving either mungbean or clusterbean in sole, inter and strip (4 : 2 and 6 : 3) cropping systems,

markedly improved pearl millet equivalent yield and benefit : cost ratio than rest of the treatments (Table 1). This might be due to proportionately higher increase in gross return than cost of cultivation, however, due to narrowing down the difference between inter (2 : 1) and strip (4 : 2 and 6 : 3) cropping systems of pearl millet and grain legumes, the differences among the values for benefit : cost ratio were small. These results are not unexpected and may be interpreted to mean that the pearl millet and grain legumes in inter and stripcropping systems grow in mutual harmony. Since the price of farm products changes from year to year the profitable cropping system may also change from year to year. The findings of almost similar nature were reported by Kalaghatagi *et al.* (1995). Contrary to this, Bhadoria *et al.* (1992) recorded highest net returns from clusterbean sole crop as compared to its inter and stripcropping systems with pearl millet.

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AN ECONOMIC ANALYSIS OF MANGO CULTIVATION IN YAMUNANAGAR DISTRICT OF HARYANA

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ABSTRACT

The present study was conducted in Yamunanagar district of Haryana, which was selected on the basis of maximum area and production under mango cultivation. Out of six selected villages, 60 mango growers were randomly selected for the study. Budgeting technique and various economic tools were used for estimation of cost of production and economic feasibility. The study revealed that overall mango growers incurred losses during the initial four years of installation of mango orchard. The profit earned increased from fifth year (Rs. 3873) to tenth year (Rs. 47477) and thereafter it became almost stagnant throughout the expected life of 30 years. The net present value per hectare was calculated at 12% discount rate, which came to Rs. 110165 for entire expected life of orchard. Further, on the basis of benefit : cost ratio (1 : 3) and internal rate of return (25%) it may be concluded that mango orchard is a profitable proposition.

Key Words : Mango, Orchard, Production, Cost of cultivation, Yamunanagar.

In the initial planning era, the Indian agriculture was cereal oriented and it was only in the Fourth Five-Year-plan that horticultural crops started getting attention and investment support at the national level. As a result, the horticulture scenario has changed to the extent that fruit trees are now grown for commercial as well as nutritional purposes all over the country in a big way. Although mango is now being grown in more than 87 countries of the world, yet no where it is so extensively cultivated as in India. During the year 2002-03, the total area and production under mango crops in India were 1.23 million hectares and 10.98 million tonnes, respectively. In Haryana, mango crop is grown over an area of 7281 hectare and produces 42838 tonnes. Mango is grown successfully in Yamunanagar district of Haryana. Like other fruits, it has a short life and, therefore, cannot be stored for longer period under ordinary conditions. No doubt mango cultivation is profitable enterprise but it requires heavy initial investment in the form of capital, labour and skilled management. To examine the economic feasibility of mango cultivation, it is essential to know the initial cost

of establishing a mango orchard, average cost of production and returns, the amortizing capacity of such orchard and profitability of mango cultivation as compared to the annual crops.

METHODOLOGY

Multistage stratified sampling technique was adopted to select the ultimate unit of sample. Out of 19 districts of Haryana state Yamunanagar district was selected, as it had highest area under mango crop which accounted about 39.45% of total area under mango in the state during 2002-03. After selection of district, Chhachhrouli tehsil having the largest area under mango was selected. A list of all mango growing villages of Chhachhrouli tehsil was obtained and then these villages were divided into two parts on the basis of market area. Thus, six villages were selected randomly from Chhachhrouli tehsil. From these six selected villages, a list of mango growers was prepared. A sample size of each village was selected by the techniques of probability proportion to number of mango growers in each selected village. Thus, in all a

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sample of 60 mango growers was selected randomly for detailed study. Primary data pertaining to the year 2002-03 were collected from selected respondents by conducting personal interviews with the help of specifically designed schedule. Suitable statistical tools were used for analysis of data and interpretation of results.

Net Present Value

Net return figures do not serve as true guide for making choice to go for mango orchard vis-à-vis other annual crops. This is mainly because of the fact that costs incurred and returns obtained from mango over the time are not comparable with annual crops grown in the area. Hence, it is necessary to estimate the net present value of future return which can be determined by discounting both the costs as well as returns at the prevailing rate of interest.

Internal Rate of Return

Rate of discount or the earning power of the investment which equalizes discounted benefits or returns (B) with discounted cost (C), *i.e.* the rate of discount which satisfies the relationship, $B-C=0$, for calculating the internal rate of return.

Benefit : Cost Ratio

The benefit : cost ratio is the ratio between the sum of discounted net benefits of returns (R) and the sum of discounted cost (K), *i.e.* $B = R/K$. If this ratio is greater than 1, then the investment in mango orchard is considered to be economically viable.

Pay Back Period

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

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

$i=1, 2, 3, \dots, n$

Where, R indicates return over a number of years and k indicates the cost of mango orchard.

RESULTS AND DISCUSSION

Establishment Cost

Mango cultivation is a capital-intensive enterprise. The initial cost of establishment of a mango orchard includes the preparation of land and layout, digging of pits, cost of filling material (manure, fertilizer, insecticides, pesticides and fungicides), cost of plant material, transportation including labour, plantation cost, cost of irrigation, permanent fencing, cost of tool, etc. (Table 1). The total cost of establishing a mango orchard in study area during the year 2002-03 was worked out to be Rs. 9253 per hectare. Dahiya (2002) analyzed the cost and return of the ber cultivation in Haryana and found that on an average Rs. 9394 per hectare were required for establishing the orchard. Singh (1992) studied the cost and returns of dussheri mango and worked out that Rs. 7076 per hectare were required for establishing the orchard.

Operational Cost

After establishment of a mango orchard, other costs such as application of manure and fertilizers, plant protection, pruning and cutting, interculture and hoeing, irrigation, replacement and casualty, watch and ward, picking cost, etc. are incurred. The operational costs for different years have been given in Table 2. There is direct relationship between the physical requirement and age of plants. The operating cost during the 5th year and onwards was higher as compared to initial four years because fruiting starts from the fifth year that required picking expenses, more plant protection expense, etc. in the later stages. These results are in consistent with those of Dahiya (2002).

Opportunity Cost/Land Rent

The land rent in Yamunanagar district on an average has been observed Rs. 14,000 per hectare per annum and it was found to be increasing with the farm size.

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TABLE 1

Establishment cost of mango orchard

S. No.	Particulars	Cost (Rs./ha)
1.	Preparation of land and lay out	1052 (11.36)
2.	Digging and filling of pits	1026 (11.08)
3.	Cost of filling material (manure, fertilizer, insecticides, pesticides and fungicides)	443 (4.78)
4.	Cost of plant material	1470 (15.88)
5.	Transportation including labour	250 (2.71)
6.	Plantation cost	270 (2.93)
7.	Cost of irrigation	1720 (18.58)
8.	Permanent fencing	2090 (22.58)
9.	Cost of tool	705 (7.64)
10.	Miscellaneous	227 (2.46)
11.	Total establishment cost	9253 (100)

Figures in the parentheses are the percentage to the total establishment cost.

TABLE 2

Operational cost of mango orchard (2002-03)

(Rs./ha)

S. No.	Particulars	Year										Total cost	Average cost per annum
		1	2	3	4	5	6	7	8	9	10		
1.	Manure and fertilizer	1215	1368	1550	1710	1836	2010	2205	2390	2560	2620	19464	1946 (13.35)
2.	Plant protection insecticides, pesticides	1422	1730	2000	2196	2977	3170	3346	3535	3795	3910	28081	2808 (19.26)
3.	Pruning and cutting	150	210	250	315	345	380	425	465	510	580	3630	363 (2.48)
4.	Interculture and hoeing	1072	1320	1610	1980	2240	2265	2410	2515	2668	2810	20890	2089 (14.33)
5.	Irrigation	1750	2100	2120	2146	2160	2190	2200	2391	2775	2790	22622	2262 (15.52)
6.	Replacement and casualty	20	24	30	35	45	50	60	68	70	75	477	48 (0.33)
7.	Watch and ward	1020	1313	1630	1780	2160	2205	2310	2340	2370	2420	19548	1955 (13.40)
8.	Picking cost	-	-	-	-	3600	4146	5000	5217	6500	6610	31073	3107 (21.32)
	Total	6649	8065	9190	10262	15360	16416	17956	18956	21248	21815	145785	14579 (100)

Figures in parentheses are the percentage to the total cost per annum.

TABLE 3
Costs and returns from mango orchard (2002-03)

(Rs./ha)

S. No.	Particulars	Year									
		1	2	3	4	5	6	7	8	9	10
1.	Production (q/ha)					48	55	68	84	102	123
2.	Rental value of land	14000	14000	14000	14000	14000	14000	14000	14000	14000	14000
3.	Operational cost	6649	8065	9190	10262	15360	16416	17956	18956	21248	21815
4.	Expected depreciation on fixed investment	93	89	87	84	81	78	76	73	71	68
5.	Interest on expenditure										
	(a) On-fixed investment less depreciation @ 12%	1099	1099	1099	1100	1100	1101	1101	1101	1101	1102
	(b) On operational cost for half period @ 12%	398	483	551	615	921	984	1077	1137	1274	1308
6.	Total cost (2 to 5)	22239	23736	24927	26061	31462	32579	34210	35267	37694	38293
7.	Marketing cost	-	-	-	-	3065	3870	4945	6150	9670	12630
8.	Gross return*	-	-	-	-	38400	44000	54400	67200	81600	98400
9.	Net return (GR-TC-MC)	-22239	-23736	-24927	-26061	3873	7551	15245	25783	34236	47477
10.	Net return from intercropping	8530	7230	6500	-	-	-	-	-	-	-
11.	Total net returns	-13709	-16506	-18427	-26061	3873	7551	15245	25783	34236	47477

*Price received by grower per quintal has been worked out Rs. 800 by taking the arrival and price from Yamunanagar and Chhachhrauli markets.

Net Returns

Taking into account the rental value of land, operational costs, expected depreciation on fixed investment, interest on fixed investment, interest on fixed capital, interest on operational cost and marketing costs, the net returns per hectare have been worked out over time and presented in Table 3. As evident from the data, orchardist has to bear a loss of Rs. 13709, Rs. 16506, Rs. 18427 and Rs. 26061 in first, second, third and fourth year, respectively. During the fifth year, the net returns become positive and worked out to be Rs. 3873. The net return increased upto tenth year (Rs. 47477) due to increase in production and after that, it becomes more or less stable upto the age of 30 years because of the stability of the size of the produce and all types of costs.

Economic Viability of Mango Orchard

To examine the economic viability of mango orchard, four indicators were used, viz. net present value (NPV), internal rate of return (IRR), benefit : cost ratio and pay-back period.

Net Present Value

Details about net present value of mango orchard have been shown in Table 4. The net returns at 12% for an hectare of mango orchard came to be Rs. 110164.73 for the entire expected life of 30 years. The present worth of an annuity of Re. 1 for 25 years at 12% is Rs. 13672.83. Thus, it can be concluded that the mango growing is economically feasible enterprise.

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TABLE 4

Net present value of mango orchard

Year	Cost (Rs.)	Net returns (Rs.)	Discount	Present value	
			coefficients	(r=12%)	
			1	Cost	Net returns
			—	(Rs.)	(Rs.)
			$(1+r)^n$		
1	-13709	-	0.8929	12241	-
2	-16506	-	0.7972	13159	-
3	-18427	-	0.7118	13116	-
4	-26061	-	0.6355	16562	-
5	-	3873	0.5674	-	2198
6	-	7551	0.5066	-	3825
7	-	15245	0.4523	-	6895
8	-	25783	0.4039	-	10414
9	-	34236	0.3606	-	12345
10 and onward (30 years)	-	47477	2.729	-	129565
Total	74703	134165		55077	165242

TABLE 5

Internal rate of return of mango orchard (per hectare)

Year	Cost (Rs.)	Annual gross return (Rs.)	Net cost flow		Present value coefficient r=25% $\frac{1}{(1+r)^n}$	Corresponding present value (Rs.)	
			(-)	(+)		(-)	(+)
1	43564	29855	-13709	-	0.800	10967	-
2	44426	27920	-16506	-	0.640	10564	-
3	41177	22750	-18427	-	0.512	9435	-
4	26061	-	-26061	-	0.410	10685	-
5	34527	38400	-	+3873	0.328	-	1270
6	36449	44000	-	+7551	0.262	-	1978
7	39155	54400	-	+15245	0.210	-	3201
8	41417	67200	-	+25783	0.168	-	4332
9	47364	81600	-	+34236	0.134	-	4588
10 and onward (upto 30 years)	50923	98400	-	+47477	0.532	-	25258
Total						41651	40627

The internal rate of return or earning power of one hectare mango orchard was found to be as high as 25 per cent.

TABLE 6

Returns and cost : benefit ratio from one hectare of different crop rotations adopted on the sample farms (2002-03)

S. No.	Crop rotation	Total cost (Rs.)	Gross return (Rs.)	Net return (Rs.)	Cost : benefit ratio
1.	Rice-wheat	52877	76030	23153	1 : 1.43
2.	Sugarcane	75000	82000	7000	1 : 1.09
3.	Sunflower-paddy	46427	68725	22298	1 : 1.48
4.	Rice (Basmati)-wheat	52250	56430	4180	1 : 1.08
5.	Rice-barley	44845	52230	7385	1 : 1.16
6.	Rice-potato	82450	99270	16820	1 : 2.04
7.	Maize-wheat	56460	65700	9240	1 : 1.63
8.	Mango orchard	6836	20509	13673	1 : 3.00

Internal Rate of Return

For calculating the internal rate of return, details have been provided in Table 5. In estimating the internal rate of returns, the investment cost from first to tenth year, *i.e.* Rs. 43564, Rs. 44426, Rs. 41177, Rs. 26061, Rs. 34527, Rs. 36449, Rs. 39155, Rs. 41417, Rs. 47364 and Rs. 50923 and the incremental gross returns from first to tenth year, *i.e.* Rs. 29855, Rs. 27920, Rs. 22750, Rs. Nil, Rs. 38400, Rs. 44000, Rs. 54400, Rs. 67200, Rs. 81600 and Rs. 98400 were calculated for each year, and then expenditure was subtracted from gross return and the result was obtained as a single value for each year. The net cash flow was obtained by using these single values which may have negative and positive signs depending on the quantum of costs and benefits or return in each year. For estimating the present value, the discounted rate was found by using the method of difference between the sum of discounted streams of positive and negative values is reduced either to zero or to a lowest minimum. Thus, the internal rate of return or earning power of one hectare mango orchard was found to be as high as 25% (Table 5). Thus, it can be concluded that the investment on mango orchard is economically viable. The results are consistent with the studies conducted by Dahiya (2002).

Benefit : Cost Ratio

The benefit : cost ratio is the ratio between the

sums of discounted net benefits or returns which was Rs. 110164.73 and sum of discounted cost (k), which was Rs. 55077.43. At the discounted rate of 12% the obtained benefit : cost ratio is equal to 3. It indicates that at the prevailing rate of interest of 12% per annum an investment of Re. 1 on mango orchard would fetch a return of Rs. 3. As this ratio is greater than one, it shows that the investment in mango is economically viable. Gupta and George (1974) in their study on the profitability of santra in Nagpur district of Maharashtra observed that the benefit : cost ratio even at high discount rate as 12% varied from 1.85 to 2.64 according to the size of the growers. Singh (1991) studied the economic feasibility of grape cultivation and observed that an investment of Re. 1 in a grape orchard fetched a return of Rs. 1.18. Similar results were observed by Tomer *et al.* (1997) and Dahiya (2002).

Pay back Period*

The net cost incurred during the first year of mango orchard was Rs. 74703 and this cost was less than the return of Rs. 134165. This shows that the return would be more than the cost in ninth year of mango orchard. Khushk and Smith (1999) observed that the pay back period of mango orchards started from 3 and 9 years with and without intercropping, respectively. Dahiya (2002) observed that capital cost of grape and ber orchard in Haryana was recoverable

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in a period of seven years. Hence, the mango growing is economically viable.

Costs and Returns from Competing Crop

To compare the cost and benefits from mango with competing crop rotations, the costs and returns of crop rotations adopted by the sample farmers during the period under study have also been worked out and presented in Table 6. Data reveal that mango yielded higher income than any other crop rotation, adopted on all the sample farms. However, this situation will hold true so long the yield and price relationship did not change significantly. Further it was found that every rupee of investment in mango orchard would fetch a return of Rs. 3 which is greater than any other crop

rotation.

Conclusion

In the light of above discussion, it may be said that although the initial investment in mango orchard establishment is very high yet it is an economically viable enterprise. To make this enterprise more remunerative, cooperative marketing should be encouraged. Processing units need to be established to avoid distress sale by the producers during the glut in the market. It has a vital potential in increasing the income and gainful employment of family community. Mango growing is a step towards the diversification and commercialization of agriculture in the State.

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DISTRIBUTION OF POTASSIUM IN SOME REPRESENTATIVE SOIL SERIES OF HARYANA IN RELATION TO SOIL PROPERTIES

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ABSTRACT

The distribution of different forms of potassium in 10 representative soil series of Gurgaon district of Haryana, viz. Bhankarka, Brijpura, Nasirbas, Jamalpur, Satlaka, Kurthla, Adbar, Ujina, Nai and Sohna, in relation to soil properties was studied. The water soluble, exchangeable, non-exchangeable, lattice and total soil K ranged from 6 to 32, 145 to 400, 520 to 1060, 9681 to 18172 and 10500 to 19000 mg kg⁻¹, respectively. The values of water soluble K did not show any specific trend with depth in most of the soil series except a decreasing trend in lower horizons of Bhankarka and Brijpura series. Also, no definite pattern of exchangeable and non-exchangeable K was observed with depth in most of the profiles, which may be due to variation of soil texture. The lowest amount of lattice K was found in Nasirbas and Jamalpur series, while Ujina and Nai series showed the highest lattice K. Highest total K was observed in the Nai series followed by Ujina and least in Jamalpur soil series. A significant positive correlation of clay and silt was found with exchangeable, non-exchangeable, lattice and total K. Amongst different forms of K, exchangeable, non-exchangeable, lattice and total K showed significant and positive correlation with each other.

The soils of Haryana have been formed through sedimentation of soil material brought down by different rivers flowing through the region in ancient times. Therefore, the distribution of K in various forms and in soil fractions is found to be heterogeneous as it is largely dependent on the deposited materials. Gurgaon, an important district of south-western Haryana is gifted with different land forms, ranging from old alluvial flood plains to hills. A knowledge of different forms of potassium and their vertical distribution will assist in assessing the long term availability of nutrients to crops and formulating a sound basis of fertilizer recommendations for efficient crop production (Dixit *et al.*, 1993; Dan *et al.*, 2004). Information on profile distribution of potassium on soil series basis is lacking in Gurgaon district of Haryana (Goyal *et al.*, 1990) and hence the present investigation was undertaken.

MATERIAL AND METHODS

Profile samples were collected from 10 soil series already identified in Gurgaon district of Haryana (Goyal *et al.*, 1990). The series are Bhankarka, Brijpura,

Nasirbas, Jamalpur, Satlaka, Kurthla, Adbar, Ujina, Nai and Sohna. The collected soil samples were air-dried, ground and sieved through a 2 mm stainless steel sieve and stored in cloth bags for laboratory analysis. The samples were analysed for their physico-chemical properties (Jackson, 1973) and different forms of potassium, viz. water soluble (1 : 2 :: Soil : water, Hanway and Heidel, 1952), exchangeable K with 1N ammonium acetate (Jackson, 1973), non-exchangeable K with 1N boiling HNO₃ (Wood and De Turk, 1940), lattice K (Wiklander, 1954) and total K, *i.e.* extractable in HF-HClO₄ mixture (Jackson, 1973). The potassium in the extract was estimated flame photometrically.

RESULTS AND DISCUSSION

The relevant physico-chemical properties of the soil series are presented in Table 1. The particle size analysis showed that the texture of soils of different profiles ranged from sand to clay loam. Minimum clay content of 5% was observed in Bhankarka series and highest 39.4% in profile of Ujina. No definite pattern of distribution of clay was found in the profiles. The

TABLE 1
Physico-chemical properties of the profile samples of different soil series

Depth (cm)	pH	EC — 1 : 2 —	OC	CaCO ₃	Sand %	Silt	Clay	Textural class
BHANKARKA SERIES								
0-22	8.7	0.26	0.30	0.80	91.6	3.4	5.0	Sand
22-60	9.0	0.24	0.24	1.28	91.1	3.6	5.3	Sand
60-105	8.8	0.23	0.23	1.12	92.2	2.1	5.7	Sand
105-150	8.9	0.25	0.24	1.10	92.0	2.3	5.7	Sand
>150	8.8	0.18	0.21	1.16	92.2	2.3	5.5	Sand
BRIJPURA SERIES								
0-25	8.5	0.29	0.28	0.93	77.8	8.1	14.1	Sandy loam
25-60	8.2	1.09	0.26	1.24	75.1	7.7	17.2	Sandy loam
60-100	8.5	0.88	0.19	3.52	62.5	13.8	23.7	Sandy clay loam
100-125	8.6	0.90	0.14	3.85	71.2	8.4	20.4	Sandy clay loam
NASIRBAS SERIES								
0-18	8.8	0.21	0.34	0.62	90.1	3.8	6.1	Sand
18-68	8.9	0.17	0.27	0.50	90.0	3.8	5.7	Sand
68-121	8.9	0.19	0.16	0.53	91.5	2.6	5.9	Sand
121-130	8.7	0.26	0.13	1.15	91.3	3.3	5.4	Sand
JAMALPUR SERIES								
0-22	8.7	0.25	0.22	0.00	91.4	3.1	5.5	Sand
22-60	8.3	0.17	0.10	0.00	91.1	3.2	5.7	Sand
60-105	8.2	0.12	0.08	0.00	89.7	3.6	6.7	Sand
105-190	8.3	0.12	0.11	0.00	90.3	3.5	6.2	Sand
SATLAKA SERIES								
0-18	7.8	16.37	0.19	2.36	83.6	10.2	6.2	Loamy sand
18-80	8.1	8.61	0.17	2.46	76.5	8.1	15.4	Sandy loam
80-125	8.0	6.59	0.11	1.72	70.5	11.0	18.5	Loam
125-165	8.0	7.67	0.06	10.50	70.5	8.3	15.2	Sandy loam
KURTHLA SERIES								
0-18	8.3	0.89	0.31	1.17	79.2	11.7	9.1	Loamy sand
18-65	8.5	0.97	0.17	1.52	75.0	10.6	15.4	Sandy loam
65-115	8.3	1.28	0.08	1.80	67.1	15.7	17.2	Loam
115-180	8.5	1.36	0.06	1.00	70.4	14.2	15.4	Loam
ADBAR SERIES								
0-18	8.5	0.41	0.36	0.00	80.0	7.2	12.8	Sandy loam
18-50	9.5	0.67	0.25	0.75	68.2	13.2	17.6	Loam
50-116	9.8	1.06	0.21	1.42	66.8	13.1	20.1	Loam
116-160	9.9	0.99	0.17	3.21	65.6	12.6	22.8	Clay loam
UJINA SERIES								
0-22	8.3	0.71	0.40	0.00	51.4	18.4	30.2	Clay loam
22-63	8.6	0.56	0.32	1.24	42.7	22.1	35.2	Clay loam
63-105	8.7	0.51	0.18	1.75	38.6	21.7	39.7	Clay loam
105-170	8.8	0.47	0.15	3.76	52.5	26.9	20.6	Silty loam
NAI SERIES								
0-20	8.1	0.23	0.32	0.00	86.7	4.5	8.8	Loamy sand
20-83	8.4	0.32	0.17	0.00	88.3	3.9	7.8	Loamy sand
83-125	8.6	0.35	0.12	2.85	83.6	6.2	10.2	Sandy loam
125-160	8.6	0.35	0.08	3.37	83.5	6.3	10.2	Sandy loam
SOHNA SERIES								
0-8	7.5	0.18	0.33	0.00	88.3	4.2	7.5	Loamy sand
8-22	7.2	0.21	0.30	0.00	66.1	15.2	18.7	Loam

CaCO₃ content varied from traces (Jamalpur series) to 10.5% (Satkala series) with a mean value of 1.50 per cent. Organic carbon followed a definite pattern in most of the profiles, as it decreased with depth and ranged from 0.06 to 0.40 per cent with a mean value of 0.20 per cent. Electrical conductivity was high in most of the profiles and it varied from 0.12 dS m⁻¹ in Jamalpur to 16.37 dS m⁻¹ in Satlaka series profile. The pH of these soils ranged from 7.2 to 9.9, but it did not follow a definite pattern of changes with soil depth. Similar observations on soils of this region were made by Goyal *et al.* (1990).

Water Soluble K

The water soluble potassium in the soil profiles (Table 2) ranged from 6 mg kg⁻¹ in Brijpura series to 32 mg kg⁻¹ in Bhankarka series with a mean value of 16.8 mg kg⁻¹ soil. It has been contributed to the tune of 0.04 to 0.25 per cent of total K. Although no definite trend of water soluble K was observed with soil depth, but a decreasing trend in lower horizons was recorded for Bhankarka and Brijpura series. However, this was not true for Nasirbas, Jamalpur, Nai and Sohna series. Higher values of water soluble K in sub-surface horizons of these soils may be due to relatively higher amounts of clay fractions all along the profile depth and also removal of more water soluble K by crops under continuous intensive cultivation from surface horizons than sub-surface (Dixit *et al.*, 1993).

Exchangeable K

Exchangeable K content in soils varied from 145 to 400 mg kg⁻¹ with a mean value of 220 mg kg⁻¹ and per cent contribution towards total K ranged from 1.2 to 2.6 per cent. Considering 60 mg kg⁻¹ as the general critical limit for crops (Yadav and Khanna, 1979) all the soil series were high in exchangeable K throughout the depths. Ujina soils contained higher exchangeable K followed by Adbar soils. In most of the profiles, no definite pattern of distribution of exchangeable K with depth was found. These results are in agreement with those of Dixit *et al.* (1993) for soil series of Western Uttar Pradesh.

Non-exchangeable K

The non exchangeable K content varied from 520 to 1060 mg kg⁻¹ with a mean value of 733 mg kg⁻¹. The contribution of this form towards total K ranged from 4.33 to 7.31 per cent. Highest fixed K content was found in Satlaka series (1060 mg kg⁻¹), while lowest in Bhankarka series (520 mg kg⁻¹) because of the lesser amount of clay content. Again, no definite trend of distribution of non-exchangeable K was found in the soil series, indicating an active pedoturbation processes operating in these pedons. These results are in agreement with Pharande and Sonar (1996).

Lattice K

The HCl soluble potassium which is considered to be fixed in lattice and mineral potassium ranged from 9681 to 18172 mg kg⁻¹ with a mean value of 12177 mg kg⁻¹. The soils containing lowest amounts of lattice K were Nasirbas and Jamalpur series with Ujina and Nai series having highest lattice K. This form of K also did not exhibit any definite pattern of changes with soil depth.

Total K

The amount of total potassium in different profiles ranged from 10500 to 19000 mg kg⁻¹ with a mean value of 13469 mg kg⁻¹ of soil. Highest total K was observed in Nai followed by Ujina and least in Jamalpur series. Comparing the total K content among various sub-surface soil horizons to surface horizons it was slightly lower in surface though it did not increase with depth. Similar observations were made by Dixit *et al.* (1993) in some soil series of Western Uttar Pradesh and Raskar and Pharande (1997) in Vertisol and Alfisol soil series of Maharashtra, where they observed that the total K was highest in sub-surface horizons as compared to surface horizon.

Correlation of Different Forms of K with Soil Properties

The coefficients of correlation between different forms of K and soil properties for the soils under study

TABLE 2

Distribution of various forms of K (mg kg⁻¹) in the profile samples of different soil series

Depth (cm)	Water soluble K	Exchangeable K	Non-exchangeable K	Lattice K	Total K
BHANKARKA SERIES					
0-22	32	170	560	12038	12800
22-60	25	160	640	11375	12200
60-105	17	165	600	10918	11700
105-150	12	150	520	11518	12200
>150	7	145	520	11328	12000
BRIJPURA SERIES					
0-25	19	175	640	10866	11700
25-60	15	147	760	11578	12500
60-100	12	172	780	11536	12500
100-125	6	235	680	13579	14500
NASIRBAS SERIES					
0-18	9	165	600	9726	10500
18-68	13	162	560	10765	11500
68-121	17	160	640	10383	11200
121-130	14	161	560	10865	11600
JAMALPUR SERIES					
0-22	19	160	640	9681	10500
22-60	18	145	680	10657	11500
60-105	22	152	800	10726	11700
105-190	26	147	720	10907	11800
SATLAKA SERIES					
0-18	30	202	740	12528	13500
18-80	15	262	1040	12883	14200
80-125	16	270	1060	13154	14500
125-165	16	266	960	13558	14800
KURTHLA SERIES					
0-18	15	252	760	13173	14200
18-65	12	250	640	12298	13200
65-115	12	245	720	14523	15500
115-180	14	263	680	14043	15000
ADBAR SERIES					
0-18	20	220	680	12780	13700
18-50	22	225	720	13633	14600
50-116	15	185	780	13720	14700
116-160	12	160	800	12528	13500
UJINA SERIES					
0-22	11	365	820	14604	15800
22-63	16	375	1060	14049	15500
63-105	18	400	980	13802	15200
105-170	12	366	940	13382	14700
NAI SERIES					
0-20	14	182	720	11284	12200
20-83	17	177	680	15326	16200
83-125	23	165	640	18172	19000
125-160	25	170	720	17285	18200
SOHNA SERIES					
0-8	17	163	640	11180	12000
8-22	23	286	920	11571	12800

DISTRIBUTION OF POTASSIUM IN SOILS OF HARYANA

TABLE 3

Correlation (r values) between different forms of potassium and soil properties

Form of K/ Soil property	EC	pH	OC	CaCO ₃	Sand	Silt	Clay
Water soluble K	0.222	-0.191	-0.034	-0.136	0.244	-0.182	-0.274
Exchangeable K	0.158	-0.179	0.094	0.216	-0.853**	0.864**	0.795**
Non-exchangeable K	0.381*	-0.270	-0.132	0.355*	-0.719**	0.684**	0.701**
Lattice K	0.109	0.045	-0.265	0.352*	-0.431**	0.428**	0.406*
Total K	0.139	0.016	-0.261	0.371*	-0.496**	0.491**	0.469**

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

are presented in Table 3. The results indicate that water soluble K was not significantly correlated with all the soil properties. The exchangeable potassium was found to have significant positive correlation with clay and silt content and significant negative with sand content of these soils suggesting that available K status of the soils are largely governed by the finer soil fractions. Non-exchangeable K also showed significant positive correlation with silt and clay and a negative correlation with sand. This form of K also showed significant positive correlation with EC and CaCO₃ content of the soils suggesting that the salt and CaCO₃ content also affect the magnitude of non-exchangeable K. Both lattice and total K content of these soils

showed significant positive correlation with finer fractions, however, they accounted for only 22 to 24 per cent of the variation clearly indicating that it is not only the absolute quantities of the finer fractions which determine the total K content but there are other factors (e.g. type of clay, CaCO₃, etc.) which are also equally important (Dinakaran *et al.*, 1995). These results are in confirmity with the findings of Singh *et al.* (1985) for soils of Haryana, Sahu and Gupta (1988) and Dixit *et al.* (1993) for soils of Uttar Pradesh, Yadav *et al.* (1999) for Vertisols of Madhya Pradesh and Dhaliwal *et al.* (2004) for benchmark soil series under rice-wheat cropping system in Punjab.

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VARIABILITY IN PRODUCTION AND FACTORS INFLUENCING AGRICULTURAL PRODUCTION IN DRYLAND AREA OF HARYANA

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ABSTRACT

The resource poor infrastructure, low investment in agriculture technology and inadequate use of inputs are characteristics of dry land farming. About 90% of coarse cereals and pulses, 81% of oilseeds and 69% of cotton are grown under rainfed condition. The information with regard to area, production and yield of pearl millet, wheat, chickpea, other pulses, rapeseed & mustard and other oil seeds, cotton (American) and cotton (desi) of Mohindergarh district, dryland area of Haryana, and state as a whole was collected from published sources for the period 1981-2004. The data pertaining to total cropped area, fertilizer consumption, price index, gross irrigated area, co-operative credit, average rainfall and number of tractors were also scanned for the same period. The coefficient of variation was used as indicator to examine the variability in area, production and yield of the principal crops. For the study of factors influencing agricultural production, the multiple regression equation was employed.

The results reveal that the amount of variation in acreage of pearl millet and chickpea for Mohindergarh district, dryland region and Haryana state as a whole was highest in the period-II (1985-89) in comparison to other time periods due to severe drought condition in the year 1987-88. But the lower acreage variability of pearl millet in Mohindergarh district and dryland area was observed because of non-availability of suitable substitute for pearl millet. The variability in wheat area for Mohindergarh district, dryland area and state as a whole was almost at low level for all periods except period-I in Mohindergarh district and dryland area due to expansion in irrigation facilities. The cotton acreage variation for dryland region and state as a whole was found higher in first period due to introduction of cotton crop and the highest variation in the yield of rapeseed-mustard was observed in dryland region with adoption of sprinkler irrigation technology. But higher variability in yield of cotton crops for dryland area and state as a whole accrued because of severe incidence of American bollworm. The regression analysis reveals that the factors having significant impact on the agricultural production index were : price index, gross irrigated area and co-operative credit in Mohindergarh district. In case of dryland region of Haryana, the average rainfall and number of tractors contributed maximum. For Haryana state, the fertilizer consumption and gross irrigated area have highly influenced the agricultural production index.

Dry land farming has a distinct place in Indian agriculture occupying 64% of the cultivated area contributing 44% of the human population and two-third of the livestock population. The resource poor infrastructure, low investment in technology and inadequate use of inputs are characteristics of dry land farming. Presently, irrigated area produces an average of two tonnes of food grains per hectare while the average productivity in rainfed areas is only 0.7 to 0.8 tonnes per hectare. About 90% of coarse cereals and pulses, 81% of oilseeds and 69% of cotton are grown

under rainfed conditions. Therefore, it is inevitable that the second green revolution in India has to come from the rainfed area.

Improvement of dryland farming is a key to the development of agriculture and removal of poverty in rural areas. The Govt. has given more emphasis towards the development of dryland areas for the utilization of potential of unused resources in rainfed area through transfer of appropriate production technology.

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 production. Secondly, the fluctuations in prices caused by production instability would render the already used inputs allocated among various crops. This inefficiency in production certainly would hamper the economic growth of the country.

The large number of varieties of crops grown in highly diverse conditions in different parts of Haryana state with use of modern production techniques resulted in variation in crop production. Therefore, there is need to explore those elements of production strategy that may reduce the conflict between growth and stability. Increase in instability cannot be attributed to new production technology only but it also arises from the adverse agro-climatic conditions and low level of productive forces on which the technology is employed. The present study was undertaken with the following objectives :

- (i) To study the variability in area, production and yield of principal crops.
- (ii) To examine factors influencing agricultural production.

METHODOLOGY

The information with regard to area, production and yield of pearl-millet, wheat, chickpea, other pulses, rapeseed-mustard and other oil seeds, cotton (American) and cotton (desi) was collected from published sources for Mohindergarh district, dryland area of Haryana and state as a whole. The data pertaining to total cropped area, fertilizer consumption, price index, gross irrigated area, co-operative credit, average rainfall and number of tractors were also scanned for Mohindergarh district, dryland region of Haryana and state as a whole for the period 1981-2004. The period under study (1981-82 to 2003-04) has been divided into five sub periods, i.e. Period-I (1981-82 to 1984-85), Period-II (1985-86

to 1988-89), Period-III (1989-90 to 1992-93), Period-IV (1993-94 to 1996-97) and Period-V (1997-98 to 2003-04).

The coefficient of variation was used as indicator to examine the variability in area, production and yield of the principal crops in Mohindergarh district, dryland region of Haryana and state as a whole for different time periods using the formula :

$$\text{Coefficient of variation (C.V.)} = \frac{SD}{\bar{X}} \times 100$$

Where,

\bar{X} =Mean of area/production/yield of the crops.

SD=Standard deviation of area/production/yield of the crops

$$SD = \sqrt{\frac{\sum (X_i - \bar{X})^2}{(n-1)}}$$

Where,

X_i = Area ('000 ha), production ('000 tonnes) and yield (kg/ha)

n=Number of observations

For the study of factors influencing agricultural production in Mohindergarh district, dryland region and state as a whole, the index of agricultural production was taken as dependent variable. Further, the independent variables included for analysis were total cropped area, fertilizer consumption, price index, gross irrigated area, co-operative credit, average rainfall and number of tractors. The multiple regression equation employed was as follows :

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + e$$

Where,

Y=Index of agricultural production

X_1 =Total cropped area

X_2 =Fertilizer consumption

X_3 =Price index

X_4 =Gross irrigated area

X_5 =Co-operative credit

X_6 =Average rainfall

X_7 =Number of tractors

e=error term

RESULTS AND DISCUSSION

Variability in Area of Principal Crops

The estimated coefficient of variation depicted in Table 1 reveals that area variability was lesser in pearl millet (11.85%) and wheat (16.76%) in Mohindergarh district. The higher area variability was observed in cotton (desi), *i.e.* 202.54% followed by cotton (American) (121.46%), chickpea (65.24%) and rapeseed-mustard (46.97%) in the overall period. The coefficient of variation for crops grown in dryland region of Haryana state indicated that acreage variability in crops was found minimum in pearl millet (12.34%) and wheat (21.34%). The cotton (desi) crop exhibited higher variation (52.77%) in area under cultivation in overall period. The variation in acreage of chickpea, rapeseed-mustard and cotton (American) accrued 46.97, 37.19 and 21.70 per cent, respectively.

The variability in area of wheat and pearl millet for the state as a whole worked out was low, *i.e.* 11.40 and 16.59 per cent, respectively. The highest variation in area cultivated was attained in case of chickpea crop. The acreage variation of rapeseed-mustard, cotton (desi) and cotton (American) calculated was 46.41, 46.25 and 23.52 per cent, respectively.

The amount of variation in acreage of pearl millet and chickpea for Mohindergarh district, dryland region and Haryana state as a whole was highest in the period-II (1985-86 to 1988-89) in comparison to other time periods due to severe drought condition in the year 1987-88. The maximum area under these crops was recorded in the rainfed areas. But the lower acreage variability of pearl millet in Mohindergarh district and

dryland area was observed because of its importance in the subsistence economy of the dryland farmers and non-availability of suitable substitute for pearl millet crop in *kharif* season to the farmers suited to the agro-climatic conditions of dry farming areas. The variability in wheat area for Mohindergarh district, dryland area and state as a whole was almost at low level for all periods except period-I of Mohindergarh district and dryland region due to expansion in irrigation facilities in the area and increased area under cultivation of this crop. The variability in chickpea acreage was observed highest for Mohindergarh district, dryland area and state as a whole. The cotton acreage variation for dryland region and state as a whole was found higher in first period (1981-82 to 1984-85). This may be attributed to introduction of cotton crop in dryland area with adoption of sprinkler irrigation technology.

Variability in Yield of Principal Crops

The coefficient of variation for the yield in Mohindergarh district was highest in case of pearl millet (61.51%) in the overall period (Table 2). The variability in yield of cotton (desi), chickpea, rapeseed-mustard and cotton (American) was 43.82, 30.74, 28.54 and 19.28 per cent in the period-VI (1981-82 to 2001-02), respectively. Among different time periods, the highest variation in yield of pearl millet, chickpea and wheat was observed in the period-II in the Mohindergarh district, dryland region and state as a whole. This variation in yield of these crops may be accrued due to higher acreage variability of these crops and maximum area under cultivation of these crops in rainfed area and severe drought condition in the year 1987-88.

For the dryland area of the State, cotton (American) exhibited highest variation in the yield followed by rapeseed-mustard (51.92%), chickpea (47.65%), pearl millet (36.34%) and wheat (43.45%) in the overall period (1981-82 to 2001-02). The yield variability of pearl millet, chickpea, rapeseed-mustard, cotton and wheat was 38.02, 29.75, 26.23, 19.89 and 17.01 per cent for the state as a whole in the overall

TABLE 1
Variability in area of principal crops

Crops	Mohindergarh district						Dryland area of Haryana state						Haryana state as a whole											
	I		II		III		IV		V		VI		I		II		III		IV		V		VI	
Pearl millet	7.31	26.61	3.29	8.51	4.96	11.85	5.17	20.36	4.77	6.00	2.89	12.34	6.13	20.83	5.88	5.71	2.33	16.59						
Wheat	13.84	9.40	8.45	4.38	7.80	16.76	9.45	6.41	5.76	2.82	8.19	21.34	5.72	3.16	3.58	0.95	5.40	11.40						
Chickpea	17.35	60.29	58.79	23.24	65.58	65.24	31.09	44.24	30.75	6.96	60.30	46.97	33.26	44.14	32.26	7.17	59.58	51.33						
Total pulses	17.30	60.39	58.73	23.96	65.84	64.51	30.32	43.85	30.13	5.69	58.51	45.62	30.97	40.16	28.50	6.07	54.34	46.41						
Rapeseed-mustard	30.38	17.44	20.35	13.11	7.28	46.97	30.52	13.28	17.61	7.83	11.23	37.19	31.40	12.86	17.09	3.10	12.47	33.35						
Total oilseed	30.39	17.38	37.78	6.99	7.39	47.92	30.95	12.78	19.54	5.25	11.20	36.44	30.40	12.31	20.41	5.37	15.17	34.50						
Cotton (American)	NA	NA	NA	161.11	16.60	121.46	11.78	12.76	5.86	1.42	11.43	21.70	12.76	14.23	6.41	1.75	11.15	23.52						
Cotton (desi)	NA	NA	NA	121.60	67.35	202.54	24.79	9.02	5.94	43.05	17.06	52.77	21.35	8.68	3.88	39.74	10.30	41.25						
Total cotton	NA	NA	NA	98.38	116.05	225.30	14.62	9.57	5.58	8.31	9.17	24.11	15.02	10.05	5.16	8.81	6.94	22.25						

I=Period-I (1981-82 to 1984-85), II=Period-II (1985-86 to 1988-89), III=Period-III (1989-90 to 1992-93), IV=Period-IV (1993-94 to 1996-97), V=Period-V (1997-98 to 2003-04), VI=Overall period (1981-82 to 2003-04).

TABLE 2
Variability in yield of principal crops

Crops	Mohindergarh district						Dryland area of Haryana state						Haryana state as a whole											
	I		II		III		IV		V		VI		I		II		III		IV		V		VI	
Pearl millet	43.68	129.32	39.53	43.51	28.79	61.51	15.85	95.97	37.92	39.08	17.37	43.45	5.34	71.63	31.68	32.77	15.43	38.02						
Wheat	6.09	12.05	6.28	1.83	1.38	19.57	11.32	14.33	11.08	5.66	9.12	36.34	3.93	9.17	5.82	3.03	5.19	17.01						
Chickpea	26.52	30.93	9.71	10.96	25.23	30.74	7.15	60.67	34.46	19.26	70.61	47.69	24.73	37.68	4.16	12.98	17.90	29.75						
Total pulses	26.45	30.78	9.66	13.59	25.14	30.38	7.01	60.01	33.89	18.71	70.17	46.96	23.67	30.22	1.73	11.14	16.74	27.20						
Rapeseed-mustard	21.35	20.41	18.14	25.40	31.80	28.54	46.22	36.56	19.13	18.59	26.49	51.92	14.33	24.46	17.24	5.73	26.61	26.23						
Total oilseed	21.25	20.38	29.16	8.86	31.78	29.47	46.25	35.34	20.95	9.91	26.40	51.85	13.68	24.13	15.17	5.45	23.27	25.54						
Cotton (American)	NA	NA	NA	5.69	24.79	19.28	15.18	12.73	8.73	9.57	26.66	30.48	18.21	16.84	4.56	12.02	32.50	19.79						
Cotton (desi)	NA	NA	NA	60.39	14.25	43.82	29.52	17.99	15.16	52.60	30.29	56.78	17.75	9.33	15.33	12.46	28.13	19.81						
Total cotton	NA	NA	NA	54.90	19.01	31.73	16.73	12.44	9.15	12.22	29.42	30.42	17.97	15.00	5.50	11.06	31.12	19.89						

I=Period-I (1981-82 to 1984-85), II=Period-II (1985-86 to 1988-89), III=Period-III (1989-90 to 1992-93), IV=Period-IV (1993-94 to 1996-97), V=Period-V (1997-98 to 2003-04), VI=Overall period (1981-82 to 2003-04).

period, respectively. The highest variation in the yield of rapeseed-mustard and cotton was observed in period-I and period-V in dryland area, respectively. The yield variability of rapeseed-mustard in period-I was obtained because of introduction of sprinkler irrigation system in large area and use of nitrogenous fertilizers in that period. But higher variability in yield of cotton crops for dryland region and state as a whole in period-V accrued because of severe incidence of American bollworm.

Variability in the Production of Principal Crops

The estimated coefficient of variation shows that production variability of wheat was lowest among other crops in Mohindergarh district, dryland area and state as a whole in different time periods as this crop involved less amount of variation in area and yield (Table 3). The highest variation in production of cotton (American) was found in Mohindergarh district in the overall period followed by cotton (desi) (102.44%), pearl millet (64.94%), chickpea (64.00%) and rapeseed-mustard (60.23%). Among different time periods for Mohindergarh district, dryland region and state as a whole, production variability for pearl millet and chickpea was highest in the period-II (1985-86 to 1988-89) because of higher variation in acreage and yield of these crops.

For the dryland area of the State, the coefficient of variation of production of pearl millet was highest followed by chickpea (30.34%), rapeseed-mustard (26.87%) and cotton (21.33%) in the overall period. The variation in production of crops for the state as a whole was maximum in rapeseed-mustard followed by chickpea (49.44%), cotton (desi) (47.66%) and pearl millet (36.94%) in the overall period (1981-82 to 2001-02).

The production variability of cotton (American) and rapeseed-mustard exhibited higher amount in period-V for dryland area and state as a whole because of large variation in the yield of these crops. The variation in production of cotton (desi) for Mohindergarh district, dryland area and state as a whole increased in the

TABLE 3
Variability in production of principal crops

Crops	Mohindergarh district						Dryland area of Haryana state						Haryana state as a whole					
	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
Pearl millet	45.79	141.46	42.11	50.58	27.00	64.94	17.86	86.76	33.82	35.13	19.52	43.58	6.23	83.83	35.87	35.67	14.28	36.94
Wheat	18.06	17.19	11.09	3.72	8.13	31.82	3.75	9.60	6.40	2.87	1.81	17.76	8.62	11.31	7.58	3.80	10.29	27.36
Chickpea	31.05	77.71	56.50	31.50	77.48	64.00	22.66	37.98	4.01	13.64	18.28	30.34	5.46	60.48	36.40	18.76	69.53	49.44
Total pulses	30.95	77.79	56.62	32.00	78.48	63.86	21.98	36.63	3.97	13.91	18.55	30.01	6.82	55.25	30.24	16.13	66.12	45.74
Rapeseed-mustard	45.69	36.69	20.98	19.60	32.66	60.23	14.19	24.95	16.76	21.17	25.83	26.87	46.53	34.26	19.05	8.40	26.21	48.71
Total oilseed	45.62	36.63	21.00	10.70	32.63	60.47	13.83	24.78	16.20	6.77	25.67	26.18	44.80	32.79	22.74	10.12	20.01	49.26
Cotton (American)	NA	NA	NA	132.58	35.48	114.49	18.34	16.41	3.87	10.19	32.57	19.78	16.16	12.80	9.46	10.47	26.22	31.49
Cotton (desi)	NA	NA	NA	73.57	62.06	102.44	16.26	10.42	10.82	12.26	30.40	21.91	27.23	16.39	13.30	48.99	27.69	47.66
Total cotton	NA	NA	NA	114.56	113.62	124.77	17.94	15.10	4.44	9.27	35.33	21.33	17.83	12.09	9.54	12.14	25.96	29.25

I=Period-I (1981-82 to 1984-85); II=Period-II (1985-86 to 1988-89), III=Period-III (1989-90 to 1992-93), IV=Period-IV (1993-94 to 1996-97), V=Period-V (1997-98 to 2003-04), VI=Overall period (1981-82 to 2003-04).

period-IV (1993-94 to 1996-97) as a result of higher acreage variability. The variation in area of this crop during the period-IV was higher due to price difference of cotton (American) and cotton (desi) as well as yield per hectare. Finally, the magnitude of instability was lower in yield than in production and reflected the importance of area variability in production variability.

Factors Influencing Agricultural Production

There have been various factors influencing agricultural production. However, in our present analysis, we have taken into consideration the independent variables, i.e. total cropped area (X_1), fertilizer consumption (X_2), price index (X_3), gross irrigated area (X_4), co-operative credit (X_5), average rainfall (X_6), number of tractors (X_7) and index of agricultural production (Y) was estimated by Directorate of Economics and Statistics, Haryana state as dependent variable. Multiple regression equation has been fitted for Mohindergarh district, dry land region of Haryana and Haryana state as a whole. In order to remove the effect of degrees of freedom, adjusted R^2 was calculated (Table 4).

The equation for Mohindergarh district reveals that variability in the production index has been explained to the extent of 92 per cent. It has marginally declined in comparison to R^2 . The factors having significant impact on the agricultural production index were price index, gross irrigated area and co-operative credit.

The equation for dryland region of Haryana shows that variability in the production index has been explained to the extent of 95 per cent. The average rainfall and number of tractors contributed maximum reflecting significant impact on the production index.

The value of R^2 for regression equation of Haryana state as a whole was 0.94. Thus, there is strong evidence that the above factors do have significant impact on the production index. The equation has given two significant factors. The maximum contribution towards the production index was due to fertilizer consumption and gross irrigated area. The high value of R^2 and adjusted R^2 indicated that production index was highly influenced by the variables taken into consideration. The value of adjusted R^2 was slightly less than the value of R^2 indicating that production index was highly influenced by the variables taken into consideration.

CONCLUSION

The results reveal that the amount of variation in acreage of pearl millet and chickpea for Mohindergarh district, dryland region and Haryana state as a whole was highest in the period-II (1985-89). But the lower acreage variability of pearl millet in Mohindergarh district and dryland area was observed because of non-availability of suitable substitute for pearl millet crop. The variability in wheat area was almost at low level for all periods except period-I of Mohindergarh district

TABLE 4
Factors influencing agricultural production (1981-2004)

Particulars	Regression equation	R^2	Adjusted R^2
Mohindergarh district	$Y=67.86+0.65X_1+0.004X_2+.448X_3^*+.282X_4^*+.331X_5^*+.008X_6+.003X_7$ (.08) (.05) (.17) (.13) (.14) (.18) (.03)	0.92	0.87
Dryland region of Haryana state	$Y=147.09+.003X_1+.43X_2^*+.099X_3+.028X_4+.028X_5+.39X_6^*+.004X_7^*$ (.01) (.19) (.118) (.04) (.03) (.15) (.01)	0.95	0.91
Haryana state as a whole	$Y=30.22+.01X_1+.26X_2^*+.04X_3+.03X_4^*+.002X_5+.18X_6+.001X_7$ (.01) (.09) (.09) (.013) (.003) (.19) (.0005)	0.94	0.91

The figures in parentheses are the standard error.

*Significant at 5% level of significance.

AGRICULTURAL PRODUCTION IN DRYLAND AREA

and dryland area due to expansion in irrigation facilities. The production variability of cotton (American) and rapeseed-mustard exhibited higher amount for dryland area and state as a whole as a result of large variation in the yield of these crops. The regression analysis reveals that the factors having significant impact on the agricultural production index were price index, gross

irrigated area and co-operative credit in Mohindergarh district. While in case of dryland region, the average rainfall and number of tractors contributed maximum towards production index. For Haryana state, the fertilizer consumption and gross irrigated area highly influenced the agricultural production index.

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WEED MANAGEMENT IN MUNGBEAN

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Mungbean/greengram (*Vigna radiata*) predominantly is a rainy season crop. In India, it is grown in almost all the states in an area of 3.1 million hectares with a total production of 1.1 million tonnes. The average productivity of greengram in India is very low (350 kg ha⁻¹) owing to competition caused by weeds, inadequate fertilization and its cultivation on poor and marginal lands. Among the major factors limiting greengram yield, weeds are of prime importance because of its relatively slow initial growth.

Modification in sowing methods coupled with suitable weed control treatments may help to realize higher yields at reduced cost of cultivation in this crop.

Keeping this in view, an experiment was conducted at Agronomy Research Farm. The soil of the experimental field was sandy loam in texture, low in available nitrogen (105 kg ha⁻¹), medium in P₂O₅ (13.5 kg ha⁻¹), high in available K₂O (370 kg ha⁻¹) and alkaline in reaction (pH 8.3). The experiment with three methods of planting (conventional sowing, zero-tillage and furrow irrigated raised bed system) as main plots and seven weed control treatments (Pendimethalin 1.0 kg ha⁻¹, pendimethalin 0.75 kg ha⁻¹+HW 30 DAS, alachlor 1.0 kg ha⁻¹, alachlor 0.75 kg ha⁻¹+HW 30 DAS, HW 20 and 40 DAS, weed free and weedy check) as sub-plots was laid out in split-plot design with four replications. Mungbean variety Asha was sown in kharif 2004. The data on dry weight of weeds and crop were recorded at different growth intervals.

The experimental field was dominated mainly by purple nutsedge (*Cyperus rotundus*) and carpetweed (*Trianthema portulacastrum*).

Sowing under furrow irrigated raised bed system (FIRBS) significantly reduced the dry weight of total

weeds as compared to zero-tillage (ZT) and conventional tillage (CT). This might be due to less infestation of *T. portulacastrum* under FIRBS as compared to other methods of sowing. Maximum reduction in dry weight of weeds was obtained with pendimethalin 0.75 kg ha⁻¹ + one hand weeding (30 DAS) upto 40 DAS, but hand weeding twice (20 and 40 DAS) provided maximum reduction in dry weight of weeds thereafter. Similar results were also reported by Gupta *et al.* (1990).

The data on dry weight of crop per square meter reveal that it increased with advancement of crop age (Table 1). The dry weight of mungbean under FIRBS, zero tillage and conventional tillage was statistically at par at various growth stages. However, weed control treatments significantly increased the dry weight of crop when compared with weedy check at all stages. At 40 DAS weed free treatment recorded significantly higher dry weight of crop as compared to rest of the treatments. At 60 DAS, Pendimethalin 0.75 kg ha⁻¹ + HW 30 DAS, alachlor 0.75 kg + HW 30 DAS and two HW at 20 and 40 DAS increased the plant dry weight by 7.1, 8.5 and 10.3 per cent, respectively, as compared to weedy check. Similar results have also been reported earlier by Balyan and Malik (1989). The data for number of seeds per pod indicate that this yield attribute was statistically not influenced by various sowing methods and weed control treatments. However, the higher value was recorded with weed free treatment. Higher seed yield was recorded under FIRBS (906 kg ha⁻¹) but it was statistically at par with ZT (814 kg ha⁻¹) and CT (833 kg ha⁻¹). In general, all the weed control treatments in greengram increased the seed yield when compared with weedy check. Maximum seed yield (962 kg ha⁻¹) was recorded in weed free plot and minimum (658 kg ha⁻¹) in weedy check plot. Except

TABLE 1
Effect of different treatments on dry weight of total weeds and crop yield attributes and seed yield

Treatment	Dry weight of weeds (g m ⁻²)		Dry weight of crop (g m ⁻²)		Yield attributes (Number of pods per plant)	Seed yield (kg ha ⁻¹)	
	40 DAS	60 DAS	40 DAS	60 DAS			
Sowing methods							
Furrow-irrigated raised bed system (FIRBS)	7.3 (63.9)	8.1 (78.0)	7.9 (75.9)	491.8	556.2	10.0	906
Zero-tillage (ZT)	8.8 (90.2)	8.8 (92.8)	8.6 (89.3)	479.9	542.8	9.3	814
Conventional tillage (CT)	8.68 (75.5)	8.8 (92.8)	8.7 (90.2)	483.9	551.0	9.9	833
CD at 5%	0.31	0.45	0.42	NS	NS	NS	NS
Weed control treatments							
Pendimethalin 1.0 kg ha ⁻¹	8.5 (73.8)	9.7 (93.0)	9.7 (93.8)	486.0	539.0	9.5	864
Pendimethalin 0.75 kg ha ⁻¹ +HW 30 DAS	6.9 (50.2)	8.7 (75.6)	8.4 (71.3)	493.7	551.1	9.8	889
Alachlor 1.0 kg ha ⁻¹	10.1 (100.6)	10.0 (99.3)	9.9 (98.8)	489.6	529.5	9.6	853
Alachlor at 0.75 kg ha ⁻¹ +HW 30 DAS	7.4 (54.5)	9.3 (85.4)	9.1 (81.8)	486.4	558.0	9.9	854
HW 20 and 40 DAS	8.0 (63.6)	6.6 (43.3)	6.4 (39.8)	493.4	567.3	10.2	877
Weedy check	13.5 (183.1)	14.8 (218.3)	14.5 (210.4)	441.3	514.0	8.9	658
Weed free	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	505.3	591.1	10.4	962
CD at 5%	0.42	0.32	0.46	12.9	14.0	NS	67

Original values given in parentheses were subjected to square root transformation before analysis.

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these two treatments (weed free and weedy check) all other weed control treatments were statistically at par with each other. Similar results were also reported by Srinivasan *et al.* (1990).

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DESIGN PREFERENCES FOR ADOLESCENT TOP

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Clothes are reflection of one's feelings, moods and individual preferences. Perhaps those costumes are preferred that promise attention. An essential part of planning is the thorough understanding of wardrobe preferences. Clothes are worn to keep pace with the social group and the activities of that group, to meet the demands of careers, and to impress others. Clothes are worn purely for functional reasons. We wear clothes that meet our economic demands and it is obvious that we must think of the needs which are based on very personal demands; personal reasons for wearing clothes. A dress should be suitable for the person for whom it has been designed. The needs regarding clothes vary, the choice of colours, material and design also differs from person to person. These variations are due to differences in age, personality, sex and role the individual has to play in the society. That is why the needs of adolescent for proper dressing up are quite different from an average individual. There is immense need of fullness in the garment because of development of body curves. At this stage, all adolescents want to be more attractive, enhance beauty and improve their personality through clothing. Thus, proper clothing is important at every stage of life but its significance is paramount in adolescence (Bane, 1973). Tops are very important garment of the adolescent girl wardrobe as these can be matched and worn with skirts as well as jeans or pants.

For the present study 60 adolescent girls were selected randomly to find out their preferences regarding design of top. Interview was used to seek out their preferences. A questionnaire schedule was developed regarding liking/disliking for home made tops, fitting of top, shape of neck, type of opening and type of sleeve. Collected data were coded, tabulated and analyzed to get inferences.

Data presented in Table 1 reveal that 66.67% of the respondents liked to wear home made tops, whereas 33.33% respondents did not prefer home stitched tops. It is also evident from the data in Table 1 that 60% respondents liked stitching by other family members, however 40% of the respondents did stitching themselves at home. It was observed that 80% respondents liked to stitch their tops at home, if paper patterns were provided to them. The higher percentage of the respondents who would like to stitch by themselves, if provided with paper patterns, may be due to the fact that by using paper pattern, cutting and stitching are easy and efficient without much difficulty. Similar results were reported by Grover (1997) who observed that the number of respondents for stitching their blouse at home increased, if provided with paper patterns.

Data in Table 2 show that first preference was given to comfortable fit in their garments (3.62) followed by tight fitting (2.92). But loose fitted (2.07)

TABLE 1

Liking for home made tops and use of paper pattern

N=60

Response	Respondents	
	Frequency	Percentage
Liking for home made tops		
Like	40	66.67
Dislike	20	33.33
Liking for stitching at home		
Respondents (self)	24	40.00
Family members	36	60.00
Liking for stitching with paper pattern		
Like	48	80.00
Dislike	12	20.00

TABLE 2

Preference for the type of fitting and length of top

N=60

Response	Weighted mean score	Rank
Type of fitting		
Tight fitting	2.92	II
Comfortable fit	3.62	I
Loose fitting	2.07	III
Very loose	1.40	IV
Top length		
Upto waist level	2.13	II
Upto hip level	2.63	I
Upto thigh level	1.23	III

and very loose (1.40) fitted tops were preferred least. Meenakshi (2001) also stated that 85% of respondents preferred to wear semi fitted tops, whereas only 15% respondents gave preference to tight fitting. Data presented in Table 2 also reveal that length of the top upto hip level was ranked first (2.63) by the respondents followed by length upto waist (2.13), whereas length upto thigh level was ranked least (1.23) by the respondents. Similar results were reported by Meenakshi (2001) that 75% of the respondents liked to wear top upto hip level.

Data pertaining to preference for sleeve in top have been presented in Table 3. It is evident that 83% respondents preferred top with sleeve, whereas sleeveless tops were preferred by 17% of respondents. It was also observed that 50% of the respondents preferred short sleeve in their tops, followed by half sleeve (36%). Sixty per cent of the respondents preferred plain sleeve over fancy sleeve (40%).

Data in Table 4 depict the results pertaining to choice for shape of neck. It is clear from the results that respondents gave first preference to round neck (4.27) followed by square (3.68). Respondents who reported their preference for 'V' shaped neck were at third rank (3.07). Regarding opening in top, front

opening with slit was ranked first (3.42) followed by front opening with placket (2.87). Opening at shoulder (2.18) was ranked third, whereas least preference was given to back opening (1.55) by the respondents. Kiran Bala (1994) also revealed that front opening was most preferred followed by side opening and back opening.

TABLE 3

Respondents preference for sleeve

N=60

Response	Respondents		
	Frequency	Percentage	Rank
Sleeve			
Sleeve	50	83	I
Sleeveless	10	17	II
Length of sleeve			
Full	3	6	IV
¾ th sleeve	4	8	III
Half sleeve	18	36	II
Short	25	50	I
Type of sleeve			
Plain	30	60	I
Fancy (Gathers, hicks)	20	40	II

TABLE 4

Preference for the shape of neck and type of opening in the top

N=60

Response	Weighted mean score	Rank
Shape of neck		
Round	4.27	I
'V' shaped	3.07	III
Square	3.68	II
Scallop	1.80	V
Any other	2.18	IV
Type of opening		
Front (with slit)	3.42	I
Front (with placket)	2.87	II
Shoulder	2.18	III
Back	1.55	IV

DESIGN PREFERENCES FOR ADOLESCENT TOP

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LEADERSHIP AMONG FARMERS IN RURAL HARYANA

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ABSTRACT

The study was conducted on 22 opinion leaders selected from 200 farmers from two villages of Sirsa district of Haryana state during 1999-2001 to identify the opinion leaders among farmers and to ascertain their personal characteristics. The data were collected through pre-tested structured schedule by holding interview at farmers' field/home. The study reveals that the opinion leaders with higher education, having high income group, better mass media exposure, more awareness of agriculture and allied practices and comparatively having more change proneness, had strong and high level of opinion leadership.

Key Words : Opinion leader, Awareness, Mass media exposure.

Leadership plays an important role in shaping the social, political and economic life of the rural community. It has been considered as an activity which influences the group behaviour in order to affect cooperation towards some desirable goals. It can also be viewed as a relation between an individual and the group built around common interests as directed and determined by the individual leader. The role of the leader is to mobilize the group to achieve the desired goal and ultimately, affecting structural changes in the society. Looking at interval dynamism it is evident that few farmers influence the decision making of others on the technological innovations. They act as 'gatekeepers' of information flow in the community distilling the unimportant message. These farmers are called opinion leaders (Rogers, 1983). They act as key communicators who are more important in communication of information than others. They are the type of opinion leaders to whom farmers look for opinions and information about new farm ideas. As such they are the 'catalyst' to the process of bringing about a speedy technological change.

The opinion leadership is the ability to informally influence other individuals' attitudes or behaviour in a desired manner with relative frequency. These opinion leaders are of old age, have higher activity participation, better family educational status, high mass media

exposure, better communication competence and frequent urban contacts, more innovative than their followers (Lionberger, 1960; Reddy and Sahay, 1973; Meher and Patil, 1984; Hossain and Crouch, 1991; Khandekar and Khandekar, 1996). An insulation of such unique factors related to opinion leadership would have helped development planners and extension workers working with such leaders for participated agricultural development. Therefore, opinion leaders play a crucial role in the transformation of information to the rural society.

Keeping the importance of opinion leadership in transfer of agricultural technology to the farming community, an attempt was made to identify the opinion leadership with the following specific objectives :

1. To identify the opinion leaders among farmers;
2. To ascertain the personal characteristics of opinion leaders;
3. To establish the relationship between leader's background variables and their opinion leadership.

METHODOLOGY

Sample

The study was undertaken in Sirsa district of

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Haryana state during 1999-2000. Out of six blocks of the district one block, namely, Sirsa-I was selected randomly. A list of all the villages of the selected block was prepared and from that list two villages (Ding and Mochiwali) were selected by using random sampling technique. One hundred farmers from each village were selected randomly which constituted 200 respondents. Eldest person of the household who was involved in decision making on farming matters was taken as respondent.

Variables and their Measurement Techniques

Dependent variable

Opinion leadership was considered as dependent variable for the present study and it was identified with the help of socio-metric technique operationalised by Singh and Pareek (1965). Sociometry is a test meant for determining the degree to which the individuals are accepted in a group or to discover the relationship which exists among these individuals and disclosing the status of group itself (Northway, 1959). In this technique, each person in a group is asked to state as to with whom, among the members of the group, he/she prefers to associate himself/herself for specific activities or in a particular situation. Accordingly each respondent was requested to name three persons of their group in order of preference, whose advice he sought or would seek on different matters. Eighteen questions regarding agriculture, animal husbandry, social aspects, etc. were asked from the respondents. These were : (i) There are so many persons in your village respected since old times whom would you respect most?, (ii) Please name three farmers of your village whom you consult for advice on farming, (iii) For proper fertilizer application and do's in crops whom do you consult normally?, (iv) For proper insecticides and pesticides application in crops who is consulted by you normally?, (v) Whom do you consult to get information about new varieties of seeds?, (vi) Whom do you consult to get information about irrigation time, etc.?, (vii) Who is consulted to get information about marketing of agriculture produce?, (viii) If you are interested to purchase cow whom do

you consult normally?, (ix) Whom do you consult for treatment of a sick cow?, (x) Whom do you consult for cow care and maintenance?, (xi) If you are interested to purchase buffalo whom do you consult normally?, (xii) Whom do you consult for treatment of buffalo?, (xiii) If you are interested to purchase any farm machinery whom do you consult normally?, (xiv) Whom do you consult for repair of farm implements?, (xv) If you are interested to seek loan for farming purposes whom do you consult for guidance?, (xvi) For proper use of farm machinery and implements whom do you consult normally?, (xvii) In your opinion who are the very good social workers? and (xviii) Whom do you consult on legal matters? On the basis of the choices recorded by the respondents, the data were quantified by giving scores of 3, 2 and 1 for first, second and third choice, respectively and matrix of incoming choices and socio-metric scores for each respondent were worked out. Those who received more than average socio-metric score were identified as opinion leaders.

Independent variables

Considering ability of the variables in accordance with objectives of the study age, education, family type, size of family, land holding, annual income, mass media exposure, and change proneness were taken as independent variables. These variables were measured by using socio-economic status scale of Trivedi (1963), change proneness scale of Moulik (1965) and mass media exposure index of Singh (1983). The data were quantified by giving appropriate scores after consulting social scientists. Frequencies, percentage and mean were worked out to draw meaningful inferences. Correlation coefficients were also computed to ascertain the relationship between dependent and independent variables.

RESULTS AND DISCUSSION

The simple verbal responses of the subjects do not reveal the realities unless these have been complemented by their socio-economic make-up. The main findings have been presented as under :

Opinion Leadership Scores of Selected Opinion Leaders

As specified earlier, the opinion leaders were identified by the socio-metric technique. The data given in Table 1 reveal that out of 200 respondents, only 12 opinion leaders were selected from village Ding and 10 from village Mochiwali on the basis of the leadership score. The maximum leadership score in both the villages was 1188, whereas minimum leadership scores were 864 and 828 in villages Ding and Mochiwali, respectively.

TABLE 1

Opinion leadership scores of selected opinion leaders

(n=22)

Opinion leaders	Opinion leadership score (V ₁)	Mean score	Opinion leaders	Opinion leadership score (V ₂)	Mean score
D ₁	1188	0.222	M ₁	1188	0.222
D ₂	1044	0.195	M ₂	1116	0.208
D ₃	1008	0.188	M ₃	1080	0.202
D ₄	1008	0.188	M ₄	972	0.181
D ₅	972	0.181	M ₅	972	0.181
D ₆	954	0.178	M ₆	936	0.175
D ₇	936	0.175	M ₇	900	0.168
D ₈	936	0.175	M ₈	900	0.168
D ₉	918	0.171	M ₉	876	0.163
D ₁₀	900	0.168	M ₁₀	828	0.154
D ₁₁	864	0.161			
D ₁₂	864	0.161			

V₁ Village DingV₂ Village Mochiwali

Profile of the Opinion Leaders

The data on profile of opinion leaders are presented in Table 2 which reveal that majority (86.36%) of the opinion leaders were from middle age group and belonged to higher caste (100%). All the respondents were represented from Hindu religion (100%), with higher educational status, *i.e.* above 10+2 (99.91%) and having farming as their main occupation (100%).

The majority (77.27%) of the opinion leaders were hailing from joint families, whereas 50% of them had medium family size. As high as 90.31% of the leaders had high level of education and mass media exposure with high level of awareness of agriculture programme and allied practices (100%). Further the study reveals that the majority of them had high level of change proneness (81.82%), as compared to the leadership score, *i.e.* simultaneously equal (50%). The similar type of profile of the respondents has been reported by Singal (1982) and Khandekar and Khandekar (1996) in their respective studies.

On the basis of these results it can be concluded that the opinion leaders had sufficient better background to discharge their duties.

Correlation Coefficients Showing Association between Opinion Leader's Background Variables and their Opinion Leadership

It is evident from Table 3 that change proneness, mass media exposure, awareness of agriculture programmes and allied practices, education, land holding and income were found to be significantly and positively correlated with the opinion leadership. It implies that the leaders with high opinion leadership score tend to have more change proneness, high exposure to mass media, high awareness of agriculture programmes and allied practices, higher education, large land holding and high income level. A similar trend was also reported by Reddy and Sahay (1973) and Khandekar and Khandekar (1996).

As the findings reveal the opinion leaders disseminate the information through interpersonal communication and informal discussions during social functions. So, the identified opinion leaders should be given training on selected extension approaches for educating and persuading other persons. As majority of opinion leaders possessed high levels of mass media exposure, change proneness and awareness thus their potential quality could still be exploited by suitable training recognizing and developing them to make them

TABLE 2
Socio-personal and economic profile of the opinion leaders

Variables	Score range	V ₁ (n=12)		V ₂ (n=10)		Total (n=22)	
		f	%	f	%	f	%
Age (years)							
Young	<35	0	0.00	0	0	0	0.00
Middle	35-50	11	91.66	8	80	19	86.36
Old	>50	1	8.34	2	20	3	13.64
Caste							
Low	1	0	0.00	0	0	0	0.00
Medium	2	0	0.00	0	0	0	0.00
Higher	3	12	100.00	10	100	0	100.00
Education							
Illiterate	0	0	0.00	0	0	0	0.00
Upto primary	1	0	0.00	0	0	0	0.00
VI to 10+2	2	1	8.33	1	10	2	9.09
Above 10+2	3	11	91.66	9	90	20	90.91
Occupation							
Agriculture labour	1	0	0.00	0	0	0	0.00
Farming	2	12	100.00	10	100	22	100.00
Land holding							
Small	<5	0	0.00	0	0	0	0.00
Medium	6-10	0	0.00	0	0	0	0.00
Large	>10	12	100.00	10	100	22	100.00
Family type							
Nuclear	1	3	25.00	2	20	5	22.72
Joint	2	9	75.00	8	80	17	77.27
Family size							
Small	2-6	7	58.33	3	30	10	45.45
Medium	7-10	5	41.66	6	60	11	50.00
Large	>10	0	0.00	1	10	1	4.54
Mass media exposure							
Low	0-6	0	0.00	0	0	0	0.00
Medium	6-12	0	0.00	2	20	2	9.09
High	12-18	12	100.00	8	80	20	90.91
Awareness of Agriculture Programmes and Allied Practices							
Low	0-5	0	0.00	0	0	0	0.00
Medium	6-10	0	0.00	0	0	0	0.00
High	>10	12	100.00	10	100	22	100.00
Change proneness							
Low	9-12	0	0.00	0	0	0	0.00
Medium	12-15	1	8.33	3	30	4	18.18
High	15-18	11	91.67	7	70	18	81.82

V₁-Village Ding, V₂-Village Mochiwali, n-Number of opinion leaders, f-Frequency.

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TABLE 3

Correlation coefficients showing relationship between leaders' background variables and their opinion leadership

Independent variables	Correlation coefficient 'r'
Age	0.081
Education	0.438*
Land holding	0.436*
Income	0.434*
Family type	0.179
Family size	0.222
Mass media exposure	0.478*
Awareness of agriculture programmes and allied practices	0.446*
Change proneness	0.606**

*Significant at 5 and 1 per cent level of probability, respectively. science oriented for the cause of speedy agricultural development. Study tours and guided visits to other villages may be arranged for opinion leaders by KGKs, KVKs and research stations to increase their knowledge regarding new farm technologies and leadership roles.

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KNOWLEDGE OF RURAL WOMEN ABOUT BUFFALO HOUSING MANAGEMENT PRACTICES IN HARYANA

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The present study was undertaken on 160 rural women selected from four villages of Hisar and Jind districts keeping highest concentration of buffalo during 2003-04. The data were collected by using a knowledge test schedule after pre-testing it through personal interview technique. The data highlighted that majority of the rural women had fair knowledge about buffalo housing management practices. Maximum knowledge was recorded about cleanliness of buffalo shed, type of shed and space required for pregnant buffalo. The rural women had least knowledge about space needed for newly young calf and heifers. Regression analysis revealed that education, socio-economic status, extension contact, mass media exposure and scientific orientation among rural women played an important role towards knowledge about housing management practices.

Key Words : Knowledge, Rural women, Housing management, Socio-personal.

Since ages women have more intimacy with the milch animals and are actively involved in feeding and care of their animals. Most of their activities such as preparation of feed, feeding, cleaning animal shed, preparing dung cakes, milking and post-harvest activities of milk are located within the premises of the household.

Women in India, like in many other developing countries, are silent workers labouring hard from dawn to dusk in the interest of their farms and homes. There is a great scope for women to participate in dairy production system because it enables them to earn more income for their family, it fits well in their household activities as there is great degree of indoor activities and is less strenuous. It is difficult to demarcate the work of women and men in dairying. Their respective contributions depend upon many factors such as type of animals, economic background of family and region specific social traditions. In landed families women are linked to dairying mainly in supervising hired labour, while marginal and landless women are directly involved in manual tasks.

Keeping the above facts in mind, a study was planned to ascertain the knowledge level of rural women about buffalo housing practices in the selected villages in Haryana.

METHODOLOGY

The present study was conducted in two districts, Jind and Hisar purposively selected because of maximum concentration of buffalo to ascertain the training needs of rural women about buffalo rearing practices. One block from each district was selected randomly. From each block two villages were also selected randomly and 20 rural women from landless families and matching sample of 20 rural women from marginal families were selected randomly from each village. Therefore, 160 respondents from both categories constituted the sample for the study. Knowledge level of rural women about housing management practices of buffalo was taken as dependent variable and was measured by developing the knowledge test. The several items pertaining to housing management practices of buffalo were included in the test to judge the knowledge of the rural women. The respondents were asked to give their responses on three point continuum, *i.e.* correct answer, partially correct and wrong answer and the weightage of 2, 1 and 0 was allotted, respectively. Sixteen important personality characteristics of rural women, *viz.* age, education, caste, family size, farm size, social participation, socio-economic status, herd size, milk production, total income, income from A. H. Sector, treatment taken, medicine used, extension contact,

mass-media exposure and scientific orientation were selected and considered as independent variables.

RESULTS AND DISCUSSION

Level of Knowledge of Rural Women about Buffalo Housing Management Practices

The data in Table 1 reveal that majority (55%) of the rural women from landless families possessed moderate level of knowledge followed by low (27.5%) and high (14%). More or less similar results of knowledge about housing management for buffaloes were also recorded in case of marginal farm families and overall data analysis.

The data in Table 1 give only overall picture about the knowledge of rural women regarding buffalo housing management practices. Therefore, it was decided to go further for item/areas-wise analysis.

TABLE 1

Distribution of rural women buffalo owners on the basis of knowledge score regarding housing management practices

Level of knowledge	Score range	Category of respondents					
		Landless		Marginal		Total	
		F	%	F	%	F	%
Low	34-45	22	27.5	19	23.8	41	25.6
Moderate	46-56	44	55.0	44	55.0	88	55.0
High	57-67	14	17.5	17	21.2	31	19.4
Total		80	100.0	80.0	100.0	160	100.0

Item-wise Knowledge of Landless Rural Women Regarding Housing Management Practices

Ten important areas were included to measure the knowledge level of rural women about housing management. Data in Table 2 highlight the different levels of knowledge about housing for buffalo. As high as 97.50% respondents were found to have high knowledge about cleanliness of buffalo shed daily followed by type of floor made for the shelter (68.80%) and space requirement for pregnant buffalo (66.20%). More than 50% of rural women from landless families

were found to have moderate knowledge about method of keeping buffalo in house followed by space requirement to a young calf (50%) and type of buffalo shelter (46.30%). However, 73.80% respondents had poor knowledge about condition for making good house for buffalo followed by area requirement to a buffalo (41.20%). Similar findings were reported by Lal (1996).

Item-wise Knowledge of Landless Rural Women Regarding Buffalo Housing Management Practices

It is clear from the data in Table 3 that knowledge among respondents was recorded high in case of cleanliness of buffalo shed (96.20%), followed by type of floor (75%) and space required for pregnant buffalo (57.50%) as 52.50% of rural women had moderate knowledge about method of buffalo keeping (loose in house) followed by area required to a buffalo (43.80%) and space needed to a heifer (41.20%). Poor knowledge of the marginal rural women was observed in the area quality of buffalo house (60%), followed by area required to a buffalo (45%), space needed to a heifer (32.50%) and space needed to a young calf (32.50%). The data also reveal overall picture about moderate to high-level knowledge regarding housing system for a buffalo.

Relationship with Buffalo Housing Management Practices

The correlation coefficients were worked out to establish the relationship between socio-personal characteristics of rural women and their knowledge about buffalo housing management practices. It is clear from the values presented in Table 4 that 10 variables, namely, education (0.278), caste (0.279), social participation (0.249), family size (0.213), SES (0.273), herd size (0.451), income (0.385), extension contact (0.325), mass media contact (0.337) and scientific orientation (0.295) had positive and significant relationship with knowledge of rural women from landless families either at 5% or at 1% level of probability. All these 10 variables were also found to have positive and significant correlation with knowledge

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TABLE 2

Knowledge level among landless respondents regarding housing management practices in buffaloes
(N=80)

S. No.	Areas of knowledge	Knowledge level					
		Full		Moderate		Poor	
		F	%	F	%	F	%
1.	Height of buffalo shed	34	42.5	18	22.5	28	35.0
2.	Method of buffalo keeping	12	15.0	41	51.2	27	33.8
3.	Type of floor in the shelter	55	68.8	22	27.5	03	03.7
4.	Type of buffalo shelter	34	42.5	37	46.3	09	11.2
5.	Quality of buffalo house	03	03.7	18	22.5	59	73.8
6.	Area requirement for a buffalo	12	15.0	35	43.8	33	41.2
7.	Space requirement for pregnant buffalo	53	66.2	18	22.5	09	11.3
8.	Space requirement for a heifer	21	26.3	36	45.0	23	28.7
9.	Space requirement for a young calf	30	37.5	40	50.0	10	12.5
10.	Cleanliness of buffalo shed	78	97.5	00	00.0	02	02.5

TABLE 3

Knowledge level among marginal rural women regarding housing management practices in buffaloes
(N=80)

S. No.	Areas of knowledge	Knowledge level					
		Full		Moderate		Poor	
		F	%	F	%	F	%
1.	Height of buffalo shed	37	46.2	22	27.5	21	26.3
2.	Method of buffalo keeping	18	22.5	42	52.5	20	25.0
3.	Type of floor in the shelter	60	75.0	17	21.2	03	03.8
4.	Type of buffalo shelter	44	55.0	28	35.0	08	10.0
5.	Quality of buffalo house	05	06.2	27	33.8	48	60.0
6.	Area requirement for a buffalo	09	11.2	35	43.8	36	45.0
7.	Space requirement for pregnant buffalo	46	57.5	15	18.7	19	23.8
8.	Space requirement for a heifer	21	26.3	33	41.2	26	32.5
9.	Space requirement for a young calf	30	37.5	24	30.0	26	32.5
10.	Cleanliness of buffalo shed	77	96.2	00	00.0	03	03.8

of housing management practices among marginal respondents and from pooled data. It implies that all these 10 variables were important to influence the knowledge of rural women about buffalo housing management practices. Similar results were also reported by Gill and Singh (1977) and Kumar and Pushkarn (1990).

Contribution of Socio-personal Variables towards Knowledge of Rural Women in Housing Management Practices in Buffaloes

It is clear from the data presented in Table 5 that beta values for education (0.824), SES (0.386), extension contact (0.995), mass media exposure (0.999) and

TABLE 4

Relationship between antecedent variables and knowledge level of rural women regarding housing management practices in buffalo

Variable code	Variables	Correlation coefficient with knowledge of housing management practices of		
		Landless 'r'	Marginal 'r'	Overall 'r'
X ₁	Age	-.177	-.041	-.091
X ₂	Education	.278*	.242*	.212**
X ₃	Caste	.279*	.039	.083
X ₄	Family size	.213*	.244*	.232**
X ₅	Farm size	-	.012	.009
X ₆	Social participation	.249*	.219*	.253**
X ₇	Socio-economic status	.273*	.277*	.188*
X ₈	Herd size	.451**	.239*	.329**
X ₉	Milk production	.097	.079	.020
X ₁₀	Total income	.366**	.266*	.262**
X ₁₁	Income from A. H.	.385**	.233*	.291**
X ₁₂	Treatment taken	.099	.180	.056
X ₁₃	Medicine used	.018	.097	.057
X ₁₄	Extension contact	.325**	.266*	.336**
X ₁₅	Mass media exposure	.337**	.233*	.236**
X ₁₆	Scientific orientation	.295**	.214*	.238**

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

TABLE 5

Regression coefficients between antecedent characteristics of rural women about buffalo housing management practices

Variable code	Variables	Regression coefficient with knowledge level of housing management practices of					
		Landless		Marginal		Overall	
		'b'	't'	'b'	't'	'b'	't'
X ₁	Age	-.420	-3.94**	-.035	-2.262*	-.208	-2.092*
X ₂	Education	.824	3.511**	.554	2.128*	.655	3.605**
X ₃	Caste	.096	.383	.091	.611	.109	.706
X ₄	Family size	.092	.567	.143	.806	.131	1.195
X ₅	Farm size	-	-	.082	.721	.068	.367
X ₆	Social participation	.190	1.745	.140	1.019	.65	.795
X ₇	Socio-economic status	.386	2.379*	.882	3.698**	.137	1.998*
X ₈	Herd size	.322	1.000	.246	1.156	.029	.187
X ₉	Milk production	.123	1.086	.064	.472	.077	.927
X ₁₀	Total income	.250	.808	.046	.204	.050	.278
X ₁₁	Income from A. H.	.158	.495	.137	.465	.062	.330
X ₁₂	Treatment taken	.110	.929	.058	.513	.004	.057
X ₁₃	Medicine used	.005	.037	.220	1.761	.063	.816
X ₁₄	Extension contact	.995	2.802*	.669	2.218*	.305	2.193*
X ₁₅	Mass media exposure	.999	2.650*	.214	3.781*	.722	4.307**
X ₁₆	Scientific orientation	.810	2.093*	.812	2.090*	.620	2.256*
R ²		.869		.839		.732	

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

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scientific orientation (0.810) were found to be positive and significant, whereas age of respondents had contributed negatively towards knowledge of rural women from landless families as far as buffalo housing management practices are concerned. All these six variables jointly explained 86.9% variation towards knowledge about housing management practices. However, these six variables jointly contributed 83.9% variation towards knowledge in case of marginal

respondents, which is lesser as compared to landless respondents. Again all these six variables had explained 73.2% variation towards knowledge about housing management practices in case of pooled analysis. F-values of both categories of respondents were found significant. These results get support from the findings reported by Gupta *et al.* (1986) and Singh and Godara (2002).

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FARMERS' KNOWLEDGE, OPINION AND BELIEFS ABOUT THE USE OF ORGANIC MANURES IN RICE-WHEAT SYSTEM IN HARYANA

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Key Words : Rice, Organic manures, Yield, Farmers.

With the introduction and use of fertilizers, insecticides, fungicides, herbicides, etc., modern agriculture took a new turn. No doubt, these farm inputs resulted in an increase in crop productivity manifold but at the same time, these have created energy crisis and adverse effects on the environment and soil health. Long-term studies in rice-wheat cropping system have shown an overall decline in the soil organic carbon (Duxbury *et al.*, 2000). It is the need of the present day agriculture to save our environment from pollution and sustain crop production. Therefore, attention should be paid to tap alternatives for such a crucial issue. Organic farming has gained reputation as a viable alternative to conventional agriculture during the past few decades. It is an holistic approach of farm design and management that seeks to create a healthy ecosystem with sustained profitability by increasing bio-diversity, nutrient recycling and soil biological and microbial activities. Due to the problems caused by chemicals used in agriculture, it is required to reduce the use of chemicals and adopt organic methods of farming. Keeping these facts in view, a survey was conducted to assess the farmer's knowledge, opinion and practices towards nutrient management through organic sources in rice-wheat growing districts of Haryana.

A benchmark survey was conducted during 2001 and 2002 on 160 randomly selected farmers in four different villages, one each in Karnal, Fatehabad, Kaithal and Sirsa districts of north-east and west Haryana representing intensive rice-wheat cropping system. Fifty farmers from each of the three villages,

viz. Bhaini Khurd (Karnal), Pirthala (Fatehabad) and Teek (Kaithal) and 10 farmers from village Rampur Thery (Sirsa) were selected randomly for the study. The respondents were classified into three categories, *viz.* small (< 2 ha), medium (2-4 ha) and large (> 4 ha) farmers depending upon the size of their land holding and interviewed personally regarding their knowledge, attitude and belief towards nitrogen management through organic manures in rice in rice-wheat cropping sequence through farmers' participatory rural appraisal technique with the help of a well-structured, precise, clear and meaningful interview schedule supplied by IRRI, Manila, Philippines. The response of each question was marked itself and farmer-wise tabulation sheet was prepared. Suitable techniques and tests were used for the analysis of data and the values for their significance were tested at 5% level of probability.

Majority (63.75%) of the farmers applied organic manures at their fields, but they covered only 11.98% of their operational land holding (Table 1). This could be due to the availability of organic manures within the farm (98.04%) and also, the farmers were aware of the fact that the application of these manures resulted in the improvement of soil structure (73.53%), crop growth and ultimately yield (96.08%). However, the farmers who did not apply these manures at their fields attributed it to the labour consuming and bulky nature (94.11%), insufficient availability (2.94%) and time consuming process (2.94%). Most of the farmers (94.11%) applied decomposed cattle dung and waste material as a source of organic manure, while only 2.94% of the total farmers used either poultry or crop

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residues for this purpose. Moreover, the use of green manure was almost non-existent in all the villages under survey study (Table 1). Ratnakar and Reddy (1991) also concluded that more than 60% of the respondents had knowledge about different practices of organic manure use.

From the above results, it could be understood that farmers were aware of the importance of organic manures in respect of improvement in soil structure, crop growth and yield. Although, the limited availability of organic manures raised a big question mark about

the feasibility of area under organic farming because the results of this study clearly indicate that only about 12% of the area could be covered by the farmers with organic manures and thus, a field can receive organic manure again after several years. Therefore, the importance of fertilizers will continue in near future. It would, therefore, mean that due to continued problem of organic manures, integrated nutrient management (INM) through organic sources would remain a problem. Therefore, it is necessary to develop alternate techniques that can improve the efficiency of inorganic nutrients in rice-wheat cropping system. Improvement in the

TABLE 1

Knowledge, opinion and beliefs towards nitrogen management through organic sources (% farmers)

S. No.	Parameters	Small (< 2 ha)	Medium (2-4 ha)	Large (>4 ha)	Total	Φ value
1. Classification of farmers						
	Number of respondents	35.00	58.00	67.00	160.00	-
	Percentage of respondents	21.88	36.25	41.87	100.00	
2. Adoption of organic manures						
	Adopters	57.14 (20)	46.55 (27)	82.09 (55)	63.75 (102)	
	Non-adopters	42.86 (15)	53.45 (31)	17.91 (12)	36.25 (58)	18.47**
3. Area (%) covered under organic manures per year¹		23.46 (20)	15.46 (27)	10.52 (55)	11.98 (102)	-
4. Quantity of organic manures applied (t ha⁻¹)¹		13.33 (20)	13.28 (27)	15.83 (55)	14.18 (102)	-
5. Type of organic manure applied¹						
	Cattle manure	100.00 (20)	100.00 (27)	85.45 (47)	94.11 (96)	
	Poultry manure	-	-	7.27 (04)	2.94 (03)	-
	Crop residues	-	-	7.27 (04)	2.94 (03)	
6. Reasons for adoption of organic manures¹						
	Available within farm	100.00 (20)	96.33 (26)	94.18 (54)	98.04 (100)	18.06**
	Cheaper than chemical fertilizer	-	3.70 (01)	5.45 (03)	3.92 (04)	2.21
	Improves soil structure	55.00 (11)	81.48 (22)	76.36 (42)	73.53 (75)	10.20**
	Improves soil moisture retention	15.00 (03)	3.70 (01)	3.63 (02)	5.88 (06)	2.67
	Improves crop growth and yield	100.00 (20)	92.59 (25)	96.36 (53)	96.08 (98)	17.75**
7. Reasons for non-adoption of organic manures²						
	Laborious and bulky to handle	100.00 (14)	100.00 (30)	85.45 (12)	94.11 (56)	16.65**
	Insufficient availability	100.00 (12)	100.00 (16)	7.27 (05)	2.94 (33)	14.73
	Time consuming process	100.00 (02)	100.00 (16)	7.27 (06)	2.94 (24)	11.88

Figures in parentheses indicate the number of farmers.

¹ and ² Indicate farmers who were adopters and non-adopters of organic manures at their fields, respectively.

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availability of organic manures, crop residue and waste management should be given proper attention and the practices like straw burning and throwing of wastes have to be avoided and these materials may be converted into manures. The research efforts would also demand the rational use of fertilizer through slow-release fertilizers reducing nutrient losses and improving soil organic carbon through development of resource conservation technologies.

There is no doubt that the productivity of organic

farms is generally lower than those managed conventionally; but by considering the merits of organic farming and organic produce, no one can deny the acceptance of this system. Although, danger of food security can be seen the main reason for not popularizing this system by the government and policy makers on a large scale. But the long-term future of Indian agriculture would depend on the success of this type of farming, which ultimately means going back to "Mother Nature" and reduction in the dependence on synthetic chemical fertilizers.

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