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CONTENT

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Efficacy of Newer Insecticides Along With Biorationals Against *Helicoverpa armigera* (Hubner) in Chickpea

S.V. Dhonde[1], V.K. Bhamare[2], S.V. Sarode[3], M.I. Khan[4] and A.Y. Deshmukh[5]

ABSTRACT

Results of a field experiment revealed that indoxacarb 75 g a.i.ha^{-1}, methoxy phenoxide 300 g a.i.ha^{-1}, beta cyfluthrin 12.5 g a.i. ha^{-1} and lambda cyhalothrin 25 g a.i. ha^{-1} were found to be the most effective treatments in that order, in reducing larval population of pod borer *H. armigera* in chickpea. These treatments were at par with each other in their efficacy and were also found effective in terms of per cent pod damage at harvest. The maximum grain yield was obtained in plots treated with indoxacarb 75 g a.i. ha^{-1}. However, it was at par with the yield obtained in lambda cyhalothrin 25 g a.i. ha^{-1}, beta cyfluthrin 12.5 g a.i. ha^{-1}, methoxy phenoxide 300 g a.i. ha^{-1}, Spinosad 75 g a.i. ha^{-1}, endosulfan 350 g a.i. ha^{-1}, Btk 1000 g ha^{-1} and HaNPV 250 LE ha^{-1} treated plots. Beta cyfluthrin 12.5 g a.i. ha^{-1} was emerged as economically the most viable treatment, followed by endosulfan 350 g a.i. ha^{-1} and azadirachtin 1500 ppm.

Helicoverpa armigera (Hubner) is a pest of greater significance and singularly the most damaging pest of many crops including chickpea. Concerted efforts are being made to control the pest globally with varying degrees of success. Nonetheless, indiscriminate use of chemicals has resulted into various problems which farmers and researches equally face. This inevitably leads to evolve newer molecules with varying modes of actions which can effectively control the pest without adversely affecting the agro-ecosystem, the beneficial fauna and human health. On the other hand biopesticides like Nuclear Polyhedrosis Virus, *Bacillus thuringiensis*, *Saccharopolyspora spinosa* and botanicals like *neem* and *karanj* products are reported effective and safe. Keeping this in view, efforts were directed towards finding the most efficacious, economic and sustainable insecticides among the recently developed ones, along with the biorationales. This exercise may help in developing IPM strategy for the effective management of pod borer in chickpea.

MATERIAL AND METHODS

A field experiment was conducted in randomized block design during the *Rabi* season of 2001-2002 at the experimental field, Department of Entomology, Dr. PDKV, Akola, with 12 treatments (Table 1) replicated thrice. The crop variety Chaffa-816 was used. The plot size of 2.4m x 4.0m (gross) and 1.8m x 3.8m (net) was used with a spacing of 30 x 10 cm. Five plants were selected randomly from each plot for recording the observations. Foliar spraying was done when Economic Threshold Level (ETL) i.e. 1-2 larvae per meter row length was reached which coincided with 50 per cent flowering stage of the crop and second spraying was given 15 days thereafter. The pre-treatment observations on larval population were recorded 24 hrs before spraying while post-treatment observations were recorded 24 hrs, 72 hrs and 7 days after the treatments, to determine the per cent larval reduction. Similarly, the per cent pod damage due to *H. armigera* based on five randomly selected plants and grain yield were also recorded at harvest to judge the efficacy at various treatments against the pod borer. To study the economics and cost effectiveness of the treatments, incremental cost benefit ratio (ICBR) was worked out based on prevailing market rates.

RESULTS AND DISCUSSION

The data presented in Table 1 on mean values based on two sprays indicated that the treatment indoxacarb 75 g a.i. ha^{-1} and methoxy phenoxide 300 g a.i. ha^{-1} recorded highest larval reduction i.e. 85.58 and 83.89 per cent, respectively, 24 hrs after treatment and they were at par with each other. These treatments were followed by lambda cyhalothrin 25 g a.i. ha^{-1} and beta cyfluthrin 12.5 g a.i. ha^{-1} recorded 80.19 and 80.00 per cent larval reduction, respectively which were at par with each other in their efficacy. Among the borationals Spinosad 45 SC @ 75 g a.i. ha^{-1} and karanj seed extract 5 per cent showed better performance over rest of the biorationals used.

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Table 1. Effect of newer insecticides along with biorationals on the per cent larval reduction, pod damage, grain yield of chickpea due to *Helicoverpa armigera*

Treatments	Larval reduction			Pod damage	Mean grain	Yield	ICBR
	24 h AT	72 h AT	7 days AT	(%)	yield (kg plot^{-1})	(q ha^{-1})	
Lamda cyhalothrin	80.19	82.75	83.85	09.42	1.35	19.73	1:12.5
25 g a.i. ha^{-1}	(63.51)*	(65.42)	(66.03)	(3.07)			
Methoxy phenoxide	83.89	85.97	85.82	8.40	1.32	19.29	1:9.06
300 g a.i. ha^{-1}	(66.27)	(67.94)	(67.37)	(2.90)			
Indoxacarb	85.58	88.94	88.94	8.18	1.39	20.32	1:2.63
75 g a.i. ha^{-1}	(67.62)	(70.54)	(70.09)	(2.85)			
Beta cyfluthrin	80.00	88.67	84.24	10.26	1.34	19.59	1:14.29
12.5 g a.i. ha^{-1}	(63.44)	(67.70)	(66.74)	(3.20)			
*Ha*NPV 250 LE ha^{-1}	56.84	62.59	68.74	15.64	1.21	17.69	1:6.59
	(48.91)	(52.24)	(55.80)	(3.95)			
Btk 1000 g ha^{-1}	62.49	74.27	71.89	14.18	1.23	17.98	1:3.07
	(52.18)	(59.47)	(57.92)	(3.76)			
Spinosod 75 g a.i. ha^{-1}	77.76	83.14	81.18	10.51	1.30	19.00	1:3.66
	(61.75)	(63.65)	(64.23)	(3.24)			
Azadirachtin 1500 ppm	62.93	72.37	66.53	18.60	1.15	16.81	1:13.07
@ 3 ml lit^{-1}	(52.48)	(58.24)	(54.63)	(4.31)			
Endosulfan 350 g a.i. ha^{-1}	77.19	80.40	78.84	11.54	1.25	18.27	1:13.69
	(61.41)	(63.72)	(62.31)	(3.39)			
Neem seed extract 5 per cent	62.21	62.21	55.89	19.85	1.11	16.22	1:11.61
	(52.06)	(52.06)	(48.33)	(4.45)			
Karanj seed extract 5 per cent	74.71	74.52	72.78	16.82	1.14	16.67	1:11.77
	(59.41)	(59.47)	(58.56)	(4.10)			
Untreated control	00.00	12.84	13.93	28.93	0.84	12.20	–
	(00.00)	(20.63)	(21.60)	(5.38)			
'F' test	Sig.	Sig.	Sig.	Sig.	Sig.	–	–
SE (m) ±	01.22	01.73	02.03	0.08	0.075	–	–
C.D. at 5%	03.45	04.87	05.69	0.24	0.22	–	–

* Arc sine transformation AT - After treatment

The results further revealed that indoxacarb 75 g a.i. ha^{-1}, beta cyfluthrin 12.5 g a.i. ha^{-1} and methoxy phenoxide 300 g a.i. ha^{-1} were the most promising treatments in reducing 88.94, 88.67 and 85.97 per cent larval population 72 h after spraying, respectively. However, the treatments, Spinosad 75 g a.i. ha^{-1}, lambda cyhalothrin 25 g a.i. ha^{-1}, endosulfan 350 g a.i. ha^{-1}, *Karanj* seed extract 5 per cent, Btk 1000 g ha^{-1} were emerged as the middle ranking treatments recording 83.14, 82.75, 80.40, 74.52 and 74.27 per cent larval reduction, respectively.

The data on larval reduction 7 days after treatment showed that indoxacarb 75 g a.i. ha^{-1}, methoxy phenoxide 300 g a.i. ha^{-1}, beta cyfluthrin 12.5 g a.i. ha^{-1} and lambda cyhalothrin 25 g a.i. ha^{-1} were at par with each other and performed better than other treatments recording 88.94, 85.82, 84.24 and 83.85 per cent larval reduction, respectively. Among the biorationals, Spinosad 75 g a.i. ha^{-1} (81.18%), *Karanj* seed extract 5 per cent (72.78 %), Btk 1000 g ha^{-1} (71.89 %), HaNPV 250 LE ha^{-1} (68.74%) and azadirachtin 1500 ppm (66.53%) were found efficacious in

reducing larval population. Earlier it was reported that indoxacarb 14.5 SC @ 75 g a.i. ha^{-1} and beta cyfluthrin 18.75 g a.i. ha^{-1} gave better control of *H. armigera* population (Anonymous, 2002). Ambulkar (2000) also revealed that methoxy phenoxide 300 g a.i. ha^{-1} and beta cyfluthrin 18.75 g a.i. ha^{-1} were found most promising against *H. armigera* in chickpea.

The results on the efficacy of various treatments in terms of pod damage caused by pod borer at harvest revealed that lambda cyhalothrin 25 g a.i. ha^{-1}, methoxy phenoxide, 300 g a.i. ha^{-1} and indoxacarb 75 g a.i. ha^{-1} recorded lowest pod borer damage i.e. 9.42, 8.40 and 8.18 per cent, respectively when compared with the rest of the treatments including untreated control. These three treatments were found to be equally effective in reducing pod damage. These results are in conformity with the results of Durairaj and Ganapathy (1998) who reported that lambda cyhalothrin 25 g a.i. ha^{-1} was found effective in having less pod damage. However, Ambulkar (2000) observed that methoxy phenoxide 300 g a.i. ha^{-1} recorded minimum pod borer damage in chickpea followed closely by beta cyfluthrin 18.75 g a.i. ha^{-1}.

The data further indicated that indoxacarb 75 g a.i. ha^{-1}, lambda cyhalothrin 25 g a.i. ha^{-1}, beta cyfluthrin 12.5 g a.i. ha^{-1}, methoxy phenoxide 300 g a.i. ha^{-1}, Btk 1000 g ha^{-1} and HaNPV 250 LE ha^{-1} were the promising treatments in that order in recording better grain yield. These results fall in the line with the earlier observations where in significantly greater grain yield was recorded due to treatments with lambda cyhalothrin 25 g a.i. ha^{-1} (Anonymous, 2000). Similarly Ambulkar (2000) reported maximum grain yield in chickpea due to foliar spraying of beta cyfluthrin 18.75 g a.i. ha^{-1}.

The data on economic ranking of various treatments revealed that the treatment of chickpea crop with beta cyfluthrin 12.5 g a.i. ha^{-1} emerged as the most economic one, registering highest ICBR of 1 : 14.29 followed closely by endosulfan 350 g a.i. ha^{-1}, azadirachtin 1500 ppm @ 3 ml lit^{-1}, lambda cyhalothrin 25 g a.i. ha^{-1}, karanj seed extract 5 per cent and Neem seed extract 5 per cent with the ICBR of 1 : 13.69, 1 : 13.07, 1 : 12.59, 1 : 11.77 and 1 : 11.61, respectively. The above results were found in conformity with the results of Ambulkar (2000) who reported that beta cyfluthrin 18.75 g a.i. ha^{-1} was the most economic treatment recording the ICBR of 1 : 15.70.

Thus the present findings would help in replacing the existing hazardous chemicals with bio-eco-friendly and economically feasible insecticides and would also help in developing IPM strategy for the effective management of *Helicoverpa armigera* (Hubner), pod borer in chickpea.

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Seed Borne Nature of *Colletotrichum dematium* var. *truncatum* in Soybean

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ABSTRACT

Studies were conducted to find out seed borne nature of *Colletotrichum dematium* var. *truncatum* in soybean. Presence of *C. dematium* var. *truncatum* was detected in seed coat, cotyledons and plumule redical axis by employing component plating technique. In seedling symptoms test, when infected seeds were sown, seed rot and characteristics symptoms on cotyledons were observed indicating the role of seed borne inculum. Out of five fungicides tested in vitro, dithane M-45 (0.3%), thiram (0.3%), carbendazim (0.1%) and combination of thiram + carbendazium (1:1) were found effective.

Many fungi are reported to be seed borne in soybean (Sinclair, 1992). *Colletotrichum dematium* var. *truncatum* (Schw). Arx. is one of the seed borne fungi (Neergaard, 1977, Khare and Chacko, 1983) which causes pod blight of soybean. The seeds infected with the fungus showed characteristic discoloration which were distorted, shrivelled, mouldy and smaller than the normal seeds (Nicholson and Sinclair, 1973).

MATERIAL AND METHODS

Ten seed samples from infected plant of soybean were obtained from different locations of Vidarbha region during Kharif, 1999. For detection of fungus on seed, standard blotter method was employed (ISTA, 1986). Two hundred seeds from each sample were surface disinfected separately for 3 minutes with 0.1% $HgCL_2$ and washed in three changes of sterilized distilled water. The seeds were plated on three layers of moist blotters and incubated under alternate cycle of 12 hour light and 12 hour darkness at 27± 2°C temperature. The fungal colonies appeared on the seed were observed under stereobinocular microscope. On 8th day, the percentage infection of the seed by *C. dematium* var. *truncatum* (based on number of seed showing infection) was calculated. Seed samples with high level of infection were selected for further studies.

Component plating technique was used for location of the fungus in soybean seeds. Individual seed from three seed samples namely 14,35 and 41 carrying high level of infection were soaked in sterilized water for 4 hours and then dissected into its components, seed coat, cotyledons and plumule radical axis and suruface disifected. Components were plated on PDA medium in petriplate at equidistance. The fungal incidence was calculated on the basis of individual seed on hundred seeds.

Seed to plant transmission studies were carried out by employing 1) Test tube agar method and 2) Sterilized soil method. For test tube agar method, 1per cent water agar was poured up to 1/3 height of presterilized rimless (2.5 cm. dia.) test tube. Hundred seeds were used and one seed was sown in each test tube. To retain moisture, they were covered individually by plastic sheet which was removed when the seedling reached the cover. The seeds and growing seedling were observed for the typical symptoms. Isolation was made from infected tissues to find out the pathogen involved.

For sterilized soil method, presterilized uniform soil was filled in 2.5 cm diameter rimless sterilized test tube up to 1/3 height of tube and moistened with sterilized distilled water.

Efficacy of fungicides was assessed in vitro by food poison technique. PDA was used as base medium, which was poisoned with requisite quantity of fungicides to get test concentration. The plain PDA served as control. Treated plates were incubated at 27 ± 2°C temperature for 7 days. After incubation, per cent inhibition of mycelium was calculated.

RESULTS AND DISCUSSION

On incubated seed, the fungus produced circular, erumpant, dark brown to black acervuli in blotter paper method. These acervuli scattered throughout the seed surface containing dull yellow to white conidial mass.

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Table 1 : Percentage of seed showing association of *C. dematium* var. *truncatum* with samples of different soybean seed.

S. N.	Sample No.	Per cent incidence of *C. dematium* var. *truncatum*
1	3	6.0
2	9	2.0
3	14	9.0
4	15	6.0
5	17	3.0
6	20	6.0
7	33	2.0
8	35	7.0
9	40	7.0
1	41	29.0

Results presented in Table – 1 showed that seeds collected from infected plants carried different levels of infection. Among the 10 samples tested, sample number 41, 14, 35 and 40 carried high level of infection.

From the data of component plating (Table 2), it was evident that most of the infection was located in seed coat (20%), followed by cotyledons (4.0%) and plumule radical axis (1.0%) in highly infected seed sample. However, cotyledons and plumule radical axis were found to be free from the infection in 14 and 35. These results conformed the findings of Neergaard (1977), Rodrigue and Sinclair (1978), Siddiqui (1983), Khare and Chacko (1983).

Embryonic infection of the fungus was observed one per cent only in the present study. However, France Neto and West (1989) have reported the embryonic infection in highly infected seed lot.

Table 2 : Per cent incidence of *C. dematium* var. *truncatum* located in various components of seed.

Sample No.	No. of seed tested	Initial seed borne incidence per cent	Per cent Fungal incidence		
			Seed coat	Cotyledon	Plumule radical axis
14	100	9.0	4.0	0.0	0.0
35	100	7.00	2.0	0.0	0.0
41	100	29.00	20.0	4.0	1.0

Table 3 : Seed to plant transmission of *C. dematium* var. *truncatum*.

S. N.	Seedling symptoms test method	No. of seeds tested	Per cent emergence	Per cent seed rot	Per cent seedling showing symptoms on cotyledon
1	Test tube agar	100	60	40	8.33
2	Stertilized soil	40	65	35	7.69

Table 4 : Efficacy of fungicides by food poison technique.

S. N.	Fungicides	Fungicides concentration (%)	Mean radial diameter (mm)	Per cent inhibition
1.	Carbendazim	0.1	5.6	86.40
2.	Dithane M-45	0.3	5.0	87.89
3.	Chlorothalonil	0.3	11.0	73.36
4.	Copper oxychloride	0.3	24.92	41.59
5.	Thiram	0.3	5.0	87.89
6.	Thiram + Carbendazim (1:1)	0.15 + 0.15	5.0	87.89
7.	Control	–	41.3	00.00
	SE(m)±		0.29	
	CD at 1%		1.16	
	CV%		4.19	

Transmission of the fungus from seed to plant (Table-3) indicates that 8.33 and 7.69 per cent seedlings showed characteristics symptom on cotyledons (dark brown, sunken, cankerous necrotic lesion) within 15 days after sowing in test tube agar and sterilized soil method, respectively. Seed rot due to fungus was 35-40 per cent in both the methods. These results correlate the findings of Neergaard (1977), Sinclair (1992), Khare and Chacko (1983), Siddiqui (1983) as they reported pathogen is of seed borne nature.

The results presented in Table 4 indicate that dithane M-45 (0.3%), carbendazim (0.1%) and combination of thiram + carbendazim (1:1) had shown minimum radial mycelial growth and the maximum 86.4 to 87.89 per cent inhibition, followed by carbendazim (5.6mm) and chlorothalonil (11.0mm). Copper oxychloride exhibits least inhibition (41.59%) of mycelium. The present result conformed the earlier finding of Khare and Chacko (1983), Sharma and Sugha (1995) and Ghawde *et al.* (1996).

From the above experiments, it can be concluded that the fungus *C. dematium* var. *truncatum* is seed borne in nature, responsible for seed rot and was found transmissible from seed to plant. Among fungicides, dithane M-45 (0.3%), thiram (0.3%), carbendazim (0.1%) and combination of thiram + carbendazim (1:1) were found effective.

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Effect of Plant Growth Regulators on Yield and Quality of Okra Seed

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ABSTRACT

An experiment was conducted at University Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to study the influence of plant growth regulators on growth and seed yield of okra. The treatments were comprised of three growth regulators viz., cycocel @ 250, 500, 750 and 1000 ppm; ethrel @ 100, 200, 400 and 800 ppm and maleic hydrazide @ 250, 500 and 750 ppm. The results indicated that, the length of fruit and test weight of seed were maximum with the application of 200 ppm ethrel. The weight of seeds fruit^{-1}, seed yield hectare^{-1} and graded seed yield were maximum with the treatment of 500 ppm cycocel. However, the diameter of fruit and germination percentage of seeds was maximum due to an application of 1000 ppm cycocel.

Okra (*Abelmoschus esculentus* L.) is one of the most common and important vegetable cultivated in India for its tender fruits during summer and rainy seasons. The scientific seed production resembles an importance of quality seed to be used for raising of crop in order to get good and higher production of quality vegetables. The seed production of okra is of great importance and a number of plant growth regulators have been used for increasing the production and quality of okra seed. However, the retardants use for okra seed production seems to be on very small scale. However, it is necessary to find out the effect of growth retardants on yield and quality of okra seed.

MATERIAL AND METHODS

The experiment was conducted at University Department of Horticulture, Dr. PDKV, Akola during *kharif* season of the year 2003 – 04 in medium black soil. The tretatment comprised of three growth regulators viz., cycocel @ 250, 500, 750 and 1000 ppm; ethrel @ 100, 200, 400 and 800 ppm and maleic hydrazide @ 250, 500 and 750 ppm. The experiment was conducted in randomized block design and replicated thrice. All these growth regulators were sprayed on okra plants at 30 days after sowing. Seeds of okra variety '*Akola Bahar*' were sown at a plant spacing of 45 x45 cm. Graded seed yield was calculated by using the sieve screen of size 4.6 mm R and graded seed yield was weighed.

The observations were recorded on length and diameter of the fruits, number of fruits plant^{-1}, number of seeds fruit^{-1}, weight of seeds fruit^{-1}, seed yield plant^{-1}, seed yield hectare^{-1}, test weight, graded seed yield and germination percentage of seed.

RESULTS AND DISCUSSION

All the characters under study were significantly influenced by the plant growth regulators except number of seeds fruit^{-1} of okra (Table 1). An application of ethrel 200 ppm produced the longest fruit of okra (18.27 cm) and being the shortest fruit (16.20 cm) was harvested from the treatment of ethrel 100 ppm. Fruit with significantly maximum diameter (2.67 cm) was noted due to an application of 1000 ppm cycocel and it was found at par with 750 ppm cycocel (2.47 cm). While minimum being recorded in the treatment of 800 ppm ethrel (2.04 cm). The fruits plant^{-1} were significantly the maximum (8.56) with an application of 750 ppm cycocel. Significantly the maximum weight of seeds fruit^{-1} (3.79 g) was observed under the treatment receiving 500 ppm cycocel and being minimum (2.38 g) with the treatment of 800 ppm ethrel.

The seed yield plant^{-1} was increased significantly and the maximum seed yield was recorded with an application of 500 ppm cycocel (31.50 g) which was found to be at par with the treatment of 250 ppm cycocel (30.27 g) and it was minimum under the treatment of 800 ppm ethrel (18.57 g). Similarly, the treatment of 500 ppm cycocel

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Table 1: Effect of plant growth regulators on yield contributing characters, yield and quality of okra seed

Treatments	Length of fruit (cm)	Diameter of fruit (cm)	No. of fruits plant^{-1}	No. of seeds fruit^{-1}	Weight of seeds fruit^{-1} (g)	Seed yield plant^{-1} (g)	Seed yield hectare^{-1} (q)	Test weight (g)	Graded seed yield (%)	Germination percentage (%)
T - Cycocel 250 ppm	17.91	2.30	7.99	69.86	3.68	30.27	13.70	59.81	71.76	77.66 (8.81)
T^1 - Cycocel 500 ppm	17.68	2.36	8.04	67.13	3.79	31.50	14.25	60.53	71.87	76.00 (8.71)
T^2 - Cycocel 750ppm	17.63	2.47	8.56	62.46	3.51	28.20	12.76	58.26	71.46	76.33 (8.73)
T^3 - Cycocel 1000ppm	17.49	2.67	8.05	63.43	3.28	26.42	11.95	54.06	70.32	80.33 (8.96)
T^4 - Ethrel 100 ppm	16.20	2.19	5.75	57.70	2.99	21.92	9.91	48.98	56.95	71.33 (8.44)
T^5 - Ethrel 200 ppm	18.27	2.36	6.55	63.63	3.58	26.79	12.12	62.94	62.64	77.00 (8.77)
T^6 - Ethrel 400 ppm	16.60	2.33	6.19	60.06	2.81	21.16	9.57	50.23	58.86	62.66 (7.91)
T^7 - Ethrel 800 ppm	16.44	2.04	6.25	55.16	2.38	18.57	8.39	49.07	54.01	62.33 (7.89)
T^8 - Maleic hydrazide 250 ppm	16.40	2.27	7.24	65.70	3.18	24.94	11.28	54.34	64.88	73.66 (8.58)
T^9 - Maleic hydrazide 500 ppm	16.45	2.37	6.86	58.13	3.19	23.95	10.84	51.49	63.09	75.00 (8.65)
T^{10} - Maleic hydrazide 750 ppm	16.74	2.39	6.87	61.03	3.41	23.46	10.61	50.76	64.59	66.66 (8.16)
T^{11} - Control	16.57	2.14	5.55	63.03	3.29	22.60	10.56	56.20	68.02	77.33 (8.78)
^{12} 'F' test	Sig.	Sig.	Sig.	NS	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE (m)±	0.29	0.08	0.20	2.89	0.25	0.71	0.32	2.15	1.81	0.14
CD at 5%	0.82	0.25	0.57	—	0.72	2.00	0.92	6.05	5.08	0.39

Figures in parenthesis indicates square root transformation

produced significantly the highest seed yield hectare^{-1} (14.25 q ha^{-1}) and it was found to be at par with the treatment of 250 ppm cycocel (13.70 q ha^{-1}). However an application of 800 ppm ethrel gave significantly the lowest hectare^{-1} seed yield of okra (8.39 q ha^{-1}) . This might have resulted into variations in yield contributing characters such as seed yield fruit^{-1}, number of fruits plant^{-1} and seed yield plant^{-1}. Similar results were reported by Arora *et al.* (1990), Rathod and Patel (1996) and Sajjan *et. al.* (2003).

The quality characters like test weight, graded seed yield and germination percentage were significantly influenced by the plant growth regulators. The treatment of ethrel 200 ppm recorded significantly the maximum test weight of seeds (62.94 g) and minimum was recored with an application of 100 ppm ethrel (48.98 g). Vijaykumar *et al.* (1988) corroborates the same result. Significantly the highest percentage of graded seed yield (71.87%) was recorded under the treatment receiving 500 ppm cycocel and it was lowest (54.01%) with the treatment of 800 ppm ethrel. The treatment of 1000 ppm cycocel recorded significantly the highest germination percentage of seed (80.33%) and being the lowest (62.33%) was recorded with an application of 800 ppm ethrel.

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Effect of Soil Solarization on Growth and Weed Control in Kagzi Lime (*Citrus aurantifolia*) Seedling Nursery

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ABSTRACT

Field experiment was conducted during 1998-99 to investigate the influence of soil solarization and fungicides on weed control, disease control and performance of lemon seedlings at Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, under irrigated condition. Soil solarization during 15th April to 30th May (45 days) with transparent polyethylene film resulted in higher soil temperature during 20th to 26th May (55.6°C) in solarized soil as against 44.4°C in nonsolarised soil. Mulching increased the temperature by 10 -12°C in the upper soil layer. There was a significant reduction in weed count (47.81) and dry weight of seeds (11.38g)in soil solarization alone over control(77.08 and 18.52) at 30 DAS. Soil solarization + Ridomil 0.2 per cent treatment recorded significantly higher survival (92.5 %) percentage of seedlings and their height (28.46). Seedling recorded more height in all the treatments except control which recorded lowest height (16.13 cm).

Soil solarization is a non-hazardous and novel method for soil disinfection. It is also called as solar heating or polythene tarping. Soil solarization has been introduced by Katal (1981). In addition to reducing number of fungi, bacteria, nematodes, insects and weed seeds, soil solarization often results in increased plant growth response (Nanjappa *et.al.*,1998 and Chen & Katan, 1980).

Soil borne diseases are caused by soil pathogens resulting into heavy losses to the majority of agricultural crops. They may be controlled by chemical or physical soil treatments before planting. The most extensively used methods are soil fumigation with various chemicals and heat treatments by steam. These methods are expensive and their application in the field is complicated. Thus, the search for new, simple, inexpensive and non-hazardous methods for disease and pest control continues.

A new method for controlling soil borne pathogens and weeds by means of solar heating of the soil was developed in Israel (Katan, 1981). Solar heating is achieved by mulching the soil during the hot season with TPE sheet, thereby increasing soil temperature and killing the pathogens. The temperature increased by TPE film mulching is primarily due to the greenhouse effect exerted by TPE film (Mahrer, 1979).

Efforts are made on in different parts of India to assess the effectiveness of solarization. However, there is limited information available on various aspects of soil solarization in Vidarbha region. Hence, this investigation was carried out to determine the influence of soil solarization and fungicides on weed control and performance of Kagzi lime seedling in medium light soil under irrigated condition.

MATERIAL AND METHODS

Field experiment was conducted durint 1998-99 to study the effect of soil solarization and fungicides on weed control and performance of *Kagzi* lime seedlings in medium light soil at Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola under irrigated condition. The experiment involved soil solarization for 45 days (15th April to 30th May) alone before seed sowing and use of four fungicides alone and in combination with soil solarization after seed sowing along with control. Thus, there were ten treatments laidout in Randomized Block Design with three replications.

Preparation of land by ploughing, harrowing and leveling was completed and raised beds of 2 m x 1 m x 15 cm were laid out as plan^{-1} creating small field bounds around each plot. The beds were irrigated for continuous three days before spreading polyethylene film of 100 micron thickness. The transparent clear polyethylene film of required size were spread on the respective beds depending on the treatments (Table 1) and were sealed to make it air tight by moist soil. Soil temperature was recorded using piercing type of mercury thermometer at 5 cm soil depth every day at 2.30 p.m. The seed sowing was carried out on 18th August 1998. Before seed sowing, all non-solarized beds were reprepared and treatments were given as shown in Table 1 after seed sowing. The following monocot and dicot weeds were observed.

Monocot weeds

Trianthema portulacastrum, Parthenium hysterophorus, Euphorbia hirta, Physalis minima, Xanthium strumarium.

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Table 1. Effect of polyethylene tarping on soil temperature at 5 cm depth at one week interval (Temperature recorded at 2.30 p.m. every day (Average of 7 days)

	Treatments	Days after solar tarping 15th April to 30th May, 1998						
		12-21	22-28	29-5	6-12	13-19	20-26	27-31
T1	Solarization 15th April to 30th May, 1998	45.5	45.7	49.6	48.5	50.8	55.6	54.5
T_2	Solarization + *Trichoderma* seed treatment (5 g kg^{-1} seed) and drenching 4 L in one month interval	45.5	46.2	48.3	49.9	51.5	55.6	54.9
T_3	Solarization + Ridomil 0.2 per cent drenching and spraying at one month interval	45.3	45.8	49.7	48.5	51.3	55.1	54.6
T_4	Solarization + Carbendazim (0.1 %) drenching and spraying at one month interval	45.6	45.9	48.8	50.1	51.3	55.3	54.6
T_5	Solarization + Diathane M-45 (50% WP) 2.5 g l^{-1} drenching and spraying at one month interval	45.5	46.1	47.7	49.0	51.6	54.0	54.7
T_6	*Trichoderma* seed treatment @ 4 g kg^{-1} seed and drenching 4 g l^{-1} at one month interval	41.6	41.9	43.6	43.2	44.2	44.4	43.2
T_7	Ridomil 0.2 per cent drenching and spraying at one month interval	41.9	41.8	43.5	43.2	44.3	44.2	43.1
T_8	Carbendazim 0.1 per cent drenching and spraying alternate one month interval	41.7	41.6	43.5	43.1	44.5	44.3	43.5
T_9	Diathane M-45 (50 % WP) 2.5 g l^{-1} drenching and spraying at one month interval	41.5	41.7	43.4	43.2	44.3	44.0	44.3
T_{10}	Control	41.2	41.8	43.9	43.9	44.5	44.4	43.1

Dicot weeds

Cynodon dactylon, Cyperus rotundus, Dinebra retraflexa, Brachiaria mutica, Commelina benghalensis.

Weed count and dry weight (g/m^2) were recorded at 30 DAS interval upto 120 days. Similarly, survival percentage of kagzi lime seedling and their height were recorded at 120 days after seed germination. Disease incidence percentage and rating of *Phytophthora parasitica* were done as per Mayee and Datar (1986).

Grade		Range
I	=	Up to 10 per cent mortality
II	=	11 to 20 per cent mortality
III	=	21 to 50 per cent mortality
IV	=	Above 50 per cent mortality

RESULTS AND DISCUSSION

Soil solarization during April and May months with TPE film mulching resulted in higher soil temperature (45.5°C to 55.6°C) at 5 cm soil depth (Table 1) and maximum temperature 55.6°C and 44.5°C were recorded during 20th to 26th May, 1998 in solarized soil and non-solarized soil, respectively. Higher temperature could be attributed to the ability of transparent polyethylene sheet to transmit the short wave length solar radiation into the polyethylene film and generating heat waves, thus raising soil temperature eventually. Higher soil temperature under TEP has been reported by Katan (1981) and Nanjappa *et. al.*, (1998)

Soil solarization with TPE done recorded less number of weed count (47.81 and 53.60 m^2) and reduced dry weight of weeds (11.38 and 12.38 g/m^2) at 30 DAS and 60 DAS, respectively and this trend continued upto 120 DAS. Maximum number of weed count and their dry weight were recorded under control treatment upto 60 DAS (77.08 to 80.91 and 18.52 to 18.55 g/m^2) (Table 2). This is attributed to direct killing of weed seeds by heat near the soil surface, the induction of germination of some more deeply buried seed, followed by killing of seedlings as they grew into the heated surface (Rubin and Benjamin, 1983).

Soil solarization + Ridomil 0.2 per cent treatment recorded highest number of plant germination (486.33) after 30 DAS. Also, it showed maximum number of plants (452.33) survived after 120 days from germination. It was also noticed that the same treatment (T_2) recorded higher survival percentage of kagzi lime seedlings (93.06%) which was closely followed by treatment Ridomil 0.2 per cent alone (T_7) recorded number of plants germinated after 30 DAS, number of plants survived 120 days after germination and survival per cent (478.33, 429.66 and 89.33% respectively). The above treatments also recorded higher plant height 28.46 and 26.23 cm, respectively and wee significantly superior over control which recorded 16.13 cm height. The increse in growth performance under soil solarization + Ridomil 0.2 per cent and Ridomil 0.2 per cent alone was due to reduced weed count and by fungicidal effect. These results are in consonance with the results of ABU-Irmailen (1991), Nanjappa *et. al.*, (1998) and Chen and Katan (1980).

As regards mortality percentage in kagzi lime seedlings, it was observed (Table 2) that the treatment of soil solarization + Ridomil 0.2 per cent recorded very less mortality of kagzi lime seedlings (7%) which is categorized in mortality grade I (1 to 10%). However, soil solarization + Trichoderma (12.04%) and Ridomil 0.2 per cent recorded moderate mortality (10.17%) which is categorized in mortality Grade II (10 to 20 %). This may be due to soil solerization and fungicidal effect on reduction in disease incidence. The control treatments recorded highest mortality (38.08%) percentage.

Hence, it is summarized that, for obtaining maximum survival percentage in kagzi lime seedlings, soil solarization along with fungicidal drenching and spraying like Ridomil, Carbendazim and diathane M-45 have shown major effects in reduction of soil borne disease like phytophthora and fusarium wilt.

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Effect of Organic Manures and Plant Spacing on Growth, Yield and Quality of Safed Musli (*Chlorophytum borivilianum*)

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ABSTRACT

The present investigation, 'Effect of oragnic manures and plant spacing on growth, yield and quality of *Safed* mulsi (*Chlorophytum borivilianum*)' was undertaken during the *Kharif* season of 2002-03 at Nagarjun Medicinal Plants Garden , Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was liad out in Factorial Randomized Block Design with three spacing (30 x 10, 30 x 15 and 30 x 20 cm^2) and five levels of organic manures 0 (control), 10 and 20 tonne FYM, and 2.5 and 5 tonne vermicompost ha^{-1}) replicated three times. The soil of the experimental was clayey in texture, low in organic carbon, nitrogen, phosphorus and rich in potash content. Growth parameters viz. number of leaves, length of leaves, leaf area, chlorophyll content and number of roots were higher due to 30 x 20 cm spacing. Yield contributory characters i.e. number of root $plant^{-1}$ was significantly higher in 30 x 20 cm, whereas, length of root and fresh root yield $plant^{-1}$ was not influenced by the plant spacing. *Safed* musli root yield (fresh and dry) was significantly higher in 30 x 10 cm spacing and also due to application of 20 tonnes FYM and 5 tonnes vermicompost ha^{-1}. Growth parameters viz. number of leaves, length of leaves, leaf area and number of roots were also significantly influenced due to these treatments.

The *Safed* musli (*Chlorophytum borivilianum*) has assumed great importance now a days, as it has good market value and potential and may become a hot cake among the medicinal plant. The white product fetches more price than the pale yellow or brownish material. It has large and consistent market demand in the country and the current projection of the annual demand is estimated to 500 to 800 tonnes (Bordia, 1992).

The research work carried out so far under All India Coordinated Reserch Project on Medicinal and Aromatic Plants is mainly confined to propagation techniques and work on the nutritional management of *Safed* musli is very meager. Due to its good market price and medicinal value, area under *Safed* musli is increasing day by day. The local farmers have queries about its package of practices particularly of agronomic practices and therefore, the present investigation was carried out to study the effect of organic manures and plant spacing on growth and yield of *Safed* musli. A study conducted at Udaipur on Safed musli, it is observed that the use of 10-15 tonnes of FYM ha^{-1} provided good nutrient status to the substratum for supporting healthy plant growth (Bordia *et. al.*, 1995).

Sharma (1996) reported that the application of 20 tonnes FYM ha^{-1} to *Safed* musi produced significantly higher fleshly root over 10 tonnes ha^{-1} and growth parameters like number of leaves, length of leaves, have increased many folds with almost 24 per cent increase in the yield.

MATERIAL AND METHODS

A field experiment to study "Effect of organic manures and plant spacing on growth and yield of *Safed* musli (*Chlorophytum borivilianum*)" was conducted at Nagarjun Meicinal Plants Garden, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Kharif* 2002-2003. The soil of the experimental site was slightly calcareous, alkaline and clayey in texture, sufficient in available K, however, low in organic carbon, available N and Olsen's P. treatments comprising of three spacing viz. 30 x 10, 30 x 15 and 30 x 20 cm^2 and five levels of organic manures supplied through FYM and vermicompost @ 0, 10, 20 tonnes FYM and 2.5, 5.0 tonnes vermicompost ha^{-1}, tried in FRBD with three replications. The growth observations as well as post harvest observations were recorded as per the treatments. The moisture content in the roots was deteimined by the standard procedure (AOAC, 1985). Saponin content in root was estimated by the procedure described by Birk, *et. al.*, (1963). Total nitrogen in root was estimated by Kjeldal's method (Piper 1966) and the nitrogen per cent was multiplied with the factor of 6.25 for obtaining protein content in per cent.

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RESULTS AND DISCUSSION

Effect of plant spacing :

The growth parameters viz. number of leaves length of leaves and leaf area plant^{-1} was higher under planting geometry of 30 x 20 cm^2 (Table 1). It indicated that wider spacing plants enjoyed the more light interception and more light interception which resulted in more number of leaves, length of leaves and higher leaf area. Very meager information is available on this aspect.

Spacing significantly influenced number of root plant^{-1}. Spacing provided at 30 x 20 cm^2 was found significant than other spacing. Whereas, length of root, girth of root and fresh root yield plant^{-1} was not influenced by the plant spacing. It indicates that planting at closer or wider spacing did not influence these parameters.

Yield of *Safed* musli (Fresh and Dry) was significantly higher under the planting pattern of 30 x 10 cm^2 than that of other spacing tried (Table 1). The closer spacing accomodates the higher number of plant unit^{-1} area and resulted in to higher fresh and dry weight of *Safed* musli. However, planting of *Safed* musli at various spacing under investigation did not reflect significantly on the saponin and protein content (%) of *Safed* musli roots (Table 2).

The yield potential of individual plant is achieved when sown in wider spacing. When sown densely, competition among plants is more for growth factors resulting in reduction in size and yield of the plant. Yield plant^{-1} decrease gradually as plant population unit^{-1} area is increased. However, the yield plant^{-1} area is increased due to efficient utilization of growth factors. Maximum yield unit^{-1} area can, therefore, be obtained when the individual plants are subjected to severe competition.

The above results are in conformity with those findings of AICRP on Medicinal and Aromatic Plants, Anand (Gujrat) and Udaipur (Rajasthan) Centres (Anonymous, 2003).

Effect of organic manures

Plant growth in terms of number of leaves, length of leaves and leaf area plant^{-1} was significantly higher under 5 t vermicompost at most of the growth stages of *Safed* musli (Table 1).

The growth attributes are mostly governed by the native fertility and supply of adequate nutrient to the plants during its growth period. Vermicompost is source of readily available nutrients (major and minor) required for plant growth.

Above findings are in conformity with those of Sharma (1996), Anonymous (1998, 2000).

Yield contributory characters viz. number of roots, length of roots, girth of roots and fresh root yield plant^{-1} was significantly influenced by the application of 20 tonne FYM ha^{-1}.

The availability of nutrient requried for the Safed musli crop might be fulfilled with the application of 20 tonne FYM and due to slow mineralization the release of nutrient was also slow and that fulfill the demands of crop in later stages of crop growth.

The yield contributing characters were significantly influenced due to the FYM application (20 tonne ha^{-1}). The luxuriant root growth seems to be associated with the application of FYM. Findings are in close accordance with the result reported by Singh (1995), Sharma (1996) and Anonymous, (1998, 2000).

Yield of *Safed* musli (fresh and dry) was significantly influenced by the application of 20 t FYM ha^{-1}. The magnitude of per cent increase was 162 per cent and 155 per cent for fresh and dry root yield than that of other applications under the study (Table 1). Application of different organic manures did not influence the saponin and protein content of Safed musli. However, application of organic manure @ 20 tonne FYM ha^{-1} recorded significantly higher saponin yield, followed by application of vermicompost 5 tonne ha^{-1} but found at par with each other (Table 2). The higher application might have created a good pool of availability nutrient for the growth of plant in addition to improving soil physical conditions and water holding capacity which might have resulted in good crop growth and also root yield. These results are in agreement with the findings of Anonymous (1998, 2000) and Sharma (1996).

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Table 1. Growth and yield of Safed musli as influenced by spacing and organic manure

Treatments	Number of leaves	Length of leaves	Leaf area sq. cm.	Chlorophyll content (mg g^{-1} tissue)	Number of roots $plant^{-1}$	Length of root (cm)	Girth of root (cm)	Fresh root yield (g $plant^{-1}$) (g $plant^{-1}$)	Fresh root (q ha^{-1}) (q ha^{-1})	Dry root (q ha^{-1})
Planting Spacing (cm)										
S1 (30 x 10)	16.93	26.04	23.33	0.448	11.79	7.86	0.67	16.87	39.97	6.66
S2 (30 x 15)	18.13	26.65	23.85	0.430	12.98	7.78	0.64	18.58	28.65	4.94
S3 (30 x 20)	18.20	26.93	24.55	0.442	12.75	7.80	0.68	18.59	21.99	3.75
SE (m)±	0.51	0.61	0.26	0.007	0.30	0.15	0.02	0.73	1.30	0.20
CD at 5%	-	-	0.76	0	0.87	0	0	0	3.77	0.59
Organic manures (t ha^{-1})										
Control	12.22	15.87	20.70	0.384	6.41	7.07	0.60	8.87	15.53	2.65
10 t FYM	18.33	27.97	24.24	0.432	10.25	7.56	0.67	14.72	26.03	4.39
20 t FYM	20.11	30.26	25.37	0.441	16.90	8.34	0.71	23.35	40.69	6.77
2.5 t VC	17.77	27.28	22.91	0.465	12.91	8.08	0.63	20.31	29.06	5.28
5.0 t VC	20.33	29.13	26.33	0.478	16.07	8.02	0.71	22.81	39.69	6.49
SE (m)±	0.66	0.78	0.33	0.010	0.39	0.20	0.63	0.94	1.68	0.26
CD at 5%	1.93	2.28	0.98	0.029	1.13	0.59	-	2.73	4.87	0.76
Interaction (Spacing x Organic manures)										
SE (m)±	1.15	1.36	0.58	1.017	0.67	0.35	0.05	1.63	2.91	0.45
CE at 5%	-	-	-	-	-	-	-	-	-	-

Table 2. Quality of Safed musli roots as influenced by plant spacing and organic manures

Treatments	Moisture (%)	Saponin (%)	Saponin (kg ha^{-1})	Protein (%)	Protein (kg ha^{-1})
Planting Spacing (cm)					
S1 (30 x 10)	82.14	6.08	41.07	5.58	57.51
S2 (30 x 15)	82.29	6.13	30.49	8.58	42.94
S3 (30 x 20)	82.05	6.02	22.80	8.60	32.49
SE (m) ±	0.31	0.24	2.21	0.18	2.23
CD at 5%	-	-	6.42	-	6.48
Organic manures (t ha^{-1})					
Control	84.01	5.94	15.70	8.33	22.15
10 t FYM	82.21	6.08	27.13	8.62	38.00
20 t FYM	81.48	6.15	42.37	8.74	59.46
2.5 t VC	81.41	6.03	32.13	8.56	45.34
5.0 t VC	81.70	6.16	39.94	8.7	56.62
SE (m) ±	0.40	0.32	2.86	0.24	2.88
CD at 5%	1.18	-	8.29	-	8.36
Interaction (Spacing x Organic manures)					
SE (m) ±	0.70	0.55	4.96	0.41	5.00
CE at 5%	-	-	-	-	-

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Influence of Integrated Weed Management on Growth and Yield of Cabbage

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ABSTRACT

A field experiment on integrated weed management in cabbage was laid out with five herbicides alone and in combination with one hand weeding at 30 DAT to study the performance of the various herbicides on growth and yield of the cabbage crop. The experiment was conducted at the Main Garden, University Department of Horticulture, Dr. PDKV, Akola with three replications. Pre-plant and Pre-emergence application of Oxyfluorfen @ 0.2 kg ha^{-1} in combination with one hand weeding at 30 DAT proved, significantly the most effective in controlling annual weeds followed by the treatment of Oxyfluorfen @ 0.2 kg ha^{-1}. While, an application of Isoproturon @ 1 kg ha^{-1} showed phytotoxic effect on cabbage crop. In unweeded control plots, the yield of cabbage heads was significantly reduced.

Cabbage (*Brassica oleracea* var. *capitata*) is the most important sole crop grown in the country. India ranks third in production of cabbage in the world. Cabbage is a good source of vitamin A and C and minerals like iron, copper, potassium and sulphur. Annual and perennial weeds reduce the yield and quality of the cabbage heads. The yield losses varies from 10 to 90 per cent (Van Der Zweep, 1995). Considering the acute problem of weed management and non-availability of labours in time at economic rate, the present investigation was undertaken to study the effect of herbicides alone and in continuation with hand weeding practice.

MATERIAL AND METHODS

A field experiment was conducted during *Rabi* season of the year 2002-2003 at University Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The soil of the experimental plot was clay loam in texture. The experiment was laid out in randomized block design with three replications and twelve treatments. The treatments comprised of Fluchloralin @ 1.0 kg ha^{-1} (T_1-Fluchoralin), Alachlor @ 2.0 kg ha^{-1} (T_2-Alachlor), Pendimethalin @ 1.0 kg ha^{-1} (T_3-Pendimethalin), Oxyfluorfen 0.2 kg ha^{-1} (T_4-Oxyfluorfen), Isoproturon @ 1.0 kg ha^{-1} (T_5-Isoprpturon), Fluchloralin @ 1.0 kg ha^{-1} + 1 HW (T_6-Fluchloralin+1 HW), Alachlor @ 2.0 kg ha^{-1} + 1 HW (T_7-Alachlor + 1 HW), Pendimethalin @ 1.0 kg ha^{-1} + 1 HW (T_8-Pendimethalin + 1 HW), Oxyfluorfen @ 0.2 kg ha^{-1} + 1 HW, (T_9 -Oxyfluorfen @ 0.2 kg ha^{-1} + 1 HW), Isoproturon 1.0 kg ha^{-1} + 1 HW (T_{10}-Isoproturon 1.0 kg ha^{-1} + 1 HW) Hand weeding at 20 and 40 DAT (T_{11}-Two HW) and Unweeded control (T_{12}-Control). Before transplanting of cabbage, all the herbicides were applied as a pre-emergence of weed. The forty days old seedlings of cabbage variety Pride of India were transplanted on 3rd December, 2002. The plants were spaced at 60 x 45 cm in ridges and furrow beds. The crop was fertilized @ 75 kg N and 50 kg P_2O_5 ha^{-1}. Half dose of nitrogen in the form of urea and full dose of phosphorous in the form of Single Super Phosphate were applied at the time of transplanting. Remaining half dose of N was applied 30 days later of transplanting.

The observations were recorded on crop stand, plant height, number of leaves, days required for head initiation, days required for harvesting, diameter of head, height of head, dry weight and yield of cabbage.

RESULTS AND DISCUSSION

The data from Table 1 revealed that, the crop stand at 10 DAT and at harvesting were maximum under the treatment of Alachlor @ 2.0 kg ha^{-1} (98.01 and 97.81%, respectively). Whereas, minimum crop stand at 10 DAT was observed under the treatment of Isoproturon 1.0 kg ha^{-1} + 1 HW (76.03 %). Similarly, at the time of harvesting, minimum crop stand (75.86 %) was recorded under the treatment of Isoproturon receiving @ 1.0 kg ha^{-1}. Significantly the tallest plant (26.32 cm) was produced under the treatment of Oxyfluorfen @ 0.2 kg ha^{-1} + 1 HW. Whereas, significantly shortest plant (15.91 cm) was noticed under the treatment of Isoproturon @ 1.0 kg ha^{-1}.

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Table 1. Growth and yield of cabbage as influenced by different herbicidal treatments

S.N.	Treatments	Crop stand		Height of plant (cm)	Num ber of leaves plant^{-1}	Days required for head initiation		Days required for harvesting		Diameter of head (cm)		Height of average head (cm)	Yield of cabbage heads q ha^{-1}
		At 10 DAT (%)	At harvest (%)			1st head initiation	50% head initiation	1st harvesting	Complate harvesting	E/W	N/W		
1.	T_1-Fluchloralin	95.84 (9.79)	93.70 (9.68)	19.68	42.00	42.00	49.00	55	72	14.40	14.50	16.26	186.09
2.	T_2-Alachlor	98.01 (9.90)	97.81 (9.89)	23.14	36.00	36.00	41.33	48	66	15.70	15.43	16.40	129.75
3.	T_3-Pendimethalin	93.70 (9.68)	93.12 (9.65)	18.18	46.00	46.00	53.00	59	76	13.70	13.80	15.50	167.62
4	T_4 - Oxyfluorfen	93.70 (9.68)	96.23 (9.81)	25.04	31.00	31.00	37.66	44	62	16.20	15.76	17.23	301.47
5	T_5 - Isoproturon	79.56 (8.92)	75.86 (8.71)	15.91	52.00	52.00	61.00	65	82	12.63	12.90	13.40	122.63
6	T_6-Fluchloralin + 1 HW	97.81 (9.89)	95.84 (9.79)	21.27	40.66	40.66	45.33	53	70	14.50	14.66	16.30	203.43
7	T_7–Alachlor + 1 HW	90.06 (9.49)	90.06 (9.49)	24.13	34.33	34.33	39.33	46	64	16.03	15.60	17.20	251.00
8	T_8–Pendimethalin + 1 HW	92.54 (9.72)	94.47 (9.62)	18.35	44.00	44.00	51.00	57	74	14.36	14.40	16.16	177.69
9	T_9 – Oxyfluorfen + 1 HW	96.43 (9.82)	92.35 (9.61)	26.32	28.00	28.00	35.66	42	60	16.50	16.26	17.33	344.04
10	T_{10}–Isoproturon + 1 HW	76.03 (8.72)	78.85 (8.88)	16.19	50.00	50.00	56.33	63	80	13.43	13.43	14.10	126.73
11	T_{11} – Two HW	97.81 (9.89)	97.81 (9.89)	22.32	38.00	38.00	43.33	50	68	14.80	15.39	16.36	211.59
12	T_{12} – Control	97.41 (9.87)	97.02 (9.85)	16.19	48.00	48.00	54.66	61	78	9.50	9.33	10.33	131.79
	'F' Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
	SE (m) ±	0.17	0.12	0.96	1.09	2.19	1.51	2.62	3.16	0.72	0.65	0.51	11.48
	CD at 5 %	0.48	0.35	2.71	3.06	6.15	4.24	7.37	8.89	2.02	1.83	1.51	32.26

Figures in parentheses indicates square root transformation

This might be due to the reason that, the crop faced minimum crop weed competition and due to this, it would have resulted into the maximum height of plant. Significantly the maximum leaves plant^{-1} (52.00) were recorded in the treatment of Isoproturon @ 1.00 kg ha^{-1}. And, it was minimum (28.00) in the treatment of Oxyfluorfen + 1 HW. Significantly early head initiation i.e. first head and 50 per cent heads initiation was observed in the treatment of Oxyfluorfen @ 0.2 kg ha^{-1} + 1 HW (28.00 and 35.66 days, respectively). The treatment took significantly the maximum period for first and 50 per cent heads initiation (52.00 and 61.00 days, respectively).

An application of Isoproturon @ 1.0 kg ha^{-1} required significantly the maximum period for first and complete harvesting (65 and 82 days, respectively). Whereas, the treatment of Oxyfluorfen @ 0.2 kg ha^{-1} + 1 HW took significantly minimum period for first and complete harvesting (42 days and 60 days, respectively).

Significantly the maximum East-West diameter was observed under the treatment receiving Oxyfluorfen @ 0.2 kg ha^{-1} + 1 HW (16.50 cm). While, significantly minimum East-West diameter of head was recorded in the control treatment (9.50 cm). Similarly, North-South diameter of head was influenced significantly and the maximum North-South diameter of cabbage head was recorded under the treatment of Oxyfluorfen @ 0.2 kg ha^{-1} + 1 HW (16.26 cm). And it was significantly minimum in the unweeded control treatment (9.33 cm).

Significantly, the maximum height of cabbage head (17.33 cm) was recorded in the treatment of Oxyfluorfen @ 0.2 kg ha^{-1} + 1 HW. However, it was significantly minimum in the control treatment (10.33 cm).

The yield of cabbage was significantly influenced by the different herbicidal treatments. The treatment of Oxyfluorfen @ 0.2 kg ha^{-1} + 1 HW produced significantly the highest yield of cabbage heads (344.04 q ha^{-1}). Whereas, significantly minimum yield of cabbage heads was obtained from the treatment of Isoproturon @ 1.0 kg ha^{-1} (122.63 q ha^{-1}).Similar results by using the same herbicides in cabbage crop was reported by the earlier workers like Bhowmik and McGlew (1986), Grabowski and Hopen (1984) and Semidey (1999).

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Microbial Population in Rhizosphere As Affected By Organics, Inorganics and Bio-fertilizers and their Influence on Soil and Leaf Nutrient Status of Sweet Orange (*Citrus sinensis* Osbeck)

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ABSTRACT

Studies were undertaken to evaluate the impact of application of organic manures, inorganic and bio-fertilizers on soil microbial population, macronutrient availability in soil and their uptake by sweet orange plants grown on Vertisol. Considerable improvement in microbial counts was observed with the application of different organic manures either alone or in combination with inorganic fertilizers. Soil bacterization with *Azotobacter* and Phosphate Solubilizing Bacteria (PSB) increased their abundance in sweet orange orchard soil and multiply well especially in presence of organic manures. It increases N and P availability in soil and their uptake by plants and can substitute N and P application at least by 25 per cent of the requirement either through inorganic fertilizers of organic manures.

In recent years, sweet orange (*Citrus sinensis* Osbeck) cultivation in 'Vidarbha' region has increased to a greater extent. It is nutrient responsive crop and large input of N and P is usually needed to maintain high citrus production. To supplement these doses, use of inorganic fertilizers or organic manures is very expensive. In order to bring about economy in these inputs, the use of bio-fertilizers was considered. The beneficial role of micro-organisms in maintaining and building up soil fertility is well established in field crops. But very few studies have been done on its role in fruit crops, especially citrus, and there is enough scope to established the bio-fertilizers like *Azotobacter* and phosphorus solubilizing bacteria (PSB) in citrus soils. Hence, the present investigation was undertaken to study the effect of bio-fertilizers in combination with organic manures and inorganic fertilizers and their effect on microbial biomass, soil fertility and leaf nutrient content in sweet orange.

MATERIAL AND METHODS

The field experiment was conducted during 2002-2004 in 9 year old sweet orange cv. Mosambi orchard at Regional Fruit Research Station, Katol, Nagpur. The soil of the experimental field was very deep (> 150 cm) and clayey throughout the soil depth. Some important characteristics of the soil were as follows : pH 7.84, EC 0.30 dS m^{-1}, organic carbon 0.70 per cent, CEC 46.5 cmol(p^+) kg^{-1}, available N, P_2O_5 and K_2O were 199.2, 19.1 and 508.4 kg ha^{-1}, respectively. A total of 13 treatments having 2-tree unit replicated three times were executed in randomised block design. Different treatments involved application of FYM, vermicompost, wheat straw and green manuring with sunhemp, as singly and in combination with inorganic fertilizers and bio-fertilizers like *Azotobacter* and Phosphate Solubilizing Bacteria (PSB). The dose of organic manures was applied on nitrogen equivalent basis. The average total N content on oven dry basis in different organic manures used was 0.88, 1.56, 0.44 and 1.86 per cent in FYM, vermicompost, wheat straw and sunhemp, respectively, with corresponding values of total P as 0.04, 0.32, 0.16 and 0.38 per cent and total K as 0.76, 0.75, 1.04 and 1.13 per cent. Soil samples were collected after two years, processed and analysed for soil macronutrients using standard methods (Black, 1965). The composite soil samples after two years of study were used for estimating microbial population by serial dilution method using specific media (Pramer and Schmidt, 1964). Leaf samples were collected after every six month, processed and analysed for major nutrients (Chapman and Pratt, 1961) and discussed on pooled average basis.

RESULTS AND DISCUSSION

Microbial population

Among the microbes, bacterial population was highest as compared to fungi and actinomycetes. Highest bacterial counts (59 x 10^6 cfu g^{-1}) were recorded with the sole application of FYM (to supply 100% N) followed by green manuring with sunhemp + 50 per cent RDF (48 x

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10^6 cfu g^{-1}) and wheat straw (to supply 50% N) + 50 per cent RDF (46 x 10^6 cfu g^{-1}). Tiwari *et al.* (2001) reported increase in microbial biomass due to green manuring in conjunction with varying levels of N. The green manure serves as an excellent substrate for soil microbes in increasing their population.

The data on fungal population showed large variation and was highest (26 x 10^5 cfu g^{-1}) with the application of wheat straw (to supply 50% N) + 50 per cent RDF followed by FYM (to supply 100% N) and green manuring with sunhemp + 50 per cent RDF. Higher amount of decayed food material available from wheat straw and FYM was beneficial for fungal colonies to multiply. Surya *et al.* (2000) reported substantial increase in fungal population with the application of wheat straw. Application of inorganic fertilizers (T_1 and T_{10}) also produces an improvement in fungal population over control. Such an increase was not purely due to nutrient response but more because of microbial oxidation of ammonium salts present in inorganic fertilizers which leads to formation of nitric acid and decreased soil pH, a predisposing condition for fungal proliferation, to take place (Alexander, 1985).

The variation in actinomycetes population was less pronounced compared to bacterial and fungi. Combined application of FYM (to supply 50% N) + 50 per cent RDF recorded highest population followed by green manuring with sunhemp + 50 per cent RDF and vermicompost (to supply 50%N) + 50 per cent RDF, while application of wheat straw was not much effective. Patil and Varade (1988) reported increased actinomycetes population with the combined application of 100 per cent NPK + FYM. It seems that although organic carbon is the major constituent of food supply for microbes, but inorganic nutrients are also beneficial for increased actinomycetes population.

The *Azotobacter* and PSB population varied from 5 to 30 x 10^2 cfu g^{-1} and 3 to 28 x 10^4 cfu g^{-1} soil, respectively. Highest population of *Azotobacter* and PSB was observed with the application of FYM (to supply 75% N) + *Azotobacter* + PSB followed by vermicompost (to supply 75% N) + *Azotobacter* + PSB. Treatments involving bacterization with *Azotobacter* and PSB increased their abundance in the soil. These observations supplemented the fact that inoculated *Azotobacter* and PSB multiplied well in the citrus orchard soil and their efficiency to multiply was comparatively very high in the presence of organic manures, due to greater availability of organic carbon and mineralized nutrients for their proliferation and further cellular developments.

In general, it observed that considerable increase in microbial count was observed with the application of

Table 1. Soil microbial population as affected by different treatments

	Treatments	Bacteria (x 10^6)	Fungi (x 10^5)	Actinomycetes (x 10^4)	*Azotobacter* (x 10^2)	PSB (x 10^4)
T_1	RDF	8	12	15	9	5
T_2	FYM (to supply 100% N)	59	24	26	20	16
T_3	Vermicompost (to supply 100% N)	40	18	22	18	10
T_4	FYM (to supply 50% N) + 50% RDF	41	19	34	18	12
T_5	Vermicompost (to supply 50% N) + 50% RDF	30	15	28	16	12
T_6	Green manuring with Sunhemp + 50% RDF	48	20	30	22	8
T_7	Wheat straw (to supply 50% N + 50% RDF	46	26	17	15	10
T_8	FYM (to supply 25% N)+50% RDF+Azoto. + PSB	32	18	21	22	15
T_9	Vermicompost (to supply 25% N)+ 50% RDF+Azoto. + PSB	25	13	20	18	12
T_{10}	75% RDF +*Azotobacter* + PSB	8	12	15	11	8
T_{11}	FYM (to supply 75% N)+ +Azoto. + PSB	44	20	22	30	28
T_{12}	Vermicompost (to supply 75% N)+ 50% RDF+Azoto. + PSB	40	18	22	25	21
T_{13}	Control	6	4	10	5	3

Table 2. Soil and leaf macronutrient content as affected by different treatments

Treatments	Soil macronutrients (kg ha^{-1})			Leaf macronutrients content (%)		
	Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	Potassium
T_1 RDF	245.0	28.2	523.4	2.07	0.096	1.15
T_2 FYM (to supply 100% N)	243.9	32.6	538.1	1.99	0.094	1.27
T_3 Vermicompost (to supply 100% N)	245.8	28.8	528.4	2.05	0.092	1.18
T_4 FYM (to supply 50% N)+50% RDF	263.5	34.0	545.5	2.19	0.111	1.38
T_5 Vermicompost (to supply 50% N) + 50% RDF	255.0	28.4	534.8	2.11	0.097	1.19
T_6 Green manuring with Sunhemp + 50% RDF	260.0	28.5	533.4	2.05	0.096	1.34
T_7 Wheat straw (to supply 50% N + 50% RDF	245.4	27.8	532.0	2.02	0.093	1.14
T_8 FYM (to supply 25% N)+50% RDF+Azoto. + PSB	250.2	30.1	538.5	2.05	0.096	1.19
T_9 Vermicompost (to supply 25% N)+ 50% RDF+Azoto. + PSB	235.5	27.6	520.0	1.98	0.098	1.20
T_{10} 75% RDF +*Azotobacter* + PSB	240.0	27.0	520.3	1.94	0.094	1.10
T_{11} FYM (to supply 75% N)+ +Azoto. + PSB	235.0	33.4	535.6	1.98	0.101	1.20
T_{12} Vermicompost (to supply 75% N)+ 50% RDF+Azoto. + PSB	230.0	28.7	522.0	1.98	0.100	1.11
T_{13} T_{13}- Control	190.2	18.5	490.2	1.83	0.089	0.99
CD at 5 %	12.3	4.1	15.5	0.13	0.005	0.09

different organic manures either alone or in combination with inorganic fertilizers. While, application of inorganic fertilizers exerted only a little response in increasing the microbial population. It might be due to fact that, the supply of nutrients in the soil exceeded the biological demand and whatever small increase was observed, it was on account of increased biomass or root growth.

Soil macronutrient content

The available soil macronutrients as N, P and K varied significantly among different treatments. Highest increase was recorded with the combined application of of FYM (to supply 50% N) + 50 per cent RDF. Incorporation of *Azotobacter* plays an important role in increasing N availability in soil. Various treatments where 75 per cent doze of nutrients was applied through inorganic fertilizer (T_{10}), FYM (T_{11}) and vermicompost (T_{12}) along with *Azotobacter* recorded slightly lower available N content compared to their corresponding treatments where 100 per cent doze of nutrients was applied through inorganic fertilizers (T_1), FYM (T_2) and vermicompost (T_3). Statistically these treatments were at par with each other. This showed that bacterization with *Azotobacter* proved to be beneficial and approximately compensate or save 25 per cent doze through organic or inorganic fertilizer. Nehra and Hooda (2002) reported that application of nitrogen at 120 kg $ha^{-1}$and 90 kg ha^{-1} + *Azotobacter* was statistically similar to that of recommended doze of NPK.

Similar observations were also observed with the incorporation of PSB to increase P availability. The role of PSB was more pronounced, when applied along with FYM. Higher available P content (33.4 kg ha^{-1}) was recorded in the treatment where 75 per cent dose of nutrients were supplied through FYM along with PSB than the treatment where 100 per cent dose of nutrients were supplied through FYM (32.6 kg ha^{-1}). This showed that phosphobacteria plays a key role in phosphate solubilization. Bhattacharyya (1999) showed that phosphate solubilizers in citrus growing soils of India have potential to solubilize insoluble phosphate equivalent to 30-50 kg P_2O_5 ha^{-1} through superphosphate.

Leaf macronutrient uptake

Leaf macronutrient as N, P and K content showed significant variation among different treatments. Highest content was recorded with the combined application of FYM (to supply 50% N) + 50 per cent RDF. Leaf N content in the treatments receiving only 75 per cent dose of nutrients through inorganic fertilizers (T_{10}), FYM (T_{11}) and vermicompost (T_{12}) along with *Azotobacter* were statistically at par with their corresponding treatments receiving 100 per cent dose of nutrients through inorganic fertilizers (T_1), FYM (T_2) and vermicompost (T_3). Similarly, leaf P content was significantly higher in the treatments T_{11} and T_{12} where only 75 per cent doze of nutrients was supplied through FYM and Vermicompost along with phosphobacteria (PSB) than those of corresponding treatments where 100 per cent doze of nutrients was supplied through FYM (T_2) and vermicompost (T_3). These observations suggest that with the inclusion of *Azotobacter* and PSB even at lower dose, there could be saving of fertilizer or organic manure to the extent of 25 per cent and the contribution of these biofertilizers was additive in presence of organics as FYM or vermicompost. These observations clearly signify the role of bio-fertilizers in enhancing the nutrient supply and uptake by fruit crops.

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Effect of Different Moisture Levels on Bulk Density and Nutrient Availability in Vertisol

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ABSTRACT

A pot culture experiment was conducted during summer to study the effect of different moisture levels on nutrient availability, bulk density and crop canopy, with and without sunflower crop. The experiment comprised two levels of bulk densities B_1 and B_2, and four moisture levels M_1-20, M_2-25, M_3-30 and M_4-35 per cent with two replications. Soil samples were drawn at different stages i.e. at 30, 60 and 90 days after sowing to study the nutrient availability in cropped and bare pots. Available nitrogen and potassium decreased with increasing moisture level. At 30 days interval nitrogen was found to be 186.97 kg ha^{-1} and available potassium was 388.89 kg ha^{-1}, at M_1 whereas available phosphorus increased with increasing level of moisture with increasing bulk density. The available phosphorus at 30 days after sowing at M_1 level was found to be 12.46 kg ha^{-1}. Similar trend was observed at each 60 and 90 days, respectively. Available nitrogen, phosphorus and potassium were higher under lower bulk density.

Vertisol is one of the important soil orders ranking 9th among ten orders of soil. A theoretical relation between thermal capacity and moisture content was derived and tested experimentally. The thermal capacity of moist soil was found to be a linear function of moisture content for sandy as well as black cotton soil. It is observed that specific heat of both soil exhibited a nearly relationship upto 15 per cent moisture content. For higher values of moisture content specific heat increase less rapidly incase of sandy soils and more rapidly in case of clayey soils with increasing moisture content.

Growth ratios under dry and wet condition suggested that high moisture reduced nitrogen absorption or nitrogen availability at low levels. Higher moisture percentage increased the availability of phosphorus and minimum fixation was found to 60 per cent moisture level (Vyas and Motiramani, 1971). Thus, movement of phosphorus was significant and it was upto 15 to 30 cm only under higher moisture levels (Suryanarayan Reddy and Shastry, 1983). Thus, moisture levels play an important role during the availability of nutrients per the enhanced crop growth. Further investigtion was observed that presence of amonia at different soil moisture level in the treated soil blocked the release of soil potassium (Kadrekar, 1970).

MATERIAL AND METHODS

The experiment was conducted at Research Farm, Marathwada Agricultural University, Parbhani. The experiment was laid by factorial randomised block design. Similarly four soil moisture levels maintained throughout the experimental period. The chemical analysis was carried out by standard procedures.

There were following sixteen treatment combinations, the details of which are shown as below

Treatment details

S.N.	Treatments	Bulk density (gcm^{-3})	Soil moisture level (per cent)	Weight basis ($cm3\ cm^{-3}$)
1.	$B_1M_1C_1$	1.2	20 per cent with crop	0.24
2.	$B_1M_2C_1$	1.2	25 per cent with crop	0.30
3.	$B_1M_3C_1$	1.2	30 per cent with crop	0.36
4.	$B_1M_4C_1$	1.2	35 per cent with crop	0.42
5.	$B_2M_1C_2$	1.2	20 per cent with out crop	0.24
6.	$B_2M_2C_2$	1.2	25 per cent with out crop	0.30
7.	$B_2M_3C_2$	1.2	30 per cent with out crop	0.36
8.	$B_2M_4C_2$	1.2	35 per cent with out crop	0.42

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9.	$B_1M_1C_1$	1.4	20 per cent with crop	0.28
10.	$B_1M_2C_1$	1.4	25 per cent with crop	0.37
11.	$B_1M_3C_1$	1.4	30 per cent with crop	0.42
12	$B_1M_4C_1$	1.4	35 per cent with crop	0.49
13.	$B_2M_1C_2$	1.4	20 per cent with crop	0.28
14.	$B_2M_2C_2$	1.4	25 per cent with crop	0.37
15.	$B_2M_3C_2$	1.4	30 per cent with crop	0.42
16.	$B_2M_4C_2$	1.4	35 per cent with crop	0.49

RESULTS AND DISCUSSION

Available Nitrogen :

The data summarised in (Table 1) was indicative of gradual and significant decrease in available nitrogen in soil with increased soil moisture levels. The results obtained at 30 days after sowing indicated that mean value of available nitrogen in soil was 177.98 kg ha^{-1}. It was further observed that as soil moisture decreased, there was gradual decrease in available nitrogen in the soil from 186.97 to 168.03 kg ha^{-1} in treatment M_1 and M_4, respectively. The highest available nitrogen (236.57 kg ha^{-1}) was found in treatment $B_1M_1C_1$. Further, the effect of bulk density indicated that as the bulk density increased from 1.2 to 1.4 g cm^{-3} there was significant decrease in available nitrogen from 186.13 to 139.15 in treatment B_1 and B_2 respectively. Lowest available nitrogen (134.00 kg ha^{-1}) was recorded in treatment $B_2M_4C_1$ where bulk density 1.4 g cm^{-3} and 35 per cent moisture in cropped plot. Thus, interaction effect of bulk density, moisture level and crop canopy was found to be non-significant. The results 60 days after sowing indicated that available nitrogen content was higher in treatment $B_1M_1C_2$ (225.06 kg ha^{-1}) and that at 90 days after sowing indicated that available nitrogen content was highest in treatment $B_2M_1C_2$ (221.57 kg ha^{-1}). Whereas it was lowest in $B_1M_4C_1$ i.e. (120.91 kg ha^{-1}). Similar results were developed by Sawant *et. al.*, (1981) and Mourya and Lal (1981).

Available phosphorus

The data predicted in (Table 2) to phosphorus availability in soil as affected by different moisture levels. The results observed at 30 days after sowing indicated that mean value of available phosphorus in soil was 16.63 kg ha^{-1}. It was also observed that as the moisture level in soil increased there was gradual increase in available phosphorus in the soil from 12.46 to 21.83 kg ha^{-1} in treatment M_1 and M_4, respectively. When moisture content increased from 20 to 35 per cent, there was significant increase in available phosphorus from 14.96 to 17.46 kg ha^{-1}, respectively. The highest available phosphorus (24.19 kg ha^{-1}) was found in treatment $B_1M_4C_2$ and lowest available phosphorus (9.56 kg ha^{-1}) was observed in treatment $B_1M_1C_1$. Interaction effects of moisture levels with crop canopy and bulk density indicated significant difference.

The beneficial effect of $B_1M_4C_2$ treatment in bare plots maintained higher level of available phosphorus in soil (17.91 and 14.78 kg ha^{-1}) at 60 and 90 days after sowing, respectively. Similar results were observed by Vyas and Motiramani (1971). Increase in moisture level enhanced the availability and movement of phosphorus.

Available potassium

The data presented (Table 3) indicated that results observed at 30 days after sowing indicated that the mean value of available potassium in soil was 283.30 kg ha^{-1}. It was found that as moisture level increased there was significant decrease in available potassium in the soil from 388.89 to 210.85 kg ha^{-1} due to treatments M_1 and M_4, respectively. Further the effect of bulk density indicated that in case of bulk density B_1 there was lower (261.19 kg ha^{-1}) available potassium in soil as compared to (305.53 kg ha^{-1}) available potassium in B_2. The highest available potassium was observed in treatment $B_2M_1C_2$ (512.22 kg ha^{-1}) while lowest potassium available was observed at 30 days interval in treatment $B_1M_4C_1$. Similar results were observed at both stages i.e. 60 days and 90 days after sowing. In these both cases highest available potassium was 504 kg ha^{-1} and 323.60 kg ha^{-1}, respectively. Similar results were observed by Sawant *et. al.*, (1981) and Mundafale (1968).

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Table 1. Effect of soil moisture levels on available nutrient content (Nitrogen kg ha^{-1}) in soil

Moisture level	B1		B2		Mean
	C_1	C_2	C_1	C_2	
30 days after sowing					
M_1	151.33	236.57	141.00	219.06	186.97
M_2	148.00	225.44	137.50	211.67	80.65
M_3	146.44	221.94	136.00	200.30	176.27
M_4	143.50	215.90	134.00	178.75	168.03
Mean	147.31	224.96	137.00	202.53	177.98
	B_1	B_2	C_1	C_2	
	186.13	169.76	139.15	213.74	

	B	M	C	B x M	B x C	M x C	B x M x C
SE (m) ±	3.56	5.03	3.56	7.12	5.03	7.12	10.07
CD at 5%	NS	NS	NS	NS	15.1	NS	30.3

60 days after sowing					
M_1	147.00	225.06	148.63	220.37	185.26
M_2	144.50	218.82	147.46	215.55	181.58
M_3	141.33	219.65	145.70	213.77	180.11
M_4	138.50	199.92	143.50	206.43	172.08
Mean	142.83	215.86	146.32	214.03	179.75
	B_1	B_2	C_1	C_2	
	179.34	180.17	144.57	214.94	

	B	M	C	B x M	B x C	M x C	B x M x C
SE (m) ±	0.95	1.35	0.95	1.91	1.35	1.91	2.70
CD at 5%	NS	4.06	2.87	5.75	4.06	5.75	8.13

90 days after sowing					
M_1	137.06	215.75	141.01	221.57	178.09
M_2	132.17	211.32	140.37	219.33	175.79
M_3	127.06	209.28	138.45	216.97	171.93
M_4	120.91	207.67	136.81	215.36	170.18
Mean	129.30	210.25	139.16	218.30	173.99
	B_1	B_2	C_1	C_2	
	169.77	178.73	137.23	214.27	

	B	M	C	B x M	B x C	M x C	B x M x C
SE (m) ±	0.49	0.69	0.49	0.98	0.69	0.98	0.39
CD at 5%	1.47	NS	NS	NS	NS	NS	NS

Table 2. Effect of soil moisture levels on available nutrient content (Phosphorus kg ha^{-1}) in soil

Moisture	B_1		B_2		Mean
level	C_1	C_2	C_1	C_2	
			30 days after sowing		
M_1	9.56	13.43	13.88	12.99	12.46
M_2	11.19	14.33	15.67	15.67	14.21
M_3	14.78	20.15	17.91	19.26	18.02
M_4	18.81	24.19	21.50	22.84	21.83
Mean	11.90	18.02	17.24	17.69	16.63
	B_1	B_2	C_1	C_2	
	14.96	17.46	14.57	17.85	

	B	M	C	B x M	B x C	M x C	B x M x C
SE (m) ±	1.02	1.44	1.02	2.04	1.44	2.04	2.89
CD at 5%	3.07	NS	3.07	6.15	4.34	6.15	8.69

			60 days after sowing			
M_1	8.51	11.19	9.40	13.48	10.64	
M_2	9.85	13.43	10.25	14.78	12.07	
M_3	11.64	15.67	11.72	15.67	13.67	
M_4	14.78	17.91	13.88	16.57	15.78	
Mean	11.19	14.55	11.31	15.12	13.04	
	B_1	B_2	C_1	C_2		
	12.87	13.21	11.25	14.83		

	B	M	C	B x M	B x C	M x C	B x M x C
SE (m) ±	0.46	0.65	0.46	0.92	0.65	0.92	1.30
CD at 5%	NS	NS	1.68	2.77	1.90	2.72	3.92

			90 days after sowing			
M_1	8.41	9.74	8.64	10.22	9.25	
M_2	7.98	11.09	9.95	11.28	10.07	
M_3	10.59	12.09	11.69	12.98	11.83	
M_4	12.09	14.78	14.43	14.33	13.90	
Mean	10.26	11.98	11.17	12.20	11.26	
	B_1	B_2	C_1	C_2		
	11.34	11.68	10.96	12.08		

	B	M	C	B x M	B x C	M x C	B x M x C
SE (m) ±	0.28	0.39	0.28	0.56	0.39	0.56	0.79
CD at 5%	NS	1.19	NS	NS	NS	NS	NS

Table 3. Effect of soil moisture levels on available nutrient content (Potassium kg ha^{-1}) in soil

Moisture level	B_1		B_2		Mean
	C_1	C_2	C_1	C_2	
30 days after sowing					
M_1	302.40	382.80	358.16	512.22	388.89
M_2	240.80	205.30	313.60	300.00	284.92
M_3	224.00	252.40	235.90	282.00	248.57
M_4	169.00	205.86	212.80	229.60	210.85
Mean	240.80	281.59	281.11	330.95	283.30
	B_1	B_2	C_1	C_2	
	261.19	305.53	260.45	306.27	

	B	M	C	B x M	B x C	M x C	B x M x C
SE (m) ±	10.4	14.74	10.42	20.85	17.74	20.85	29.49
CD at 5%	31.37	44.36	31.37	62.74	44.36	62.74	88.73

60 days after sowing					
M_1	314.70	371.45	382.80	504.00	393.23
M_2	257.80	284.30	287.13	296.31	281.13
M_3	282.20	260.94	244.50	285.46	255.77
M_4	182.74	210.58	209.65	228.50	207.86
Mean	246.86	218.82	281.02	328.56	284.49
	B_1	B_2	C_1	C_2	
	264.34	304.79	263.94	305.19	

	B	M	C	B x M	B x C	M x C	B x M x C
SE (m) ±	8.33	11.7	8.33	16.6	11.9	16.6	23.57
CD at 5%	25.08	35.49	25.08	50.16	35.47	50.16	70.94

90 days after sowing					
M_1	301.90	315.13	317.13	323.60	314.34
M_2	247.10	312.80	313.20	312.23	298.08
M_3	223.20	309.84	263.30	315.13	277.86
M_4	179.00	302.10	341.50	307.60	257.55
Mean	237.70	309.96	283.78	316.39	286.95
	B_1	B_2	C_1	C_2	

	B	M	C	B x M	B x C	M x C	B x M x C
SE (m) ±	1.00	1.41	1.00	2.00	1.41	2.00	2.83
CD at 5%	3.01	4.26	3.01	6.03	4.26	6.03	8.53

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Physico- Chemical Contributions on Development of Pulses Powdery Mildew

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ABSTRACT

Upper leaves showed higher amount of chlorophyll a, b and total chlorophyll compared to middle and lower leaves in pea, greengram and black gram. No definite correlation was observed between the chlorophyll content and the cultivar's reaction against powdery mildew. The phenol content varied with the reaction of the cultivars i.e. more phenol content was observed in resistant cultivars as compared to susceptible. Sugar content showed reverse trend i.e. more sugar content was found in susceptible as compared to moderately resistant and resistant cultivars.The protein percentage was found in more quantity in lower leaves compared to middle and upper leaves.

Vegetarian Indians prefers pulses as a richest source of protein. Commonly known as "Dal" pulses are not only a source of inexpensive proteins but also a necessary supplement for people whose diet is either cereal or tuber based, particularly in the Asia Pacific Region. India is fortunately bestowed with varying agro-climatic conditions, enabling one or other pulse crop to grow throughout the year. Moreover many pulse crops mature in a very short duration of 60 to 75 days. As a result green gram and black gram in *Kharif* and pea in *Rabi* have become the important pulse crop in India. But the average productivity of these pulses are very low compared to their genetic potential. The production of pulses has never been parallel to that of population. Most important constraint in production of these crops are diseases.

Among the commonly occurring diseases of pulse crops, powdery mildew caused by *Erysiphe polygoni* DC is the most serious and destructive, which appears in epidemic form every year in various parts of the country. Powdery mildew of most of the legumes first appears on lower leaves and then progress towards middle and upper leaves. Also different cultivars of the same crop responds to the disease differently i.e. susceptible cultivars showed disease incidence earlier than the moderately susceptible, moderately resistant or resistant cultivar of the same crop. This may be either due to the environmental factors or due to the concentration of biochemical constituents and nutritional status of that cultivar, which determines the severity of the disease. Phenolic compounds are said to be involved in resistant mechanism. Considering variable preference of the pathogen to the cultivars of host, biochemical constituents/ nutritional status of different cultivars of green gram, black gram and pea have been analysed in an experiment to find out the role of these constituents in the progress of the disease so that the infection can be minimized by altering the host nutrition, if the nutritional status is found to be involved in the mechanism of infection.

MATERIAL AND METHODS

Powdery mildew of pea, green gram and black gram first appear on lower leaves and then progress towards middle and upper leaves. Hence an attempt was made to quantify the biochemical composition of lower, middle and upper leaves in an experiment conducted during 2000-2001. For this before flowering lower, middle and upper healthy leaves of five varieties of pea :T-163 and Bonneville (both highly susceptible to powdery mildew), KFPD-1 (moderately susceptible), Rachana (moderately resistant) and HFP-4 (resistant); 6 varieties of green gram: Kopergaon (highly susceptible), AKM-8802 (susceptible), BM-4 and ML-131(both moderately susceptible) and TARM-18 and AKM-9242 (both resistant) and 2 varieties of black gram: No.55 (highly susceptible) and TAU-1 (susceptible) were collected from field in respective crop season and analysed for chlorophyll a, b and total chlorophyll by the method suggested by Arnon,1949. Total phenols were analysed

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by the method given by Farkas and Kiraly (1962), phenolic acids by method described by Bray and Thorpe(1954). Dubois *et.al.* (1956) method was applied for total sugar analysis and the protein content was calculated by analyzing N content (micro Kjeldahl method) and converting it to protein by the formula suggested by Singh,1977

Protein per cent = (T X B) X 5 X N X 1.4/S X 6.25

Where

T= Sample titration reading (ml)

B= Blank titration reading (ml)

N= Normality of HCl (1/28)

S= Weight of plant material

T X B was multiplied by 5 because only 10 ml out of 50ml digest has been used

The value was multiplied by 6.25 as the amount of Nitrogen in protein is 1/16 by weight 1.4 is the N factor.

RESULTS AND DISCUSSION

Chlorophyll :- Over all chlorophyll a, b and total chlorophyll content was more in upper leaves followed by lower and middle leaves. In pea the content of chlorophyll "a" varied from 1.268 to 1.899 mg g^{-1} in upper leaves, from 0.936 to 1.750 mg g^{-1} in lower leaves and from 0.757 to 1.425 mg g^{-1} in middle leaves depending upon crop variety. More or less similar results were observed in green gram (Table 2) and black gram (Table 3). Chlorophyll "b" in black gram did not vary much in upper and middle leaves but showed reduction in lower leaves (0.326 to 0.360 mg g^{-1}). Total chlorophyll was also higher in upper leaves in all the three crops, followed by lower and middle in pea and green gram and by middle and lower in black gram. It varied from 1.756 to 2.550 mg g^{-1} in upper leaves of pea, from 1.368 to 2.414 mg g^{-1} in lower leaves and from 1.121 to 2.005 mg g^{-1} in middle leaves depending upon variety of the crop (Table 1). In green gram also higher total chlorophyll was obtained in upper leaves (1.282 to 2.381 mg g^{-1}), followed by lower (1.760 to 2.153 mg g^{-1}) and middle (1.621 to 2.708 mg g^{-1}) depending upon crop variety (Table 2). Black gram showed higher total chlorophyll content in upper leaves (1.708 to 1.876 mg g^{-1}), followed by middle (1.528 to 1.812 mg g^{-1}) and lower leaves (1.562 to 1.638 mg g^{-1}) (Table 3). These results can not be discussed due to lack of literature, however all the varieties of the crops showed similar trend in content of chlorophyll a, b and total chlorophyll which was not related anyway to the onset and spread of the disease, hence it may be suggested that chlorophyll content doesn't play any role in the progress and spread of the powdery mildew disease.

Total phenols : Data in Table 1 showed that upper leaves of pea contained total phenol in higher quantity which varied from 1.66 to 2.12 mg g^{-1} followed by middle (1.62 to

Table 1. Biochemical composition of upper, middle and lower leaves of different varieties of pea

Crop entries		Chlorophyll (mg g^{-1})			Total Phenols mg g^{-1}	Phenolic acids mg g^{-1}	Total sugars mg g^{-1}	Protein %
		a	b	Total				
T-163	Upper	1.342	0.520	1.880	1.96	0.50	27.3	2.79
(Highly	Middle	1.264	0.575	1.794	1.76	0.48	22.5	2.85
susceptible)	Lower	1.357	0.613	1.939	1.58	0.42	32.5	2.92
Bonneville	Upper	1.458	0.554	2.026	1.66	0.48	21.6	2.88
(Highly	Middle	1.425	0.555	2.005	1.62	0.44	23.2	2.96
susceptible)	Lower	0.936	0.411	1.368	1.54	0.38	29.3	3.08
KFPD-1	Upper	1.847	0.480	2.269	1.86	0.49	18.6	2.50
(Moderately	Middle	0.950	0.289	1.237	1.70	0.46	20.6	2.64
susceptible)	Lower	1.684	0.542	2.182	1.62	0.39	24.8	2.62
HFP-4	Upper	1.268	0.483	1.756	2.12	0.48	13.4	2.50
(Resistant)	Middle	0.988	0.354	1.287	1.88	0.43	14.8	2.59
	Lower	1.228	0.513	1.753	1.64	0.40	16.0	2.58
Rachana	Upper	1.899	0.640	2.550	2.06	0.43	17.2	2.39
(Moderately	Middle	0.757	0.356	1.121	1.84	0.39	18.6	2.43
resistant)	Lower	1.750	0.628	2.414	1.78	0.35	13.0	2.52

Table 2. Biochemical composition of upper, middle and lower leaves of different varieties of green gram

Crop entries		Chlorophyll (mg g^{-1}) a	b	Total	Total Phenols mg^{-1}	Phenolic acids mg^{-1}	Total sugars mg g^{-1}	Protein %
Kopergaon	Upper	1.532	0.438	1.932	1.98	0.35	7.3	3.15
(Highly susceptible)	Middle	1.318	0.321	1.621	1.64	0.30	8.6	3.11
	Lower	1.431	0.456	1.897	1.46	0.27	10.1	3.20
AKM-8802	Upper	1.392	0.632	2.034	2.08	0.38	7.2	2.98
(Susceptible)	Middle	1.216	0.490	2.708	1.82	0.35	6.5	3.03
	Lower	1.380	0.586	1.926	1.54	0.31	9.8	3.16
BM-4	Upper	1.468	0.422	1.832	2.56	0.39	4.7	3.00
(Moderately	Middle	1.419	0.391	1.821	1.96	0.36	5.9	3.06
susceptible)	Lower	1.216	0.530	1.782	1.64	0.29	6.2	3.12
ML-131	Upper	1.632	0.610	2.251	2.58	0.40	4.8	2.95
(Moderately	Middle	1.532	0.320	1.862	2.08	0.37	5.2	2.98
susceptible)	Lower	1.198	0.552	1.760	1.72	0.35	6.5	3.01
TARM-18	Upper	1.739	0.526	1.282	2.76	0.41	4.0	2.78
(Resistant)	Middle	1.448	0.423	1.823	2.34	0.39	3.8	2.82
	Lower	1.534	0.613	2.153	1.96	0.32	5.3	2.90
AKM-9242 (Resistant)	Upper	1.823	0.553	2.381	2.94	0.43	3.2	2.79
	Middle	1.632	0.312	1.934	2.13	0.38	4.1	2.78
	Lower	1.608	0.493	2.112	2.06	0.34	5.6	2.82

1.88mg g^{-1}) and lower leaves (1.54 to 1.78 mg g^{-1}). Green gram and black gram upper leaves also contained more total phenols followed by middle and lower(Table 2 & 3). The trend was observed in all the varieties of pea, green gram and black gram. The infection of powdery mildew starts from lower leaves and progresses towards middle and then upper leaves. Moreover susceptible varieties contained less total phenols than moderately resistant and resistant varieties. In greengram highly susceptible Kopergaon contained 1.46 mg g^{-1} total phenols in lower leaves which goes on increasing as the resistance of the variety increases i.e. susceptible AKM-8802 contained 1.54 mg g^{-1}, moderately susceptible BM-4 and ML-131 contained 1.64 mg g^{-1} and 1.72 mg g^{-1} total phenols and resistant TARM-18 and AKM-9242 contained 1.96 mg g^{-1} and 2.06 mg g^{-1} total phenols in lower leaves (Table 2) i.e. total phenols were more in resistant varieties indicating the role of phenols in disease resistance. Higher content of total phenols in leaves of powdery mildew resistant and moderately resistant varieties of pea have been also reported by Sindhan and Parashar (1984), Parashar and Sindhan (1986), Munshi *et.al.* (1987), Sharma *et. al.*(1996) and Rathi *et. al.* (1998). Guleria *et. al.* (1998) opined that increased level of key enzymes of the phenol propanoid pathway and orthodihydroxy phenolic content may confer resistance to infection by *Erysiphe polygoni.*

Phenolic acids : In all the varieties of 3 crops phenolic acids were more in upper leaves followed by middle and lower leaves. In upper, middle and lower leaves of pea its content varied from 0.43 to 0.50, 0.39 to 0.48 and 0.35 to 0.42 mg g^{-1}, respectively (Table 1). In green gram also higher phenolic acid content was observed in upper leaves (0.35 to 0.43 mg g^{-1}) followed by middle (0.30 to 0.39 mg g^{-1}) and lower leaves (0.27 to 0.35 mg g^{-1}) (Table 2). Phenolic acids were also in higher quantity in blackgram upper leaves (0.36 to 0.41 mg g^{-1}), followed by middle (0.35 mg g^{-1} in both varieties) and lower leaves (0.30 to 0.32 mg g^{-1}) (Table 3). In general, phenolic acids content was more in upper leaves followed by middle and lower in all the varieties of 3 crops but like total phenols its involvement in disease resistance cannot be confirmed due to lack of literature and variation in content irrespective of the susceptibility or resistance of the variety.

Total Sugars : Total sugars were higher in lower leaves followed by middle and upper leaves in all the varieties under study. The total sugar contents were detected as 13.0 to 32.5 mg g^{-1} in lower leaves, 14.8 to 23.2 mg g^{-1} in middle and 13.4 to 27.3 mg g^{-1} in upper leaves of pea (Table 1) . In green gram also total sugars were obtained in higher quantity from lower leaves (5.3 to 10.1 mg g^{-1}) followed by middle (3.8 to 8.6 mg g^{-1}) and upper leaves (3.2 to 7.3 mg g^{-1}) (Table 2). In black gram total sugars in

Table 3. Biochemical composition of upper, middle and lower leaves of different varieties of black gram

Crop entries		Chlorophyll (mg^{-1}) a	b	Total	Total phenols $mg\ g^{-1}$	Phenolic acid $mg\ g^{-1}$	Total sugars $mg\ g^{-1}$	Protein %
No.55 (Highly susceptible)	Upper	1.362	0.396	1.708	1.83	0.36	9.6	3.43
	Middle	1.116	0.412	1.528	1.69	0.35	11.3	3.50
	Lower	1.236	0.326	1.562	1.52	0.32	10.6	3.39
TAU-1 (Susceptible)	Upper	1.486	0.401	1.876	1.93	0.41	9.3	3.46
	Middle	1.519	0.389	1.812	1.81	0.35	10.5	3.40
	Lower	1.373	0.360	1.638	1.49	0.30	12.0	3.47

lower, middle and upper leaves were 10.6 to 12.0, 10.5 to 11.3 and 9.3 to 9.6 mg g^{-1} respectively (Table 3) . The present study showed that highly susceptible varieties contain more total sugars than susceptible, susceptible contains more than moderately susceptibles, moderately susceptibles contains more than resistant and resistant contains more than highly resistant which indicates that the total sugars may be a factor responsible for disease incidence and disease intensity. Rathi *et. al.* (1998) also observed higher content of total sugars and reducing sugars in powdery mildew susceptible cultivars of pea than resistant.

Protein percentage: As presented in Table 1 protein percentage was also higher in lower leaves of pea i.e.from 2.52 to 3.08, followed by middle (2.43 to 2.96) and upper leaves (2.39 to 2.88). In green gram higher content of protein in lower leaves was followed by upper and middle leaves (Table 2) while in black gram protein percentage failed to show consistency in upper, middle and lower leaves which varied 3.43 to 3.46, 3.40 to 3.50 and 3.39 to 3.47 per cent, respectively (Table 3).

From the observations of the present study it can be concluded that lower leaves because of less content of total phenols and phenolic acids and more content of total sugars and protein probably become first prone to attack of powdery mildew fungus. Although environmental factors play an important role in disease incidence, the host nutrition and changes in its composition with the age of the host cannot be ignored as a factor responsible for disease occurrence and its spread within the host.

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Response of Sorghum (*Sorghum bicolor*) to Varying Fertility Levels

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ABSTRACT

Balanced fertilizer use based on scientific principles requires to take an account of crop requirement, initial soil fertility status and efficiency of crop/variety to utilize soil and fertilizer nutrients. The results revealed that the response of sorghum (SPH-388) in relation to yield, concentration and uptake of nutrients was increased with increase in initial soil fertility status.

Sorghum is the most important food and fodder crop of Maharashtra state. In Maharashtra, sorghum is grown on an area of 21.50 lakh hectare in *Kharif* season with the production of 39.11 lakh tonnes and average yield of 1819 kg ha^{-1}.

Sorghum grain contains about 10-12 percent protein , 3 per cent fats and 70 per cent carbohydrates. It is popular because of its wide adaptability, quick growing habit, drought resistance, high yielding ability, capability of regeneration, palatability and high digestibility and above all, it has making quality.

Our farmers are likely to use too little or too much of fertilizer. Soil testing for fertility helps them to eliminate the guess work and apply fertilizers according to the needs of the crop. In this regard targeted yield approach evolved in which a combined use of soil as well as plant analysis is considered for formulating the fertilizer recommendations. Thus, it gives the fertilizer recommendations in balance and quantitative terms in relation to soil test values and crop requirement that is necessary to optimize the response to added fertilzer, maximum profit and to achieve desired yield target along with the maintenance of soil fertility.

MATERIAL AND METHODS

The field experiment was conducted on sorghum (SPH-388) on Typic ustrorthents at the research farm of Shivar Block, Central Research Station, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during 2001-2002 and 2002-2003. The field layout for crop consisted of four equal; size strips in which a fertility gradient was created in the preceding season by applying the graded doses of N, P and K fertilizers to get sufficient range in soil test values which is essential for conducting a successful soil test crop response experiment. The preparatory crop i.e. wheat (AKW-381) was grown in the preceding season on these four strips, so that the applied fertilizer interacts with soil, plants and microbes and become a part of soil system. After the harvest of the gradient crop the standard field experiments were conducted in subsequent seasons by dividing each of four fertility strips into 27 plots. In each strip, 21 plots received fertilizer treatments with various combinations and levels of N, P and k and other 6 plots were kept as control (unfertilized). The level of nutrients for sorghum were N = 0, 40, 80, 120 and 160, P = 0, 30, 60 and 90 and K = 0, 40 and 80 kg K_2O ha^{-1}. The fertilizer materials used were urea, single super phosphate and muriate of potash. Half does of N and full dose of P and K were applied as basal by broadcasting and mixing in the soil by disking. The remaining half dose of N was top dressed. The soil samples from 0-15 cm depth were collected from all the 108 plots before application to fertilizers and sowing of main crop i.e. sorghum.

The grain and straw yield for all the plots were recorded at the end of the experiment. The plant samples were analyzed for per cent content of N, P and K. Similarly soil samples were analyzed for available N, P and K by alkaline $KMNO_4$, Olsen's and NH_4OAC method, respectively.

RESULTS AND DISCUSSION

The persual of data (Table 1) revealed that the grain and straw yield of wheat were increased with increasing the fertilizer level, however increase in the grain and straw yield were comparatively lower in case of higher level of fertilizer application during both the years of experimentation. Maximum grain yield i.e. 27.12 and 42.25 q ha^{-1} with the application of double the recommended dose of wheat during the year 2001-2002 and 2002-03, respectively, whereas the lowest grain yield was recorded in control (Unfertilized) plots. Tiwari *et. al.*, (2002) reported

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Table 1. Yield (q ha^{-1}) of wheat (AKW-381) in different fertility gradient

Fertility strips	2001-02			2002-03		
	Grain	Straw	Total	Grain	Straw	Total
L_0	9.10	10.37	19.47	16.12	19.30	35.42
$L_{1/2}$	19.37	27.12	46.49	34.50	37.75	72.25
L_1	23.00	30.37	53.37	40.50	45.80	86.30
L_2	27.12	30.1257.24	42.25	48.20	90.46	

Table 2. Available N, P and K (kg ha^{-1}) status in soil after harvest of wheat crop

Available nutrient (kg ha^{-1})	2001-2002				2002-03			
	Fertility gradient							
	L_0	$L_{1/2}$	L_1	L_2	L_0	$L_{1/2}$	L_1	L_2
Nitrogen	133	152	168	230	138	1261	179	250
Phosphorus	8.50	10.50	15.70	26.50	6.30	9.20	14.40	18.60
Potassium	152	167	201	242	213	274	284	308

that use of sub optimal dose of (50% NPK) had caused 94 and 182 per cent increase in yield over control in soybean and wheat, respectively.

The available nitrogen, phosphorus and potassium content in the soil (Table 2) after harvest of wheat crop were found to be increased with increasing the fertilizer levels. The average increase in available nitrogen content over control were 19, 35, 97 kg ha^{-1} during 2001-2002 and 23, 41 and 112 kg ha^{-1} during 2002-2003 in $L^{1/2}$, L_1 and L_2 fertility strip, respectively. Similar trend was also recorded in case of available phosphorous the average increase over control was 2.0 and 18 kg ha^{-1} during 2001-02 and 2.90, 8.10 and 12.30 kg ha^{-1} during 2002-03 $L^{1/2}$, L_1 and L_2 fertility strip, respectively. Similar trend was also recorded in case of available potassium content in different fertility strips indicating that the fertility gradient showing a wide variation in soil fertility has been developed in respect of available N, P and K. Swarup and Singh (1989) revealed that continuous use of fertilizer N alone or in combination with P and K significantly enhanced the available NPK content in soil

The sorghum yields (Table 3) showed increasing trend from L_0 and L_2 fertility strip. The average yield of control plots in different fertility strips were 5.72, 8.23 and 9.11 and 10.23 q ha^{-1} and in fertilized plots the mean yield were 28.62, 31.29, 33.99 and 34.97 q ha^{-1} in L_0, $L^{1/2}$, L_1 and L_2 fertility gradient strips, respectively indicating that the sorghum yields increases with increasing residual fertility status of soil. The maximum yield was obtained in the treatments where the NPK fertilizer were applied in balanced ratio as compared to their individual application. The results are conformity with that of Singh and Sharma (1978), Mali *et. al.*, (2000).

The data in respect of sorghum yield, initial soil values and fertilizer doses applied were use to derive multiple regression equation. The equations were separately derived from control and fertilized plots. Multile regression equation for control pltos :

$$Y = 428.974 + 1.184\ SN + 0.005\ SN^2 + 70.968\ SP^2 - 3.952\ SP2 - 2.364\ SK + 0.008\ K^2$$

$$R^2 = 0.72^{**}$$

Multiple regression equation for control plots :

$$Y = -3250.446 + 28.261\ SN^{*} - 0.061\ SN^2 - 26.508\ SP + 1.112\ SP^2 + 12.632\ SK - 0.023\ SK^2 + 35.275\ FN^{**} - 0.085\ FN^{2**} + 0.440\ FP - 0.009\ FP^2 + 1.276\ FK - 0.009\ FK^2 - 0.037\ FNSN + 0.375\ FPSP + 0.016\ FKSK$$

$$R^2 = 0.79^{**}$$

Where, FN, FP and FK are fertilizer NPK in kg ha^{-1}, SN, SP and SK are soil available NPK kg ha^{-1} and Y is sorghum yield q ha^{-1}.

A significant value of coefficient of determination ($R^2 = 0.72$) indicate the variation in the yield of control plots significantly dependent upon the available nutrients in soil. While, in fertilized plots the coefficient of determination ($R^2 = 0.79$) value indicated that there were 79 per cent variation obtained in the sorghum yield due to the contribution of fertilizer and soil N, P and K. Bangar (1990) reported that the R^2 values for multiple regression equations above 0.66 indicated good fit, 0.65 to 0.45 moderate fit and above 0.45 as poor fit.

The perusal of data (Table 3) revealed that the nitrogen, phosphorus and potassium concentration in sorghum grain and straw increased with increasing fertilizer doses. Increasing trend of these nutrients was also observed in increasing soil available nutrient status. The mean N uptake by sorghum in different soil fertility strips to $L_{1/2}$, L_1 and L_2 were 74.42, 81.06 and 94.84 kg ha^{-1} under fertilized plots, whereas N uptake were 12.59, 17.90, 20.06 and 22.61 kg ha^{-1} under control plots, respectively. As regards the phosphorus, it was noted that mean total uptake of phosphorus by sorghum both in control as well as in fertilized plots were found to be increased with increasing the soil fertility status. Similar trend was also observed in case of potassium uptake by sorghum. These results are in conformity with the findings of Hirpara *et. al.*, (1999).

This information is valuable and of practical importance for efficient and judicious use of fertilizer in increasing food production.

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Biochemical Variation of Sweet Sorghum Juice, Stalk and Quality of Grain Malt

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ABSTRACT

Ten genotypes of sweet sorghum were studied for their chemical composition. Bagasse were analysed for hemicellulose, cellulose, lignin and sugar. Highest hemicellulose content was recorded in Wray and NSS-104. While, maximum cellulose and lignin content were observed in NSS-104. Bagasse contains less percent of reducing and non reducing sugar. Stalk's juice analysis for sugars revealed that minimum reducing sugar was recorded in NSS-208. Maximum non reducing sugar and total sugar were noticed in BJ-248. Grain malt prepared from BJ-248 contains highest diastatic power amongst all.

Sweet sorghum is a C_4 plant characterized by a high biomass yield crop among all graminaceous crops and thus, excels sugarcane in the efficiency of converting cultural energy (Goss, 1996). The use of sorghum in industries will not only meet the growing demand of industrial products but also to maintain its value at remunerative price level for farmers since sorghum produces fermentable sugars as well as grains, it is one of the most ideal crop for simultaneous production of energy and food.

Bagasse and straw hold a prominent place as non pulp-making raw materials. Since food production comes first to feed the hungry masses, the residue then becomes the byproduct for the paper industry. Nevertheless very little is known about the chemical structure of the sweet sorghum components which is critical for the optimization of the different scenarios for industrial exploitation or biofuel production.

Considering the importance of malt in brewing, sweet sorghum grains were processed for malt and diastatic activity was determined, since higher the diastatic power, better the malt quality.

MATERIAL AND METHODS

Experiment was carried out at Agro Product Development Research Centre, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during 2003. Ten genotypes of sweet sorghum were studied for their chemical composition. At physiological maturity of crop, cobs and leaves were separated and stalks were passed through roller crusher to extract the juice. Juice of each genotype was collected separately and analysed for reducing sugar (Miller, 1959) and total sugar (Dubois *et al.*, 1956). Non reducing sugar was calculated by the difference between total soluble sugar and reducing sugar. The bagasse were allowed to dry and chipped. Hemicellulose, cellulose and lignin were determined according to the method described by TAPPI standard (1978). Malt were prepared from grains of different sweet sorghum genotypes and diastatic activity was determined by alkaline ferricyanide method (Daiber, 1971).

RESULTS AND DISCUSSION

Results (Table 1) revealed that, bagasse of Wray contains the maximum hemicellulose content (25.20 %), followed by NSS-104 (22.30 %) and BJ-248 (22.00%). While, its lowest content was recorded in NSS-04 (16.20%). Highest cellulose content was noticed in NSS-104 (37.23%). Bagasse of Wray and RSSV-09 also shows the higher content of cellulose i.e. 35.64 and 35.12 per cent, respectively. Differences in hemicellulose and cellulose content may be due to genetic variation which influenced the homopolysaccharides formation from photosynthates. Considering lignin factor significantly highest content was observed in NSS-104 (17.31 %), followed by Wray (16.77 %) and BJ-248 (15.56 %). Lignin as an cementing material, it is observed that NSS-104 has more resistance power regarding infection caused by

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Table 1. Chemical composition (%) of sweet sorghum bagasse

Genotypes	Hemicellulose	Cellulose	Lignin	Reducing sugar	Non reducing sugar
SSV-84	17.90	32.41	15.40	0.09	2.50
NSS-104	22.30	37.23	17.31	0.08	2.42
NSS-208	20.50	30.55	14.85	0.09	2.61
RSSV-09	19.80	35.12	14.44	0.06	2.12
NSS-04	16.20	30.00	13.61	0.07	2.24
BJ-248	22.00	33.52	15.56	0.05	2.85
Wray	25.20	35.64	16.77	0.04	2.82
Keller	20.20	30.35	12.59	0.08	2.75
Madhura	16.40	32.03	13.22	0.06	2.61
AKSSV-22	17.60	34.56	12.20	0.09	1.95
SE (m)±	0.61	0.20	9.61	0.002	0.011
CD (P = 0.05)	1.70	0.56	0.27	0.006	0.032
CV (%)	5.30	1.05	1.14	4.10	0.60

Table 2. Sugar content (%) in sweet sorghum stalk's juice and diastatic power (DU g^{-1}) of their grain malt

Genotypes	Reducing sugar	Stalk's juice	Total sugar	Grain malt
		Non reducing sugar		Diastatic power
SSV-84	2.10	11.50	13.60	30.62
NSS-104	1.90	10.10	12.00	33.51
NSS-208	1.46	10.04	11.50	29.32
RSSV-09	2.48	12.22	14.70	27.04
NSS-04	1.71	11.29	13.00	41.65
BJ-248	1.58	15.82	17.40	45.82
Wray	1.76	14.44	16.20	30.14
Keller	1.73	13.57	15.30	37.21
Madhura	1.66	13.04	14.70	29.16
AKSSV-22	1.73	10.97	12.70	32.43
SE (m)±	0.04	0.87	0.57	8.50
CD (P = 0.05)	0.11	2.58	1.70	2.39
CV (%)	3.79	13.19	7.00	0.04

insects and micro-organisms as compared to other genotypes.

Bagasse were also analysed for sugars. Results obtained inferred that reducing sugar content of different sweet sorghum cultivars was ranged from 0.04 to 0.09 per cent and the lowest content was recorded in Wray (0.04 %), followed by BJ – 248 (0.05 %). While, non reducing sugar was ranged from 1.95 to 2.85 per cent and highest content was noticed in BJ – 248 (2.85 %), followed by Wray (2.82 %).

Considering the analysis of stalk's juice for sugars (Table 2), the least reducing sugar was recorded in NSS-208 (1.46 %), followed by BJ–248 (1.58%). However, significantly maximum non reducing sugar was noticed in BJ–248 (15.82%), followed by Wray (14.44 %). Its lowest content was observed in NSS-208 (10.04 %). Regarding total sugar content, amongst all, BJ–248 recorded maximum percentage of about 17.40 per cent followed by Wray (16.20 %). Considering sugar, it is observed that due to photosynthetic activity through carbohydrate production which has been taking place in the plant may be polarized and form into non reducing sugars in BJ-248 and Wray as compared to other genotypes.

Grain malt were prepared from different sweet sorghum genotypes. Diastatic power was determined from malt. Significantly maximum diastatic power was noticed for BJ-248 (45.82 DU g^{-1}). NSS-04 also showed the higher diastatic power i.e. 41.65 DU g^{-1}. Whereas, it was found lower in RSSV-09 (27.04 DU g^{-1}). Malt having high diastatic power are accepted in brewing industries.

Overall scrutiny of the result inferred that Wray, BJ-248 and NSS-04 genotypes were found to be better for their hemicellulose, cellulose and lignin content. BJ-248, Wray and Keller are best for extracting high content of non reducing sugar as well as total sugar in stalk's juice. While, BJ-248 and NSS-04 were found best malt yielding cultivars.

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Residual Effect of FYM, Nitrogen and Phosphorus on Succeeding Mustard in Rice-Mustard Sequence

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ABSTRACT

A field experiment was conducted at N.M.College of Agriculture, Navsari Agricultural University, during the *Kharif* and *Rabi* seasons of 2001-02 and 2002-03 to study the residual effect of different levels of inorganic nitrogen and phosphorus integrated with FYM @10 t ha^{-1} on mustard in rice-mustard sequence. The direct effect of FYM @ 10 t ha^{-1} in combination with 100 kg N ha^{-1} irrespective of phosphorus levels to rice was more reflected in terms of higher grain and equivalent yield of rice and their residual effect on seed yield of mustard. The per cent oil content in seed did not influence significantly during both the years and protein content in seed and stover during second year, however, their yields influenced significantly during both the years due to residual effects of FYM integrated with different levels of N and P_2O_5. Positive build up in soil available nitrogen on completion of two cycles of rice-mustard was observed with the application of 75 and 100 kg N ha^{-1} in combination with FYM to rice.

The responses in component crop of the cropping system are influenced by the preceding crops and the inputs applied to them. Organic manure like FYM have carry over effect on succeeding crops. About less than 30 per cent of nitrogen and small fraction of phosphorus and potash of organic manure may become available to immediate crop and rest to subsequent crops (Gaur, 1982). In addition to this it also helps in improvement of soil physical properties (Bharadwaj and Gaur, 1985). Therefore, judicious mixing of organic as well as inorganic sources of nutrients in preceding crops is an imperative in order to economize the use of chemical fertilizers but also improve the physico-chemical status of soil. Keeping this in mind, an effort was made to find out the effect of FYM in conjunction with inorganic nitrogen and phosphorus in rice-mustard system.

MATERIAL AND METHODS

A field experiment was conducted at N. M. College of Agriculture, Navsari during 2001-02 and 2002-03 on a vertisol, having 0.42 per cent organic carbon and 219.80, 39.60 and 320.12 Kg ha^{-1} of N, P_2O_5 and K_2O, respectively. The treatments comprised of 12 combinations of two levels of FYM (0 and 10 t ha^{-1}), four levels of N (0, 50,75 and 100 kg ha^{-1}) and four levels of phosphorus (0, 25, 37.5 and 50 kg ha^{-1}) in randomized block design replicated thrice. The treatments were applied to preceding rice crop during both the years (Table). Succeeding mustard which received uniform dose of 50 kg ha^{-1} each of nitrogen and phosphorus.

After harvest of rice, mustard cv. Gujrat mustard - 2 was sown in 1st week of November during both the years. A plant spacing of 45 X 15 cm was maintained by thinning 20 days after germination. After harvest of rice and mustard available soil N content and per cent N, P and K content in seed and stover were estimated treatment-wise. Nitrogen balance was worked out at the end of two cycles of rice-mustard sequence.

RESULTS AND DISCUSSION

Yield and Yield Attributes

Integration of FYM @ 10 t ha^{-1} with 100 kg N ha^{-1} irrespective of phosphorus levels reorded highest grain and equivalent yield of rice and seed yield of mustard. However, residual effect of manure and inorganic fertilizer receiving treatments remained at par. The increased seed yield of mustard might be due to increased yield attributes such as siliquae and seed yield per plant and test weight. The results conformed the findings of Rajput (1995) and Jana and Ghosh (1996). FYM application into the preceding rice crop might have also improved soil physical properties as soil physical condition deteriorates after prolonged submergence of soil during rice crop growth (Bhardwaj and Gaur, 1985).

Nutrient Uptake

Application of FYM @ 10 t ha^{-1} along with different levels of nitrogen and phosphorus in rice significantly influenced nutrient uptake (Table 1). The data revealed that application of FYM @ 10 t ha^{-1} along with each of 50, 75 and 100 Kg N ha^{-1} with respective phosphorus levels (T_4 to T_{11}), being at par with each other recorded significantly higher N P and K uptake compared with recommended N and P_2O_5 without FYM (T_{12}), only FYM (T_2), FYM + P_2O_5 (T_3) and absolute control. This could be due to residual effect of the nutrients available through FYM to the succeeding crop.

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Table 1 : Yield and yield attribute s and nutrient uptake of mustard as influenced by residual effect of different treatments applied to rice

Treatments	Siliqua plant^{-1}		Seed yield plant^{-1} (g)		1000-Seed weight (g)		Seed yield (t ha^{-1})		Rice grain (t ha^{-1})		Rice grain Equiv. yield (t ha^{-1})		Uptake kg ha^{-1} N		P		K	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
T_1- $F_0N_0P_0$	116.67	73.67	5.90	4.05	3.93	4.22	0.78	0.60	3.91	3.10	6.51	5.09	36.95	22.32	6.56	4.51	34.88	23.77
T_2- $F_{10}N_0P_0$	187.19	144.17	8.20	6.70	4.99	4.82	1.37	1.05	4.03	3.70	8.59	7.19	64.76	42.15	11.93	8.11	51.85	40.14
T_3- $F_{10}N_0P_{50}$	188.91	145.18	8.25	6.79	5.06	4.85	1.38	1.10	4.61	4.42	9.20	8.10	66.05	44.82	12.25	8.60	52.47	42.09
T_4- $F_{10}N_{50}P_{25}$	190.27	148.94	8.42	6.81	5.14	4.92	1.44	1.13	5.62	5.31	10.42	9.05	71.85	49.44	13.09	9.14	59.21	47.40
T_5- $F_{10}N_{50}P_{50}$	189.81	147.86	8.37	6.80	5.05	4.87	1.43	1.15	5.53	5.30	10.29	9.12	70.92	49.48	12.94	9.22	58.49	46.52
T_6- $F_{10}N_{75}P_{37.5}$	193.47	150.00	8.84	7.19	5.19	5.17	1.47	1.19	6.30	6.05	11.20	10.06	75.56	53.69	13.72	9.83	63.81	52.21
T_7- $F_{10}N_{75}P_{50}$	192.80	149.67	8.83	7.16	5.17	5.11	1.47	1.18	6.23	6.00	11.19	9.93	74.10	52.69	13.53	9.75	61.88	51.63
T_8- $F_{10}N_{100}P_0$	197.00	154.01	9.12	7.39	5.18	5.12	1.51	1.21	6.60	6.42	11.62	10.44	77.17	54.81	14.82	10.42	65.86	55.06
T_9- $F_{10}N_{100}P_{25}$	198.53	155.64	9.18	7.45	5.20	5.14	1.52	1.21	6.63	6.41	11.70	10.43	77.54	54.47	14.86	10.40	66.08	54.82
T_{10}-$F_{10}N_{100}P_{37.5}$	201.87	157.87	9.27	7.50	5.18	5.15	1.54	1.22	6.72	6.33	11.84	10.39	79.13	55.38	15.02	10.53	68.30	56.13
T_{11}- $F_{10}N_{100}P_{50}$	203.88	158.60	9.30	7.59	5.22	5.20	1.56	1.24	6.81	6.62	12.02	10.74	80.70	56.47	15.10	10.71	69.52	57.54
T_{12}- $F_0N_{100}P_{50}$	173.81	132.30	7.50	6.23	4.94	4.78	1.24	0.96	6.50	6.21	10.62	9.42	59.75	39.07	10.95	7.46	48.88	38.46
CD at 5%	17.18	15.33	1.20	0.88	NS	NS	0.21	0.19	0.82	0.82	-	-	6.38	5.24	1.10	1.05	7.23	7.86

Y1-2001-02

Y2-2002-03

Table 2: Oil and protein content and their yields of mustard as influenced by residue of different treatments applied to rice

Treatments	Oil content (%)		Oil yield (q ha^{-1})		Crude protein content (%)				Total Crude Protein yield (q ha^{-1})	
			Seed	Stover						
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
T_{1-} $F_0N_OP_O$	38.42	38.45	3.01	2.30	16.76	15.18	3.98	2.84	2.25	1.45
T_{2-} $F_{10}N_OP_O$	38.35	38.11	5.25	3.96	17.44	16.79	5.23	3.40	4.09	2.70
T_{3-} $F_{10}N_OP_{50}$	38.31	38.39	5.29	4.22	17.45	16.81	5.25	3.43	4.13	2.83
T_{4-} $F_{10}N_{50}P_{25}$	38.29	38.24	5.51	4.42	17.48	17.35	5.39	3.55	4.52	3.07
T_{5-} $F_{10}N_{50}P_{50}$	38.17	38.18	5.46	4.39	17.47	17.18	5.31	3.53	4.44	3.11
T_{6-} $F_{10}N_{75}P_{37.5}$	37.75	37.82	5.55	4.49	17.49	17.39	5.40	3.58	4.73	3.33
T_{7-} $F_{10}N_{75}P_{50}$	37.78	37.80	5.53	4.44	17.48	17.38	5.38	3.57	4.64	3.30
T_{8-} $F_{10}N_{100}P_O$	37.60	37.89	5.68	4.60	17.57	17.39	5.40	3.64	4.83	3.43
T_{9-} $F_{10}N_{100}P_{25}$	37.90	37.94	5.74	4.58	17.58	17.40	5.40	3.60	4.86	3.41
T_{10-}-$F_{10}N_{100}P_{37.5}$	37.56	37.93	5.78	4.62	17.59	17.40	5.41	3.60	4.97	3.47
T_{11-} $F_{10}N_{100}P_{50}$	37.86	37.95	5.90	4.70	17.62	17.41	5.42	3.61	5.04	3.52
T_{12-} $F_0N_{100}P_{50}$	37.79	37.84	4.69	3.63	17.37	17.32	5.26	3.43	3.84	2.61
CD at 5%	NS	NS	0.92	0.78	0.43	NS	0.77	NS	0.33	0.47

Table 3: Nitrogen balance (Kg N ha^{-1}) of rice-mustard cropping system as after 2 years

Treatments	Initial soil available N (kg ha^{-1})	Available and added N (Kg ha^{-1})	N uptake by crops (Kg ha^{-1})	Computedbalance (Kg N ha^{-1})	Soil netgain (+)/loss(-) (Kg N ha^{-1})
T_1- $F_0N_0P_0$	219.80	219.80	193.75	122.25	-71.50
T_2- $F_{10}N_0P_0$	219.80	445.80	259.31	3.55	-29.76
T_3- $F_{10}N_0P_{50}$	219.80	445.80	279.73	26.05	-27.68
T_4- $F_{10}N_{50}P_{25}$	219.80	545.80	329.44	-7.49	-10.93
T_5- $F_{10}N_{50}P_{50}$	219.80	545.80	330.18	-5.83	-10.01
T_6- $F_{10}N_{75}P_{37.5}$	219.80	595.80	367.70	-4.25	4.05
T_7- $F_{10}N_{75}P_{50}$	219.80	595.80	362.38	-10.83	2.79
T_8- $F_{10}N_{100}P_0$	219.80	645.80	391.06	-25.98	8.96
T_9- $F_{10}N_{100}P_{25}$	219.80	645.80	391.42	-28.53	6.05
T_{10}-$F_{10}N_{100}P_{37.5}$	219.80	645.80	395.93	-23.64	6.43
T_{11}-$F_{10}N_{100}P_{50}$	219.80	645.80	403.30	-17.23	5.47
T_{12}-$F_0N_{100}P_{50}$	219.80	519.80	354.70	20.27	-34.43

The results conform the findings of Dhurandher *et al.* (1999) and Singh *et al.* (2001). The accumulated nutrients gradually mineralized and utilized by successive crop resulting into higher nutrient uptake, which is evident from nitrogen balance sheet (Table 2).

Nitrogen Balance

Increasing levels of nitrogen up to 75 kg ha^{-1} in combination with FYM and their respective phosphorus levels to preceding rice increased soil available nitrogen. Similar finding was also reported by Prasad (1994).

Quality

The data presented in Table 2 revealed that residual effect of nitrogen and phosphorus blended with and without FYM @ 10 t ha^{-1} in preceding rice did not influence the oil content in mustard, however, successive increase in nitrogen fertilization recorded lower oil content in seed. Protein content in seed and stover were influenced appreciably due to residue developed by the application of FYM along with graded levels of N (50, 75 and 100 kg ha^{-1}) irrespective of phosphorus levels in preceding rice (T_4 to T_{11}) during first year of study only. This was primarily due to higher nitrogen and phosphorus removal by the plants. Thus, an adequate N supply not only stimulate photosynthesis but also affect amino acids which constitute building blocks of protein, formation of some stable phosphor-protein compounds (Verma and Kheria, 1973) in presence of phosphorus.

The oil and protein yields increased significantly upto 100 kg N ha^{-1} applied along with FYM @ 10 t ha^{-1} irrespective of phosphorus levels (T_8 to T_{11}) in preceding rice during individual years. Although higher N availability resulted in reduced oil percent in seeds but it increased the oil yield ha^{-1} significantly, since oil as well as protein yields were the resultant of seed yields. The results substantiated with the reports of Singh *et al.* (2003).

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Correlation and Path Analysis Studies For Yield and Yield Contributing Characters in Sesamum (*Sesamum indicum* L.)

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ABSTRACT

Correlation and path analysis studies on seven parents and 21 hybrids of Sesamum indicated that the seed yield was significantly and positively correlated with days to first flowering, days to 50 per cent flowering, days to maturity, number of branches plant^{-1}, plant height, number of capsules plant^{-1}, weight of seed capsule^{-1}, length of capsule, 1000 seed weight and oil content. Strong positive direct effects were observed for plant height, days to 50 per cent flowering and weight of seed capsule. The indiret negative effects of yield were observed for days to flowering, days to maturity, number of branches plant^{-1}, number of capsules plant^{-1}, and length of capsule.

Sesame (*Sesamum indicum* L.) known as til is an ancient oilseed crop grown in India. Besides its oil value, it possesses medicinal value. Yield is a complex character, therefore, the knowledge of relationship of the various yield contributing characters is of great importance in any crop improvement programme for the effective selection. Such studies are also helpful for the plant breeder to develop appropriate line of action for crop improvement. The correlation coefficient does not give the correct idea about the magnitude of contribution made by various component characters. Therefore, the path analysis was also studied which is useful for separating out direct and indirect effects so as to measure the relative importance of the causal factors. Both these help the breeder to build a selection criterion for selecting and developing high yielding genotypes in Sesamum.

MATERIAL AND METHODS

The present investigations were carried out by using the diallel mating design involving seven parental lines and the 21 F_1 hybrids derived from all possible cross combinations among the lines (excluding reciprocals). The experiment consisting of seven parents viz., Krishna Z-4-Co-1, TKG 32, TC 25, AHT 123, TKG 105, TKG 117 and RT 161 and 21 F_1 hybrids were laid out in a randomized block design with three replications in *Kharif* 1998. Both parents and F_1's were sown in a plot of one row of 2.5 meter length. Recommended package of practices for Sesamum was followed. Observations on eleven different quantitative traits were recorded on five randomly selected plants in each replication.

The phenotypic and genotypic correlation coefficients were calculated according to method suggested by Croxton and Cowden (1964). The genotypic correlation coefficients were further partitioned in to direct and indirect effects on yield by path coefficient analysis given by Dewey and Lu (1959).

RESULTS AND DISCUSSION

In most of the traits, the values of genotypic correlations were of higher magnitude than phenotypic correlations (Table 1). This suggested that there was a strong inherent association between characters which was truly reflected in phenotypic expressions. The grain yield plant^{-1} showed highly significant and strong positive correlations with days to first flowering, days to 50 per cent flowering, days to maturity, number of branches plant^{-1} height, number of capsules plant^{-1}, weight of seed capsule^{-1}, length of capsule and 1000 seed weight except oil content in per cent. Similar observations have been reported by Krishnadoss and Kadambavanasundram (1986), Reddy and Ramachandraih (1990) and Reddy and Priya (1991). Further, significant and positive correlation was observed between number of days to flowering and number of capsules plant^{-1}, 1000 seed weight and number of capsule plant^{-1}, plant height and number of seed capsule^{-1}, number of capsules plant^{-1} and 1000 seed weight, weight of seed capsule^{-1} had significant positive genotypic correlation with the length of capsule (0.2184) at genotypic level. So also length of capsule was found

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Table 1.Phenotypic (P) and Genotypic (G) correlation confficient for ten charadters is sesame.

Characters		Daysto 50% flowering	Day to maturity	No.of branches/ plant	Plant height (cm)	No.of capsules/ plant	Weight of seed/ capsules	Length of caps. (cm)	1000 seed weight	Oil content (%)	Yield plant Plant
1	2	3	4	5	6	7	8	9	10	11	12
Days to first flowering	G	0.863**	1.049**	0.179	0.806**	0.748**	0.066	0.182	0.407**	0.007	0.519**
	P	0.104**	0.574**	0.010	0.422	0.439**	0.040	0.058	0.212*	0.019	0.342**
Days of 50% flowering	G		1.022**	0.242*	0.676**	0.599**	-0.095	0.293**	0.295**	-0.030	0.400**
	P		0.880**	0.141	0.557**	0.520**	0.062	0.251*	0.252*	0.005	0.352**
Days to maturity	G			0.265**	0.711**	0.562**	0.074	0.284**	0.371**	0.081	0.401**
	P			0.236	0.677**	0.591**	0.075	0.254**	0.350**	0.097	0.383**
No of branches / plant	G				0.350**	0.222*	0.023	0.201	0.291**	0.204*	0.208**
	P				0.308**	0.207	0.017	0.146	0.259*	0.2350*	0.177
Plant height(cm)	G					0.711**	0.345**	0.538**	0.481**	0.182	0.804**
	P					0.677**	0.336**	0.466**	0.465**	0.172	0.740**
No. of capsules	G						0.123	0.082	0.269**	0.040	0.507**
	P						0.114	0.072	0.250*	0.058	0.475**
Weight of seed / capsules	G							0.218*	0.056	0.100	0.599**
	P							0.172	0.084	0.116	0.550**
Lengthof capsules	G								0.405**	0.061	0.427**
	P								0.354**	0.037	0.3647**
1000seed weight	G									0.165	0.367**
	P									0.133	0.331**
Oil content	G										0.188
	P										0.183

**Significant at 1per cent level , * Significant at 5 per cent level

Table 2. Path coefficience analysis showing direct and indirect effect of factors influencing yield in F1

Character		Day to first flowering	Days to 50% flowering	Day to maturity	No.of branches/ Plant	Plant height (cm)	No.of capsules plant	Weight of seed/ capsules	Length of caps. (cm)	1000 seed weight	oil cntent %
1	2	3	4	5	6	7	8	9	10	11	12
Character	G	-0.364	0.357	-0.237	-0.052	0.802	-0.043	0.024	-0.034	0.045	0.000
	P	0.044	0.039	0.131	0.001	0.284	0.005	0.012	0.004	0.005	0.001
Day to 50%	G	-0.314	0.414	0.231	-0.043	0.672	-0.034	-0.036	-0.054	0.032	0.000
flowering	P	0.044	0.145	0.200	0.010	0.375	0.007	-0.019	0.000	0.006	0.000
Days of maturity	G	-0.320	0.423	-0.226	-0.048	0.707	-0.035	-0.027	-0.053	0.415	0.002
	P	0.042	0.130	0.228	-0.018	0.455	0.007	0.023	0.000	0.009	0.006
No of branches plant	G	-0.065	0.100	-0.060	-0.151	0.347	0.012	0.076	-0.037	0.032	0.007
	P	0.001	0.020	0.053	0.077	0.207	0.009	0.054	0.000	0.006	0.015
Plant height(cm)	G	-0.293	0.280	-0.161	-0.063	0.994	-0.041	0.129	-0.100	0.153	0.004
	P	0.031	0.052	0.154	0.023	0.673	0.009	0.105	0.000	0.012	0.011
No of capsules plant	G	-0.272	0.248	-0.14	-0.040	0.707	-0.057	0.046	-0.015	0.029	0.001
	P	0.032	0.077	0.134	0.016	-0.456	0.013	0.035	0.000	0.006	0.003
Weight of seed /	G	-0.024	-0.040	0.016	-0.0396	0.343	-0.007	0.375	-0.040	0.009	0.002
capsules	P	0.002	0.009	0.017	0.013	0.226	0.001	0.314	0.000	0.002	0.007
Length o capsules	G	-0.066	0.121	-0.064	-0.036	0.535	-0.004	0.081	-0.187	0.048.	-0.001
	P	0.004	0.037	0.057	0.011	0.314	0.000	0.054	0.000	0.009	0.002
1000 seed weight	G	-0.1480.	0122	-0.084	-0.052	0.478	-0.015	0.034	-0.081	0.111	0.004
	P	0.015	0.037	0.079	0.02	0.313	0.003	0.026	0.000	0.026	0.008
Oi.l content(%)	G	-0.002	-0.012	-0.018	-0.051	0.18	-0.002	0.037	0.011	0.018	0.027
	P	0.001	0.000	0.022	0.018	0.116	0.000	0.036	0.000	0.003	0.064

Bold =Directeffects

significantly correlated with 1000 seed weight. Sharma and Chauhan (1984) and Rong and Wu (1989) reported similar results.

The results of path analysis (Table 2) revealed that plant height, days to 50 per cent flowering and weight of seed capsule^{-1} exerted the greatest positive direct effect on grain yield plant^{-1}. Diret positive effect of 1000 seed weight and oil content (%) on grain yield was minor, while, days to first flowering, days to maturity, number of branches plant^{-1}, number of capsule plant^{-1} and length of capsules had negative direct effect on grain yield. Days to first flowering, days to maturity, number of capsules plant^{-1} and days to 50 per cent flowering had the maximum indirect effect on seed yield plant^{-1} via plant height. Similar results were reported by Reddy and Priya (1991), Reddy and Ramachandraiah (1990) and indirect effect of days to flowering was reported by Reddy *et. al.*, (1984).

The above studies on characters association suggested that the characters viz. days to first flowering, days to maturity, number of branches plant^{-1}, plant height, number of capsules plant^{-1}, length of capsules and 1000 seed weight should be considered to improve yield in Sesamum, which the path analysis suggested that the characters viz. plant height, days to 50 per cent flowering and weight of seed capsule^{-1} had larger direct effect on grain yield plant^{-1} and thus these values for the trait should be incorporated in the sesame ideotype to achieve significant improvement in seed yield.

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Hybrid Vigour in Okra (*Abelmoschus esculentus* L. Moench)

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ABSTRACT

The performance of 30 hybrids along with their parents of diverse origin were studied to investigate heterosis over Mid Parent (MP) and Better Parent (BP) for yield plant^{-1}and its nine other component characters. Based on per se performance, Parbhani Kranti was better parent for days to flower initiation, plant height and yield plant^{-1}. AKO-73 for days to 50 per cent flowering, plant height, number of fruiting nodes on main stem, number of fruits plant^{-1} and yield plant^{-1}. Most heterotic crosses identified on the basis of mid parent and better parent were Arka Anamika x Tot-1494 for number of branches on main stem and fruit yield plant^{-1}, Arka Anamika x Tot-1502 for number of primary branches on main stem.

In recent years, the exploitation of hybrid vigour in vegetable crops has assumed the greater importance due to several advantages over open pollinated varieties such as increased early and total yields, resistance to pests, diseases and unfavourable weather conditions. With the ease in fruit set and good number of seeds fruit^{-1}, okra offers a good scope for the production of hybrids on commercial scale. Keeping in view, the importance of heterosis breeding in okra, the present investigation was designed to study the extent of heterosis and hybrid vigour involving the varieties recommended for cultivation and the newly evolved yellow vein mosaic resistant varieties in India.

MATERIAL AND METHODS

The experimental material comprised of three females (testers: AKO-73, Arka Anamika and Parbhani Kranti) and ten males (lines: Tot-1492, Tot-1494, Tot-1497, Tot-1498, Tot-1500, Tot-1502, Tot-1566, Tot-1577, Tot-2200 and JNDO-5) were crossed in L x T fashion. The 30 F_1's along with their parents were planted in a randomized complete block design with three replications at the farm of Chilli and Vegetable Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.).

Each entry had three row plot with spacing of 60 x 45 cm. Five plants from each entry were selected at random and data recorded for various characters (Table 1). Heterosis over mid parent and better parent were worked out as per the standard procedure given by Rai (1979).

RESULTS AND DISCUSSION

The range of per se performance, heterosis over mid parent and better parent are presented in Table 1. The maximum range of per se performance for parents and crosses was observed for yield plant^{-1}, plant height and number of seeds per fruit^{-1}. The range of various heterotic effect was high for number of primary branches on main stem, yield plant^{-1} and number of fruits plant^{-1}. Based on per se performance, Parbahni Kranti and AKO-73 were the better parents for days to 50 per cent flowering, plant height, number of primary branches on main stem, number of fruits plant^{-1} and yield plant^{-1}.

Considering the heterosis effects, the number of crosses having desirable heterosis were more with yield plant^{-1} and number of fruits plant^{-1}. The magnitude of desirable heterobeltiosis effect was high with the attributes number of primary branches on main stem, yield plant^{-1} and number of fruits plant^{-1}. The negative heterosis was observed in some of the crosses may be attributed to non-allelic interaction, which can either increase or decrease to expression of heterosis.

A perusal of the top heterotic crosses revealed that, not a single cross showed heterosis for all the characters (Table 2). Out of thirty crosses studied, none of the cross showed significant positive heterobeltiosis

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Table 1. Range of parents, crosses and heterosis along with better parents in okra

Characters	Range				Better parents(Based on per se Performance)
	Per se Performance		Heterosis		
	Parents	Crosses	Mid Parent	Better Parent	
Days to first flower initiation	51.00-68.07	49.2-69.33	-0.66-25.00	-2.09-32.82	Parbhani Kranti (51.0) & JNDO-5(51.0)
Days to 50% flowering	60.67-74.33	58.00-74.33	-0.50-1.86	1.08-20.83	AKO-73 (60.67),Arka Anamika (62.00)
Length of fruit (cm)	8.60-1.30	8.65-2.85	-0.07-31.83	-0.71-23.59	Tot 1502 (11.30),Tot 1577 (10.72)
Weight of fruit (g)	8.93-0.34	7.74-2.59	1.42-27.28	-1.23-23.27	Tot 1497 (10.34),Tot 1500 (10.29)
Plant height (cm)	48.91-92.69	55.63-6.01	-4.60-72.13	-3.1-46.37	Parbhani Kranti(92.69),AKO 73(91.55)
Number of primary branches on main stem	1.60-5.67	2.07-1.13	-3.45-232.65	-3.53-49.25	AKO 73 (5.67),Parbhani Kranti (5.27)
Number of fruiting nodes on main stem	5.60-3.20	9.33-7.07	-2.56-67.61	0.00-33.13	AKO 73 (13.2),JNDO 5(12.53)
Number of fruits plant^{-1}	8.67-28.40	20.60-39.13	-6.7-11.49	0.23-50.42	AKO 73&Parbhani Kranti(28.4),JNDO 5(25.07)
Number of seeds fruit^{-1}	56.87-84.00	42.80-97.87	0.95-26.10	-0.95-9.27	Tot 1500 (84.00),Tot 1497 (83.13)
Fruit Yield plant^{-1}	76.25-289.97	147.27-381.06	-1.37-30.29	-1.61-67.94	Parbhani Kranti(289.97),AKO 73(261.85)

Figures in parentheses indicates *per se* Performance

Table 2. Most heterotic crosses for ten characters in okra

Characters	Number of hybrids having significant heterotic effect (Based on BP)		Best hybrids on	
	Positive	Negative	Mid Parent	Better Parent
Days to first flower initiation	22	-	Arka Anamika X Tot 1492 (-7.58)	Arka Anamika X Tot 2200 (7.79)
Days to 50 % flowering	18	-	Parbhani Kranti X Tot 1492 (8.50)	Parbhani Kranti X Tot 1500 (9.24)
Length of fruit (cm)	01	05	Parbhani Kranti X Tot 1494 (31.83)	Parbhani Kranti X Tot1494 (23.59)
Weight of fruit (g)	03	12	Parbhani Kranti X Tot 1494 (27.28)	Parbhani Kranti X Tot1494 (23.27)
Plant height (cm)	01	02	Arka Anamika X Tot 1498 (72.13)	Arka Anamika X Tot 1498 (46.37)
Number of primary branches on main stem	03	16	Arka Anamika X Tot 1494 (232.65)	Arka Anamika X Tot 1502 (149.25)
Number of fruiting nodes on main stem	-	-	Arka Anamika X Tot 1492 (67.61)	—
Number of fruits plant plant^{-1}	04	-	Arka Anamika X Tot 1494 (111.49)	Arka Anamika X Tot 1494 (50.42)
Number of seeds fruit plant^{-1}	01	11	Arka Anamika X Tot 1497 (26.10)	Ako 73 X JNDO 5 (26.28)
Yield plant plant^{-1}	04	03	Arka Anamika X Tot 1494 (131.19)	Arka Anamika X Tot 1494 (67.94)

Figures in parentheses indicate heterosis value.

for number of fruiting nodes on main stem. The cross Arka Anamika x Tot-1494 showed the highest heterosis and heterobeltiosis for number of primary branches on main stem and fruit yield plant^{-1}, respectively.

The cross Arka Anamika x Tot-1502 for number of primary branches on main stem recorded the highest heterobeltiosis. Only four F_1's exhibited significant desired heterobeltiosis of which the crosses Arka Anamika x Tot-1494 had shown the highest value. The crosses Parbhani Kranti x Tot-1494 and Arka Anamika x Tot-1498 showed maximum estimates of all the heterotic effects for length of fruit, weight of fruit and plant height, respectively. Only two crosses each showed significant positive heterobeltiosis for plant height and number of seeds fruit^{-1}. Similar results were reported by Dayasagar (1994); Pathak and Syamal (1997) and Kale (1999).

In the present investigation, considerable amount of heterosis was observed in desired direction for all the characters except number of fruiting nodes on main stem.. For days to flower initiation and days to 50 per cent flowering exhibited positive heterobeltiosis, but negative heterosis is more desirable in these characters as the interest of plant breeders invariably is in incorporating earliness. From the above study, it is clear that a promising hybrids could be obtained in okra. To make hybrid seed production economical and swift, it is necessary to develop a promising ms lines.

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Comparative Study of Heterosis in CMS, GMS Based and Conventional Intra Hirsutum Cotton Hybrids

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ABSTRACT

A comparative study was carried out during 2003 in CMS, GMS based and corresponding conventional hybrids, which were generated by three lines AK – 32, G Cot-10 and MCU-5, in three back grounds viz. CMS and GMS along with their fertile (B line) with four restorers. The conventional lines exhibited high heterosis over mid-parents for seed cotton yield plant^{-1}, followed by CMS and finally by GMS based hybrids. Six hybrids from conventional group, five hybrids from CMS based hybrids and four hybrids from GMS based hybrids showed simultaneous heterosis for seed cotton yield plant^{-1}, number of bolls plant^{-1}, boll weight, number of seeds boll^{-1} along with high yield. Further three hybrids viz. AK-32 x AKH-073, G Cot-10 x DHY – 281 and G Cot-10 x AKH -073 showed significant heterosis for all the yield contributing with high yield in all the three group, thus can be exploited as future hybrids based both male sterility systems. Further for fibre fineness CMS hybrids exhibited superior heterosis value than conventional, followed by GMS based hybrids. Whereas GMS based hybrids was found to be more heterotic value for uniformity ratio and fibre strength than CMS based hybrid, followed by conventional. Conventional were superior over CMS, followed by GMS for 2.5 per cent span length. Female MCU-5 found to be heterotic for all the four fibre character in CMS and conventional background whereas male parent AKH-976 and AKH-073 may be exploited for uniformity ratio and bundle strength, respectively in all the three backgrounds.

Heterosis breeding in cotton has paid rich dividends in increasing production and productivity. One of the chief factors contributing to the increased production and productivity in cotton is the development of hybrids and their successful cultivation in about 45 per cent area of the country and which is ever so increasing. Even though hybrid area is increasing with every year, the job of production of conventional hybrid is cumbersome and costly. Use of genetic male sterility and cytoplasmic male sterility can considerably reduce the cost of hybrid seed production at least by 30 per cent by avoiding labour cost required for intensive emasculation (Meshram and Marawar 1995). Several workers have reported genetic and cytoplasmic male sterility in American cotton. Information on interaction of cytoplasms or genomes of lines, affecting the hybrid performance is a prerequisite for practical use of any male sterility system in exploitation of hybrid vigour.

The hybrids developed by utilizing cytoplasmic and genetic male sterile lines and their fertile counterpart as females crossed with selected restorers, formed the material for the present investigation, to study the extend of heterosis over mid –parental value in CMS, GMS based as compared to conventional hybrids.

MATERIAL AND METHODS

Nine females; three each from CMS and GMS lines of three fertile counterparts viz., AK-32, G Cot-10 and MCU-5 were crossed with four selected restorer lines viz. DHY-286-1, AKH-073, AKH-1174 and AKH-976. Thus twelve CMS, GMS and conventional hybrids of each line were obtained by crossing nine females with four restorers, in all 36 hybrids were produced in *Kharif* of 2002. These resulting 36 hybrids were grown in *Kharif* of 2003 under rainfed situation at AICCIP, Dr. PDKV, Akola along with their parents and evaluated in RBD with three replications. Five competitive plants were tagged at random in each replication and in each entry for recording observations on 8 quantitative traits. The heterosis over mid parents was calculated by the method of Turner, (1953) and Hayes *et. al.* (1955). The average heterosis of hybrids was worked out on the basis of mean values of all fertile i.e. ten parents and 36 hybrids.

RESULTS AND DISCUSSION

The magnitude of heterosis over mid–parent is presented in Table 1 for all the 8 quantitative traits and abstracted information in Table 2. For effective presentation and discussion of the results, the 8

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characters are grouped into two viz. yield and its components and fibre properties.

Yield and Yield components:

The magnitude of the average heterosis was high for seed cotton yield compared to remaining traits and it was followed by number of bolls plant^{-1} and boll weight. Similar results were reported by Kajjidoni *et al.* (1999) in intra-arboreum hybrids.

Among the three sets of hybrids the conventional hybrids exhibited better average heterosis than the CMS based and GMS based hybrids for seed cotton yield plant^{-1}. The range of heterosis for seed cotton yield was high (65.17 to 248.55 %) in conventional hybrids, followed by CMS based hybrids (20.81 to 165.37 %) and then by GMS based hybrids (7.7 to 118.68 %t). The superiority of the conventional over CMS hybrids and CMS hybrids over GMS based hybrids was probably due to the action of component trait like number of bolls plant^{-1}. Similar results for GMS based hybrids were reported by Srinivasan and Gururajan (1983) in the study of reconstituted GMS based hybrids H_4 and Varalaxmi compared to their respective conventional hybrids. Kajjidoni *et al.* (1999) also compared GMS hybrids with conventional.

All conventional hybrids and all CMS hybrids i.e. twelve each showed significantly superior heterosis in positive direction, whereas single hybrid from GMS based hybrids exhibited non-significant heterosis for seed cotton yield plant^{-1}. The mean performance of hybrids along with heterosis will serve as useful guide in selecting potential hybrids. From this point of view, nine conventional, six GMS and five CMS based hybrids were better for seed cotton yield plant^{-1} than best *per se* performance (28.32 g plant^{-1}). In general three hybrids AK-32 x AKH – 073, G Cot-10 x DHY-286-1 and G Cot-10 x AKH-073 showed significant heterosis for seed cotton yield, number of bolls plant^{-1} and boll weight in all three groups.These are potential male sterility based hybrids as they had shown significant heterotic value in GMS as well as CMS background.

In CMS based hybrids, all twelve hybrids were heterotic for seed cotton yield plant^{-1} and boll weight, whereas ten and seven hybrids for number of bolls plant^{-1} and number seeds plant^{-1}, respectively. Out of these, five hybrids exhibited simultaneous heterosis, for seed cotton yield plant^{-1}, boll weight and number of bolls plant^{-1}, CAK-32 x DHY-286-1 being the highest seed cotton yielder plant^{-1} in all the three groups (52.72 g plant^{-1}). Other four hybrids which showed simultaneous significant heterotic values for seed cotton yield, boll weight and number of bolls plant^{-1} were CAK-32 x AKH-073, G Cot-10 (CMS) x DHY-286-1, G Cot-10 (CMS) x AKH-073 along with better seed cotton yield plant^{-1} than best per se performance.

Silva and Olivera (1985) found highest heterosis for yield, number of bolls plant^{-1} and boll weight than the other characters. Meshram *et. al.* (1998) observed similar results that of Silva for cytosterile hybrids developed from 2 restorers.

In GMS based hybrids ten hybrids showed significant heterosis for number of bolls plant^{-1}, boll weight and number of seeds boll^{-1} whereas eleven hybrids showed significant heterosis for seed cotton yield plant^{-1}. Out of these four showed simultaneous heterosis for number of bolls plant^{-1}, boll weight, seed cotton yield plant^{-1} and number of seeds boll^{-1} viz. GAK-32 x DHY-286-1, GAK-32 x AKH-074, G Cot-10 (GMS) x AKH-073 and MCU-5 (GMS) x AKH-073 along with better seed cotton yield than best per se performance. Single hybrid MCU-5 (GMS) x DHY-286-1 showed simultaneous heterosis for boll weight, number of seeds boll^{-1} and seed cotton yield plant^{-1} and G Cot-10 (GMS) x DHY-286-1 exhibited simultaneous heterosis for number of bolls plant^{-1} and seed cotton yield plant^{-1} with better seed cotton yield than best per se performance.

In conventional hybrids out of twelve hybrids eleven hybrids showed simultaneous heterosis for number of bolls plant^{-1} and seed cotton yield plant^{-1}. Out of these eleven six hybrids showed simultaneous heterosis for number of bolls plant^{-1}, boll weight, number of seeds boll^{-1} and seed cotton yield plant^{-1} further exhibited better seed cotton yield than best per se performance viz. AK-32 x AKH-073, G Cot-10 x DHY-286-1, G Cot1-10 x AKH-11764, G Cot – 10 x AKH-976, MCU-5 x AKH-073.

Overall study for yield contributing character revealed that isogenic hybrids of AK-32 with DHY-286-1 recorded significant heterotic values at least for the two yield contributing character and were top at their respective group. Whereas MCU-5 x AKH-1174 showed highest heterotic value for seed cotton yield (248.51%) simultaneously showed significant heterosis for number

Table 1: Heterosis in percentage for different characters.

S.N.	Hybrids	No. of bolls plant^{-1}	Boll weight (g)	No. of seeds boll^{-1}	Seed cotton yield plant^{-1} (g)	2.5% span length (mm)	Uniformity ratio	Fibre fineness (µg inch^{-1})	Bundle strength (g tex^{-1})
		1	2	3	4	5	6	7	8
	Conventional hybrids								
1	AK-32X DHY-286-1	71.02**	-2.44**	3.07	175.67**	6.81**	4.13**	12.65**	10.24**
2	AK-32X AKH-1174	0.00	15.15**	3.00	65.17**	13.75**	4.18**	16.73**	13.27**
3	AK-32X AKH-073	95.48**	13.58**	6.48**	127.86**	16.02**	2.53**	14.74**	16.85**
4	AK-32X AKH-976	39.62**	46.41**	17.82**	98.36**	10.89**	3.97**	-9.60**	13.57**
5	GCot-10X DHY-286-1	63.64**	17.79**	10.67**	164.14**	4.81**	12.37**	-5.65**	16.28**
6	GCot-10X AKH-1174	39.00**	18.79**	4.84*	177.87**	2.57**	12.54**	2.42**	14.69**
7	GCot-10X AKH-073	94.41**	10.91**	4.33	120.62**	7.37**	8.00**	-1.57**	14.93**
8	GCot-10X AKH-976	43.46**	22.15**	6.86**	192.31**	0.68	13.29**	-13.83**	5.39**
9	MCU-5X DHY-286-1	25.09**	13.30**	-0.61	115.03**	33.02**	-2.22*	-15.10**	15.05**
10	MCU-5X AKH-1174	64.96**	17.00**	4.25	248.51**	29.26**	-3.54**	-12.65**	14.65**
11	MCU-5X AKH-073	74.13**	19.14**	11.52**	113.18**	33.68**	-1.27	-13.15**	23.08**
12	MCU-5X AKH-976	43.73**	19.86**	24.43**	86.18**	28.36**	0.66	-20.8**	9.85**
	GMS based hybrids								
13	GAK-32X DHY-286-1	96.90**	33.96**	9.00**	118.68**	-4.57**	12.41**	23.3**	13.33**
14	GAK-32X AKH-1174	5.08**	-0.13	-2.11	7.70	-2.95**	10.49**	22.33**	15.55**
15	GAK-32X AKH-073	64.31**	27.32**	18.05**	23.74**	2.27**	10.65**	31.13**	14.40**
16	GAK-32X AKH-976	24.06**	39.83**	10.10**	26.81**	3.50**	17.69**	9.00**	19.29**
17	GCot-10(GMS)X DHY-286-1	25.80**	-7.49**	-0.97	107.64**	9.55**	12.37**	2.73**	18.01**
18	GCot-10(GMS)X AKH-1174	-1.71	13.02**	10.29**	71.26**	13.82**	9.15**	11.82**	16.17**
19	GCot-10(GMS)X AKH-073	70.64**	27.14**	10.05**	47.32**	17.80**	12.67**	7.96**	28.23**
20	GCot-10(GMS)X AKH-976	28.30**	58.28**	28.02**	85.22**	9.78**	13.29**	-15.56**	20.56**
21	MCU-5(GMS)X DHY-286-1	0.60	34.80**	10.71**	26.04*	1.83**	10.34**	25.24**	10.45**
22	MCU-5(GMS)X AKH-1174	22.07**	9.07**	16.23**	24.7**	3.59**	7.69**	15.53**	11.33**
23	MCU-5(GMS)X AKH-073	54.74**	43.33**	16.05**	28.31**	5.29**	5.15**	-2.83**	23.08**
24	MCU-5(GMS)X AKH-976	61.46**	77.91**	35.99**	16.97**	3.50**	12.64**	-3.32**	16.84**
	CMS based hybrids								
25	CAK-32X DHY-286-1	94.44**	21.05**	-11.2**	165.37**	2.89**	9.45**	13.51**	6.31**
26	CAK-32X AKH-1174	30.79**	24.08**	6.07**	51.78**	3.43**	8.91**	24.32**	4.41**
27	CAK-32X AKH-073	111.49**	18.34**	-1.60	90.98**	12.66**	7.14**	17.54**	16.12**
28	CAK-32X AKH-976	82.91**	55.88**	4.99*	71.39**	8.74**	12.93**	-2.20**	15.14**
29	GCot-10(CMS)X DHY-286-1	4.31**	9.79**	-3.48	103.52**	2.43**	7.10**	9.01**	3.24**
30	GCot-10(CMS)X AKH-1174	-0.89	28.44**	15.59**	58.97**	-3.01**	7.19**	12.61**	7.14**
31	GCot-10(CMS)X AKH-073	38.92**	21.79**	4.57	77.70**	5.98**	4.82**	0.00	10.37**
32	GCot-10(CMS)X AKH-976	51.19**	43.13**	16.55**	144.09**	0.85*	8.42**	-9.25**	8.12**
33	MCU-5(CMS)X DHY-286-1	34.71**	4.86**	6.08**	20.81**	23.35**	5.54**	-7.21**	16.16**
34	MCU-5(CMS)XAKH-1174	-7.51**	2.70**	-12.02**	58.74**	29.45**	4.29**	-2.70**	18.01**
35	MCU-5(CMS)X AKH-073	77.22**	19.80**	11.22**	27.57**	27.04**	1.95*	-16.67**	21.39**
36	MCU-5(CMS)X AKH-976	37.67**	30.46**	8.91**	70.64**	24.77**	6.12**	-21.59**	18.92**
	SE (d) (H_1)	1.66	0.37	2.34	5.46	0.43	0.87	0.09	0.45
	CD at 5%	3.25	0.73	4.59	10.7	0.84	1.71	0.18	0.88
	CD at 1%	4.28	0.95	6.03	14.06	1.11	2.24	0.23	1.16

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

Table 2 : Mean performance of F_1s and parents, average heterosis and range of mid-parent heterosis with number of heterotic crosses in desirable direction in respect of thirteen quantitative characters in *G.hirsutum* L.

S. N.	Character with overall heterosis range	Type of hybrids	Average mean value (hybrids)	Average mean value (pare-nts)	Average heterosis heterosis	Range of desirable	No. of crosses with significant heterosis in desirable direction	Best cross
1	Number of bolls	Con	13.01		52.16	0 to 95.48	11	9
	plant^{-1}	GMS	11.42	8.55	33.56	- 1.71 to 96.9	10	6
	– 7.51 to 111.49 %	CMS	11.90		39.18	- 7.51 to111.49	10	7
2	Boll weight (g)	Con	3.66		29.32	- 2.44 to 46.41	11	3
	- 7.49 to 77.91 %	GMS	3.48	2.83	22.97	- 7.49 to 77.91	10	3
		CMS	3.29		16.25	2.7 to 55.88	All	1
3	Number of seeds boll^{-1}	Con	28.43		10.84	0.61 to 24.43	7	1
	– 12.02 to 35.99 %	GMS	29.50	25.65	15.01	2.11 to 35.99	10	6
		CMS	26.57		3.59	- 12.02 to 16.55	7	1
4	Seed cotton yield	Con	38.02		124.0	65.17 to 248.51	All	9
	plant^{-1} (g)	GMS	27.55	16.97	462.35	7.7 to 118.68	11	6
	7.7 to 248.51 %	CMS	29.63		74.60	20.81 to 165.37	All	5
5	2.5 % span length	Con	27.41		8.00	0.68 to 33.68	11	2
	(mm)	GMS	27.51	25.38	8.39	– 4.57 to 17.8	10	0
	– 4.57 to 33.68%	CMS	27.46		8.20	– 3.01 to 29.45	11	1
6	Uniformity ratio (%)	Con	53.19		6.96	– 3.54 to 13.29	8	7
	– 3.54 to 17.69 %	GMS	53.56	49.73	7.70	5.15 to 17.69	All	8
		CMS	54.19		8.96	1.95 to 12.93	All	9
7	Fibre fineness	Con	3.99		-8.49	– 20.8 to 16.73	8	5
	(µg inch^{-1})	GMS	3.93	4.36	-9.86	– 15.56 to 31.13	3	3
	– 21.59 to 31.13 %	CMS	3.80		-31.88	– 21.59 to 24.32	6	6
8	Bundle strength	Con	20.25		11.94	5.39 to 23.08	All	6
	(g tex^{-1})	GMS	20.55	18.09	13.60	10.45 to 28.23	All	8
	3.24 to 28.23 %	CMS	20.70		14.43	3.24 to 21.39	All	9

of bolls plant^{-1} and boll weight. Thus AK-32 performed best in all the cross combinations which was confirmed by gca estimates.

Fibre properties:

For fibre fineness, in general CMS based hybrids showed superiority over conventional hybrids followed by GMS based hybrids as indicated by the heterosis range. Similarly GMS based hybrids exhibited superiority over CMS based and conventional hybrids for uniformity ratio and bundle strength. Whereas conventional were found to be superior for 2.5 per cent span length than CMS and GMS based hybrids.

Shroff *et. al.* (1983) showed that the hybrids based on cytoplasmic male sterility restoıer system was more finer and lesser number of motes than their fertile counterpart.

Liu Hai Tao *et. al.* (2000) observed that boll weight, seed index, 2.5 per cent span length, fibre strength and micronaire value were possibly affected by the

cytoplasmic inheritance from same combinations of conventional hybrids

Among the 36 hybrids six hybrid from CMS, three hybrids from GMS and conventional group showed significant heterosis for all the fibre properties studied. However single hybrid each from CMS and GMS group showed better seed cotton yield than per se performance viz. MCU-5 (CMS) x AKH-073 and MCU-5 (GMS) x AKH – 073, respectively along with significant desirable heterosis for all the four fibre properties. Further two conventional hybrids G Cot-10 x DHY-286-1 and G Cot-10 x AKH-073 exhibited better seed cotton yield than best *per se* performance along with significant desirable heterosis for four fibre properties. Thus these four hybrids could be considered as potential crosses for 2.5 per cent span length, uniformity ratio, fibre fineness and fibre strength with simultaneous exploitation of hybrid vigour for seed cotton yield.

The female MCU-5 with all the males showed highest significant heterosis for bundle strength, 2.5 per cent span length, fibre fineness in conventional as well as CMS based hybrids. Further MCU-5 in CMS background also showed positive heterosis for uniformity ratio also, which wasn't found in the conventional hybrids. Thus MCU-5 in CMS background may be used as female parent to exploit heterosis for four fibre related quality trait. Further MCU-5 x AKH-1174, a conventional hybrid showed highest heterosis for seed cotton yield and also showed better seed cotton yield plant^{-1} than the best per se performance for seed cotton yield plant^{-1}. Further for uniformity ratio AKH-976 showed highest heterosis with every female in all the three backgrounds except with AK-32 (conventional line). In case of bundle strength, hybrids having AKH-073 with every female found superior in all the three background except with G Cot-10 (Conventional) and GAK -32 (GMS line). Thus female MCU-5 can be exploited for fibre fineness in CMS background, bundle strength and 2.5 per cent span length in conventional background. But to exploit MCU-5 for all the three fibre properties it might be useful in CMS background as indicated by the heterotic values exhibited by the female with each four male. From male AKH – 976 for uniformity ratio and AKH-073 for bundle strength may be exploited for heterosis breeding in all the three backgrounds.

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Effect of Nutrients on Yield Components of MS-27A Seed Parent For CSH-16 Seed Production

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ABSTRACT

The experiment laid out in the field of Post Graduate Institute, Department of Agriculture Botany, Dr. PDKV, Akola during *Kharif* 2000-2001 indicated that high doses of nitrogen and phosphorus to parental lines of CSH-16 sorghum hybrid seed production induced vigorous vegetative growth, yield components and yield. The application of nitrogen significantly increased the number of leaves and leaf area plant^{-1} up to 120 kg N, leaf chlorophyll, phytomass plant^{-1}, panicle length, seed yield plant^{-1}, seed and stover yield ha^{-1} up to 180 kg N ha^{-1}, respectively. Contact by the phosphatic fertilization improved the leaf chlorophyll 120 kg P_2O_5 ha^{-1}. Significant increase in number of leaves, leaf area plant^{-1} , panicle length, test weight, seed yield plant^{-1} and ha^{-1} was realized by the application of 80 kg P_2O_5 ha^{-1} , while a significant increase in stover yield was limited to 40 kg P_2O_5 ha^{-1}. The parental line of CSH-16 sorghum hybrid should fertilised with 180 kg N and 80 kg P_2O_5 ha^{-1} for high seed and stover yield.

Sorghum (*Sorghum bicolor* L.) Moench is the 5th major cereal crop in agriculture scenario of the globe. The exploitation of hybrid vigour has increased the productivity of this crop by three fold than the yield from the traditional varieties (Murthy *et. al.*, 1994). Among the co-ordinated sorghum hybrids under the aegis of ICAR, CSH-16 released is widely cultivated. Its hybrid seed production programmes are extensively launched in Andhra Pradesh, which is distinctly recognized as the seed belt of India. The behaviour of parental lines grown for seed production is not the same to applied nutrients as for the field performance of resulting hybrid seed (Krishnaswami and Ramaswamy, 1984). The application of nitrogen by farmers for hybrid seed production ranged from 70 to 327 kg ha^{-1} and phosphorus from 47 to 447 kg ha^{-1} (Reddy *et. al.*, 1992). Hence, the present investigation was planed and executed to find out the nitrogen and phosphrous application rates for maximum production of CSH-16, sorghum hybrid seed.

MATERIAL AND METHODS

The experiment was laid out in the field of Post Graduate Institute, Department of Agriculture Botany, Dr. PDKV, Akola during *Kharif* 2000-01. The soil was sandy loam having 7.2 pH and electrical conductivity 0.5 dS/m^2. Its fertility status was low in available nitrogen (160 kg N ha^{-1}) and phosphorus (12.5 kg P_2O_5 ha^{-1}) but medium in available potassium (180 kg K_2O ha^{-1}). The experiment was laid out in randomized block design. The treatment of nitrogen was @ 0, 60, 120 and 180 kg ha^{-1} and phosphorus was @ 0, 40, 80 and 120 kg ha^{-1} . The treatment dose of nitrogen was applied in split, half at sowing along with the treatment dose of phosphorus and a uniform dose of 20 kg K_2O ha^{-1} to all the treatments. Remaining half of the nitrogen was side dressed to the crop a month after sowing. The plot size was 10 x 8 mt^2. The pollen parent C-43 was sown on 2nd June and seed parent MS-27 A on 5th June in 3:3 row proportion at a distance of 60 cm between the rows and 20 cm within the plants. The chlorophyll content was estimated as Arnon (1949). At maturity seed parent MS-27A was harvested separately from each treatment. The statistical evaluation of treatments effect was through the factorial analysis of variance technique (Panse and Sukhatme, 1981).

RESULTS AND DISCUSSION

Data revealed that (Table 1) the application of nitrogen and phosphorus to the parental lines of CSH-16 sorghum hybrid seed had remarkable influence on the crop growth. The plant height was the only the vegetative parameter which was not influenced by nitrogen and phosphorus. The seed parent fertilized with 120 kg N and 80 kg P_2O_5 ha^{-1} significantly enhanced the number of leaves and leaf area plant^{-1} as compared to the low dose of 60 kg N and 40 kg P_2O_5 ha^{-1}. The chlorophyll content increase with every increase of additional 60 to

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Table 1. Effect of nitrogen and phosphatic fertilizers on vegetative growth of MS-27 A (Seed parent) of CSH-16 sorghum hybrid.

Treatments	Plant height (cm)	Number of leaves plant^{-1}	Leaf area plant-1 (cm^2)	Chlorophyll content (mg g^{-1})	Phytomass (g plant^{-1})
Nitrogen (kg ha^{-1})					
N_0	106.4	6.0	317	2.82	134.6
N_{60}	111.2	6.0	333	3.74	150.7
N_{120}	113.8	6.6	415	4.02	163.7
N_{180}	109.1	6.7	432	4.59	178.7
SE (m) ±	6.3	0.1	20	0.13	3.3
CD at 5%	NS	0.2	41	0.27	6.9
Phosphorus (kg ha^{-1})					
P_0	103.1	6.2	322	2.83	155.6
P_{40}	105.9	6.3	367	3.18	164.0
P_{80}	111.5	6.4	444	3.84	170.8
P_{120}	113.9	6.5	461	5.32	176.5
SE (m) ±	6.3	0.1	20	0.13	3.2
CD at 5%	NS	0.2	41	0.27	6.5
Interaction					
SE (m) ±	12.6	0.2	40	0.27	6.9
CD at 5%	NS	NS	NS	NS	NS

180 kg N ha^{-1}. Similarly every increment of 40 to 120 kg P_2O_5 ha^{-1} significantly increased the leaf chlorophyll content. These beneficial effects of nitrogen and phosphorus application to the parental lines in improving the photosynthetic efficiency of seed parent through more number of leaves with large leaf area and higher chlorophyll content, results in synthesizing a strong source for the sink. The phytomass accumulation plant^{-1} also significanlty increased with successive increase in the levels of nitrogen up to 180 kg ha^{-1} . The crop also responded to accumulate larger quantity of phytomass with increase in the dose of phosphorus up to 120 kg P_2O_5 ha^{-1}. However, the phytomass production due to 80 kg P_2O_5 ha^{-1} was at par with this treatment. The interaction effects of the two fertilizers indicated that the crop growth parameters were not altered by their combined effect at different levels.

The yield components and yield of CSH-16 sorghum hybrid were remarkably influenced by nourishing the parental lines with high levels of nitrogen and phosphorus (Table 2). The seed parent developed longer panicle with more number of seeds and higher seed weight by increase in the level of nitrogen upto 120 kg N ha^{-1} . The improvement in these yield components eventually led to increased production of CSH-16 sorghum hybrid seed plant^{-1} and ha^{-1} . The production increase significantly in response to every increase in the dose of fertilizer upto 180 kg N ha^{-1} . The stover yield was also maximum, the crop fertilized with phosphorus produced larger panicles with significant increase in test weight by increase in dose upto 80 kg P_2O_5 ha^{-1}. A number of seeds panicle^{-1} was not influenced by fertilizer treatment. The seed yield plant^{-1} and ha^{-1} also increased significantly by the application of 80 kg P_2O_5 ha^{-1}. The improvement in yield of stover was not significant by increasing the fertilizer dose beyond the 40 kg P_2O_5 ha^{-1}.

The yield advantages through adequate nourishment of 180 kg N and 80 kg P_2O_5 ha^{-1} through improvement in yield components by uninterrupted supply of these most vital nutrient elements was observed. Krishnasamy and Ramaswamy (1986) reported that the availability of nitrogen induced the formation of

Table 2. Effect of nitrogen and phosphatic fertilizers on yield component of MS-27 A (Seed parent) of CSH-16 sorghum hybrid.

Treatments	Yield components				Yield (q ha^{-1})	
	Panicle length (cm)	Number of seeds plant^{-1}	100 seed weight (g)	Seed yield plant^{-1} (g)	Seed	Stover
Nitrogen (kg ha^{-1})						
N_0	25.7	470	3.2	25.5	14.30	14.50
N_{60}	27.9	524	4.3	28.2	17.20	17.99
N_{120}	34.3	591	5.3	34.1	20.85	20.45
N_{180}	36.4	640	5.3	38.8	22.06	21.9
SE (m) ±	0.9	33	0.2	0.9	0.41	1.80
CD at 5%	1.9	69	0.4	1.9	0.85	3.80
Phosphorus (kg ha^{-1})						
P_0	28.00	535	4.5	29.1	17.9	15.91
P_{40}	30.1	572	4.6	31.0	22.1	20.29
P_{80}	32.5	582	5.3	33.5	23.0	21.71
P_{120}	33.5	595	5.5	34.5	23.4	22.35
SE (m) ±	0.9	33	0.2	0.9	0.41	1.80
CD at 5%	1.9	NS	0.4	1.9	0.85	3.80
Interaction						
SE (m) ±	40.0	68	0.8	1.9	0.83	3.75
CD at 5%	1.9	NS	NS	NS	NS	NS

protein and enzymes in adequate quantities, which acted on the metabolites in the leaves and stem enhancing their conversion, transportation and accumulation in the seeds. The parental lines for CSH-14 sorghum hybrid seed production needed a high dose of 150 kg N ha^{-1} (Kumar, 1997). The study indicated that the parental lines for CSH-16 sorghum hybrid seed production should be fertilized with 180 kg N and 80 kg P_2O_5 to realize high seed and stover yield.

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Character Association and Component Analysis in Aromatic Rice Accessions From Chhattisgarh and Madhya Pradesh

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ABSTRACT

Association analysis studies indicated that grain yield plant^{-1} had positive significant correlation with ear bearing tiller plant^{-1}, filled grains per panicle, plant height and days to 50 per cent flowering. The positive and significance correlation of head rice recovery percentage was also observed with plant height, filled grains panicle^{-1}, panicle length, ear bearing tillers and elongation ratio. Path coefficient analysis revealed that direct selection for days to 50 per cent flowering, ear bearing tillers plant^{-1} and filled grain panicle^{-1} would likely be effective for increasing grain yield. Direct selection for elongation ratio, panicle length, filled grains panicle^{-1} and ear bearing tillers panicle^{-1} would increase head rice recovery. This study indicated that there are no common causal factors that directly influenced grain yield plant^{-1} and head rice recovery percentage. Although, filled grains panicle^{-1} and ear bearing tillers plant^{-1} could be used as selection criteria for the simultaneous improvement of both traits.

Knowledge of association of yield components with yield and among themselves is of paramount importance in formulating effective selection programme for crop improvement. Hence, it is necessary to know the extent of genetic variability present in plant populations. The greater the genetic diversity in the material, larger would be scope for improvement. The inter relationship of component characters of yield provide the information about the likely consequences of selection for simultaneous improvement of disirable characters under selection. Therefore, direct selection for yield is often not effective. Thus, it is essential to study the association ofyield components with yield, which are prone to environmental influence. Hence, a study was made to partition the overall variance into heritable and non-heritable components with the help of suitable genetic parameters, to sutdy the association of different quantitative characters with grain yield and work out path coefficient analysis.

MATERIAL AND METHODS

The material for this study consisted of 128 aromatic rice germplasm from Chhattisgarh and Madhya Pradesh states in India along with seven cultivars. The material was grown in a randomized complete block design with two replications. Each line was grown in 4.2 m long rows at spacing of 20 cm between rows and 20 cm between plants in rows. The experiment was conducted during the wet season 2000. Urea, super phosphate and murate of potash were applied at the rate of 60, 40 and 20, kg ha^{-1}, respectively. Observations were recorded on five randomly selected plants in each line replication^{-1} for twenty traits viz. days to 50 per cent flowering, plant height, ear bearing tillers plant^{-1}, panicle length, filled grains panicle^{-1} unfilled grains panicle^{-1}, 1000 grains weight paddy length, paddy length : breadth ratio, brown rice length, brown rice length : breath ratio, kernel length, kernel length : breadth ratio, kernel length of cooked rice, kernel length : breadth ratio of cooked rice, elongation ratio, alkali spreading value, amylose content, head rice recovery and grain yield plant^{-1}. Hundred gram paddy of each genotypes was taken in duplicate and shelled in a Satake laboratory dehusker and milled in sample McGill Miller No. 1 under standard condition (Indudhara Swamy *et. al.*, 1984) to about 8 per cent degree of milling recovery was determined after separating broken (3/4th grain or less) from the milled rice in duplicate. Alkali spreading value was measured in terms of alkali disintegration using a '7' point numerical scale as suggested by Little *et. al.*, (1958). The amylose content was determined by Juliano (1971) method with kernel moisture stabilized 20^{0}C and hundred milligrams weighed in duplicate and samples of each entry were analysised. The milled rice was cooked as per the method of Juliano and Perez (1984). Elongation ratio was derived by dividing the mean L/B ratio of cooked rice to the mean L/B of milled rice (Juliano and Perez, 1984). Genotypic and phenotypic correlation coefficient for all

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possible comparisons were computed as per the formula suggested by Miller *et. al.*, (1958). The partitioning of genotypic correlation coefficient of traits into direct and indirect effect was carried out using the procedure suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The analysis of variance revealed significant difference within the aromatic rice germplasm for all the traits studied except panicle length (Table 1). The genotypic correlation in general is slightly higher than the corresponding phenotypic correlation (Table 2). This is due to modified effect of environment on characters association at the genetic level. Grain yield plant^{-1} exhibited highly positive and significant correlation with ear bearing tillers plant^{-1}, filled grains panicle^{-1} , plant height and days to 50 per cent flowering at both genotypic and phenotypic levels. This indicates the relative utility of all these traits for selection with respect to grain yield plant^{-1}. This was in conformity with the finding of Ganapathy et. al., (1994), Sarawgi et al. (2000) and Anna Durai (2001) for ear bearing tillers per plant. Sarawgi et al. (1996) and Rao and Shrivastava (1999) reported the significant positive association of filled grains per panicle with grain yield per plant. Head rice recovery percentage had significant and positive association with plant height, filled grains per panicle, length, ear bearing tillers per plant and elongation ratio at genotypic and phenotypic levels whereas head rice recovery percentage as also showed negative and significant association with 1000 grains weight, paddy length, brown rice length, brown rice length: breadth ratio, kernel length, kernel length: breadth ratio, kernel legnth, kernel length : breadth ratio, kernel of cooked rice, kernel length : breadth ratio of cooked rice and amylose content at genotypic and phenotypic level. The findings of negative and significant association of head rice recovery with length : Breadth ratio of grain are in agreement with the finding of Goswami *et. al.*, (2000).

In the present study, path coefficient analysis has been conducted taking grain yield as dependent variable. Plant coefficient analysis revealed that kernel length had highest positive direct effect on grain yield, followed by filled grains per panicle, ear bearing tillers plant^{-1}, paddy length : breadth ratio, elongation ratio, days to 50 per cent flowering, 1000 grains weight, panicle length and amylose content (Table 3). Similar result was also observed by Satyavathi *et. al.*, (2001). The correlation analysis did not reveal any association of grain yield plant^{-1} with kernel length. This may be due to high negative indirect effects via kernel length : breadth ratio and kernel length of cooked rice. The characters filled grain panicle^{-1}, ear bearing tillers plant^{-1} and days to 50 per cent flowering had positive direct effect and exhibited significant positive correlation with grain yield, indicating the true relatiohsip among these traits. This may indicate that the direct selection for filled grains panicle^{-1}, ear bearing tillers plant^{-1} and days to 50 per cent flowering would likely be effective in increasing grain yield.

Positive direct effects of various characters on grain yield observed in the present study are in accordance with the finding of Babu (1996) and Kumar *et. al.*, (1998) for filled grains panicle^{-1} and Babu (1996) for bearing tillers. Plant height had a low negative direct effect but exhibited positive significant correlation with grain yield plant^{-1} due to positive direct effect of ear bearing tillers plant^{-1} , panicle length, filled grains panicle^{-1} and elongation ratio. Babu (1996) and Nandrajan and Kumarvelu (1994) also reported negative direct effects of plant height on grain yield per plant. The ideotype to increase grain yield in rice should have more fertile spikelets panicle^{-1} , ear bearing tillers, more thousand grain weight, greater grain length, less breadth and low spikelet sterility percentage.

The direct and indirect effect of different characters on head rice recovery percentage are presented in Table 4. The highest positive direct effect of kernel length was followed by elongation ratio, panicle length, paddy length : breadth ratio and paddy length. Kernel length, paddy length:breadth ratio and paddy length exhibited negative correlation with head rice recovery percentage. This is due to the negative indirect effect of kernel length via panicle length, filled grains per panicle and elongation ratio, the negative indirect effect of paddy length: breadth ratio via, kernel length: breadth ratio, filled grains per panicle, brown rice length: breadth ratio and kernel length of cooked rice and the negative indirect effect of paddy length via kernel length: breadth ratio, filled grains per panicle, elongation ratio and brown rice length: breadth ratio. The characters ear bearing tillers per plant, panicle length, filled grains per panicle and elongation ratio had the positive direct effect and also revealed significant positive correlation with head rice recovery percentage indicating true relationship. This suggested that the selection for ear bearing tillers per plant, panicle length, filled grains per panicle and elongation ratio would likely bring the improvement in head rice recovery.

Table1 : Analysis of variance for morphological and quality characters

SV	df	1	2	3	4	5	6	7	8	9	10
Replication	1	0.001	6.50	.0082	21.18	82.00	12.65	1.27	0.0478	0.076	0.0302
Treatments	134	100.86*	523.30**	3.19**	36.46	2017.30**	96.42**	21.30**	2.61**	0.841**	1.683**
Errors	134	0.067	1.39	0.1289	10.62	70.21	4.19	0.077	0.0011	0.0014	0.0023

SV	df	1	2	3	4	5	6	7	8	9	10
Replication	1	0.0008	0.135	0.044	0.068	0.041	0.003	0.0034	0.146	0.187	0.316
Treatments	134	0.065**	1U16**	0.48**	1.71**	0.356	0.044**	0.425**	7.803**	45.90**	9.46**
Errors	134	0.036	0.0076	0.0028	0.001	0.0036	0.0007	0.00006	0.024	0.070	0.439

**Significant at 1% level *Significant at 5% level

6- Unfilled grain percenteg 7- Thousand grain weight (gm) 8- paddy length (mm) 9- paddy length :breadth ratio 10- Brown rice length 11- Brown rice length :breadth ratio 12-Kernel length 13- Kernel length :breadth ratio 14- Kernel length of cooked rice 15- Kernel length :breadth ratio of cooked rice 16- Elongation ratio 17- Amyiose content (mm) 18- alkaili sorending valie 19- head rice recovery (%) 20- Graiin yield per plant (gm)

Table 2. Gentypic (G) and Phenotypic (P) correlation for morphological and quality traits

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
1	P	0.016	-0.117	-0.051	0.375**	0.171*	-0.312**	-0.274**	-0.085-	-0.207	-0.054	-0.246**	-0.115	-0.220	-0.040	0.059	-0.185*	-0.013	0.021	0.192**
	G	0.016	-0.122	-0.067	0.388**	0.179*	-0.313**	-0.274**	-0.085	-0.208*	-0.057	00.247**	-0.115	-0.220**	-0.041	0.059	-0.185*	-0.013	0.022	0.221*
2	P		0.379**	0.518**	0.166*	-0.098	-0.179*	-0.383**	-0.377**	-0.370**	-0.401**	-0.335**	-0.405**	-0.250**	-0.259**	-0.206*	-0.148	-0.153	0.320**	0.218**
	G		0.396**	0.697**	0.172*	-0.104	-0.180*	-0.384**	-0.378**	-0.372**	-0.425**	-0.339**	-0.410**	-0.251**	-0.260**	0.212*	-0.149	-0.154	0.321**	0.227**
3	P			0.215*	-0.081	0.015	-0.192*	-0.118	-0.061	-0.130	-0.085	-0.106*	-0.037	-0.152	-0.026	-0.011	-0.103	-0.166*	0.173*	0.247**
	G			0.286**	-0.088	0.011	-0.201*	-0.124	-0.063	-0.135	-0.093	-0.114	-0.040	-0.159	-0.030	-0.008	-0.107	-0.175*	0.174*	0.271**
4	P				0.181*	0.050	-0.192*	-0.295**	-0.250**	-00.228*	0.215*	-0.223-	0.215**	-0.178*	-0.133	-0.131	-0.288**	-0.125	0.336**	0.088
	G				0.248**	0.069	-0.253*	-0.398**	-0.339**	-0.314**	-0.315-	0.302	-0.287	-0.245**	-0.175*	0.173*	-0.309**	-0.167*	0.447**	0.144
5	P					-0.206*	-0.494**	-0.523**	-0.339**	-0.48**	-0.303**	-0.473**	-0.320**	-0.401**	-0.260**	0.212*	-0.129	0.051	0.269**	0.311**
	G					-0.224**	-0.511**	-0.353**	-0.541**	-0.498**	-0.498**	-0.493**	-0.332**	-0.415**	-0.271**	0.223**	-0.134	0.053	0.279**	0.314**
6	P						0.019	0.119	0.149	0.120	0.139	0.128	0.168	0.119	0.160	-0.064	-0.036	-0.017	0.040	-0.126
	G						0.022	0.125	0.156	0.126	0.157	0.136	0.183*	0.123	0.172*	-0.071	-0.037	-0.020	0.042	-0.136
7	P							0.706	0.420**	0.609**	0.367**	0.605**	0.365**	0.603**	0.356**	-0.138	0.231**	-0.117	-0.348**	0.035
	G							0.709	0.423**	0.612**	0.392**	0.610**	0.368**	0.605**	0.362**	-0.139	0.232**	-0.117	-0.350**	0.036
8	P							0.854**	0.875**	0.742**	0.872**	0.756**	0.697**	0.584**	-0.0451**	0.307**	0.025	-0.476*	0.023	
	G								0.857**	0.877**	0.784**	0.879**	0.760**	0.698**	0.590**	-0.459**	0.308**	0.025	-0.478**	0.025
9	P								0.780	0.820**	0.773**	0.815	0.570**	0.565**	-0.459**	0.168*	0.051	-0.411**	0.094	
	G									0.783**	0.869**	0.781**	0.822**	0.571**	0.572**	-0.470**	0.168*	0.051	-0.412**	0.097
10	P										0.806**	0.939**	0.829**	0.714**	0.617	-0.516*	0.272**	0.045	-0.553**	0.013
	G										0.853**	0.946**	0.835**	0.716**	0.624**	-0.524**	0.273**	0.045	-0.555**	0.014
11	P										0.778**	0.830**	0.550**	0.561**	0.484**	0.201*	0.041	-0.477***	0.037	
	G											0.829**	0.886**	0.583*	0.599**	-0.520**	-0.213*	0.043	-0.507**	0.033
12	P												0.885**	0.774**	0.625**	-0.538**	0.319**	0.050	-0.502**	0.028
	G												0.887**	0.779**	0.635**	-0.530**	0.321**	0.050	-0.506**	0.038
13	P													0.624**	0.634**	-0.564**	0.256**	0.085	-0.456**	0.012
	G													0.628**	0.644*	-0.563**	0.257**	0.085	-0.460**	0.021
14	P														0.651**	0.105	0.342**	-0.103	-0.461**	0.107
	G														0.660**	0.105	0.342**	-0.103	-0.461**	0.112
15	P															-0.130	0.241**	-0.065	-0.336**	0.022
	G															-0.132	0.244**	-0.066	-0.340	0.023
16	P																-0.056	-0.218**	0.213*	0.115
	G																-0.057	-0.222**	0.217*	0.109
17	P																	0.190*	-0.201*	0.037
	G																	0.191*	-0.201*	0.037
18	P																		-0.042	-0.121
	G																		-0.042	-0.127
19	P																			-0.001
	G																			0.001

** Significant at 1% level * Significant at 5% level

1- day to 50 per cent flowering 2- plant height (cm) 3- Ear bearing tiller plant $^{-1}$ 4- panicle length (cm) 5- Filled grainper panicle 6-Unfilled grain percentage 7- Thousand grain wt. 8-Paddy length 9- PaddyL.B.ratio 10- Brow rie length 11- Brown rice L.B ratio 12 Kernel length 13 nKernel L:B ratio 14- Kernel length of cookedrice 15-Kernel L:B ratio of coked rice 16- Elongation ratio 17- Amylose content

Table 3. Path confficent showing direct and indirect effect of different Character on grain yield per plant

SN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	rg
1	0.293	0.000	-0.053	-0.009	0.191	-0.019	-0.062	0.012	-0.034	0.014	0.008	-0.220	0.040	0.035	0.007	0.019	-0.019	0.000	-0.001	0.021
2	0.005	-0.026	0.172	0.099	0.085	0.011	-0.036	0.017	-0.152	0.026	0.061	-0.302	0.144	0.040	0.044	0.069	-0.015	0.005	-0.018	0.227
3	-0.036	-0.010	0.433	0.040	-0.43	-0.001	-0.040	0.006	-0.025	0.009	0.013	-0.102	0.014	0.025	0.005	-0002	-0.011	0.006	-0.010	0.271*
4	-0.019	-0.018	0.124	0.142	0.122	-0.007	-0.050	0.018	-0.137	0.022	0.045	-0.269	0.101	0.039	0.030	0.056	-0.032	0.006	-0.025	0.144
5	0.114	-0.004	-0.038	0.035	0.491	0.024	-0.102	0.024	-0.142	0.034	0.048	-0.439	0.117	0.065	0.046	0.072	-0.014	-0.002	-0.016	0.314**
6	0.052	0.003	0.005	0.010	-0.110	-0.106	0.004	-0.006	0.063	-0.009	-0.023	0.122	-0.064	-0.19	-0.029	-0.023	-0.004	-0.001	-0.002	-0.136
7	-0.092	0.005	-0.087	-0.036	-0.251	-0.002	0.199	-0.032	0.170	-0.042	-0.056	0.544	-0.129	-0.095	-0.061	-0.045	0.024	0.004	0.020	0.036
8	-0.080	0.010	-0.054	-0.056	-0.266	-0.013	0.141	0.045	0.345	-0.060	-0.113	0.783	-0.267	0.110	0.0100	0.149	0.032	-0.001	0.027	0.025
9	-0.025	0.010	-0.027	-0.048	-0.173	-0.017	0.084	-0.039	0.403	-0.054	-0.125	--0.696	-0.288	-0.090	-0.097	-0.153	0.017	-0.002	0.023	0.097
10	-0.061	0.010	-0.059	-0.044	-0.245	-0.013	0.122	-0.040	0.316	-0.069	-0.123	0.843	-0.293	-0.113	-0.106	-0.170	0.028	-0.002	0.031	0.014
11	-0.017	0.011	-0.040	-0.045	-0.166	-0.017	0.078	-0.035	0.350	0.059	-0.144	0.739	-0.311	-0.092	-0.101	-0.169	0.022	-0.002	0.029	0.033
12	-0.072	0.009	-0.049	-0.043	-0.242	-0.014	0.121	-0.040	0.315	-0.065	-0.119	0.892	-0.311	-0.123	-0.108	-0.172	0.033	-0.002	0.029	0.038
13	-0.034	0.011	-0.017	-0.041	-0.163	-0.019	0.073	-0.034	0.331	-0.057	-0.127	0.791	-0351	-0.099	-0.109	-0.183	0.027	-0.003	0.026	0.021
14	-0.064	0.007	-0.069	-0.035-	-0.204	-0.013	0.120	-0.031	0.230	-0.049	-0.084	0.695	-0.220	-0.158	-0.112	0.034	0.035	0.004	0.026	0.112
15	-0.012	0.007	-0.013	-0.025	-0.133-	0.018	0.072	-0.027	0.230	0.043	-0.086	0.566	-0.226	-0.104	-0.169	-0.043	0.025	0.002	0.019	0.023
16	0.017	-0.006	-0.003	0.025	0.109	0.007	-0.028	0.021	-0.189	0.036	0.075	-0.473	0.198	-0.017	0.022	0.325	-0.006	0.008	-0.012	0.109
17	-0.054	0.004	-0.046	-0.044	-0.066	0.004	0.046	-0.014	0.068	-0.019	-0.031	0.286	-0.090	-0.054	-0.041	-0.018	0.104	-0.007	0.011	0.039
18	-0.004	0.004	-0.076	-0.024	0.026	0.002	-0.023	-0.001	-0.020	-0.003	-0.006	0.045	-0.030	0.016	0.011	-0.072	0.020	-0.035	-0.127	0.002
19	0.006	-0.008	0.075	0.063	0.137	-0.004	-0.070	0.022	-0.166	0.038	0.073	-0.451	0.162	0.073	0.058	0.070	-0.021	0.001	-0.057	0.001

Residual effect =0.5525

1 - Dyas to 50 per cent flowering, 2 - F, 3 - Ear bearing tiller plant^{-1}, 4- Panicle length (cm), 5 - Filled grain per panicle, 6 - Unfilled grain percentage, 7 - Thousand grain weight, 8 - Paddy length, 9 - Paddy length : breadth ratio, 10 - Brown rice length , 11- Brown rice length : breadth ratio, 12 - kernel length, 13- kernel length :breadth ratio 14- Kernel length of cooked rice, 15 - Kernel length : breadth ratio of cooked rice, 16 - Elongation ratio, 17 - Amylose content, 18 - Alkali spreading value, 19 - Head rice recovery percentage rg-Grain yield per cent.

Table 4: Path confficient showing direct and indirect effect of different charecter on Head Rice Recovery percentage

SN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	rhrr
1	0.035	-0.003	-0.004	-0.027	0.010	0.015	0.013	-0.046	-0022	0.0156	0.021	-0.605	0.017	0.414	-0.003	0.071	-0.012	0.000	-0.010	0.022
2	00.01	-0.178	0.012	0.283	0.004	-0.008	0.008	-0.064	-0.098	0.280	0.160	-0.831	0.060	0.473	-0.017	0.258	-0.010	0.003	-0.012	0.321**
3	-0.004	-0.071	0.029	0.116	-0.002	0.001	0.009	-0.021	-0.016	0.102	0.035	-0.279	0.006	0.300	-0.002	-0.009	-0.007	0.003	-0.014	-0.174*
4	-0.002	-0.124	0.008	0.405	0.006	0.006	0.011	-0.066	-0.088	0.236	0.118	-0.741	0.042	0.463	-0.012	0.211	0.021	0.003	0.007	0.447**
5	0.014	-0.031	-0.003	0.100	0.025	-0.018	0.022	-0.090	-0.092	0.375	0.127	-1.209	-0.048	-0.788	-0.018	0.271	0.009	-0.001	-0.016	0.279**
6	0.006	0.019	0.000	-0.028	-0.006	0.081	-0.001	0.021	0.041	-0.095	-0.059	0.334	-0.027	-0.232	0.011	-0.086	-0.003	0.000	0.007	0.042
7	-0.011	0.032	-0.006	-0.103	-0.013	0.002	-0.043	0.118	0.110	-0.460	-0.147	1.496	-0.054	0.142	0.024	-0.170	0.016	0.002	-0.002	-0.35**
8	-0.010	0.068	-0004	-0.161	-0.014	0.010	-0.030	0.166	0.223	-0.659	-0.295	2.155	-0.111	-1.316	0.039	-0.559	0.021	0.000	-0.001	-0.478*
9	-0.003	0.067	-0.002	-0.137	-0.009	0.013	-0.018	0.142	0.260	-0.589	-0.326	-1.915	-0.119	-1.077	0.038	-0.572	0.011	-0.001	-0.005	-0.412*
10	-0.007	0.066	-0.004	-0.127	-0.013	0.010	-0.026	0.145	0.204	-0.752	-0.320	2.319	-0.121	-1.350	0.041	-0.673	0.018	-0.001	-0.001	-0.555*
11	-0.002	0.076	-0.003	-0.127	-0.009	0.013	-0.017	0.130	0.226	-0.641	-0.376	2.033	-0.129	-1.100	0.040	-0.633	0.014	-0.001	-0.002	-0.507*
12	-0.009	0.060	-0.003	-0.122	-0.013	0.011	-0.026	0.146	0.203	-0.711	-0.311	2.452	-0.129	-1.470	0.042	-0.646	0.022	-0.001	-0.002	-0506*
13	-0.004	0.073	-0.001-	0.116	-0.008	0.015	-0.016	0.126	0.214	-0.628	-0.333	2.176	-0.145	-1.184	0.043	-0.686	0.017	-0.001	-0.001	-046**
14	-0.008	0.045	-0.005	-0.099	-0.011	0.010	-0.026	0.116	0.149	-0.538	-0.219	1.911	-0.091	-1.886	0.044	0.128	0.023	0.002	-0.006	-0.461*
15	-0.001	0.047	0.001	-0.071	-0.007	0.014	-0.015	0.098	0.149	-0.469	-0.225	1.558	-0.094	-1.244	0.066	-0.160	0.016	0.001	-0.001	-0.34**
16	0.002	-0.038	0.000	0.070	0.006	-0.006	0.006	-0.076	-0.122	0.394	0.196	-1.301	0.082	-0.198	-0.009	1.217	-0.004	0.004	-0.006	0.218*
17	-0.006	0.026	-0.003	-0.125	-0.003	-0.003	-0.010	0.051	0.044	-0.205	-0.080	0.787	-0.037	-0.645	0.016	-0.069	0.067	-0.003	-0.002	-0.201*
18	0.000	0.027	-0.005	-0.068	0.001	-0.002	0.05	0.004	0.013	-0.034	-0016	0.123	-0.012	0.194	-0.004	-0.270	0.013	-0.017	0.006	-0.042
19	0.007	-0.040	0.08	0.058	0.008	-0.011	-0.022	0.004	0.025	-0.010	-0.012	0.093	-0.003	-0.212	0.002	0.133	0.002	0.002	-0.051	0.001

Residual efect = 0.4987

1- Days to 50 per cent flowering 2-F

6- Unfilled grain percentage 7- Thousand grain weight 8- Paddy length 9- Paddy length :breadth ratio 10- Brown rice length

11- Brown rice length :breadth ratio 12- Kernel length 13- Kenel length breadth ratio 14- Kernellength of cooked rice

15- Kernel length :breadth ratio of cooked rice 16- Elongaion ratio 17- Amylose content 18-Alkali spreading value

19- Grain yield per plant rhrr- Head recovery percentage.

The path analysis indicate that there is no common causal factor that directly influence both grain yield and head rice recovery, although, filled grains per panicle and ear bearing tillers per plant could be used as selection criteria for the simultaneous improvement of both traits.

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Genetic Variability Studies in Some Grain Mould Tolerant Sorghum Genotypes

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ABSTRACT

The various genetic variability parameters were estimated using 20 derived sorghum (*Sorghum bicolor* L. Moench) lines along with two susceptible lines, two resistant lines and two moderately resistant lines as checks. Heritability estimates in broad sense were high in magnitude for the characters i.e. specific gravity, plant height, grain yield plant^{-1}, endosperm texture, electrical conductivity and water absorption rate. High expected genetic advance noted in characters grain yield plant^{-1}, panicle breadth and 100 seed weight. The magnitude of phenotypic coefficient of variation were higher than genotypic coefficient of variation.

Grain moulds constitute one of the most important constraints to sorghum quality improvement and production changes in physical properties of the grain occur because of alternate wetting and drying. Prolonged rainfall, high humidity, high temperature and alternate periods of wetting and drying before and after physiological maturity of the grain all favour grain deterioration by infestation of moulds. Koteswara Rao and Poornachandradu (1977), Rao and Williams (1977), Aziz (1980). Hence, the breeders ought to develop grain mould tolerant genotypes of sorghum. The effectiveness of selection in any crop depends upon the extent and nature of phenotypic and genotypic variability present in different traits of the population. The present studies were undertaken to estimate the genetic variability among some of the derived Akola Grain Mould Resistance (AKGMR) lines.

MATERIAL AND METHODS

The experimental material comprised of 20 derived lines viz. AKGMR-24, 25, 26, 28, 29, 33, 34,36, 37, 38, 39, 40, 41, 42, 51, 52, 53, 54, 55, 56 two susceptible lines AKMS-14B and B-296, two resistant lines GMRP-4 and IS-14332 and two moderately resistant lines PVK-801 and PVK-809 as checks of sorghum obtained from Sorghum Research Unit, Dr. PDKV, Akola (M.S.). These lines were sown in Randomized block design with three replications during *Kharif* 2002. The observations were recorded on five randomly selected plants from each genotype per replication on sixteen characters. viz. days to 50 per cent flowering, plant height (cm), panicle length (cm), panicle breadth (cm), threshed grain mould rating (TGMR), 100 seed weight (g), seed hardness (kg cm^2), specific gravity (g ml^1), electrical conductivity (d sm^{-1}), water absorption rate (ml), germination percentage, endosperm texture (%), *Curvularia* spp. (%), *Fusarium* spp. (%), other fungi spp. (%) and grain yield plant^{-1} (g) for grain yield and yield contributing components.

The various genetic parameters such as genotypic and phenotypic coefficients of (GCV and PCV) variation (Burton, 1952), heritability estimtes in broad sense (Johnson, *et. al.*, 1955), expected genetic advance (Johnson, *et. al.*, 1955), electrical conductivity of the grain leachates was measured using method of Hendricks and Taylorson (1976) with some modification. The fungal load of *Fusarium* spp., *Curvularia spp.*, and other mould spp., Standard Blotter Paper Method (SBM) of ISTA (1976) was used.

RESULTS AND DISCUSSION

The data pertaining to various genetic parameters are presented in Table 1. The values of genotypic coefficient of variation ranged from 3.08 per cent for electrial conductivity to 26.16 per cent for grain yield plant^{-1}. The characters viz. plant height, water absorption rate, TGMR and panicle length exhibited high estimates of genotypic coefficients of variation. The remaining characters showed low amount of variation. The high estimates of genetic variation were also reported by Raut *et. al.*, (1994), and Bhongle *et. al.*, (2002), for

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Table 1. Estimates of genotypic, phenotypic coefficient of variation, heritability and expressed genetic advance over mean

S.N.	Characters	Mean	Range		Genetopic coefficient of variation (%)	Phenotypic coefficient of variation (%)	Heritability estimates (%)	Expected genetic advances over % of mean
			Minimum	Maximum				
1.	Days to 50 % flowering	71.77	65.05	78.25	4.29	5.43	62.30	5.01
2.	Plant height (cm)	239.13	121.22	333.14	23.73	24.32	95.21	114.05
3.	Panicle length (cm)	20.61	16.00	24.44	9.68	12.82	57.08	3.11
4.	Panicle breadth (cm)	5.17	4.39	6.02	7.90	9.62	67.49	0.69
5.	TGMR	2.64	2.36	3.47	9.89	14.94	43.75	0.36
6.	100 - seed weight (g)	3.18	2.78	3.42	3.08	5.48	31.72	0.11
7.	Seed hardness (kg $cm^2)^{-1}$	7.22	6.27	7.96	4.51	7.03	41.13	0.43
8.	Specific gravity (g ml^{-1})	1.19	1.02	1.47	8.93	9.05	97.39	0.22
9.	Electrical conductivity (dSm^{-1})	126.24	119.33	138.10	3.28	3.84	72.90	7.27
10.	Water absorption rate (ml)	0.63	0.49	0.74	11.91	13.97	72.74	0.13
11.	Germination percentage	61.49	50.09	65.71	6.16	9.23	44.51	5.21
12.	Endosperm texture (%)	43.30	36.86	47.72	5.29	5.76	84.43	4.33
13.	*Curvularia* spp. (%)	32.90	26.99	38.84	6.26	13.07	22.90	2.03
14.	Fusarium spp. (%)	26.71	21.59	30.86	9.38	12.32	58.00	3.93
15.	Other fungi spp. (%)	20.76	17.44	23.30	5.67	8.97	40.02	1.51
16.	Grain yield $plant^{-1}$ (g)	47.15	15.36	67.11	26.16	28.01	87.27	23.98

plant height, Rao and Patel (1996) for grain yield plant^{-1} and plant height. Phenotypic values coefficient of variation ranged from 3.84 per cent for electrical conductivity to 28.16 per cent for grain yield plant^{-1}. The chatacters viz., plant height, threshed grain mould rating (TGMR), water absorption rate, exhibited high estimates of phenotypic coefficient of variation. The magnitudes of phenotypic coefficient of variation were higher than genotypic coefficient of variation. Similar type of results were obtained by Raut *et. al.* (1994), Rao and Patel (1996) and Bhongle *et. al.*, (2002).

The highest estimates of heritability were observed in specific gravity (97.39%), followed by plant height (95.21%), grain yield plant^{-1} (87.27%), endosperm texture (84.43%), electrical conductivity (72.90%), water absorption rate (72.74%), panicle breadth (67.49%), days to 50 per cent flowering (62.30%), Fusarium infection (58.00%) and panicle length (57.08%). This indicates that the remaining characters are more influenced by environmental fluctuations. A relative comparison of heritability estimates and expected genetic advance will give an idea about the nature of gene action governing a particular character. A comparison of these two estimates made in this study revealed that plant height, grain yield plant^{-1} and electrical conductivity had high heritability estimates coupled with high genetic advance indicating the substantial contribution of additive genetic variance in the expression of these characters. Rest of the characters showed low heritability estimtes coupled with low genetic advance indicating the significant contribution of non-dditive gene action observed for these characters. High heritability estimates observed in the present investigation are in accordance with the finding of Dadeech *et. al.*, (1999) for grain yield plant^{-1}. Similar types of result for heritability were reported by Bhongle (2002) for plant height and grain yield plant^{-1}. From an overall observation of findings of heritability estimates and genetic advance, it could be concluded that the selection criteria based on plant height and grain yield plant^{-1} will serve the purpose of improvement of grain yield in sorghum.

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Determinants of Knowledge and Adoption of Paddy Growers About Integrated Pest Management Practices

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ABSTRACT

The assessment of knowledge and adoption of IPM practices of paddy in Tumsar Panchayat Samiti of Bhandara district showed that majority of the paddy growers had medium level of knowledge and adoption of these practices. The major determinants of knowledge were education and annual income and that of adoption were age, education and knowledge. It has indicated a need for equipping the paddy growers with requisite knowledge about IPM practices with a view to promote their adoption.

The levels of yield in paddy are generally determined by the efforts of farmers to manage insect pests and diseases. The farmers are expected to discontinue the indiscriminate use of pesticides and fungicides on paddy. Rather they are required not only to rely on chemicals but should also make use of other pest management practices. It not only brings the expenditure at minimum but are ecofriendly. The per hectare yield levels in paddy are comparatively low due to inadequate knowledge on the part of paddy growers about pest and disease attack and the adoption of various pest and disease management practices recommended under integrated pest management approach.

Efforts were therefore made in the present study to ascertain the level of knowledge and adoption of IPM practices by the paddy growers and to identify the factors determining them.

MATERIAL AND METHODS

Tumsar Panchayat Samiti of Bhandara district in Maharashtra state was purposively selected for study because of higher area under paddy during 2000-2001. A sample of 150 paddy growers was drawn by using probability proportionate random sampling method from fifteen villages having more area under paddy. An ex-post-facto design of social research was used and the requisite data were collected from the selected paddy growers with the help of a structured interview schedule in a face to face situation. The various integrated pest management practices identified and recommended by Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola were considered for the construction of knowledge test. The knowledge test had 31 questions with bipolar responses as correct/incorrect or yes/no with a score of one and zero, respectively. Considering the knowledge score earned by each farmer, the knowledge index was worked out. Adoption was ascertained by developing 20 questions related to the recommended IPM practices of paddy. Each question was having a three point response i.e. adopted on complete potential area, adopted on some of the potential area and non-adoption with a score of 2, 1 and 0, respectively. The adoption score earned by each farmer was then converted into adoption index. Considering the mean and standard deviation of the distribution, the paddy growers were classified into three levels of knowledge and adoption as low, medium and high.

RESULTS AND DISCUSSION

1. Profile of paddy growers

The paddy growers under study were observed to be mostly mediocre with regard to various characteristics. Higher percentage of them were above 35 years of age and literate (89.33%) with a landholding and area under paddy in the range of 2.01 to 4.00 ha and an annual income in between Rs. 25,001 to 50,000(56%). They were medium in social participation (73.33%), socio-economic status (60%), use of source of information about IPM practices (67.33%), risk preference (88.00%) and economic motivation (68.00%).

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2. Extent of knowledge and adoption of IPM practices of paddy

The categorization of paddy growers on the basis of knowledge in Table 1 shows that majority of them belonged to medium category (63.33%). Nearly equal percentage of paddy growers were found to be having high and low level of knowledge. These findings are at par with the findings of Chandra (2001) and Vijayalayan (2001). The paddy growers in majority in the present study were found to be mostly aware about cultural and mechanical practices and use of brine solution for paddy seed treatment under IPM practices. However, they were found to be poor in knowledge in chemical and biological practices recommended for management of insect-pest and diseases of paddy.

Table 1. Extent of knowledge and adoption of IPM practices by paddy growers

S.N.	Category	Frequency (n = 150)	Percentage
1	**Knowledge**		
	Low	27	18.00
	Medium	95	63.33
	High	28	18.67
2.	**Adoption**		
	Low	33	22.00
	Medium	93	62.00
	High	24	16.00

Regarding adoption of IPM practices in paddy, it was observed that 62 per cent paddy growers belonged

Table 2. Determination of knowledge and adoption of integrated pest management practices by paddy growers

S.N.	Characters	Knowledge about IPM practices			Adoption of IPM practices		
		Coefficient of correlation 'r'	Regression coefficient 'b'	't' value of 'b' 'r'	Coefficient of correlation	Regression coefficient 'b'	't' value of 'b'
1.	Age	-0.745**	0.345 (0.197)	1.79	-0.712**	0.384* (1.181)	2.121
2.	Education	0.823**	3.820** (0.510)	7.481	0.769**	2.614** (0.469)	5.565
3.	Land holding	0.176*	0.797 (1.181)	0.675	0.203*	0.358 (1.086)	0.330
4.	Area under paddy	0.161*	6.106 (3.130)	1.844	0.194*	1.088 (3.044)	0.857
5.	Annual income	0.141	0.000 (0.00)	1.972	0.188	0.00 (0.00)	0.217
6.	Social participation	0.313**	0.083 (1.119)	0.074	0.288**	0.305 (1.029)	0.296
7.	Socio-economic status	0.413**	0.559 (0.441)	1.267	0.401**	0.246 (0.405)	0.606
8.	Sources of information	0.274**	0.749 (0.534)	1.403	0.234**	0.031 (0.491)	0.624
9.	Risk preference	0.157	1.371 (0.489)	0.279	0.240**	0.7933 (0.450)	1.761
10.	Economic motivation	0.0716	0.058 (0.557)	0.103	0.092	0.014 (0.512)	0.028
11.	Knowledge				0.894**	0.667** (5.388)	12.382
		$R^2 = 0.7013^{**}$, F value = 32.63			$R^2 = 0.8212^{**}$, F value = 57.61		

to medium category of adoption.This is so because more than 50 per cent of the paddy growers were found to be only adopting cultural practices namely, burning stubbles of grasses, ploughing field after harvest of previous crop, raising nursery in the month of June, undertaking transplanting of seedlings after 20-25 days and cutting paddy close to ground level. Their adoption of mechanical, chemical and biological practices included under IPM was found to be meagre.

3. **Determinants of knowledge and adoption of IPM practices in paddy by paddy growers**

The relational analysis showed that (Table 2) the variables namely, education, land holding, area under paddy, social participation, socio-economic status and sources of information were positively and significantly related with the paddy growers' knowledge about integrated pest management practices. Thus the paddy growers with higher education, more social participation, more exposure to various sources of information about integrated pest management practices of paddy, belonging to high socio-economic status, possessing larger land holding and having more area under paddy happened to be adequately aware about integrated pest management practices of paddy.

The findings of regression analysis in Table 2 further revealed that only two variables namely, education and annual income contributed significantly towards the total variation of 70.18 per cent produced by all the ten independent variables in knowledge of paddy grower about integrated pest management practices of paddy and were found to be the important determinants of knowledge of paddy growers about IPM Practices.

The variables, namely, education, land holding, area under paddy, annual income, social participation, socio-economic status, sources of information, risk preference and knowledge were observed to be positively and significantly related with adoption of integrated pest management practices of paddy by paddy growers (Table 2). Thus, with the increase in education, land holding, area under paddy, annual income, social participation, socio-economic status, sources of information, risk preference and knowledge of individual paddy grower, there had been an increase in adoption of integrated pest management practices of paddy.

The regression analysis further indicated that only three variables viz. age, education and knowledge were found to cause significant variation and substantially contributing to the variation of 82.12 per cent in adoption of integrated pest management practices of paddy by paddy growers. It may therefore, be suggested that for promoting the adoption of IPM practices in paddy there is a need to manipulate the knowledge of paddy growers about IPM practices by organizing demonstrations, field visits and IPM training for paddy growers.

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Spatio- Temporal Analysis of Subsidies For Agricultural Inputs in India

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ABSTRACT

Subsidies are common features of economic management in most of economics in the world, both developed or developing. Subsidies in Indian economy are implicit as well as explicit and cover several social and economic sectors including education, health, transport, trade, industry and agriculture. In the present study, change in the agricultural input subsidies over the year was the main focus of study. In consonance of this focus the study was undertaken with the following objectives viz, to study the growth of agricultural input subsidies in different states of India. To examine the deviation or shift in agricultural input subsidies in different states of India over the years. For these study, secondary data for the period from 1980-81 to 1999-2000 on fertilizers, electricity, canal irrigation and total farm input subsidies under different states of India published by different publications were used. The study indicated that, all growth rates of agricultural input subsidies under different states of India were positive and significant, as that positive change was observed in agricultural input subsidies over the period of 20 years. Rank correlation between inputs at different points of time indicate that all the correlation coefficients were found significant at 1 per cent level in all agricultural input subsidies in India. The input subsidies for four components almost remain the same as compared with the status of 1980 over the last 20 years. This is clearly indicated by the coefficient of concordance which was ranging between 0.86 and 0.93 i.e. since these values are closer to 1 and significant. It implies that over the last 20 years though the input subsidies are changed in magnitude. Statistically there was no changed in agricultural input subsidies.

Subsidy, often viewed as the converse of tax, is a potent welfare augmenting instrument of any fiscal policy subsidy. Subsidy is a rebait or relaxation in the prices of inputs. Subsidies are common features of economic management in most of economics in the world, both developed or developing. India obviously is not an exception. Subsidies in Indian economy are implicit as well as explicit and cover several social and economic sectors including education, health, transport, trade, industry and agriculture. Broadly, half of the huge supposedly agricultural subsidy on fertilizers and power, amounting to more than Rs. 31000 crores and comprising 2 per cent of G.D.P. is either going to industry in the case of fertilizers or is simply being stolen by non-agricultural consumers in the case of power.

Input subsidies in Indian agriculture can be divided into two broad categories viz., explicit input subsidies and implicit input subsidies. Explicit input subsidies are payments made to the farmers to meet a part of the cost of an input. These are in the nature of explicit, payments made to the farmer. As for example, subsidy on improved or high-yielding variety seeds, plant protection chemicals, improved agricultural implements and supply of minikits containing seeds, fertilizers and plant protection chemicals for certain crops are the explicit subsidies. These are usually made available to small and marginal farmers and those belonging to scheduled castes and scheduled tribes. The objective of such subsidies is to induce the farmers to adopt yield increasing inputs so that they are able to realize the benefits of a new technology. The coverage of these subsidies in terms of crops, inputs, regions and target groups has been changing from time to time. Explicit subsidies have formed only a small fraction of the development expenditure of the Central or State Government.

As regard the implicit input subsidies are hidden in nature. This arises on account of mechanics of pricing of inputs. If inputs whose prices are administratively determined and priced low as compared to their economic cost, it becomes a case of implicit subsidization. As far as the farmer is concerned, he does not receive any direct payment but somebody in the economy accounts for the difference.

Input subsidies helped in balancing the conflicting interest of farmers and consumers and in achieving macro and micro food-security. The economic

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conditions of farmers have not improved to a desirable level. Subsidies on farm inputs cannot be seen in isolation of the subsidies in other sectors of the economy, which are many a times more and consequences of their withdrawal are less painful. This has resulted into study the changes in subsidies over the year.

MATERIAL AND METHODS

The study was based on secondary data for the period from 1980-81 to 1999-2000 on fertilizers, electricity, canal irrigation and total farm input subsidies under different states of India. The data were collected from different publications.

Analytical Tools:

1. Growth in agricultural input subsidies:

The growth in agricultural input subsidies was studied using the exponential model. The model used is as follows.

$$Y = a.b^t$$

Where, Y = Dependent variable

a = Constant

b = Regression coefficient

t = Time variable

CGR = [Antilog (log b) – 1] x 100

2. Shift or deviation in agricultural input subsidies:

The concept of shift in agricultural inputs subsidies refers to the relative order of placement i.e. the rank of the concerned component of the input subsidies. The methodology adopted by Ramasubban (1963) is adopted in the present study to arrive the conclusion.

The rank correlation coefficient is used to study the relationship between the ranks of the components of subsidies under different periods.

To examine the shift or deviation in input subsidies over the years, "Kendall's rank correlation and concordance coefficient" were estimated with the help of following formulae.

$$\text{Kendall's rank correlation coefficient} = \frac{4S}{n(n-1)}$$

Where, n = Number of states

S = Total score

Sub-score S in Y state is formed by considering each number in sequence and counting the total numbers which lies to the right of and whose magnitudes are larger than the number under consideration, adding the score. We arrive total score S.

Test of significance of Kendall's rank correlation coefficient.

$$\sigma_r = \left[\frac{2(2n+5)}{9n(n-1)}\right]^{1/2}$$

Concordance coefficient W

$$W = \frac{12 \Sigma Di^2}{[m^3(n^3-n)+2]}$$

Where,

W = Concordance coefficient

Di^2 = Square difference between the observed and expected rank total

m = number of years

n = number of states

Test of significance of W is given by :

$$F = \frac{(m-1)W}{1-W}$$

For, $V_1 = (n-1) \times 2/m$ degree of freedom

$V_2 = (m-1) V_1$ degree of freedom for greater and lesser estimates, respectively.

RESULTS AND DISCUSSION

Share of input subsidies in total subsidies:

The input subsidies and their share in total subsidies in Indian agriculture for the period 1980-81 to 1999-2000 are worked out and presented in Table 1.

It could be seen from Table 1 that the total subsidies in Uttar Pradesh accounted for higher amount throughout the period, but its share has declined from 20.5 per cent in 1980-81 to 13.2 per cent in 1999-2000. Next to Uttar Pradesh, Punjab occupied second position in 1980-81 came down to the fourth rank in 1990-91 and further to seventh rank in 1999-2000, when its share was 7.4 per cent. Another important aspect that needs to be noted here is that Maharashtra, Andhra Pradesh, Gujarat,

Table 1: Share of different states in total agricultural input subsidies

State	1980-81		1990-91		1999-2000		% increase of decrease over 1980 for 1990-91	% increase of decrease over 1980 for 1999-2000
	Rs. in crores	%	Rs. in crores	%	Rs. in crores	%		
Uttar Pradesh	290.5	20.45	1159.9	17.1	6118.1	13.2	-3.35	-7.25
	(1)		(1)		(1)			
Maharashtra	94.1	6.63	1112.6	9.7	5519.0	11.88	3.07	5.25
	(5)		(3)		(2)			
Andhra Pradesh	139.6	9.83	1430.8	12.5	5144.3	11.1	2.67	1.27
	(3)		(2)		(3)			
Gujrat	77.4	5.45	835.7	7.3	4467.0	9.6	1.85	4.15
	(7)		(5)		(4)			
Madhya Pradesh	65.3	4.59	7393	6.4	4261.2	9.2	1.81	4.61
	(10)		(8)		(5)			
Karnataka	61.3	4.32	821.8	7.2	3648	7.8	2.88	3.48
	(12)		(6)		(6)			
Punjab	166	11.7	1108	9.7	3430.6	7.4	-2	-4.3
	(2)		(4)		(7)			
Tamil Nadu	133.3	9.39	774.3	6.8	3175	6.74	-2.59	-2.59
	(4)		(7)		(8)			
Rajasthan	71.4	5.03	544.1	4.7	2839.7	6.1	-0.33	1.07
	(8)		(10)		(9)			
Haryana	87.3	6.15	648.4	5.6	2650.4	5.66	-0.55	-0.49
	(6)		(9)		(10)			
Bihar	70.4	4.98	502.2	4.4	1796.5	3.86	-0.58	-1.12
	(9)		(11)		(11)			
West Bengal	64.1	4.51	409.7	3.6	1704.9	3.7	-0.91	-0.81
	(11)		(12)		(12)			
Orissa	38.8	2.73	216.3	1.9	776.7	1.7	-0.82	-1.02
	(13)		(13)		(13)			
Kerala	14.8	1.04	120.2	1	287.5	0.6	-0.04	-0.44
	(14)		(14)		(14)			
Others	45.7	3.21	238.3	2.1	628.7	1.4	-1.11	-1.81
Total	1420.0	100.00	11462.0	100.0	46445	100.0		

(Figures in parentheses denote ranking in total inputs subsidies)

Table 2: Compound growth rate of agricultural input subsidies in India (1980-2000)

State	Fertilizers	Electricity	Canal irrigation	Total farm inputs
Andhra Pradesh	18.94	28.40	24.39	20.98
Bihar	20.28	23.10	15.22	18.70
Gujarat	17.85	31.27	18.37	24.97
Haryana	20.02	23.28	16.42	19.83
Karnataka	18.50	34.26	18.39	24.08
Kerala	16.02	19.60	14.78	16.34
Madhya Pradesh	23.18	37.94	18.73	26.20
Maharashtra	20.25	26.81	19.12	23.97
Orissa	19.82	20.88	16.36	28.39
Punjab	14.62	21.91	14.76	17.08
Rajasthan	23.46	25.08	19.69	22.38
Tamil Nadu	15.52	21.49	15.14	18.39
Uttar Pradesh	17.51	21.12	14.70	17.57
West Bengal	20.54	37.17	15.16	19.99
Others	11.83	25.51	15.46	15.27
All India	18.22	25.91	16.02	20.50

Madhya Pradesh, Karnataka and Rajasthan have recorded considerable improvement in their respective shares between 1980-81 to 1999-2000. The states recording decrease in their shares during this period were Uttar Pradesh, Punjab, Tamil Nadu, Haryana, Bihar, West Bengal and Orissa.

Performance of input subsidies:

The performance of agricultural input subsidies was examined by estimating the compound growth rate using exponential model. The results obtained are present in Table 2.

Table 2 indicate that the growth rates of fertilizers, electricity and canal irrigation were positive being 18.22, 25.91,16.02, 20.50 and significant for India as a whole. Among the different states the highest growth rate of fertilizers, electricity and canal irrigation and total farm input subsidies were observed in Madhya Pradesh i.e. 23.18, 37.94, 26.20. They were positive and significant. However, in canal irrigation the highest growth rate was for Andhra Pradesh i.e. 24.39. The lowest growth rate of electricity and total farm input subsidies were in Kerala. In canal irrigation the growth rate was lowest in Uttar Pradesh i.e. 24.39. The lowest growth rate of electricity and total farm input subsidies were in Kerala which were positive and significant. In fertilizers the growth rate was lowest in others states i.e. 11.93 which was positive and significant.

Hence, it could be concluded that there was positive change in farm input subsidies over a period of 20 years of study.

Table 3: Kendall's rank correlation coefficient

Year	Fertilizers	Electricity	Canal irrigation	Total farm inputs
1980-85	0.83	0.88	0.77	0.77
1980-90	0.77	0.66	0.75	0.73
1980-95	0.75	0.54	0.62	0.41
1980-2000	0.71	0.50	0.60	0.58
Test of concordance	0.3	0.86	0.91	0.89

Temporal changes in input subsidies:

In the present study, Kendall's Rank correlation was used to examine the change in input subsidies over the years. Results obtained are presented in Table 3.

Overall agreement in input subsidies:

Table 3 shows the Kendall's rank correlation coefficients which are calculated for 1980-85, 1980-90, 1980-95 and 1980-2000, different period of time. All Kendall's Rank correlation coefficients were positive and significant and concordance coefficient was also positive and significant. Hence there was change in agricultural input subsidies over the period of time.

Policy Implication:

The policy implication that emerges from the present study is that subsidy programme may please be continued on long term basis in favour of farming community particularly for marginal and small farmers, so as to reduce the cost of cultivation, cost of cultivation expenditure and to boost the farm income. So that farmer can be able to raise their productivity level substantially.

CONCLUSION

1. All growth rates of agricultural input subsidies under different states of India were positive and significant. hence it was concluded that positive change was observed in agricultural input subsidies over the period of 20 years.
2. Rank correlation between inputs at different points of time indicate that all the correlation coefficients were found significant at 1per cent level in all agricultural inputs subsidies in India. The input subsidies for the four components almost remains the same as compared with the status of 1980 over the last 20 years. This is clearly indicated by the coefficient of concordance which is ranging between 0.86 and 0.93 i.e. since these values are closer to 1 and significant. It implies that over the last 20 years though the input subsidies are change in magnitude. Statistically there was no change in agricultural input subsidies.

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Study of Semi-Portable Drip Irrigation System

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ABSTRACT

Drip irrigation has emerged as an appropriate water saving and production augmenting technique for wide spaced crops and also for commercial crops. However, the initial cost of the drip set is higher and use of the system is limited. Hence, it is modified to semi-portable mode keeping water source and pumping plant fixed with extended main line. The drip irrigation system originally designed for 2.5 hectare area whose annual cost of operation was Rs. 44577 was made semi-portable. It was used for irrigating 13 ha premansoon cotton and 12 ha pigeonpea during the year 2001-2002, 2002-2003 and 2003-2004 and benefited the farmer by Rs. 32500 and 11650 ha^{-1} $year^{-1}$ over rainfed, respectively. The yield obtained was three times more than rainfed in both crops. The net benefit earned was Rs.562300 in one season from 25 hectare land due to supplementary irrigation provided through semi-portable drip irrigation system where shifting of system from one block to other requires 2 man days. The semi-portable drip irrigation system of particular capacity could be used for large area of the same crop at different time for life saving irrigation. As the system used was semi-portable, the system cost has been reduced to one tenth. Thus, this will be a solution to the main constraints like high cost of installation and limited use of system, experienced in popularization of a drip, an efficient system of irrigation.

India has less land holding per farmer and cannot increase it horizontally, hence needs to focus on taking more crops in different season from the same land. Due to the limited water available and need of taking more crops through out the year, judicious use of water is utmost required. There are many systems available, providing irrigation but has got lot of disadvantages like very less uniform distribution of water, water wastage (obviously results in shortage of water), fertilizer wastage, inefficient use of man power, contamination of soil and under ground water source, etc.

Among the different systems available, drip irrigation is one of the latest technologies for applying water efficiently and effectively. It has got dominating advantages over other systems, like judicious use of water, uniformity in distribution of water, no or less fertilizer wastage, adequate and calculated supply of water as per the crop water requirements.

However, the major disadvantage of this system are its high initial investment and limited use of system to a particular field for which it is designed.

Hence to overcome these problems, system is modified to semi - portable drip irrigation system. In modified form, a set of system of a particular capacity can be used for number of blocks of the field (Sourell, 1993). This can be achieved by shifting the set of system from one block to another with an extended main line.

MATERIAL AND METHODS

The study was conducted on the field of Mr. Keshavrao Metkar, Khairkhed. Khairkhed is situated in Akola district i.e. in Vidarbha region of Maharashtra state and comes under sub-tropical zone. It is located at the altitude of 318.15 m above mean sea level at intersection of 20° 42' North latitude and 77° 02' East longitude. The average annual precipitation is 760 mm, out of which approximately 86 per cent is received during June to September.

After completion of seedbed preparation, cotton (NH- 44) was sown at spacing of 90 X 60 cm and pigeonpea (local) was sown at spacing of 120 X 20 cm. One lateral was provided for irrigation of two crop rows hence the laterals were shifted manually to each row and first irrigation was given for 12 hours for proper germination. After the germination, laterals were kept in the centre of two rows. There were no moisture sensors in the field to determine the moisture stress in the crop root zone. However, water was applied with his sense of humor as a protective irrigation (Hiwase *et. al.*, 2003).

RESULTS AND DISCUSSION

Amount of water applied to the crops:

The presowing irrigation was applied on 24th and 26th May 03 to bring the seed bed at the field capacity. Cotton was sown on 28th May 03. Pigeonpea was sown

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on15th July 03 without presowing irrigation. There after the protective irrigation (life saving) was given by semi – portable drip irrigation system. The water was applied on the basis of visual observation of crops.

Table 1. Irrigation water applied to the crops (Cotton & Pigeonpea)

S. N.	Crop	Date	Depth (mm)	Volume (m^3 ha^{-1})
1.	Cotton	24th May 03	15.20	152.0
		26th May 03	10.80	108.0
		11th Oct. 03	13.10	131.0
		6th Nov. 03	14.70	147.0
		3rd Dec. 03	16.50	165.0
	Total		70.30	703.0
2.	Pigeonpea	27th Oct. 03	14.20	142.0
		20th Nov. 03	14,30	143.0
		13th Nov.03	14.50	145.0
	Total		43.00	430.0

Table 1 shows the actual irrigation water applied to the crops (Cotton & Pigeonpea). Total depth of water applied to cotton and pigeonpea was 70.30 mm and 43.00 mm, respectively during their crop period as a life saving irrigation.

The system was shifted to different blocks of the field by extending main line, which is the main feature of semi – portable drip irrigation system.

Irrigation efficiencies

The average application efficiency of semi-portable drip irrigation set on a sub-main was 93.82 per cent. It may be concluded that application efficiency was more than 90 percent; means irrigation water was applied well. The result of efficiency corresponds with the finding of Wu and Gitlin (1975) and Nakayan and Bucks (1986).

The distribution efficiency on sub main was 94.54 per cent. Therefore, it may be concluded that the water applied by semi - portable drip irrigation system was uniformly distributed throughout the field. These results are in agreement with the result of Wu and Gitlin (1975).

The table 2 indicates that the maximum water use efficiency was observed in pigeonpea. It is because of its less water requirement as compared to cotton. The result corresponds with the findings of Awasarmal *et. al.* (1983).

Time required for system installation and shifting:

As this is the semi-portable type drip irrigation system, it has a portable type pipe and tube network, which can be shifted to the number of blocks of the same field by extending main line. The field of 25 ha (under study) was irrigated with a drip set having a capacity 2.5 ha by shifting to the number of blocks manually. The time required to shift the set of system from one block to another was 2 man-days.

Economics of the system:

The cost economics of the semi-portable system for three years under study is given in Table 3 & 4.

From Table 3, it is observed that the benefit due to semi-portable drip irrigation system over rainfed was Rs 32500 and Rs 11650 ha^{-1}, in cotton and Pigeonpea, respectively. Thus cotton is more beneficial than pigeonpea. Study also reveals that the total benefit with semi portable drip irrigation system over control on 13 ha of cotton and 12 ha of pigeonpea was Rs 422500 and 139800, respectively. Thus the total benefit by the modified system on 25 ha cotton and pigeonpea was Rs. 562300.

The data of Table 4 revealed that the Benefit Cost ratio in semi portable drip irrigation system was higher in cotton (4.70), followed by pigeonpea (2.63). The results are in agreement with the results of Jadhav (1973). Hence cultivation of cotton and pigeonpea is

Table 2. Irrigation water use efficiency of cotton and pigeonpea under semi portable drip irrigation system

S. N.	Crops	Yield (kg ha^{-1})	Water applied (mm)	Irrigation water use efficiency (Kg ha^{-1}-mm)	Application efficiency (%)	Distribution efficiency (%)
1	Cotton	2600	70.30	36.98	93.82	94.54
2	Pigeonpea	1750	43.00	40.70		

Table 3. Benefit of semi - portable drip irrigation system- pooled effects

S.N.	Crop	Area (ha)	Yield (q ha^{-1})	Gross return (Rs ha^{-1})	Total cost (Rs ha^{-1})	Net return (Rs ha^{-1})	Benefit over control (Rs ha^{-1})	Total benefit over control (Rs.)
1.	Cotton (Irrigated)	13	22	55000	11700	43300	32500	422500
2.	Cotton (Rainfed)	4	7.2	18000	7200	10800	–	–
3.	Pigeonpea (Irrigated)	12	14.5	23925	9100	14825	11650	139800
4.	Pigeonpea (Rainfed)	4	5.5	9075	5900	3175	–	–
	Total						Rs	562300

Table 4. Economics of the semi portable drip irrigation system- Pooled effects

S. N.	Crop	Yield (q ha^{-1})				Gross return	Total cost (Rs ha^{-1})	Net return (Rs ha^{-1})	BC ratio
		2001-2002	2002-2003	2003-2004	Pooled mean				
1.	Cotton (Irrigated)	20	20	26	22	55000	11700	43300	4.70
2.	Cotton (Rainfed)	8	6	7.6	7.2	18000	7200	10800	2.50
3.	Pigeonpea (Irrigated)	9	17	17.5	14.5	23925	9100	14825	2.63
4.	Pigeonpea (Rainfed)	4	5	7.5	5.5	9075	5900	3175	1.51

Market price of cotton :Rs. 2500 q^{-1} & Market price of pigeonpea :Rs. 1650 q^{-1}

beneficial to the farmers by using semi - portable drip irrigation system.

Thus, the semi-portable drip irrigation system of particular capacity can be economically used for large areas of the same/various crop in different times.

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Study of Orange Harvesting Methods in *Mrig* Bahar

P. A. Borkar [1] , S. P. Umbarkar[2] and V. M. Nachane[3]

ABSTRACT

Traditionally the oranges are harvested manually, The partial mechanization may improve the efficiency and save the time of harvesting. The present investigations on different orange harvesting techniques were undertaken in *Mrig* crop season. The different methods were adopted for harvesting Nagpur oranges. The mechanical shaker was tested for harvesting oranges at various frequencies and amplitudes. The shaker was tested for 20 seconds on different three branches. In case of harvesting techniques except mechanical shaker, time required to harvest fifty fruits was recorded. The tests were replicated thrice. The harvesters were tested for harvesting capacity, fruit damage, buttonhole injury and shelf life of the harvested fruits. The harvesting capacity differed significantly with different harvesting techniques. The harvesting capacity was found to be higher with mechanical shaker (504kgh^{-1}), followed by snapping (9126kg h^{-1}), kinnow scissoı (113.87 kg h^{-1}) and modified mango harvester (58.91 kgh^{-1}) used for orange harvesting. The mechanical shaker could be the best harvesting technique if the fruits could be protected from damage resulted due to dropping on the ground.

India ranks seventh in the production of citrus in the world. Orange occupies first place among the citrus fruits produced in the country. The world production of oranges is 58.13 million tonnes in which India ranks sixth with its production level as 4.58 million tonnes and ranks third in area and production accounting for 12 and 10.4 per cent of the total area and production respectively (Anonymous, 2003). Presently in Maharashtra orange crop covers about 87,400 ha area annually producing 11,13,700 million tonnes which is comprising about 48 per cent of area and production of India (Anonymous, 2004). Post harvest management of oranges is of prime importance in order to sustain higher production, proper distribution with minimum losses and increasing export. In India, due to lack of proper post harvest handling system and appropriate processing technology, not only does a huge quantity of fruits go waste but also the country dose not get proper distribution of fresh fruits and good market for processed products for both internal trade and export.

Traditionally the oranges are harvested manually, which is time and energy consuming also leads to injury to fruits. The partial mechanization may improve the efficiency and save the time of harvesting.

MATERIAL AND METHODS

A kinnow scissor was procured from Central Institute of Post Harvest Engineering and Technology, Ludhiana (Fig 1.) to be tested for orange harvesting. The mango harvester is also procured from Konkan Krishi Vidyapeeth , Dapoli (Fig. 2) having 290 mm diameter ring of 6mm bar attached with a serrated circular shearing blade of mild steel (30 mm Φ). Nylon net is fixed around a ring of 90 mm diameter to collect the cut fruits thus avoiding damage. The net depth is kept at about 310 mm. The entire cutting mechanism was fitted to a conduit pipe of 18 mm diameter and 1860 mm length. This fruit harvester was modified by increasing diameter of the ring to 460 mm provided with serrated circular shearing blade of 70 mm diameter of the ring to 460 mm provided with serrated circular shearing blade of 70 mm diameter and by providing canvas cloth of 460 mm diameter and 3750 mm length so as to unload the harvested fruits directly in to container or gunny bag (Fig 3) Pacheco and Rehkugler (1980), Coppack *et.al.* (1985), Peterson (1993), Glenns *et.al.* (1970), Marshal and Hedden (1970) worked on mechanical harvesting of fruits. On similar lines a mechanical shaker (Fig.4) was developed by Department of Agriculture Process Engineering, CAET, Akola and modified by the Post Harvest Technology Scheme Akola , by fixing the solid pulley to a 0.5 hp commutator motor having provision for fitting the ball bearing (6mm Φ) with nut bolt at four eccentrics(3mm, 6.5 mm,10mm, and 13.5 mm), providing displacement of 6mm,13mm,20mm,27mm. The electric motor was attached to variable autotransformer by which the speed can be varied thereby varying the frequency of vibration. An 18 mm diameter conduit pipe of 760 mm length was provided with clamping arrangement to be fitted to any branch of tree to be harvested. This pipe was provided with an

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arrangement to be fitted to ball bearing. Another pipe of 1800 mm was provided with clamping arrangement to be fitted to any branch of tree to be harvested. The present investigations on different orange harvesting techniques were undertaken in *Mrig* crop season. The different methods adopted for harvesting Nagpur oranges were 1) Snapping: twisting and pulling of fruits by hand 2) Kinnow Scissor 3) Mango harvester (KKV) 4) Modified mango harvester 5) Mechanical shaker the fruits were harvested by shaking the branches of the tree . The fruits were allowed to fall on the ground and were collected from ground.

The mechanical shaker was tested for harvesting oranges at various frequencies and amplitudes. It was impossible to get same size branch i.e. having same length, thickness and same number of fruits for harvesting trials in order to compare harvesting at various combinations of amplitudes and frequencies. The branch was selected randomly, the amplitudes was fixed and the frequency was varied. The details of branch such as diameter of branch at clamp , length of branch , diameter of branch at the end fruit and number of fruits on branch were recorded and shaken for various amplitudes (6,13 and 20mm) and frequencies (8-18cps) after finding the best possible combination of frequency and amplitudes. The shaker was tested for 20 seconds on different three branches. In case of harvesting techniques except mechanical shaker, time required to harvest fifty fruits was recorded. The tests were replicated thrice. The harvesters were tested for harvesting capacity, fruit damage, buttonhole injury and shelf life of the harvested fruits were also assessed.

RESULTS AND DISCUSSION

The details of orange harvesting by mechanical shaker at various frequencies and amplitudes are given in Table 1. It was observed that the amplitudes of vibrations at the point of branch where clamp is fixed was higher and was found reducing towards the end of the branch due to damping and hence those fruits which were near the shaking point dropped initially at lower frequencies than those away from the shaking point. The two fruits dropped at very low frequency (8-9 cps) and amplitude 6mm were due to its full ripening. The fruits dropped do not show definite trend with increase in frequency. However it shows that as frequency increases the number of fruits dropping increases up to 13-16cps and then decreases in case of all the amplitudes used. The un harvested fruits were five in first branch shaked with 6mm amplitudes and two in the second branch shaked with 13mm amplitudes whereas all the fruits were harvested in case of using frequency upto 18cps and 20 mm amplitudes for shaking. In this case two fruits of adjoining branch were also dropped. Hence, 17-18 frequency and 20m amplitude was found the best possible combination for mechanical harvesting.

The comparative results of testing various harvesters are given in Table 2. The harvesting capacity differed significantly with different harvesting techniques. The harvesting capacity was found to be

Table 1. Orange fruit harvesting by mechanical shaker at various frequencies and amplitudes

	Amplitude, mm		
	6	13	20
Branch details, mm			
Diameter at clamp	30	50	36
Length of branch	1100	900	1500
Diameter at end fruit	6	8	9
Total no. of fruits on branches	20	25	22
Frequency		**No. of fruits harvested**	
8-9	2	0	0
11-12	3	0	2
13-14	5	6	6
15-16	3	11	8
17-18	2	6	6
Un harvested fruits	5	2	0
Fruits of adjoining branches harvested	0	0	2

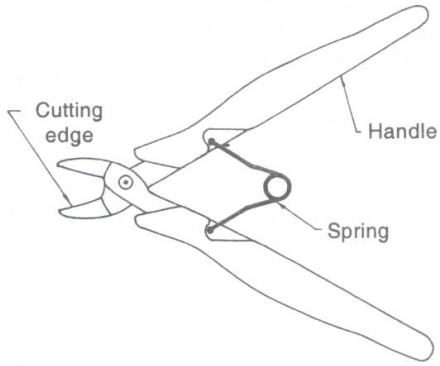

Fig. 1 Kinnow scissor

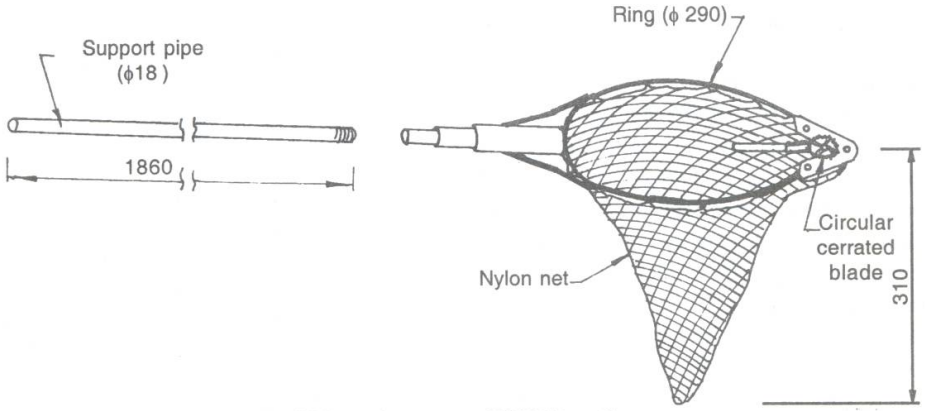

Fig. 2 Mango harvester of KKV, Dapoli

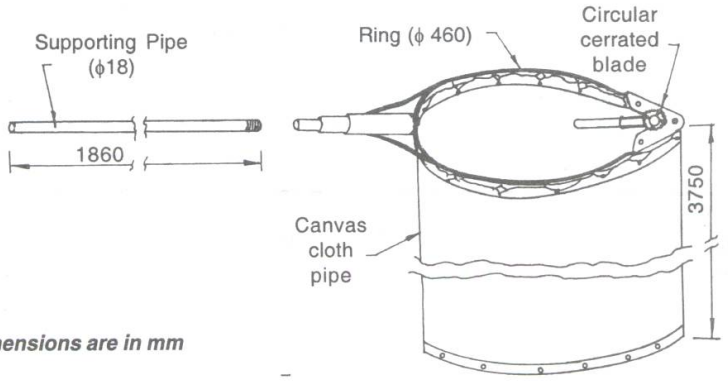

Fig. 3.3 Mango harvester modified for orange harvesting

higher with mechanical shaker (504 kgh^{-1}), followed by snapping (126 kgh^{-1}), kinnow scissor (113.87 kgh^{-1}) and modified mango harvester (58.91 kgh^{-1}) used for orange harvesting. But since fruits in case of mechanical shaker were allowed to drop on the ground itself the damaged fruits were 48.15 per cent. Hence the mechanical shaker could be the best harvesting technique if the fruits could be protected from damage resulted due to dropping on the ground. It was difficult to provide the source of power at different harvesting points in the orchard. It also found difficult to fix the clamp to the branch of the tree due to dense branches of the tree. The same difficulty was observed with Mango harvester of the KKV and modified mango harvester used for orange harvesting. The time in

Table 2. Comparision of various orange harvesting methods

Harvesting method	Total harvested fruits		Time required	Harvesting capacity	Harvested fruits with stem			Fruits without stem		Damaged fruits	Fruits with button hole stem	
	No.	Weight kg	Sec.	Kgh^{-1}	No.	Weight kg	Stem length	No.	Weight kg	No.	No.	Weight kg
Mechanical shaker	27	2.800	20	504	Nil	Nil	Nil	27	2.800 (100)	13	1	0.120 (4.29)
Snapping	50	5.600	160	126	Nil	Nil	Nil	50	5.600 (100)	Nil	1	0.110
Kinnow scissor	50	5.630	178	113.87	24	2.700 (47.96)	3-12	26	2.930 (52.04)	Nil	Nil	Nil
Modified Mango Harvester	50	5.400	300	58.91	1	0.100 (1.85)	3	49	5.300 (98.15)	Nil	2	0.210 (3.89)
Mango Harvester(KKV)	50	5.220	330	56.95	2	0.140 (2.68)	8&12	48	5.080 (97.32)	Nil	2	0.220 (4.22)

Note: Figures in parenthesis represent per cent value

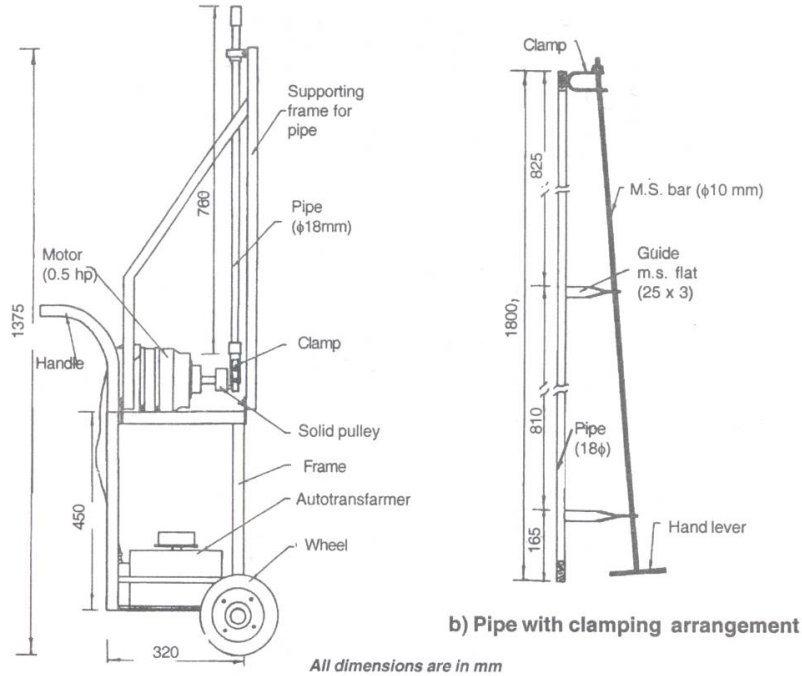

Fig. 3.4 Mechanical shaker

climbing the tree with the help of saddle and coming down for unloading the cloth bag could save in this type of harvesting. The fruits could be easily harvested up to the height of 3.0 m from the ground. The harvesting capacity by snapping was good because it is an age-old practice and people became expert in harvesting manually. The harvesting capacity with kinnow scissor was good next to snapping (manual harvesting). If the people practiced harvesting with kinnow scissor the harvesting capacity may enhance. The fruits harvested with stem are more in case of kinnow scissor (47.96%), followed by mango harvester (2.68%) and modified mango harvester (1.85%). The button hole injury was more in case of mechanical shaker (4.29%), followed by mango harvester of KKV (4.225), modified mango harvester (3.89%) and least in snapping (1.965) and no button hole injury was observed in case of harvesting with kinnow scissor . Hence harvesting with kinnow scissor was good with no button hole injury and by practice the fruits can be harvested (clipped) near fruits surface there by minimizing the stem length. In case of mechanical shaker the harvesting capacity is more but since the button hole injury and damages are more efforts should be made for providing cushioning thereby minimizing injuries.

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Estimation of Crop Coefficients For Okra in Semi-Arid Climate of Akola

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ABSTRACT

Pot culture experiment was conducted on okra during spring summer season by water balance equation to measure the crop evapotranspiration from 17th January 2004 to 19th April 2004 at Akola. The maximum ETc was found to be 8.80 mm day^{-1} at 10th weeks after sowing in mid season stage and it declined to 6.19 mm day^{-1} in late season stage. Seasonal ETc was found to be 529.7 mm. The estimated values of crop coefficients for okra at initial, mid season and late season stages were 0.82,1.17 and 0.82 respectively. The estimated Kc values of okra are 36.6 per cent and 14.15 per cent higher than FAO Kc values during initial and mid season stages respectively. In late season stage it is closer to FAO Kc values.

Okra (*Abelmoscus Esculantus* L. Moench) or Lady's Finger commonly known, as 'Bhendi' is one of the most important rainy and summer seasons fruit vegetable. Being short duration and high yielding, growers get more profit unit^{-1} area hence demand of okra is increasing day by day. Yield and quality of this crop is suffered due to insufficient water supply and improper scheduling of irrigation. A step towards better planning and proper irrigation scheduling calls for estimation of crop water requirement by using detailed data of crop evapotranspiration (ETc). Hence, the present study was undertaken for water requirement of okra through pot culture studies by water balance method. To extrapolate the measurement of ETc for irrigation planning in regional scale, crop coefficient (Kc) is often used. Abdulmumin and Misari (1990), Elliot *et al.* (1988) and Mohan and Arumugam (1994) have suggested that crop coefficient values need to be developed empirically for each crop in local climatic conditions. Crop coefficient values for number of crops grown under different climatic conditions have been suggested by Doorenbos and Pruitt (1977). Crop coefficients for okra at various growth stages were estimated under climatic conditions of Akola.

MATERIAL AND METHODS

Crop evapotranspiration

The study was conducted at the Department of Irrigation and Drainage Engineering, Dr. PDKV, Akola. Okra (AKOV-97-16) was grown from 16th January 2004 to 19th April 2004 for measurement of daily evapotranspiration. Pot culture study on okra was undertaken to find out crop evapotranspiration (ETc) using water balance method. Crop evapotranspiration was obtained from weight changes of the earthen pots using water balance equation:

Crop evapotranspiration loss (cm^{3}day^{-1}) in volume = Wt. of pot before watering (g) + Water added (ml) − Next day Wt.of pot (g) in tray(ml) − Next day drainage

$$\text{Crop evapotranspiration (mm day}^{-1}\text{)} = \frac{\text{Crop evapotranspiration loss in volume (cm}^3\text{day}^{-1}\text{)}}{\text{Surface area of pot (cm}^2\text{)}} \times 10$$

Reference Evapotranspiration

As a result of an expert consultation held in May 1990, the FAO Penman – Monteith is now recommended as the sole standard method for computation of reference evapotranspiration (FAO 56). The reference evapotranspiration rate from a short green crop completely shading the ground and never short of water is expressed in generalized form as follows (Allen *et al.*, 1998):

$$ETo = \frac{0.408\ \Delta\ (Rn-G) + \dfrac{\gamma\ 900}{T+273}\ U_2\ (es-ea)}{\Delta + \gamma\ (1+0.34\ U_2)}$$

in which,

ETo = Reference evapotranspiration (mm day^{-1})
Rn = Net radiation at crop surface (MJ m^{-2} day^{-1})
G = Soil heat flux density (MJ m^{-2} day^{-1})

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T = Mean daily air temperature at 2m height (°C)
U_2 = Wind speed at 2m ht. (m s^{-1})
es = Saturation vapour pressure (kPa)
ea = Actual vapour pressure (kPa)
es-ea = Saturation vapour pressure deficit (kPa)
Δ = Slope vapour pressure curve (kPa $°C^{-1}$)
γ = Psychrometric constant (kPa $°C^{-1}$)

Crop coefficient

The effect of crop characteristics on crop water requirement is given by crop coefficient, which represents the relationship between reference evapotranspiration and crop evapotranspiration. The crop coefficient (Kc) is empirically obtained for a particular crop at a given growth stage as follows:

$$Kc = ETc / ETo$$

Leaf area index

As the crop develops the ground cover, crop height and leaf area changes. It influences ETc during various growth stages. Leaf area per plant divided by land area occupied by plant foliage is expressed as leaf area index. It was recorded at 30 , 45, 60 , 75 and 90 days after sowing and averages were calculated (Table3).

RESULTS AND DISCUSSION

Variation of crop evapotranspiration by water balance method with respect to time at Akola is presented in Table1. The growth stages in initial stage, mid season stage and late season stage for okra were 49, 28 and 17 days, respectively. From fig.1 it is seen that minimum ETc was found to be 2.35 mm day^{-1} at 1st weeks after sowing (WAS) in initial stage of growth while ETc increased rapidly in mid season stage from 6.26 to 8.80 mm day^{-1} (8th to 11th WAS) due to increased leaf area index from 60 to 75 days after sowing (Table 3). ETc was decreased in 11th WAS due to cloudy days and less evaporation loss. ETc declined in late season stage from 8.11to 6.19 mm day^{-1} as LAI was decreased from 2.63 to 0.96 at 75 to 90 days after sowing i.e. from 12 to 14 WAS. Seasonal ETc of Okra was found to be 529.7 mm.

From the daily values of weather parameters monitored at weather station, reference evapotranspiration was computed by standard Penman Monteith FAO-56 model.

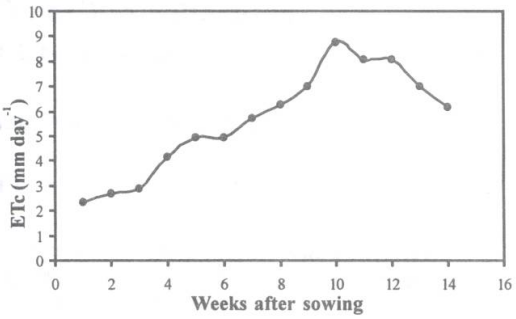

Fig. 1. Variation of crop evapotranspiration (mm day^{-1}) by water balance method with respect to time at Akoal

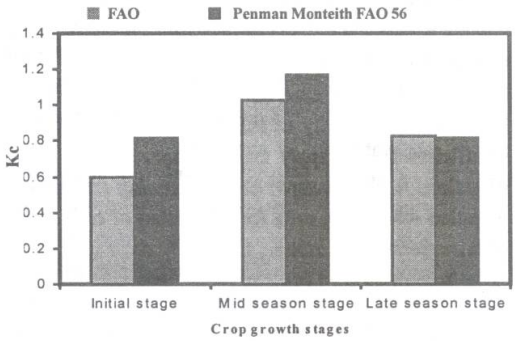

Fig. 2. Crop coefficients derived from Peman Monteith FAO-56 model and existing FAO Kc values for okra

It is seen from Table 1 that highest ETo was 11.18 mm day^{-1} at 14 WAS and lowest ETo was found to be 3.79 mm day^{-1} at 2 WAS respectively. Generally increasing trend is seen from 1st WAS to 14th WAS. ETo at 11th WAS was found to be 6.59 mm day^{-1} which was less due to cloudy days and less evaporation loss.

The estimated Kc values by Penman Monteith FAO-56 model in I, II and III stages were 0.82,1.17 and 0.82 respectively (Table 2). These Kc values were compared with the values determined by FAO for humid region but widely used for any region because of its non-availability in particular region. These values were 36.6 per cent higher,

Table 1: Weekly reference evapotranspiration, ETo (mm day^{-1}) by Penman Monteith FAO-56 model

WAS	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ETo	4.17	3.79	4.19	4.83	5.17	5.08	5.67	5.56	6.03	7.54	6.59	8.34	9.50	11.18

14.15 per cent higher and 0.6 per cent lower than FAO Kc values (Table 2). Similar results were found by Tyagi *et. al.* (2000). From Fig.2 it is seen that estimated Kc values higher than existing FAO Kc values in initial and mid season stages while it is closer in late season stage.

Table2. Growth stage wise computed values of crop coefficients derived from Penman Monteith FAO-56 model and existing FAO Kc values for okra

S.N.	Model	Crop growth stages		
		I initial	II mid season	III late season
1	Penman Monteith FAO-56	0.82	1.17	0.82
2	FAO	0.5-0.7	1.0-1.05	0.7-0.95

Variation of leaf area index with respect to time is presented in Table3. Leaf area index (LAI) increased slowly upto 45 days after sowing (DAS) than from 45 to 75 days after sowing it was observed that LAI increased rapidly and achieved value of 2.67 respectively. At 90 DAS LAI was found 0.96, due to late season stage.

Table 3: Variation of leaf area index with respect to time

S.N.	Days after sowing	Leaf area index
1	15	0.51
2	30	0.79
3	45	1.06
4	60	2.38
5	75	2.67
6	90	0.96

CONCLUSIONS

The minimum and maximum weekly crop evapotranspiration values at 1st and 10th WAS were 2.35 and 8.80 mm day^{-1} respectively. Total seasonal crop evapotranspiration was found to be 529.7 mm. The estimated Kc values for okra under climatic conditions of Akola are 0.82, 1.17 and 0.82 respectively during initial, mid season and late season growth stages. The estimated values of Kc for this region differ considerably at all stages from those suggested by FAO. Hence to estimate ET_c through Penman Monteith FAO-56 model for okra in this region, Kc are used for estimating ETc in this region.

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Evaluation of Hydraulics of Microtube Trickle Irrigation

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ABSTRACT

The study was carried out in the Department of Irrigation and Drainage Engineering, Dr. PDKV, Akola, to evaluate the hydraulics of microtube trickle irrigation system with objective to develop ready recknors, nomographs and equations for predicting optimum length of lateral (16 mm Φ) and discharge of microtube (1.2 mm Φ) corresponding to different microtube lengths (50, 100, 150 and 200 cm) and spacings of microtube (1.5 and 3.0 m) under different operating pressures (0.6, 0.8, 1.0 and 1.2 kg/cm^2) to suit the farmers' need according to crop and pumping unit characteristics. It was found that optimum length of lateral (L_l), increases with increase in microtube length (Lm) or operating pressure (P) or microtube spacing (S) along lateral. The prediction equation for optimum length of lateral has been developed as, $L_l = -21.15 + 0.105$ Lm + 19.125 P + 20 S ($R^2 = 0.969$). It was also observed that discharge of microtube (Q) decreases with increase in microtube length. However, it increases with increase in operating pressure or microtube spacing along lateral. The prediction equation for discharge of microtube has been developed as, $Q = 5.41 - 0.0367$ Lm + 7.075 P + 0.8592 S ($R^2 = 0.919$).

Microtube is a simple type of emitter which can be considered as small plastic tubes with an inside diameter ranging from 0.8 mm to 4 mm. Microtube is easy to install and relatively low in cost compared to other types of emitter. Clogging problem is also very rare in case of microtube as compared to other types of emitter. Microtube is suitable for wide spaced orchards or high value plantation crops. Microtube dissipates energy and discharges small amount of flow. Ideally, emitters are used to dissipate the pressure and supply the water at low flow rate with minimum variation in discharge and pressure. In reality, unit-to-unit emitter discharge is varied as confirmed by Soloman (1979) and Bralts *et. al.* (1981).

The discharge through the microtube emission device depends on tube length, size and operating pressure. Generally, emission devices are designed for pressure of 1.0 kg/cm^2 i.e. 10 m of water column. But in the field because of various constraints, it is some times very difficult to maintain the required pressure, which ultimately affects the discharge through emitter. Not only this, microtube discharge is the function of energy drop, which is the combination of entrance loss and friction drop from the inner wall of the tube along the length of microtube. Thus discharge of microtube depends on length of microtube also.

An important elements in trickle irrigation design procedure are lateral length, size, emitter spacing, slope and emitter flow rate. In regards cost of trickle irrigation system, cost of submain pipes, lateral lines and emitters are having major share. It is, therefore, very important to select desired but maximum lateral length for selected type of emitter, which again depends on spacing and discharge rates of emitters, to reduce the cost of submain pipes.

Under such circumstances the information on the optimum length of lateral using microtube as emitter and discharge of microtube, with different lengths and spacings under different operating pressures, will facilitate one to select desirable lateral length and to select the proper length of microtube under available pressure to get desirable discharge according to water requirement of crop.

MATERIAL AND METHODS

The experiment was conducted at Department of Irrigation and Drainage Engineering, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola using polyethylene tube of 16 mm internal diameter as lateral line and microtube of 1.2 mm internal diameter as emitting device to decide design parameters of trickle irrigation system.

Three variables viz. microtube spacing along lateral, microtube length and operating pressure were considered for study. Details of variables are given in Table 1.

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Table 1. Details of experimental variables

S.N.	Variables	Level
1	Operating pressure (Inlet)	0.6 kg/cm²
		0.8 kg/cm²
		1.0 kg/cm²
		1.2 kg/cm²
2	Microtube length	50 cm
		100 cm
		150 cm
		200 cm
3	Microtube spacing along lateral	1.5 m
		3.0 m

Considering above levels of different variables, 32 combinations of variables were tried. For each set of combination of variables, maximum permissible (optimum) length of lateral was finalized. Desired operating pressure was adjusted at the inlet of lateral for each set of observation and pressure at tail end of lateral was measured with pressure gauge. Simultaneously, the minimum and maximum discharge rates of microtubes at tail and head end of lateral were recorded. Further, lateral length was reduced by folding one outlet (microtube) from tail end and the desired operating pressure was maintained through regulating valve. Again pressure of the end point was recorded and flow rates through microtubes of tail and head ends were measured, untill the discharge variation and pressure variation was obtained within desirable limits of 10 per cent and 20 per cent respectively, for respective sets of combination of variables. Same procedure was repeated for optimization of lateral length and number of outlets in all 32 treatments under study.

For each set of observation, discharge through alternate microtubes along whole lateral was measured by volumetric method, after finalizing the optimum length of lateral to study the effect of different operating pressures and microtube lengths with different spacings. Each trial was replicated thrice on levelled field (zero per cent slope). Multiple linear regression analysis has been carried out to relate the optimum length of lateral and discharge of microtube with microtube length, operating pressure and microtube spacing.

RESULTS AND DISCUSSION

Optimization of lateral length (16 mm ID):

The maximum permissible (optimum) length of lateral was decided considering the desirable limit of flow variation as 10 per cent in all 32 combinations of variables.

The values obtained for optimum lateral length are tabulated and presented in Table 2.

Table 2 shows optimum length of lateral, affected by different combinations of microtube length, operating pressure and microtube spacing and corresponding flow and pressure variation.

It is seen from results that optimum length of lateral varies between 30 m to 87 m corresponding to different combination of variables and it increases with increase in microtube length or operating pressure or microtube spacing along lateral.

Table 2 can be used as ready recknor for deciding optimum length of lateral of 16 mm ID, corresponding to different combinations of microtube length , spacing and operating pressure, while designing and laying out microtube trickle irrigation system.

From results the nomograph has been plotted for predicting optimum length of lateral as shown in Fig. 1 (a) and 1 (b) for 1.5 m and 3 m microtube spacing, respectively, which can also be used as design tool, Fig. 1 (a) & (b). Considering the observation of optimum length of lateral for different combinations regression analysis has been carried out and their interrelationship was found as given in equation 1.

$$L_l = -21.15 + 0.105\, L_m + 19.125\, P + 20\, S \quad \text{——(1)}$$

$$R^2 = 0.969$$

Where,

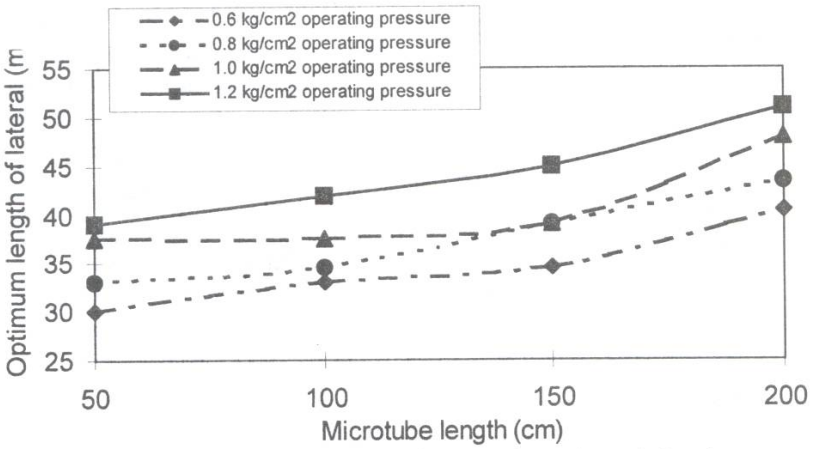
L_l = Maximum permissible(optimum)length of lateral(16 mm Φ), m

L_m = Length of microtube (1.2 mm Φ), cm

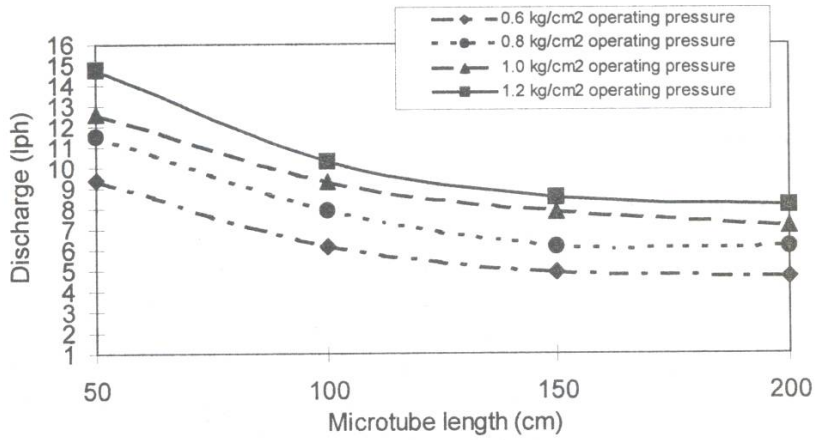
P = Operating pressure, kg/cm²

S = Microtube spacing along lateral, m

Using equation 1, optimum length of lateral may be estimated for various combinations of microtube length, operating pressure and microtube spacing along lateral with high degree of accuracy ($R^2 = 0.969$). For verifying the reliability of equation 1, the optimum length was estimated using above equation and then compared



(a) For 1.5 m microtube spacing along lateral



(a) For 1.5 m microtube spacing along lateral

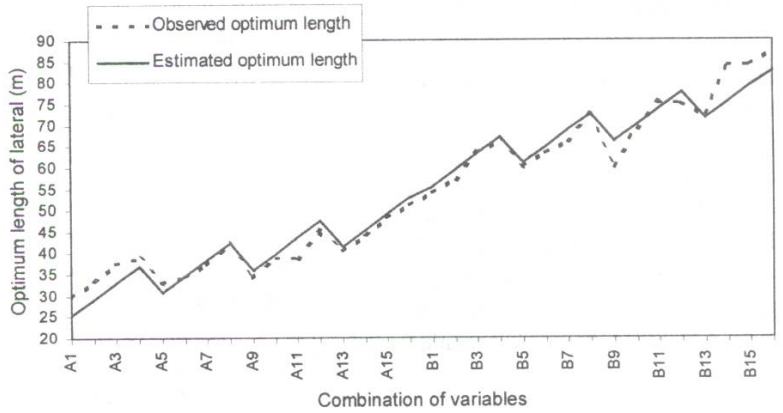


Fig. 2: Observed and estimated values of optimum length of lateral

Table 2. Maximum permissible (optimum) length of lateral (16mm) corresponding to different microtube lengths, operating pressures and microtube spacings

Microtube spacing along lateral (m)	Microtube length (cm)	Optimum length of lateral with flow and pressure variation under different operating pressures					
		0.6 kg/cm²			0.8 kg/cm²		
		Optimum lateral length (m)	Average flow variation (%)	Pressure variation (%)	Optimum lateral length (m)	Average flow variation (%)	Pressure variation (%)
1.5	50	30 (20)	9.91	5.00	33 (22)	9.34	7.50
	100	33 (22)	9.65	5.00	34.5 (23)	9.72	5.00
	150	34.5 (23)	9.55	3.33	39 (26)	9.72	5.00
	200	40.5 (27)	9.62	8.33	43.5 (29)	10.19	7.50
3.0	50	54 (18)	9.14	10.00	57 (19)	9.48	8.75
	100	60 (20)	9.17	5.00	63 (21)	10.00	8.75
	150	60 (20)	9.67	3.33	69 (23)	9.44	10.00
	200	72 (24)	9.46	7.00	84 (28)	9.35	7.50
			1.0 kg/cm²			**1.2 kg/cm²**	
1.5	50	37.5 (25)	9.04	4.00	39 (26)	10.18	5.00
	100	37.5 (25)	9.19	5.00	42 (28)	9.18	6.67
	150	39 (26)	10.16	4.00	45 (30)	9.55	6.67
	200	48 (32)	9.38	4.00	51 (34)	9.29	5.00
3.0	50	63 (21)	9.93	4.00	66 (22)	9.45	8.33
	100	66 (22)	9.90	4.00	72 (24)	9.26	8.33
	150	75 (25)	10.03	6.00	75 (25)	9.80	6.67
	200	84 (28)	9.47	6.00	87 (29)	9.81	4.17

Figures in parentheses indicate number of microtube (outlets)

with corresponding observed optimum length as shown in Fig. 2.

Discharge of microtube with respect to different microtube lengths; operating pressures and microtube spacings:

After analyzing the optimum length of lateral, the discharge of alternate microtube for different combinations of variables have been observed and every trial has been replicated thrice. From mean discharges of three observation trials of each combination of variables, grand mean discharges were calculated and represented in Table 3.

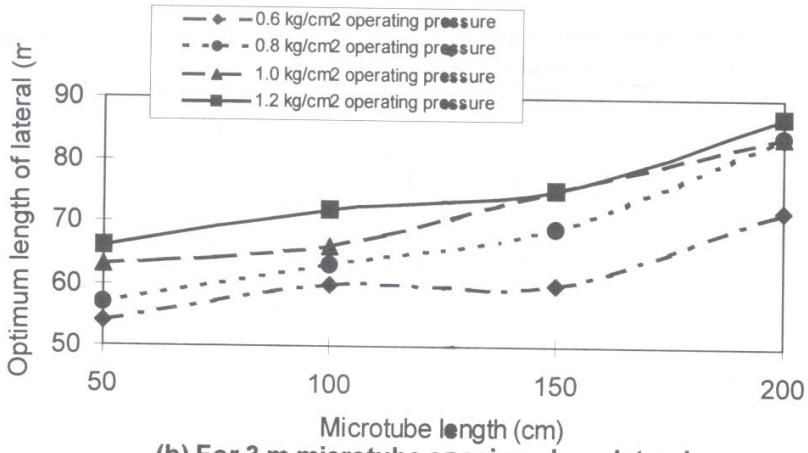
It is seen from table 3 that discharge decreases with increase in microtube length. However, it increases with increase in operating pressure or microtube spacing along lateral. Table 3 can be used as ready recknor for deciding discharge of microtube of 1.2 mm (ID), corresponding to different combinations of microtube length and spacing and operating pressure, while designing microtube trickle irrigation system.

From results, the nomograph has been plotted for predicting discharge as shown in Fig. 3 (a) and 3 (b) for 1.5 m and 3 m microtube spacing, respectively, which can also be used as design tool.

Considering the observation of discharge for all combinations regression analysis has been carried out and their interrelationship was found as given in equation 2.

$$Q = 5.41 - 0.0367 L_m + 7.075 P + 0.8592 S \quad \text{— (2)}$$

$$R^2 = 0.919$$



(b) For 3 m microtube spacing along lateral

Fig. 1: Nomograph for predicting optimum length of lateral

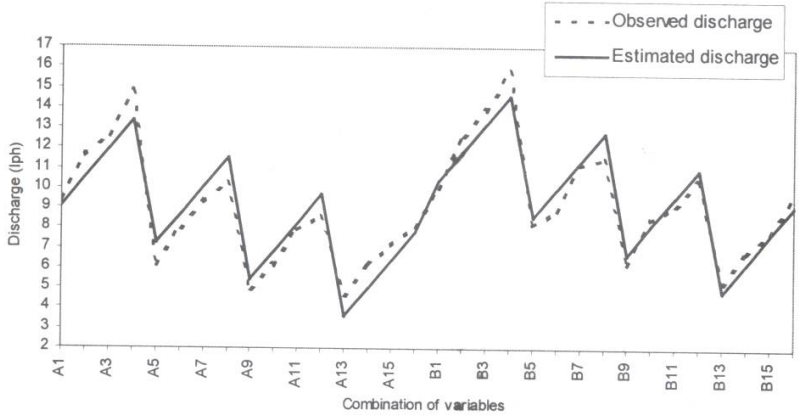
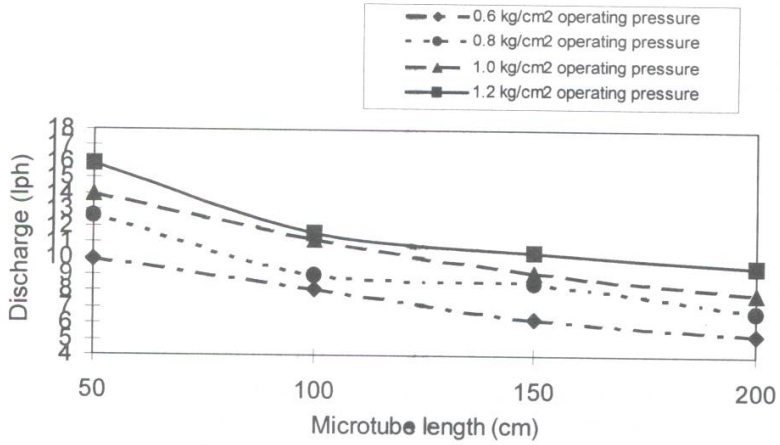


Fig. 4: Observed and estimated values of discharge



(b) For 3 m microtube spacing along lateral

Fig. 3: Nomograph for predicting discharge of microtube

Table 3. Ready recknor for discharge of microtube with respect to different microtube lengths, operating pressures and microtube spacings

Microtube spacing (m)	Microtube length (cm)	Discharge of microtube (lit hr^{-1}) at different operating pressures (kg/cm^2)			
		0.6	0.8	1.0	1.2
1.5	50	9.41	11.57	12.59	14.76
	100	6.14	7.94	9.27	10.28
	150	4.95	6.15	7.86	8.57
	200	4.67	6.13	7.17	8.13
3	50	9.99	12.66	13.95	15.89
	100	8.15	8.95	11.16	11.53
	150	6.28	8.46	9.19	10.41
	200	5.34	6.74	7.92	9.59

Where,

Q = Discharge of microtube, lph

Using equation 2, discharge may be estimated for various combinations of microtube length, operating pressure and microtube spacing along lateral. For verifying the reliability of equation 2, the discharge was estimated using the equation and then compared with corresponding observed discharge as shown in Fig. 4.

Thus, the ready recknors, nomographs and prediction equations developed may be directly useful to designers and planners for estimating the discharge of microtube and optimum length of lateral for available pressure head and selected combination of microtube length and spacing; while designing the microtube trickle irrigation system.

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Combined Effect of Air Sleeve and Nozzle Angles on Spray Deposition

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ABSTRACT

Air sleeve boom was developed and tested in the laboratory to study the influence of different air sleeve and nozzle angles on deposition of droplets at six different positions through the plant canopy. The study was conducted with four air sleeve angles i.e.,-15°, 0°, 15°, 30° and three nozzle angles i.e., 25°, 35°, 45° as independent variables. The effect of combination of the independent variables showed significant effect on deposition of droplet density at only middle and bottom positions of the plant and the lower surface of the leaf and there was a non-significant difference in VMD of the droplets obtained at all most all positiond of the plant. The deposition index was found within the range for all combinations of air sleeve angle with 35° nozzle angle.

Cotton is grown on about 330-lakh hectare all over the world and about 25 per cent of it is shared by the India alone. In the Vidarbha region of state Maharashtra, cotton is grown on around 18 lakh hectare contributing 40 per cent of total area under the cotton in the state. If average production per hectare is taken into consideration, India ranks 4th in the world whereas, Maharashtra ranks last in India. Among many other problems in cultivation of cotton crop i.e., good quality seed, high yielding variety, sowing technique, and intercultural practices till harvesting of crop, special attention is also required towards the application of correct amount of pesticide and on to the target. Spraying is an important topic to applicator, producers as well as industry research and extension personnel. Much effort has been devoted to increase the spray deposition on the cotton crop deep into the canopy. The insect and pest in cotton mostly attack on the lower surface of the leaf. In conventional boom spraying in foliage crop, only top position of the plant receives deposition skipping middle and bottom positions untreated. Hence efforts were done to improve the deposition of spray droplets deep onto the canopy and on the lower surface of the leaf (Womac,1992).

Air assisted spraying is a technique that has the potential to improve the leaf coverage through the plant canopy. Air assisted sleeve boom spraying is the emerging technology to increase the spray deposition. Therefore, the study was undertaken to evaluate the influence of different air sleeve and nozzle angles on droplets density and spray volume per sq.cm on the leaf surfaces through the plant canopy.

MATERIAL AND METHODS

A flexible air sleeve was constructed based on the parameters obtained to satisfy the design cosideration. For the laboratory evaluation the tapering air sleeve 0.25 m in diameter at inlet and 2.5 m in length converging to zero diameter towards the dead end made of fiber- reinforced PVC was sewed to distribute air over the full length of the boom. At the bottom of the sleeve, the orifices of 0.04 m diameter spaced at 0.09 m were made continuously throughout its length. The system consists of a boom fitted with hydraulic nozzles and along flexible air sleeve to deliver the air from behind the nozzles. This helps the spray droplets, produce by hydraulic nozzles, to get transported to the target through a stream of air whose direction and velocity is better controlled. The nozzles were directed to converge the spray into the air stream at an angle where it get entrain with stream at some height above plant canopy, disintegrated into finer droplets and transported deep into the target. A mounted type air-moving device was developed and the boom was a M.S. angle structure, a frame to support the air sleeve and hydraulic nozzles to make a final delivery system of air and liquid - pesticide mixture onto the target. It is made up of angle iron of 254 × 254 × 50mm section. Four rings (20-30 cm dia.) made up of M.S. rod (10mm dia.) were provided on the boom. The nozzles were

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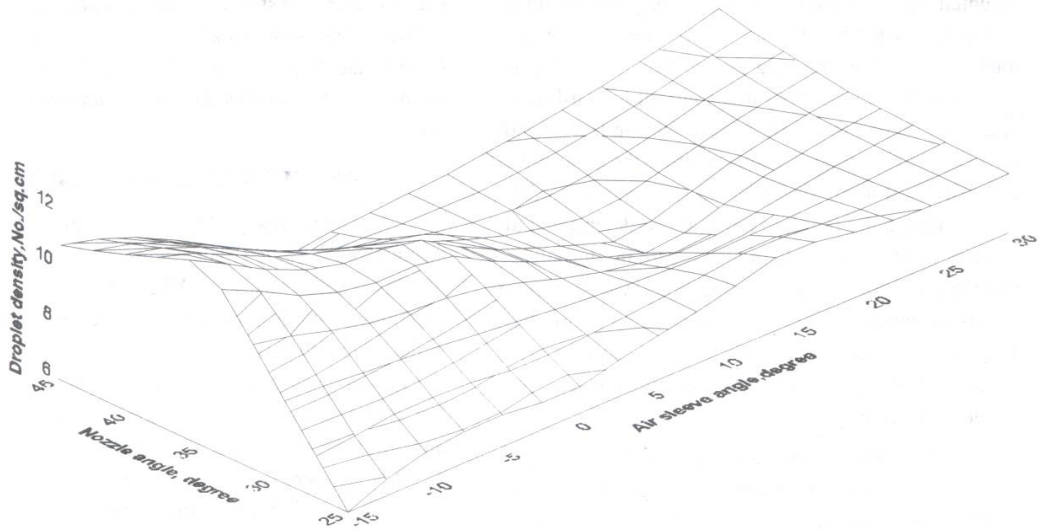
mounted on the straight G.I pipe along the length of horizontal air sleeve. The air sleeve boom attached to tractor mounted air moving device was trailed behind the tractor in the laboratory at a constant forward speed of 2 km h^{-1} above the plant canopy. During the forward travel the blower rotates, sucks air from the atmosphere and delivers it to air sleeves. The air comes out of the sleeve through the multiple holes at pre-determined air velocity of 26m $sec.^{-1}$ which also create the turbulence into the plant canopy in turn brings the lower surface of the leaves upward to receive the deposition of droplets. This helps to receive the higher droplet density on to the lower surface of the leaf mostly the surface where from the pest and insect attacks

The system was tested at four sleeve angles i.e., -15 ^{0}, 0^0, 15 ^{0}, 30 ^{0} and three nozzle angles 25 ^{0}, 35 ^{0}, 45 ^{0}. The zero degree sleeve angle was straight vertically downward and positive angle was in direction of travel. The arrangement was made on the system to change the angle of the sleeve as well as the angle of nozzle. As per the recommendation for foliage crop hallow cone nozzle was selected for the study. The smaller spray angle nozzle gives slightly larger droplet size as compared to larger spray angle for given type and pressure of nozzle (Jose, 1987). Taking into the consideration the above facts, HCN/PB -80450 Hallow Cone Mist Spray Nozzle was selected for the experiment (80-indicate the spray angle, 450- discharge rate) among the best available nozzles.

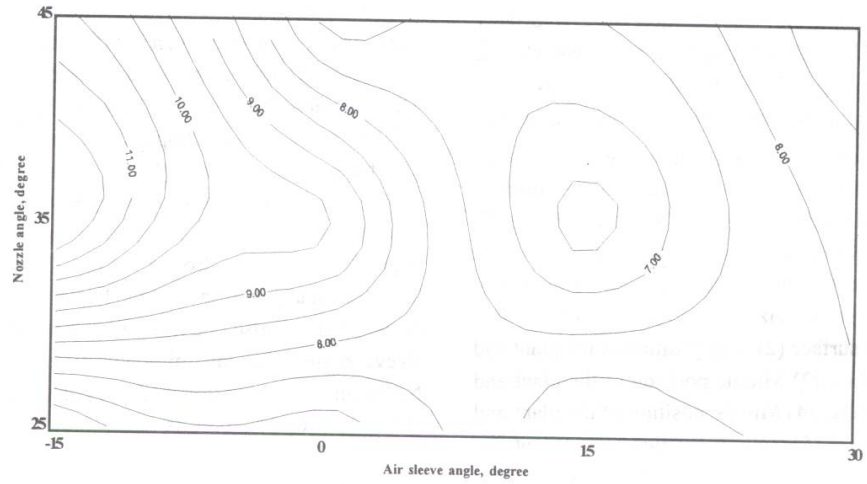
The performance of the developed sleeve boom was tested in the laboratory for obtaining the optimum combination of levels of air sleeve and nozzle angle. To facilitate the evaluation of spray penetration in to the canopy of the cotton plant, the plant was divided in to six different positions viz., (1) Top position of the plant and upper leaf surface (2). Top position of the plant and lower leaf surface (3) Middle position of the plant and upper leaf surface (4) Middle position of the plant and lower leaf surface (5) Bottom position of the plant and upper leaf surface (6) Bottom position of the plant and lower leaf surface. Three glossy papers were stapled on the leaves on three different locations at each position to observe the deposition of the droplets. After making all adjustments, setup of the equipment was run ideally for 30 minutes. The spray deposition was collected on the sample cards of the glossy paper. The sample cards were carefully removed and then taken for further analysis in the computer laboratory. Digital image analyzer was used to determine stain diameter and droplet size, which analyzes these samples after 24 hours of application to ensure that droplets had stopped spreading. A spread factor has to be calculated to determine the actual size of droplets.

RESULTS AND DISCUSSION

The results obtained by analyzing the data are summarized in Table 1. The results are discussed in terms of spray droplet density and VMD of droplets at different locations through plant canopy. The analysis of data indicates that the effect of combination of two variables i.e., air sleeve angle and nozzle angle on droplet density was found non significant on top position of the plant on both surface of leaves. The maximum droplet density 27.94 No. sq. cm^{-1} obtained on top position of the plant and on upper surface of the leaves was an effect of combination of 35^0 nozzle angle and 30^0 air sleeve angle. Whereas, minimum density 15.72 No sq. cm^{-1} was observed as an effect of 25^0 nozzle angle and 0^0 air sleeve angle. The maximum droplet density 27.44 No. $sq.cm^{-1}$ on top position of the plant and lower surface of the leaf was an effect of 35^0 nozzle angle and 30^0 air sleeve angle. Whereas, minimum droplet density 13.83 No. $sq.cm^{-1}$ at same position was due to 45^0 nozzle angle and 0^0 air sleeve angle. The effect was also non significant on upper surface of the leaf at middle and bottom position of the plant. The maximum droplet density 24.66 No. $sq.cm^{-1}$ on middle position of the plant and upper surface of the leaf was an effect due to 35^0 nozzle angle and -15^0 as well as 30^0 air sleeve angle. The minimum droplet density at same position was an effect of 45^0 nozzle angle and 0^0 air sleeve angle. The maximum droplet density 22.94 No. $sq.cm^{-1}$ obtained on upper surface of the leaf at bottom position of the plant was also due to 35^0 nozzle angle and 30^0 air sleeve angle. Whereas, minimum droplet density 16.5 No.$sq.cm^{-1}$ was due to effect of 45^0 nozzle angle and 0^0 air sleeve angle. The results show the droplet density observed on upper surface of the leaf at top, middle and bottom position of the plant was within the range of maximum 28 No. $sq.cm^{-1}$ to minimum 15 No. $sq.cm^{-1}$ and it was due to the effect of 35^0 nozzle angle and 30^0 air sleeve angle. The effect of different combinations of air sleeve angle and nozzle angle was found significant at middle and bottom position of the plant and only on lower surface of the leaf. The maximum droplet density 12.44 No. sq. cm^{-1} obtained at middle position of the plant and on lower surface of the leaf was due to the effect of positioning air

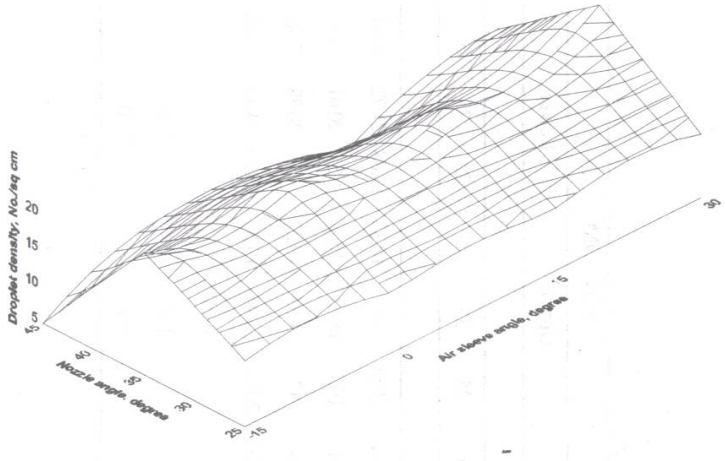


(a) Surface response

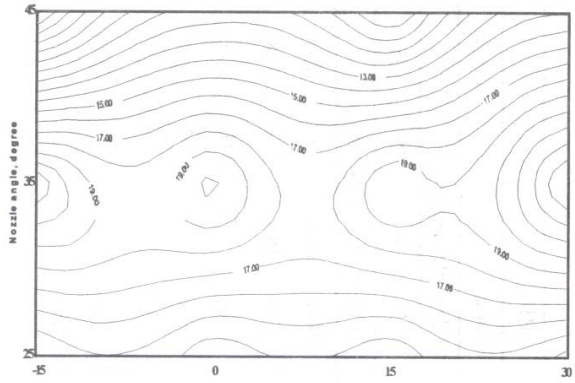


(a) Surface response

Fig. 1. Influence of air sleeve and nozzle angles on droplet density on middle position of the plant and lower leaf surface



(a) Surface response



(a) Contour plot

Fig. 2. Influence of air sleeve and nozzle angles on droplet density on bottom position of the plant and lower leaf surface

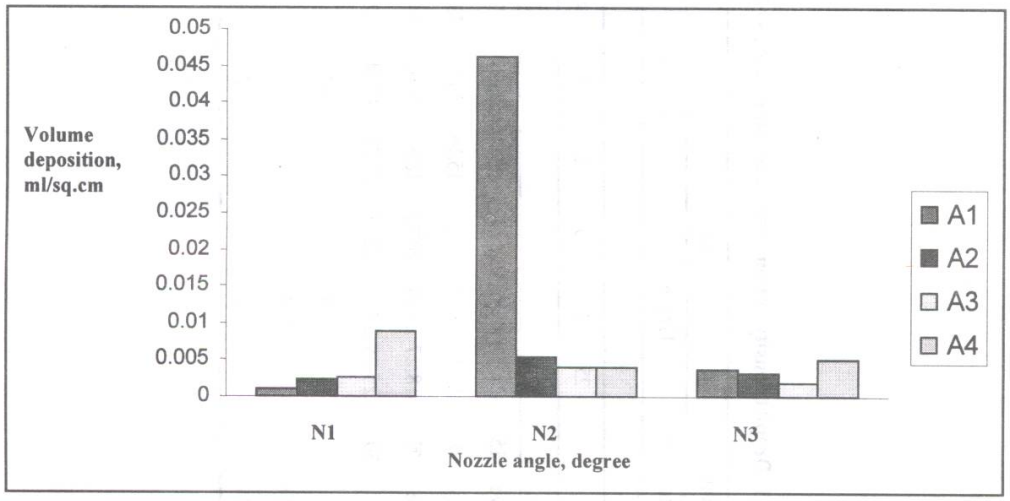


Fig. 3. Influence of air sleeve angle and nozzle angle on volume deposition

Table 1 Droplet density obtained on different positions of the plant and surfaces of the leaf

Position		TOP						MIDDLE						BOTTOM					
Surface		Upper			Lower			Upper			Lower			Upper			Lower		
		Nozzle angle, degree																	
		25	35	45	25	35	45	25	35	45	25	35	45	25	35	45	25	35	45
		Droplet density, No./sq.cm																	
Sleeve	-15	21.72	27.61	21.61	19.11	25.05	15	20.61	24.66	18.61	5.83	12.44	10.61	17.66	22	18.33	13.88	21.72	4.66
angle,	0	15.72	23.77	18.2	15.16	23.5	13.83	18.72	21.55	16.5	6.61	9.88	6.61	16.2	18.61	16.5	13	20.61	11.33
degree	15	18.27	24.16	20.22	18.83	24.61	14.88	18.38	24.22	19.77	8.66	6.11	7.5	17	21.83	19.27	13	20.38	7.38
	30	25.38	27.94	23.45	21.38	27.44	22.05	22.55	24.66	22.11	7.94	8.16	9.05	20.11	22.94	19.83	13.66	24.44	13.88
F_{test}			N.S			N.S			N.S			S			N.S			S	
SE(m)±			1.14			1.41			1.38			1.23			1.39			1.04	
CD=0.05			3.16			3.92			3.84			3.43			3.86			2.90	

sleeve at -15° air sleeve angle and setting nozzle at angle 35°. It was significantly higher over the maximum droplet density obtained as an effect of positioning air sleeve at 0° 15°, 30° angle in combination of nozzle set at 25° and 45° angles (Fig.1).

The maximum deposition 24.44 No. sq.cm^{-1} of the droplets on bottom position of the plant and on lower surface of the leaves was also due to an effect of the 30° air sleeve angle in combination of 35° nozzle angle(Fig.2). It was significantly higher over the maximum value of droplets at same position obtained as an effect of other air sleeve angles in combination of 25° and 45° nozzle angles. Thus results show that the combination of 35°nozzle angle and 30° air sleeve angle was best for obtaining the maximum droplet density around the recommended density of 25 No. sq.cm.$^{-1}$

The amount of spray deposition was determined as an influence of treatments of different combinations of air sleeve and nozzle angles and represented graphically in Fig-3. It was observed that the deposition index calculated for combination of all four-air sleeve angle with nozzle set at 25° angle was well above the range 1 to15 indicating the runoff volume deposited through the plant canopy. It was also found that the effect of nozzle angle 45° shows the deposition index was above the range for the treatments of combination of 15° sleeve angle. The data reveled that effect of combination of nozzle angle 45° with -15° and 0° air sleeve angles was in the range but on the higher surface approaching towards the runoff volume. However, the same nozzle angle combined with 30° air sleeve angle indicated that deposition index was well within the range below 10 showing good deposition of spray volume. The influence of nozzle angle 35° combined with four different air sleeve angles shows that the deposition index was well below the 10 indicating the good deposition of volume of spray through the plant canopy.

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Energy Use Pattern and Losses in Groundnut Oil Extraction Industry

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ABSTRACT

This study reports the thermal energy requirement for extraction of groundnut oil and thermal energy loss during the process. The total thermal energy requirement during the processing of extraction was accounted to be 15.19 $kWhq^{-1}$. Thermal loss was found to be 6.26 $kWhq^{-1}$ (41.21%). Out of total energy requirement of 27.67 $kWhq^{-1}$, electrical energy share is 12.17 and manual energy is 0.36 $kWhq^{-1}$

India has a highly developed oil based industry, employing more than 15 million persons. However, it remains an essentially food oil industry accounting for as much as 83 per cent of the total supply of vegetable oil in the country (Kothari, 1994).

As per the information of DIC's office there are 48 groundnut extraction industries registered in Akola district up to 1994. So far as oil industries are concerned very few research work has been done pertaining to thermal energy consumption and losses there on. Keeping this in view, the study was undertaken with the objectives of studying the energy consumption in groundnut oil extraction industries and to study the thermal energy loss during the extraction of groundnut oil.

MATERIAL AND METHODS

Only the groundnut is raw material for extraction of oil in groundnut oil industries. Thermal energy is calculated by noting the quantity of fuel required per quintal of raw material and calorific value of fuel. Manual energy is calculated by noting the time required for processing of the quintal finished product and number of persons engaged in the processing. Electrical energy is calculated by noting the HP of the motor and time required for processing the quintal finished product (Nalhe and Kukde, 1996).

Heat losses

The volume of water evaporated for steaming was calculated by noting down the height of boiler, circumference of exhaust pipe, initial water level in the boiler and the reduced level of water after one or two hours of boiling. Heat transfer through boiler was calculated by using the following equation (Balaney, 1982)

$Q\ (kWhq^{-1}) = mCp\ \Delta T\ (\text{raw material}) + mCp\ \Delta T\ (\text{water})$

Where,

Q= Thermal energy loss, $kWhq^{-1}$

m= Mass flow rate, $kgsec^{-1}$

$\Delta T = (T_1 - T_2)$

Thermal energy produced by the wood

Over all Q $kWhq^{-1}$ = Calorific value of fuel (Babul) x Quantity of wood

Thermal energy loss $Kcalq^{-1}$ =

(Energy produced by the wood) – (Energy requirement for the processing)

RESULTS AND DISCUSSION

From the energy use pattern studied, Table 1 depict the different forms of energy requirement . The thermal energy shares the major portion of the energy consumed i.e. 15.14 $kWhq^{-1}$ (54.71 %). The second highest energy consumed was electrical energy 12.17 $kWhq^{-1}$ (43.98 %) and the least was manual energy 0.36 $kWhq^{-1}$ (1.30 %). Thermal energy was consumed in the process of steaming only (15.14 $kWhq^{-1}$), which is more than fifty per cent of the total energy consumed. Electrical energy was accounted to be 12.17 $kWhq^{-1}$ (43.98%), which was used in crushing, extraction and filtration.

Different unit operations carried out in oil extraction process are cleaning , loading, steaming , crushing and extraction , first stage fileration and second stage filtration in sequence. As per the unit operations, energy consumption in steaming was found to be highest i.e. 15.21 $kWhq^{-1}$ (54.96%), followed by crushing and extraction 10.13 $kWhq^{-1}$ (39.13%), followed by filtration 1.62 $kWhq^{-1}$ (5.84 %) and least in cleaning 0.01 $kWhq^{-1}$ (0.03%). The sequence of operation carried out in processing of groundnut oil extraction in industries and consumption of specific energy during different operations is shown in Table 1. Figures in above Table are average of observations taken on three industries. From this Table, it was found that energy consumption

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Table 1. Energy consumption for various unit operations in processing of groundnut oil extraction industries

S.N.	Operations	Electrical energy kWhq^{-1}	Manual energy kWhq^{-1}	Thermal energy kWhq^{-1}	Total kWh q^{-1}
1	Cleaning	-	0.01	-	0.01 (0.03)
2	Steaming	-	0.07	15.14	15.21 (54.96)
3	Crushing and extraction	10.69	0.14	-	10.83 (39.13)
4	Filtration 1	0.74	0.07	-	0.81 (2.92)
5	Filtration 2	0.74	0.07	-	0.81 (2.92)
	Total	12.17 (43.98)	0.36 (1.30)	15.14 (54.71)	27.67

Note: figures in parentheses represents percent value

Table 2. Thermal energy losses in groundnut oil industry

Name of the industry	Produced by fuel wood (kWhq^{-1})	Required for steaming (kWhq^{-1})	Losses (kWhq^{-1})
Ambika	14.57	8.08	6.49
Jayant	13.53	7.86	5.67
Patil Bandhu	17.48	10.85	6.63
Total	45.58	26.79	18.79
Average	15.19	8.93 (58.78)	6.26 (41.21)

Note: figures in parentheses represent per cent value

for thermal mode application was observed to be highest (15.14 kWhq^{-1}) than energy accounting in other operations.

Energy consumption for steaming 15.21 kWhq^{-1} (54.96%) out of total energy consumption (27.67kWhq^{-1}) for extraction of oil, followed by crushing and extraction (10.83kWhq^{-1}), followed by filtration 1(0.81 kWhq^{-1}) and filtration 2 (0.81 kWhq^{-1}), respectively, followed by cleaning (0.01 kWhq^{-1}).

In groundnut oil industries, during the process of crushing and extraction of oil, groundnut cake is obtained as by product which is sold as animal fodder.

It was also found that a lot of thermal losses occur during the heat application process. As shown in Table 2, the thermal energy loss in system was accounted as 6.26 kWhq^{-1} (41.21%). This might be due to leakage to the atmosphere by the bare steam pipe and heat losses through exhaust pipe of boiler.

CONCLUSIONS

1. The energy consumption for processing of groundnut oil was 27.20 kWhq^{-1}. Out of which the thermal energy consumption in processing of oil was observed to be 15.14 kWhq^{-1} (54.71%)
2. Thermal energy loss in groundnut oil industry was accounted to be 6.26 kWhq^{-1} which is 41.21 per cent and can be minimized by using insulation of supply pipe line and choosing a good boiler

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Design and Development of Solar Water Heater Cum Distillation Unit For Domestic Use

S. H. Sengar [1] A. K. Kurchania[2] ,P. M. Nachane[3] and D. M. Mahalle[4]

ABSTRACT

Designed and developed composite solar unit for domestic use as Solar Water Heater cum Distillation (SWHD) for hot water and distilled water simultaneously. Unit was tested for full load condition in winter and summer to find out its performance. In solar water heater cum distillation unit the maximum temperatures of water in storage tank were found to be 48.68^{0}C and 58.28^{0}C in winter and summer, respectively. Total distilled water in 24 hours produced from SWHD in February 2004 and April 2004 was 5007 ml/m^2/day and 5275ml/m^2/day respectively. Efficiency of SWHD for winter and summer was found to be 36.70 per cent and 27.65 per cent for solar water heater, and 49.55 per cent and 43.97 per cent for distillation for winter and summer, respectively. The total cost of SWHD was worked out to be Rs.8930.

The conversion of solar energy into traditionally usable form of energy like heat or electricity has found viable now a days through different conversion techniques. Different solar heaters are being already developed and also commercially implemented for use of solar energy. Solar energy gadgets for heating domestic water could be used for heating water up to 50-60^0 C. The distillation of salty water to recover potable water is accomplished by exposing thin layer of the salty water to solar radiation and condensing the water vapour produced on transparent cover in such a way that it can be collected in receiving troughs. Taking in to consideration these two operations, a composite system named as Solar Water Heater cum Distillation (SWHD) unit was designed and fabricated at Department of Renewable Energy Source, C.T.A.E.,Udaipur

MATERIAL AND METHODS

For Solar Water Heater cum Distillation device a flat plate collector was considered and at the top of the storage tank of water, a trough of 0.45 x 0.45 x 0.19 m size was provided for the water supply as well as to cool the distillation unit system compoents are shown in the Fig.1. Temperature difference between the hot water of the storage tank and of the top cover produced the convection water current inside the storage tank. These currents brought the humid air into the contact with relatively cool cover and resulted condensation.This condensation slid down the slope and collected in the distillation bowl and drained out through the piping. Systems were studied in winter as well as summer season during daytime. The main components of SWHD were flat plate collector, insulated tank, water trough, bowel for distillation and the pipe connection. when solar radiation fell on collector, water gets heated and circulates in the system automatically by natural convection called thermosyphon. (Singh *et. al.*, 2004). In this unit water heating as well as distillation occur simultaneously. At time of testing, ambient temperature (Ta), inlet temperature of collector (Ti), outlet temperature of collector (To), storage tank temperature (Tst), and yield per sq. meter for distillation were observed.

Design Consideration

a) Slope of collector

Slope of collector β was calculated (Breindorfer *et. al.*,1985) for January 20 and latitudes 24.6 (Udaipur) which comes to be +45^0 . The collector was kept south facing at an angle of 45^0.

b) Intensity of insulations on collector surface (Ic)

To calculate angle of incidence for insolation falling on surface standard equation were used (Eldighidy, 1991) and considering surface azimuth angle and hour

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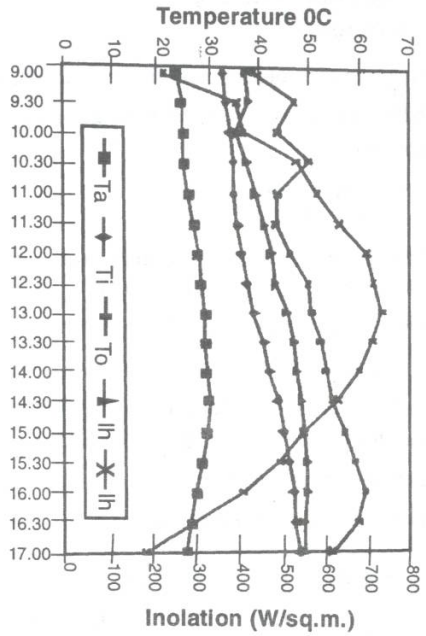

Fig. 2. Thermal performance curve for SWHD for water heater in winter

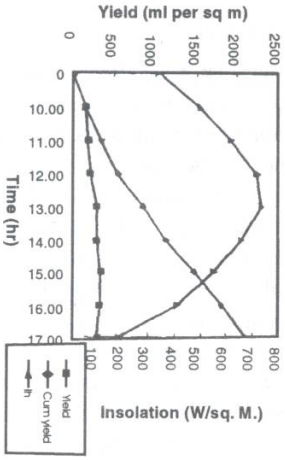

Fig. 4. Performance of SWHD for distillation during winter

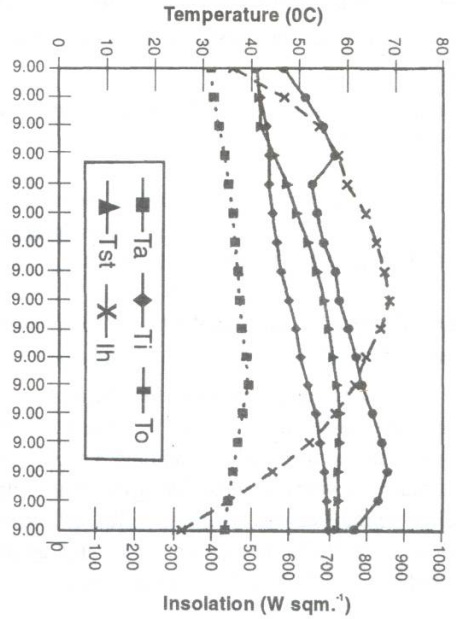

Fig. 3. Thermal performance curve for Solar water heater in SWHD for summer

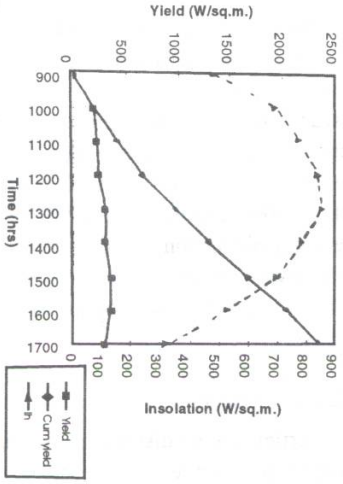

Fig. 5. Performance of SWHD for distillation during summer

angle as zero Cos θ comes to be 0.998

$Ic = I_h \times \cos\theta$, Where,

Ih = Intensity of insolation on horizontal surface, W/m²

= 620 W/m² (Anna Mani and S.Rangarajan)

Ic = 620 x 0.998

= 618.76 = 619 W/m²

c) Determination of energy requirement for solar water heater cum solar distillation.

Following assumptions were made

1. Mass of water (m) to be heated is 100 Kg
2. Initial temperature of water is 15°C which was the lowest temperature on the day of 10th December
3. Water is to be heated upto 60° C.
4. Specific heat of water is 4.187k J.

The energy required E = mcp ΔT kJ.

E = 100 x 4.187 x (60°C-15°C)

= **16748kJ**

d) Determination of absorber area of collector

Following steps were considered for determining the absorber area of collector

1. Heat required per day =16748kJ
2. Energy incident on the inclined surface of collector is Ic x solar hr day^{-1} x 3600 - 619 x 9 x 3600 =20055 kJ/m² day^{-1}
3. Overall efficiency of collector is taken as 40 per cent by considering the lower limit.

Collector absorber area required = Energy required/ Energy available x η_c

= (16748 / 20055) x 0.4 = 2.0 Sq. m.

e) Method for performance evaluation of Solar Water Heater of SWHD

In order to calculate the performance of water heater cum desalination plant, half hourly reading of inlet-outlet water temperature in plants, ambient temperature and solar radiation were measured during day time. Total distilled water produced was measured and the efficiency of the different units of SWHD was calculated as per Antonopoulos *et. al.*,1992 and Garg *et.al.*,1998.

RESULTS AND DISCUSSION

Solar water heater

The Solar Water Heater System in SWHD device was tested for the winter and summer season . It was operated from 9:00 a.m. to 5:00 p.m. to get maximum input of solar energy. The maximum temperatures of water in storage tank were found to be 48.68° C and 58.28° C in winter and summer, respectively. Maximum solar energy input was available at 13:00 hours. After 13:00 hours there was gradual decrease in the incident solar radiation. With the increase in the solar radiation, the temperature of water increased. Also there was a sudden decline in water temperature as the hot water was taken at 10:00 hour and level of water was again maintained (Fig. 2 and Fig. 3). Testing revealed that the efficiency of SWH system was 35.70 to 27.48 per cent in the month of February 04 and April 04, respectively. It was observed that the efficiency in the month of April was lesser due to more heat losses from pipe and storage tank.

Performance Evaluation of Solar Distillation Plants

It is evident that the out put of solar distillation plant increased with the time and then decreased as (Fig. 4 and Fig. 5) for month of February and April. The output distillation increased upto 3 p.m. The maximum out put of distilled water was at 3:00 p.m. in the plant due to the maximum temperature and consequently maximum evaporation.

Total distilled water in 24 hours produced from SWHD in February 2004 and April 2004 were 5007 ml/m² / day and 5275 mk/m² /day. The difference in the yield increased upto 3:00 p.m. and then decreased. During night time, the temperature in water trough decreased while the temperature inside storage tank was more due to insulation. Hence, there was more condensation and consequently distillation was also more. The output of the SWHD was greater in February than April as shown in Fig.4 and Fig. 5 since there seemed to be more heat loss in summer.

Distillation efficiency

Efficiency of distillation unit in SWHD was observed as 49.55 per cent in February and 43.97 per cent in April. More efficiency was observed as compared to the basin type solar distillation devices since the water inside the storage tank was warmer due to the use of solar

collector and preheating of cold water in water trough above the storage tank due to the utilization of latent heat while condensation. In winter more eficiency was found than summer since more heat loss was found in summer from pipe and storage tank.

Total Dissolved Solid and pH

The results of pH and total dissolved solid measurement of distilled water and normal water were 7.1, 7.9 and 30 ppm, 600 ppm, respectively. Which are similar to the results quoted by Dutt *et. al.,* 1994. The distilled water can be used for various purposes considering its low dissolved solid and normal pH.

CONCLUSIONS

1. The Solar Water Heater cum Distillation device was able to perform the functions of water heating and distillation at the same time. Efficiency for the solar water heater of SWHD for winter and summer was found to be 36.70 per cent and 27.48 per cent, respectively. The maximum temperature of hot water in winter and summer were 48.68 and 52.28, respectively.
2. The yield of distilled water in SWHD device was found 5007 ml/m^2 day^{-1} in winter and 5275 ml/m^2/day in summer. Efficiency of distillation unit in winter and summer was found to be 49.55 per cent and 43.97per cent, respectively.

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Studies on Pneumatic Paddy Parboiling Process

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ABSTRACT

The pneumatic paddy parboiling process, investigated by SPRERI, eliminates use of steam and thus the expensive boiler. Five popular varieties of paddy parboiled in Gujarat were selected for this work and their basic properties like geletinization temperature and soaking time with respect to temperature were studied. A one kg paddy parboiling unit was designed and fabricated for laboratory experiments. The milling and cooking quality of parboiled paddy were conducted to optimize different parboiling parameters such as soaking time, soaking temperature and pneumatic pressure the rice produced by this parboiling process was found to be uniform light colour .

Parboiling is premilling treatment given to paddy for improving its milling quality, there is significant increase in hardness of the kernel during parboiling due to geletinization of starch (Ali Nawab and Pandya, 1974). Parboiled paddy is produced in India by both traditional and modern processes. The traditional process consists of soaking paddy in cold water for 36 to 72 h, followed by steaming of paddy for 10 to 12 minutes in iron kettles (Chakravarthy, A., 1988). The steamed paddy is sun dried. Modern parboiling method have eliminated some of the effect of traditional parboiling process such as long soaking time, bad smell and high labor requirement. The modern method evolved by the Central Food Technological and Research Institute (CFTRI) Mysore, uses hot water soaking for 4.5 to 5 hrs at 70 to 75° C to eliminate problems associated with traditional methods.(Deshpande, *et.al*, 1981).This method also has certain drawbacks like dark coloured rice and required expensive boiler .

In pneumatic parboiling, paddy is soaked in hot water at its geletinization temperature under pneumatic pressure (Houstan.D.F 1972, and Ienger, N.G.C *et.al*,1980). The process has distinct advantage like eliminating high energy consuming steaming process; long processing time, dark colour and the process produces hard texture in the product. Sardar Patel Renewable Energy Research Institute has conducted extensive experimental study on this process to develop prototype.

MATERIAL AND METHODS

Five varieties of paddy namely Nawagam-19, GR-11, Jaya, GR-101 and Basmati(local) which are popularly parboiled in Gujarat have been selected for the experimental work. The physical characteristics of these paddy varieties are given in Table 1. Experiments were carried out to find out the geletinization temperature of each type of paddy so as to determine the temperature of hot water to be used for parboiling process. Soaking period for each variety of paddy to attain 30 per cent moisture has also been determined.

Based on the test results, a 1 kg capacity pneumatic paddy parboiling unit (PPU) was designed and fabricated Fig 1 and 2 shows the schematic diagram and photograph of the unit. The PPU made of 12 mm mild steel had 160 mm height and 150 mm diameter. It had arrangement for injecting air, measuring temperature of water and safety valve release excess air. Initial experiments were conducted with 500g of paddy in the PPU and later full load tests were conducted. After closing the lid tightly, the pressure inside the PPU was increased up to desired level with the help of an air compressor. On attaining the required pressure the vessel was isolated to maintain the pneumatic pressure constant throughout the experiment.

The PPU was kept inside a constant temperature water bath for maintaining uniform temperature during the experiments (Fig.4). On completion of experiment, the pressure was released and the paddy removed and sun dried up to 13-14 per cent (W.B) moisture content.

RESULTS AND DISCUSSION

Geletinization temperature of different varieties of paddy has been determined by two methods namely Alkali test and Birefringence End Point Temperature (BEPT) method

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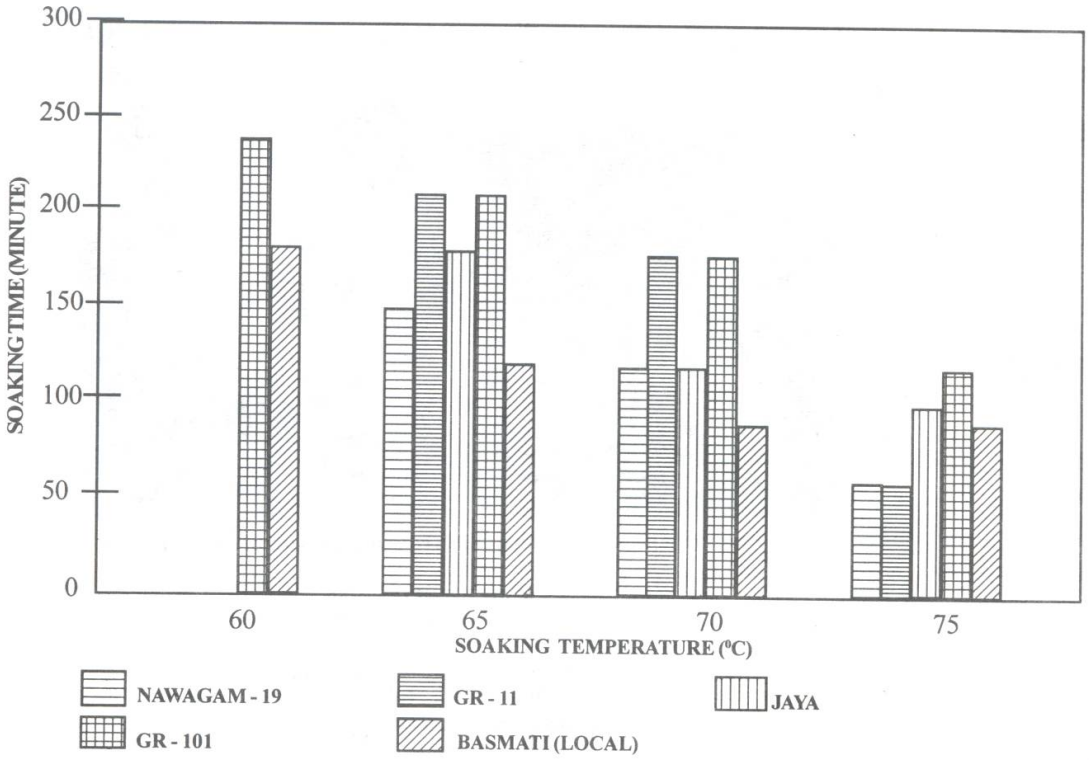

Fig. 1. Soaking period for different varieties of paddy at different temperature

Table 1. Physical characteristics of paddy used in the study

Variety	Duration	Yield (Kg ha $^{-1}$)		Wt. of 1000 grains (g)	Rice quality	Length & Width (mm)
		Grain	Straw			
Nawagam-19	145	4000-4500	6000	24.6	White and long	6.9&1.5
GR-11	125	5000-6000	5000-5500	16.1	White and fine	5.8 & 1.5
Jaya	128	4500-5000	5000	28.0	White and Coarse	5.7 & 1.9
GR-101	130	5500-6000	6500	18.5	White and medium	4.7 & 1.5
Basmati	135	3000-3500	5000	24.2	White and Long	7.2 & 1.6

Table 2. Geletinization temperature of different varieties of paddy

Paddy Variety	Alkali test		BEPT Test
	Alkali score	Geletinization temp Range ^{0} C	Geletinization temp ^{0}C
Nawagam-19	1	>74	76-78
GR-11	3	70-74	70-71
Jaya	7	<69	58-59
GR-101	7	<69	58-60
Basmati (local)	1	>74	74-75

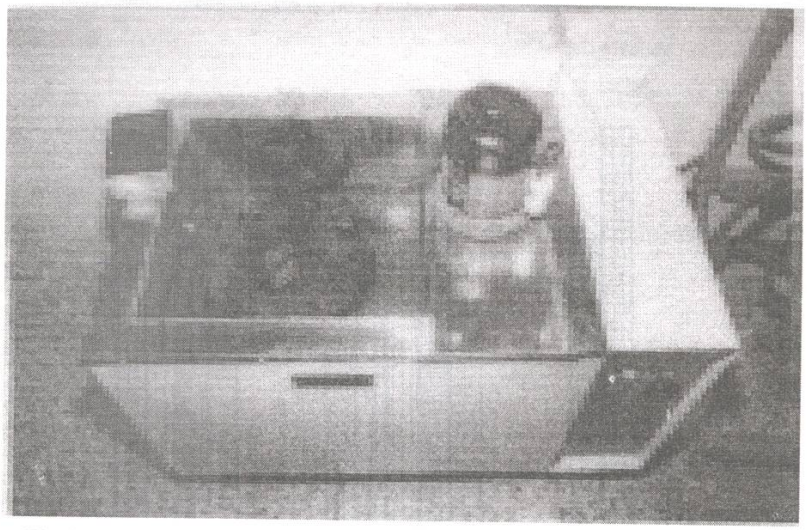

Fig. 2. Pneumatic paddy parboiling unit in constant temperature water bath

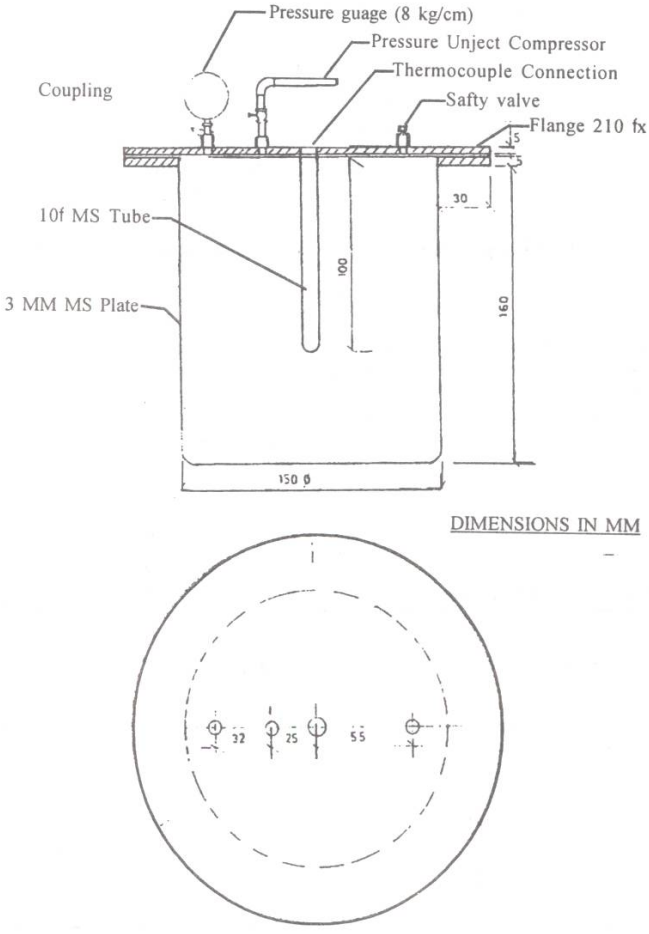

Fig. 3. Pneumatic paddy parboiling unit for 1 kg

Table 3. Changes in quality characters of paddy due to pneumatic pressure parboiling

Variety	Geletinization Temp.(°C)	Soaking Temp.(°C)	Soaking time(h)	Pneumatic pressure (Kg/cm²)	Total yield(%)	Head yield	Broken content(%)	Chalky grains(%)	Hardness Kg/cm²	Swelling Index	Cooking time (Min.)
GR-11	70-71	65	3	3	73.71	45.87	31.02	26.8	8.70	7.2	20
		65	3 .5	3	73.52	47.24	30.24	24.3	8.80	7.4	20
		65	4	3	73.00	49.28	19.57	20.2	9.20	7.9	22
		70	2.5	3	73.14	48.52	29.62	5.5	8.90	8.34	23
		70	3	3	73.00	70.46	4.81	1.12	10.10	8.40	26
		70	3.5	3	76.00	72.81	3.62	1.1	10.25	8.40	28
		70	4	3	73.40	73.1	3.24	1.0	10.40	8.41	29
Raw rice	–	–	–	–	65.6	35.4	31.6	36.4	2.80	5.23	18
		70	4	3	73.40	73.1	3.24	1.0	10.40	8.41	29
Basmati	74-75										
Nawagam-19	76-78	75	3.5	3	65.00	64.24	2.92	1.14	8.80	7.12	31
GR-101	58-60	60	3.5	3	66.45	64.28	2.18	2.14	10.10	7.62	29
Jaya	58-59	60	3.5	3	73.18	69.12	9.15	10.84	7.95	8.40	35

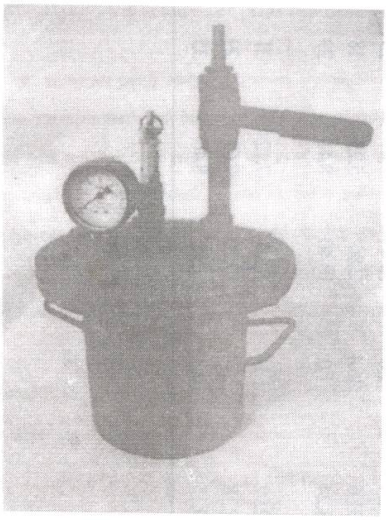

Fig. 4. 1 Kg capacity pneumatic paddy parboiling unit

(Houstan, D.F., 1972). The results of the tests are presented in Table 2.The results show that fine varieties of paddy have higher geletinization temperature compared to coarse and medium varieties of paddy

Soaking is one of the main operations in paddy parboiling process which decides the total time taken. The soaking period for each variety of paddy to attain 30 per cent moisture has been determined and the results are presented in Fig 3. It can be noticed that the soaking period decreases with increase in temperature

Experiment was carried out to optimize the different parameters influencing the parboiling process such as soaking time, soaking temperature and pneumatic pressure. The effect of these parameters were evolved on the basis of milling qualities of paddy such as head yield, broken content, chalky grains and grain hardness. The results obtained for GR-11, which is the most popular paddy used for parboiling are shown in Table 3. To optimize the pneumatic pressure, experiments were conducted at different pneumatic pressure viz. 1, 2, 3, 3.5 and 4 kg/cm^2 and it was found that presser above 3kg/cm^2 produced dark coloured rice. Experiments were also carried out at 1, 2 and 3kg/cm^2 pneumatic pressure with different combinations and soaking temperature and time. The best results were obtained at 70^0 C with 3 hours soaking period and 3kg/cm^2 pneumatic pressure. Though higher head yield was possible for longer soaking time and higher pressure, the rice had dark colour. The percentage of chalky grains (1.12 %) and broken content (4.18 %) decreased with increase in soaking temperature and time.

The cooking quality of the parboiled rice determined in terms of swelling index (7.8) and cooking time (26min.) obtained for the pneumatic parboiled paddy was observed higher compared to raw paddy. Similar trends were obtained for other varieties of paddy such as Basmati, Nawagam-19, GR-101 and Jaya and are similar to that of the results quoted by Pillaiyer, P(1993).

CONCLUSION

The pneumatic paddy parboiling process eliminates the steam essential in the CFTRI method. The total time taken in the pneumatic method is only 3 to 3 1/2 hrs, which is much less than the traditional method. Milling analysis of parboiled rice from various treatments showed that good quality parboiled rice with 2 to 4 per cent of white bellies can be obtained by soaking the paddy at its geletinization temperature under pneumatic pressure without any further heat treatments.

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Therapeutic Efficacy of Autogenous Vaccine with Herbal Drugs Against Subclinical Mastitis With Reference to Immunological Study*

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ABSTRACT

Therapeutic efficacy of autogenous vaccine with herbal drugs was evaluated against subclinical mastitis (SCM) in cows in terms of its effect on immunological parameters. The study revealed significant increase in lymphocyte per cent, serum and milk immunoglobulins and somatic cell count (SCC) whereas decrease in total leucocyte count (TLC), neutrophils and phagocytic activity in SCM. The combined therapy of autogenous vaccine and herbal drugs initiated improvement in the altered TLC, neutrophil per cent lymphocyte per cent, phagocytic activity, milk and serum immunoglobulins and somatic cell count. However, combined therapy did not restore all these parameters to normalcy except milk immunoglobulin within 15 days of treatment. It indicted partial efficacy of given treatment in improving immunological parameters.

Subclinical mastitis (SCM) is a milder but most dangerous form of the udder infection which cause heavy economic losses to dairy industries in terms of quality and quantity of milk. The economic losses in India have been estimated upto Rs. 4365.32 crores per annum (Dua, 2001). The therapy of mastitis relies upon use of antibiotics which leads to several complications viz. bacterial resistance, residues in milk and meat causing hazards to human health. Therefore, alternative treatment is the new approach for treatment and control of subclinical infection of mammary gland.

In view of the above, the autogenous vaccine along with herbal therapy (*Azadirachta indica* and *Curcuma longa*) was evaluated for the treatment of SCM in terms of its effect on altered immunological parameters.

MATERIAL AND METHODS

Total 12 cross bred lactating cows positive for SCM as detected by Modified California Mastitis Test (MCMT) were selected and randomly divided into two equal groups. One additional group of 6 normal cows free from SCM was kept as normal healthy control (T_1). Out of 2 groups of SCM positive cows, one was kept as untreated control (T_2) whereas another was treated with autogenous killed *Staphylococcal* vaccine prepared from organisms isolated from the milk of respective cow @ 5 ml (3×10^9 bacteria ml^{-1}) subcutaneously on neck region at both the sides on alternate day for 15 days and aqeous extract of *A. indica* bark powder @ 250 ml with 20 per cent concentration bid daily orally along with the locl application on udder with paste prepared from *A. indica* bark powder and *C. longa* rhizome powder bid daily for 15 days.

The milk samples from all the cows were collected before treatment ('0' day) and 3rd, 7th, 10th and 15th day post treatment for estimation of SCC (Schalm *et. al.*, 1971) and milk immunoglobulins (Pfeiffer *el. al.*,1977). Likewise blood samples from all the cows were also collected before treatment ('0' day) and 3rd, 7th, 10th and 15th day post treatment for estimation of TLC, neutrophils, lymphocytes (Sastry, 1989), srum immunoglobulins (Pfeiffer *et. al.*, 1977) and phagocytic activity of neutrophils (Malik, 2003).

The data collected were analyzed statistically by factorial completely randomized design (FCRD) as described by Snedcor and Cochran (1971).

RESULTS AND DISCUSSION

In the present investigation, total 21 quarters of 6 cows were found positive for SCM by MCMT. Out of 21 positive quarters, only 11 quarters showed distinct negative reaction to MCMT after 15 days of treatment with autogenous vaccine along with herbal drugs. The recovery rate calculated was 52.38 per cent which indicated that the treatment reduced the severity of SCM. However, it could not eliminate the subclinical mastitic infection completely within 15 days of treatment.

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The average changes in the TLC, neutrophils, lymphocytes, phagocytic activity, serum and milk immunoglobulins and somatic cell count are presented in the Table 1.

The study of leukocytic changes revealed leukopenia, neutropenia and lymphocytosis in the SCM. Leukopenia and neutropenia in SCM might be due to increase in diapedesis of leukocytes into the mammary gland (Sordillo *et. al.*, 1997). After treatment with autogenous vaccine along with herbal drugs TLC and neutrophils increased significantly on 7th day post treatment over pretreatment value. However, it did not restore to normalcy within 15 days of treatment. Where as lymphocyte percentage decreased significantly on 15th day post treatment over pretreatment value. The increase in the TLC and neutrophil due to given treatments might be due to potentiation of neutrophil recruitment with production of specific antibodies facilitate opsonization and subsequent reduction in infection and inflammation by autogenous vaccine (Sordillo *et. al.*, 1997) and anti-inflammatory and antimicrobial effect of herbal drugs (Upadhyaya and Dhawan, 1994 and Shukla *et. al.*, 2003). The decrease in the lymphocyte per cent might be due to increase in neutrophils.

Phagocytic activity in all subclinical mastitic cows was found significantly decreased as compared to normal healthy group (Guidry *et. al.*, 1975). The reduction in phagocytic activity in SCM might be due to weakness in defence mechanism in animals leads to mobilization of polymorphonuclear leucocytes (PMN) into the milk as a result of udder infection (Guidry *et. al.*, 1975).

After treatment with autogenous vaccine and herbal drugs, the phagocytic activity increased significantly on the 10th day post treatment (Table 1) over pretreatment value but did not restore to normal even within 15 days of treatment. This rise in phagocytic activity might be due to synergistic effect of autogenous vaccine and herbal drugs, which causes elevation of serum antibodies (cytophillic IgG_2) resulted into opsonization of bacteria and thus enhanced phagocytic activity of PMN (Watson and Kennedy, 1981 and Guidry *et. al.*, 1991).

The milk and serum immunoglobulins were found elevated significanlty in subclinical mastitic cows as compared to normal healthy cows. Increase in serum and milk immunoglobulin in SCM could be attributed to the transfer of bacterial antigen from the mammary gland to blood serum due to impaired blood : milk barrier and specific stimulation of general immune system (Caffin *et. al.*, 1983).

After treatment with autogenous vaccine and herbal drugs the milk immunoglobulin level decreased significantly on 7th day and restored to normal on 10th day after treatment. The serum immunoglobulins level was decreased apparently after treatment over pretreatment values within 15 days of treatment. The reduction in milk and serum immunoglobulins might be due to improvement in impaired blood : milk barrier and thus prevent the entry of immunoglobulins in the lacteal secretion as a result of elimination of infection and subsequent improvement in inflammation by autogenous vaccine (Watson and Keneddy, 1981) and herbal drugs i.e. *A. indica* and *C. longa* by virtue of their antibacterial and anti-inflammatory effect, respcetively (Drury, 1978).

In normal healthy control group, SCC was in the range of 2.94 ± 0.10 to $3.25 \pm 0.15 \times 10^5$ cells/ml. It was significantly increased in subclinical mastitic cows as compared to normal healthy group. In untreated control group it remained significantly higher. The increase in SCC in SCM might be due to shift of leucocytes to the udder after entry of infection in the mammary gland and as a protective mechanism against infection (Pednekar *et. al.*, 1992). After treatment with autogenous vaccine and herbal drug the SSC was decreased signficantly on 7th day post treatment over pretreatment value but did not restore to normalcy within 15 days of treatment. This decrease in SCC might be due to reversal of increased permeability of udder parenchyma to leukocyte from blood stream to lacteal secretion because of reduction of infection and inflammation by enhancing phagocytic activity and immunopotentiating effect by autogenous vaccine (Sordillo et. al., 1997) and anti-inflammatory and antibacterial activity of herbal drugs (Drury, 1978 and Upadhyaya and Dhawan, 1994).

From above findings it is concluded that the autogenous vaccine with herbal drug initiated improvement in the altered values of TLC, neutrophil per cent, lymphocyte per cent, phagocytic activity and milk and serum immunoglobulins and SCC. However, it did not restore them to normal except milk immunoglobulin within 15 days of treatment indicating partial efficacy of given combined treatment in reducing the infection and in improving altered immunological parameters in SCM in cows. Thus needs further investigation.

Table1: Showing average value of total leukocyte count (TLC), neutrophils, lymphocyte, phagocytic activity, milk and serum immunoglobulins and somatic cell count (SCC) in normal and subclinical mastitis cows before treatment ('0'day) and 3rd, 7th,10th and 15th day post treatment.

Group	Period	TLC (–x10^3/)	Netrophil (%)	Lymphocyte (%)	Phagocttic activity (%)	Milk immuno globilin mg ml^{-1}	Serum immuno globulin mg ml^{-1}	Somatc cell count (..... X 10^5 cell ml^{-1})
	0	9.53a* ± 0.4	37.17a* ± 2.44	56.17a* ± 2.36	45.17a* ± 1.25	6.57a* ± 0.27	25.82 ± 1.34	2.96a* ± 0.15
	3	9.42a* ± 0.33	39.33a* ± 2.16	55.50a* ± 2.05	45.67a* ± 0.71	6.5a* ± 0.21	25.82 ± 1.29	3.08a* ± 0.22
Normal healthy control	7	9.59a* ± 0.36	38.83a* ± 2.4	54.50a* ± 2.59	44.5a* ± 0.67	6.39a* ± 0.17	25.57 ± 0.44	2.95a* 0.17
(T_1)	10	9.73a* ± 0.37	4.0.5a* ± 1.8	53.33a* ± 1.63	45a* ± 1.18	6.43a* ± 0.21	27.03 ± 0.98	2.94 ± 0.10
	15	9.74 ± 0.24	40.17a* ± 1.62	53.33a* ± 1.69	45.83a* ± 1.45	6.53a* ± 10.16	26.03 ± 0.72	3.25a* ± 0.15
	0	6.90a ± 0.27	28.33c ± 1.05	64.83a ± 1.05	34.67b ± 1.43	10.03a ± 0.88	30.8 ± 1.03	5.71a 0.51
Untreated	3	6.78a	26bc	67.17ab	32.83ab	10.37ab	31.5	6.04a
control		± 0.25	± 0.93	± 0.75	± 1.3	± 0.88	± 1.2	± 0.56
(T_2)	7	6.54a ± 0.2	23.83ab ± 0.83	70bc ± 0.97	31.17a ± 0.98	11.64ab ± 0.94	32.23 ± 1.31	8.35b ± 0.93
	10	6.28a ± 0.18	21a ± 0.52	73c ± 0.52	30.17a ± 1.14	13.69bc ± 0.92	32.68 ± 1.33	11.12c ± 0.9
	15	6.3a ± 0.17	19.67a ± 0.56	74.33c ± 0.49	29.83a ± 1.17	15.11c ± 0.98	33.6 ± 1.34	14b ± 0.54
	0	6.54a ± 0.16	26.67a ± 1.89	65b ± 1.97	35a ± 1.46	10.72c ± 0.93	30.75 ± 1.0	7.79c ± 0.10
Autogenous	3	6.81ab	27.5ab	64.5b	36.33ab	10.2bc	30.2	6.51
vaccine		± 0.13	± 1.61	± 2.00	± 1.41	± 0.75	± 1.01	± 0.9
+	7	7.2bc	29.17ab	63.83b	37.17ab	9.33ab	29.67	5.61
Herbal		± 0.19	± 1.7	± 1.82	± 0.95	± 0.56	± 0.91	± 0.5
preparation	10	7.66c	31.33bc	61.17ab	39bc	8.49ab	29.27	4.93ab
(T_3)		± 0.2	± 1.86	± 1.99	± 1.15	± 0.61	± 0.88	± 0.59
	15	8.36d ± 0.19	34.17c ± 1.47	58.5a ± 1.41	40c ± 1.15	7.62a* ± 0.49	28.92 ± 0.85	4.38a ± 0.51

a,b,c,d denotes significant difference($P<0.01$) within different intervals of respective parameters and groups.

* Denotes Significant difference ($P<0.01$)between T_1 and corresponding perriod of T_2 and T_3 groups.

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RESEARCH NOTE

Management of Alternaria Blight of Sunflower

Sunflower (*Helianthus annuus* L.) is a major oil seed crop in India and cultivated in Maharashtra, Karnataka and Andhra Pradesh. Alterneria blight caused by *Alternaria helianthi* (Hansf.) Tubaki and Nishihara is the most important disease of sunflower crop and causes yield losses to the extent of 80 per cent (Balasubrahmanyan and Kolte, 1980). The present investigation emphasized on proper management of Alternatia blight by using fungicides, plant extracts and bioagents.

The field experiment was conducted in the Department of Plant Pathology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during Kharif, 2002. The seed of sunflower variety 'morden' was sown on 1st July 2002. The field trial was laid out in randomised block design with three replications and eleven treatments. The plot size was 2.7 x 3.0 m^2 with spacing of 45 cm x 30 cm.

The fungicides evaluated were Sulphur 80 WP, Carbendazim 50 WP, Dinocap 48 EC and plant extracts of Neem, Eucalyptus and Behada leaf extracts. The efficacy of bioagents viz. *Trichoderma harzianum* and *Trichoderma viride* (10^5 cfu ml^{-1}) were also assessed. The Neem, Behada and Nilgiri leaf extracts were prepared from fresh, green leaves of respective plants by adopting the procedure suggested by Bambode and Shukla (1993).

In order to increase disease pressure conidial and mycelial suspension of *Alternaria helianthi* was sprayed on all plots 20 days after sowing. The treatments

Table 1. Effect of foliar sprays of fungicides, plant extracts and bioagents on per cent disease intensity of Alternaria blight sunflower

Treatments	Conc. %	Disease intensity (%) 45 DAS	60 DAS	75 DAS	Per cent disease control	Yield (q ha^{-1})	Increase over control (%)
Wettable sulphur	0.3	12.44 (3.51)*	13.82 (3.71)	16.31 (4.03)	44.41	7.89	8.82
Carbendazim	0.1	7.40 (2.68)	10.37 (3.31)	12.82 (3.69)	56.30	9.36	29.10
Tridemorph	0.05	11.11 (3.30)	13.08 (3.59)	15.18 (3.88)	48.26	8.58	18.34
Chlorothalonil	0.25	9.25 (3.01)	12.16 (3.47)	14.07 (3.73)	52.04	8.97	23.72
Dinocap	0.1	12.07 (3.46)	13.52 (3.66)	15.93 (3.97)	45.70	7.94	9.51
Neem leaf extract	5	12.96 (3.57)	15.46 (3.91)	17.66 (4.19)	39.80	7.84	8.31
Eucalyptus leaf extract	5	13.32 (3.63)	17.64 (4.19)	20.78 (4.55)	29.17	7.66	5.65
Behada leaf extract	5	14.07 (3.73)	17.68 (4.19)	21.05 (4.47)	28.25	8.25	17.24
Trichoderma harzianum	10^5 cuf ml^{-1}	17.03 (4.11)	1.17 (4.48)	23.47 (4.84)	20.0	7.85	8.27
Trichoderma viride	105 cfu ml^{-1}	16.14 (3.93)	19.78 (4.40)	23.06 (4.78)	21.40	7.99	10.23
Control	-	19.99 (4.55)	23.68 (4.85)	29.34 (5.41)	-	7.25	-
'F' test		Sig	Sig	Sig		Sig	
SE (m)±		0.28	0.20	0.16		0.36	
CD (P = 0.05)		0.80	0.56	0.75		1.03	

* Figure in parenthesis are square root transformations.

were imposed at the first appearance of the disease. Three sprays at an interval of 15 days were applied.

Five plants were randomly selected from each plot for scoring the intensity of the disease and 0 to 9 ratig scale developed by Mayee and Datar (1986) was used. At maturity the plots were harvested separately and the grains were sundried properly and yield recorded.

It is observed from the data presented in Table 1 that, foliar sprays of fungicides, plant leaf extracts and bioagents were found to be significant in reducing Alternaria blight of sunflower. The intensity was recorded at 45, 60 and 75 days after sowing.

At 45 days after sowing (DAS), Carbendazim @ 0.1 per cent recorded least disease intensity (7.40%), followed by Chlorothalonil @ 0.25 pr cent (9.25%). Sulphur @ 0.3 per cent (12.44%), Dinocap @ 0.1 per cent (12.07%) and Neem leaf extract @ 5 per cent (12.96%) and these treatments were at par with each other. Maximum disease intensity was recorded in control (19.99 %), followed by *Trichoderma harzianum* @ 10^5 cfu ml^{-1} (17.03%), *T. viride* @ 10^5 cfu ml^{-1} (16.14%).

The per cent disease intensity at 60 and 75 DAS also revealed significant differences. At 75 DAS least intensity of alternaria blight was obtained in Carbendazim @ 0.1 per cent (12.82%), followed by Chlorothalonil @ 0.25 per cent (14.07%) and Tridemorph @ 0.05 per cent (16.31%). The efficiency of *T. harzianum* @ 10^5 cfu ml^{-1} (23.47%) and *T. viride* @ 10^5 cfu ml^{-1} (23.06%) were observed at par with each other.The disease pressures in control was maximum i.e. (29.34%).

The results of the present study are in concorandance with the published data of Srinivas *et. al.*, (1997) as they reported that Carbendazim @ 0.1 per cent was most effective in controlling the alternaria blight. Singh (2002) also reported high efficacious nature of Carbendazim + Mancozeb, followed by Carbendazim, Mancozeb and Chlorothalonil.

Among plant extracts, Neem leaf extract @ 5 per cent proved quite effective and recorded 39.80 per cent disease control, followed by Eucalyptus leaf extract @ 5 per ent (29.17%) and Behada leaf extract @ 5 per cent (28.25%). These experimental results conform the findings of Sarvamangla *et. al.*, (1993) as they proved that *Azadiracta indica* and *Eucalyptus* spp. were highly toxic to *Certelium fici* and *Cercospora moricola* under field condition. Antagonists, *Trichoderma viride* and *T. harzianum* (10^5 cfu ml^{-1}) recorded 21.40 and 20 per cent disease reduction, respectively. These results coincide with the findings quoted by Lal and Upadhyay (2002) stating that *T.viride* @ 4 g l^{-1} water effectively controlled leaf blight of pigeon pea (35.59 PDC).

Maximum yield was in Carbendazim (9.36 q ha^{-1}) i.e. 29.10 per cent increase over control, followed by Chlorothalonil (8.97 q ha^{-1}) and Tridemorph (8.58 q ha^{-1}). Lowest yield (7.25 q ha^{-1}) was recorded in control. Thus, it is concluded that three sprayings of Carbendazim (0.1%) at 15 days interval, starting from the first appearance of disease. It could reduce the disease and increase the grain yield of sunflower. These results correlate the findings of Vyas (1997).

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Histopathology of Soybean Seed Infected With *Colletotrichum dematium* var. *truncatum*

Colletotrichum pod blight is one of the major disease caused *by Colletotrichum dematium* var. *truncatum* (Schw.) Arx. Many workers have reported seed borne nature of this fungus (Neergaard, 1977, Khare and Chacko, 1983). The seed infected with the fungus showed characteristic discoloration which were distorted, shrivelled or mouldy and smaller than the normal seeds (Nicholson and Sinclair, 1973). Very less information is available on histopathology of soybean seed infected with C. *dematium* var. *truncatum*. Thus, the present histopathological investigation was conducted using naturally infected symptomatic soybean seed with the fungus.

Twenty seeds from infected seed sample having characteristic symptoms were boiled in distilled water (Kunwar *et al.,* 1985) for two hours and fixed in 70 per cent ethanol for 48 hours. Seeds were cut transversely into two pieces at the centre of seed hilum to ensure better dehydration, infiltration and embedding. The fixed seed were dehydrated through acetone-benzene series and infiltrated using melted paraffin wax at 52°C for two hours and embedded in liquid paraffin wax. After solidification of paraffin, blocks were used for serial microtome sections of 10-15u thickness by using hand rotary microtome. The sections were stained with cotton blue, mounted in DPX and observed.

Histopathological examination with light microscope revealed the colonization of mycelium in hourglass (plate-I) and upper palisade cell layers(plate-II) of seed coat tissues. The pathogen was not observed in cotyledonary tissues. Mycelium of the fungus was identified on the basis of its thick, dark and irregularly shaped cells in seed tissues (Schneider *et al.,* 1974). The present observation correlates with studies reported earlier by Schneider *et al.,* (1974), Rodriguez and Sinclair (1978) and Kunwar *et. al.*, (1985).

Presence of characteristic mycelium in upper palisade cell layer of seed coat conformed the earlier findings of Nik and Lim (1984) and Kunwar *et. al.,* (1985).

Based on histopathological examination, it can be concluded that the fungus conformed site of its infection to be seed coat tissues only and not further in the cotyledonary tissues of infected soybean seeds.

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Leaf Nutritional Status of Acid lime Orchards (*Citrus aurantifolia*) in Akola District of Maharashtra

Citrus is the most important fruit crop in the world and areawise it stands third in position in subtropical fruit in India. Among the important Citrus fruit, acid lime is cultivated on a very large scale specially in central and south Indian states. Maharashtra state is leading in acid lime cultivation. Vidarbha region of the Maharashtra State particularly in Akola district have more acid lime growing area. Leaf analysis in recent years have been widely used to identify nutritional problems to detect deficiencies of nutrients and to measure the response to the applied plant nutrients. It is considered fairly a good index to mesure the fertilizer need of citrus plants. The present investigation is related to find out mean values of macro and micro nutrients in the leaf tissue of acid lime plants. These norms will be used for identifying the deficiency or adequacy of nutrient elements in acid lime orchards.

Forty-eight acid lime orchards were selected from fourteen location in Akola district. From each orchard 50 leaves from 4-7 month old flush from non fruiting terminals preferably 2nd, 3rd and 4th leaf at the height of 1.5 to 1.8 meter from ground were collected randomly from all the side of the plant in Oct. 2003 (Srivastava *et. al.*, 1994). The leaves samples were prepared for analysis as per Chapman (1964). The leaf samples were analysed for nitogen, phosphorus, potassium, calcium and magnesium by standard methods as described by Jackson (1967). Total iron, manganese, copper and zinc were determined by Atomic Absorption Spectrophotometer method (Lindsay and Norvell, 1978).

The data pertaining to macro and micro nutrient status of acid lime leaves are presented in table.

Micro nutrient status of leaves

Total nitrogen content in leaves of trees varied from 1.21 per cent to 2.49 per cent with mean value of 2.01 per cent. Similar results were recorded by Mann *et. al.*, (1979). Total Phosphorus content in leaves varied from 0.14 per cent to 0.20 per cent with an average of 0.17 per cent. Similar observations were also reported by Mann *et. al.*, (1979). Total Potassium content in leaves varied from 1.20 per cent to 1.96 per cent with an averge of 1.48 per cent. Similar findings were reported by mann *et. al.*, (1979). In present investigation leaves of acid lime tree show the range of calcium between 2.96 per cent to 4.15 per cent with an average 3.42 per cent , which was in optimum concentration in leaves as per the standards of the Smith (1966). Similar observations were reported by mann *et. al.* (1979). Magnesium content in leaves varied from 0.33 per cent to 0.44 per cent with an average of 0.39 per cent. Similar finding were reported by Borade (2000). Magnesium as weak competitor against Potassium the optimum norms for magnesium was reported to be 0.40 to 0.60 per cent indicating magnesium is not deficient in the orchard as per Smith (1966). It could be seen from the results that Sulphur ranges between 0.09 per cent to 0.25 per cent with an average 0.16 per cent. Similar observations were recorded by Borade (2000).

Micronutrient status of acid lime leaves

The concentration of Copper varied from 25.5 ppm to 62.00 ppm with an average of 34.59 ppm. Similar observations were recorded by Borade (2000). Zinc content in trees varied from 12.9 ppm to 20.15 ppm with an average of 16.02 ppm indicating severe dificiency in the orchards, because the optimum norms ranged from 25 ppm to 50 ppm as per Smith (1966). Similar observation was reported by Borade (2000). This proved that the decline conditions of leaves were because of zinc deficiency. manganese was optimum in leaves ranged from 26.3 ppm to 60.60 ppm with an average of 39.12 ppm. Thus, none of the leaf samples were in deficient range in respect of manganese concentration. The optimum levels of magnese in acid lime leaves should be in the range of 20 to 200 ppm (Tandon, 1993). From the results Iron contents in leaves varied from 91.02 ppm to 141.37 ppm with an average of 112.27 ppm. Similar findings were reported by mann *et. al.*, (1979).

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Table 1. Micro and macro nutrient status of Acid lime orchard leaves

S.N.	Name of village	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium	Sulphur	Copper	Zinc	Maganese	Iron
			%	%	%	%	%	(PPM)	(PPM)	(PPM)	(PPM)
1.	Maispur	2.22	0.19	1.51	3.78	0.44	0.15	45.57	16.07	29.45	121.72
2.	Lakhanwada	2.36	0.15	1.20	3.06	0.38	0.14	34.22	12.90	45.45	103.35
3.	Barshitakali	1.78	0.20	1.96	2.96	0.36	0.13	36.10	19.05	57.65	109.6
4.	Kapshi	2.06	0.16	1.67	3.30	0.33	0.09	31.20	16.15	60.6	131.45
5.	Chikhalgaon	2.35	0.19	1.43	2.34	0.41	0.16	27.27	13.97	39.87	116.07
6.	Deulgaon	1.89	0.19	1.21	3.25	0.41	0.18	32.12	15.55	36.40	141.37
7.	Wadegaon	2.49	0.14	1.35	4.13	0.42	0.20	62.00	14.70	39.65	115.67
8.	Patur	2.37	0.19	1.38	3.45	0.40	0.11	27.15	13.40	33.45	111.2
9.	Babhulgaon	1.54	0.16	1.32	3.47	0.34	0.16	37.12	14.07	26.30	102.4
10.	Borgaon (Manju)	1.21	0.20	1.52	3.38	0.40	0.11	26.5	17.85	35.55	96.1
11.	Dongargaon	1.71	0.18	1.49	3.34	0.41	0.17	27.92	18.02	35.52	113.55
12.	Wyala	2.30	0.18	1.44	3.38	0.36	0.22	37.35	14.12	40.27	115.35
13.	Kanheri	2.00	0.15	1.94	3.95	0.39	0.19	34.25	18.3	36.55	91.02
14.	Shadad	1.99	0.16	1.42	4.15	0.44	0.25	25.5	20.15	31.05	103.02
	Mean	2.01	0.17	1.48	3.42	0.39	0.16	34.59	16.02	39.12	112.27

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Growth, Yield, Quality of Wheat and Soil Properties as Influenced by Bath Water Irrigation

About 12 to 13 per cent cultivable area of Maharashtra state is under irrigation and hardly 30 to 32 per cent area can be provided with irrigation facility even after complete exploitation of all water resources. In the near past, due to inadequate and uneven rainfall, irrigation water has become precious input. Therefore, it is inevitable to search alternative sources of irrigation water. Household and hostel waste water is one of the sources which can be utilized for crop irrigation with minimum treatment.

At Vivekanand Ashram, about 1200 students are residing in the hostel. About 12000 to 18000 litre (12 to 18 m^3) of bath waste water is available daily, which can be utilized for irrigation purpose. Therefore, a non replicated trial to study the feasibility of utilizing bath waste water for irrigation to wheat was conducted during *Rabi* season of 2003-04, on the farm of Vivekanand Agriculture College, Vivekanand Nagar, Hiwara , Tq. Mehkar, Dist. Buldana.

A trial with two treatments viz. Irrigation with normal water and bath waste water was laid out on a plot size of 10 m x 10 m. The soil of the experimental site was clay loam having 0.45 per cent organic carbon, available nitrogen as 203 kg ha^{-1} with a pH of 8.0 in case of first treatment and having 0.71 per cent organic carbon, available nitrogen 319 kg ha^{-1} with same pH in case of second treatment. Wheat cv. Chandoshi was sown and raised with recommended package of practices except irrigation treatment. The chemical analysis of bath waste water (B.W.W.) and normal water (N.W.) is as below

Type of water	pH	Chloride content	R.S.C.
B.W.W.	8.0	11 meq. lit^{-1}	less than 1
N.W.	8.0	3 meq. Lit^{-1}	less than 1

Grain yield :

Irrigation of wheat crop with bath waste water has recorded 25.6 q ha^{-1} yield whereas normal water recorded 24.3 q ha^{-1} indicating increased by 5.3 per cent higher yield (Table 1). Growth parameters such as plant height, number of tillers $plant^{-1}$ and dry matter accumulation were enhanced due to bath waste water irrigation to the extent of 3.32, 4.27 and 6.66 per cent, respectively as compared to normal water irrigation. Yield attributes such as grain yield $plant^{-1}$ and number of grains $earhead^{-1}$ were also augmented each by 16.27 and 2.94 per cent due to bath waste water irrigation than normal water irrigation. Improvement in growth parameters and yield attributes might have enhanced the yield of wheat in case of bath waste water irrigation. Dahatonde *et. al.* (2000) has also observed increase in growth parameters, yield attributes and yield of cotton with the use of hostel waste water. Test weight of grain was also enhanced by 4.16 per cent due to bath waste water irrigation which indicates improvement in the grain size.

Table 1. Growth, yield attributes and yield of wheat as influenced by bath waste water irrigation

Treatment	Plant height (cm)	Number of tillers plant^{-1}	Dry matter accumulation (g)	Number of grains earhead^{-1}	Yield plant^{-1}	Test weight (g)	Grain yield (q ha^{-1})
Bath water irrigation	83.9	12.2	20.64	35	16.65	37.5	25.6
Normal water irrigation	81.2	11.7	19.35	34	14.32	36.0	24.3
Per cent (+)	+3.32	+4.27	+6.66	+2.94	+16.27	+4.16	+5.35

Table 2. Content of pathogenic and non-pathogenic fungi in soil after harvest of wheat

Treatment	pH		Per cent	Organic carbon		Available nitrogen		Per cent
	Initial	At harvest		Initial	At harvest	Initial	At harvest	increase
Bath water irrigation	8	7.6	5.0	0.71	1.20	319	537	68.34
Normal water irrigation	8	7.7	3.75	0.45	0.99	203	443	118.23
change (+)	-	-0.1	-	-	+0.21	-	+94	

Table 3. Content of pathogenic and non-pathogenic fungi in soil after harvest of wheat

S.N.	Fungal isolate	Av. fungal (CFU x 10^4)	
		Norrmal water	Bath water
A	**Pathogenic**		
1	Alternaria sp.	7.55	6.95
2.	Drechsleria sp.	5.44	7.05
3.	Rhizoctonia sp.	3.69	2.57
4.	Collectotrichum sp.	2.05	2.45
5.	Fusarium sp.	2.42	2.42
	Average I		
B.	**Non Pathogenic**		
1.	Aspergillus sp.	7.80	7.02
2.	Penicillum sp.	9.61	5.35
3.	Curvularia sp.	2.75	2.93
4.	Trichoderma sp.	5.61	2.00
	Average II	6.44	4.32
	Average I + II	10.67	8.60

Soil properties (Chemical) :

Data on soil properties after harvest of wheat (Table 2) indicated that soil pH was almost same in case of bath waste water and normal water irrigtion, although it was reduced as compared to initial, in both the treatments. There was increase in organic carbon content by 0.21 per cent and available nitrogen by 94 kg ha^{-1} due to bath waste water irrigation over normal water. Similarly increase in electrical conductivity (0.01 %) and available potash was recorded in case of bath waste irrigation than normal water.

Soil Properties (Biological)

The data on incidence of pathogenic and non pathogenic fungi in the soil, after harvest of wheat (Table 3) indicated that in general the quantum of pathogenic fungi were almost equal in case of both the sources of irrigation water. However, intensity of non-pathogenic fungi was less in case of bath waste water irrigation than normal water. Amongst pathogenic fungi the intensity of *Alternaria* and *Rhizoctonia* decreased whereas that of *Drechslera* and *Collectotrichum* increased. But the quantum of *Fusarium* remained unchanged.

Non pathogenic fungi such as *Aspergillus, Penicillium* and *Trichoderma* decreased in case of bath waste water irrigation than normal water. However, the quantum of *Curvuleria* was increased.

Thus, the present study indicated that the bath waste water can safely be used for irrigation of wheat crop.

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Status of Improved Agricultural Implements

Agriculture mechanization has been recognized as a integral part of agricultural development for improving productivity and it involves the availability and use of improved implements, machines by the farmers. The economic progress of a nation directly depends upon availability of power and its fruitful utilization. In India, adoption of improved farm implements and machineries plays an important role and help to achieve timeliness of farm operations. At present a few operations have been partially done by tractor power and rest of the operations carried out by bullock drawn implements. The contribution of animal power has been decreased to 22 per cent whereas, mechanical and electrical power has increased by 41 and 33 per cent, respectively (Bangarwa and Kadian, 1999). Therefore, the present investigation was conducted to find out the actual level of mechanization in Akot tahsil of Akola district.

The investigation regarding status of improved agricultural implements was carried out during 2000-2001. The required information pertaining to adaptation of different implements for crop cultivation and other related parameters was collected from sample respondents on well structured survey schedule, designed for the purpose. Data regarding use of different implements on farm were collected by taking interviews of the farmers and tabulated and analyzed to accomplish the objectives of the study.

The level of tractorization in each tahsil of Akola district is presented in Table 1. From this table, it was observed that the number of tractors in Akot tahsil was increased from 43 to 411 by the year 1962 to 2000 and the level of tractorization was increased by 89.53 per cent. The majority of respondents of Akot tahsil were adopting improved implements and percentage of adaptation of different implements operated either by bullock or tractor is presented in Table 2. After surveying 120 respondents it was observed that 15.01, 32.49 and 22.51 per cent farmers used bullock drawn wooden plough, turn wrest and Deshi plough, respectively in irrigated area and 18.3, 38.35 and 29.16 per cent farmers used these ploughs in rain fed areas, respectively. Whereas, the use of tractor drawn M.B. plough on irrigated and rain fed area was 29.99 and 14.19 per cent, respectively. Harrow used by farmers for land preparation, means for breaking clods and pulverizing the soil. Majority of the farmers i.e. 90.84 and 96.40 per cent used bullock drawn blade harrow in irrigated land and rain fed land, respectively. Whereas, 9.16 and 3.60 per cent farmers used tractor drawn disc harrow (Table 2). The use of tractor drawn

Table 1. Total number of tractors registered in each tahsils of Akola District

S. N.	Tahsils	Year								
		1962	1967	1972	1977	1982	1987	1992	1997	2000
1	Akola	38	29	44	87	94	105	233	407	549
2	Akot	43	38	41	38	120	138	196	329	411
3	Balapur	22	21	20	25	61	69	55	104	148
4	Barshitakli	N.A.	N.A.	12	24	40	55	98	185	231
5	Murtizapur	22	33	27	50	75	84	124	198	264
6	Telhara	N.A.	N.A.	27	3	48	59	71	280	162
7	Patur	N.A.	N.A.	6	N.A.	38	43	42	67	85

(All figures in per cent)

Table 2: Adaptation of implements by respondents in Akot tahsil

S. N.	Name of implements	Bullock drawn		Tractor drawn	
		Irrigated land	Rainfed land	Irrigated land	Rainfed land
1.	Plough				
	i) Wooden plough	15.01	18.30	–	–
	ii) Turn wrest plough	32.49	38.35	–	–
	iii) Deshi plough	22.51	29.16	–	–
	iv) M.B. Plough	–	–	29.99	14.19
2.	Harrow				
	Blade harrow	90.84	96.40	–	–
	Disc harrow	–	–	9.16	3.68
3.	Seed drill	74.66	83.16	25.34	16.84
4.	Cultivators	72.63	81.00	27.47	19.00

(All figures in per cent)

Table 3: Adaptation of equipments by respondents in Akot Tahsil

S. N.	Name of equipments	Manually operated		Power operated	
		Irrigated land	Rainfed land	Irrigated land	Rainfed land
1	Knapsack sprayer	33.33	20.00	31.66	20.83
2.	Thresher (multi-crop)				
	i) operated by electric motor	–	–	15.00	8.33
	ii) operated by diesel engine	–	–	2.50	2.76
3.	Chaff-cutter	15.00	8.33	–	–
	i) operated by electric motor	–	–	1.66	–
	ii) operated by tractor	–	–	14.16	5.00

(All figures in per cent)

single acting disc harrow was negligible. It means farmers preferred double action disc harrow. Various types of seed drill were used in Akot tahsil. The results in Table 2 revealed that 74.66 per cent farmers used bullock drawn seed drill in irrigated land and 83.16 per cent farmers in rain fed land. Whereas, 25.34 and 16.84 per cent of farmers used tractor drawn seed drill in irrigated and rain fed land, respectively.

Animal drawn cultivators are manufactured and used in large number in Akot tahsil compared to tractor drawn cultivators. Though, they are primarily meant for intercultivation operations but were being used for seedbed preparation and for sowing with seeding attachment also. From Table 3, it is observed that 72.63 and 81.00 per cent farmer used bullock drawn cultivators in irrigated and rain fed area whereas, 27.47 and 19.00 per cent farmers used tractor drawn cultivators in irrigated and rain fed land, respectively. Various types of spraying and dusting equipments were available in market for pesticide application, but farmers preferred these equipments which were easy to handle and covered more area per unit time. From investigation it was observed that 33.33 and 20.0 per cent farmers used hand operated knapsack sprayer and 31.66 and 20.82 per cent farmers used power operated knapsack sprayers in irrigated and rain fed land, respectively.

In addition to cotton, sorghum, wheat, pigeon pea and safflower are also the major crops grown in Akot tahsil and hence the farmers are using multi- crop thresher. Form Table 3, it was observed that 15.00 and 8.33 per cent farmers used thresher, operated by electric motor and 2.50 and 2.76 per cent farmers used diesel engine operated thresher in irrigated and rain fed land, respectively. Utilization of thresher with electric motor was higher because of easily availability of electricity at village level in Akot tahsil. From Table 3, it is revealed that 15.00 and 8.38 per cent respondents used hand operated chaff-cutter and 1.66 per cent of respondents used electric motor operated chaff-cutter. Whereas, 14.16 and 5.00 per cent farmers used tractor operated chaff-cutter in irrigated and rain fed area, respectively. The tractor operated chaff cutters have very high capacity compared to conventional chaff cutter and this parameter justifies its use by the farmers.

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Comparison Between Tractor and Multipaired Bullock Drawn M. B. Plough

A study was conducted in light soil at Anwi (Akola district) to determine the field capacity, field efficiency and cost of ploughing using tractor operated and multi-paired bullock drawn M.B. plough. In Anwi, for multi-paired bullock drawn M. B. plough observations were taken on average depth (cm), h.p., field efficiency(per cent), average speed (km-hr^{-1}), average moisture content (per cent) and total cost of ploughing (Rs-ha^{-1}) were 11.50, 1.5, 91.42, 1.39, 9.69 and 1725.47, respectively. Whereas, for tractor drawn M.B. plough, observations were 17.51, 35, 85.85, 3.19, 8.82 and 2535.95, respectively. Multi-paired bullock drawn M.B. plough found more efficient and cost effective than tractor drawn M.B. plough.

According to the 1972 census, (1976) the working animal population in India was 80 million and the total cropped area 167 million hectares. Thus on an average one pair of working animals, i.e. bullock was available for 4.16 hectares of land. Management studies have shown that a pair of bullocks can manage about 3 hectares farm. According to Roy S.E. (1966) the maximum area of land which can be cultivated by a pair of bullock, not only depends on the efficiency of bullocks and the size of holding but also on factors such as period available for cultivation, nature of soil, crops grown and timeliness requirement of each operation. Draught animals have an important role in Indian agriculture for energy supply to Indian farms. They are used for conducting various farm, post harvest operations and transportation work. It is pertinent to state that there is a direct relation between energy inputs to crop production in terms of output. The "tractorization" has grown at a rapid space and about 2.5 lakhs tractors are being added annually to the Indian farms to help the farmer to supply energy for conducting various farm operations and transport activities. The tractors are suited for big size farms but farmers are not aware with the bad effect of tractorization.

Regular use of tractor makes the soil hard and compact and also reduces fertility and moisture content of the soil. Due to the compacted layer of the soil beneath the earth infiltration and percolation properties of the soil goes on decreasing and so sufficient soil moisture is not available for the growth of deep rooted crops and there is no rise in water table. For removing deep-rooted weed and preparation of smooth seedbed multi-paired bullock drawn mould board plough is used.

Considering these facts it was decided to undertake an experiment to evaluate the performance of multi-paired bullock drawn M.B. plough and tractor operated M.B. plough in light soil to judge the use of bullock drawn M.B. plough on the field over tractor drawn M.B. plough.

The experimental trials were conducted in light soil at Anwi (Akola district) on 2000 m^2 area for using tractor and multi-paired bullock drawn M.B. plough. The trials were conducted according to RNAM test codes. The parameters like depth of operation (cm), operating speed (Km-ha^{-1}), field efficiency (%), H.P., cost of ploughing (Rs-ha^{-1}) were evaluated. The data were used for comparing the performance of tractor operated M.B. plough and multi-paired bullock drawn M.B. plough.

Tractor used (HP)	- 35
No. of bullock pairs used	- 2 pairs
Size of M.B. plough for tractor drawn (cm)	- 52.5
Size of M.B. plough for bullock drawn (cm)	- 30
Average age of bullocks (years)	- 12
Breed of bullocks	- Jersey

From the study, it was observed that the higher depth, that is, 17.50 cm was observed in case of tractor drawn M.B. plough compared to bullock drawn M.B. plough, that is 11.50, which is obvious. It indicates the deformation of soil at higher depth by tractor drawn M.B. plough, which is sometimes undesirable because soil manipulation below root zone depth is not required. Soil manipulation at greater depth also requires higher energy hence it is wastage of energy. Whenever, deep ploughing is required tractor drawn M.B. plough can be used.

The speed of operation for tractor drawn M.B. plough was 3.19 km-h^{-1} and that of bullock drawn M.B. plough was 1.5 km-ha^{-1}. Also the size of M.B. plough used with tractor was 52.5 cm and that used with bullocks was 30 cm. Hence the field capacity of tractor drawn M.B. plough was 0.12 ha-hr^{-1} and that of bullock drawn M.B. plough was 0.03 ha-hr^{-1} only. But the field efficiency of bullock drawn M.B. plough was found higher i.e. 91.42per cent compared to tractor drawn M.B. plough for which it was 85.85per cent. This was because of the fact that the tractor takes higher turning time at the head lands compared to bullocks.

The cost of operation in case of bullock drawn M.B. plough was found less than that of tractor drawn M.B. plough which is one more advantage of using bullock drawn M.B. plough.

Considering the time limits available for manipulation of soil and field capacity of tractor drawn M.B. plough it is advisable to use it on the large fields. But the task can be done more efficiently by bullock drawn M.B. plough on small fields that in turn saves cost of operation.

Multi paired bullock drawn M.B. plough found more efficient and cost effective than tractor drawn M.B. plough

Table 1 Field observations of the experiments

S.N.	Parameters	Tractor drawn M.B. plough	Bullock drawn M.B. plough
1	Depth of operation (cm)	17.50	11.50
2	Width of cut (cm)	2.79	2.07
3	Field Capacity (ha-hr^{-1})	0.12	0.03
4	Field efficiency (%)	85.85	91.42
5	Speed (km-ha^{-1})	3.19	1.39
6	Soil moisture content (%)	20	9.69
7	Cost for ploughing (Rs-ha)	2535.95	1725.347
8	Width of M.B. plough (cm)	52.5	30

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Information Technology - It's Role in Agriculture

Indian agriculture is set to face new challenges from the developed countries in the WTO regime. To meet these challenge agriculture sector in India needs tangible improvement in terms of cost, quality and output. To fulfill these needs, Indian farmers must be well informed about the latest trends in agriculture industry, i.e. about new methods of cultivation, new crops, seeds insecticides, pesticides, water and nutrient management, and marketing of the products. This could be possible only with the farmer's interface millennium technology that is Information Technology (IT), which playing an important role sweeping changes in socio economic development in the era of globalization.

Farmers require timely information on weather, sowing time, availability and recommendations on inputs, availability of credit, expert advice on maintaining his crop in healthy condition, information on markets and on all other areas of interest to him and his family. Despite best

efforts and expenditure, the conventional apparatus could not meet these requirements satisfactorily. An It based service for farmers to address this lacuna is an important tool in the new era of information technology (Shrotriya and Caore, 2002).

Previously, a decade almost all data processsing could be summed up in a single word : "computers". Today, this term has given way to the broader descriptor *"information technology"*, which has become globaly accepted. It refers to a rapidly expanding range of services, methods, techniques, applications, equipment and electronic technologies used for the collection, manipulation, processing, classification, storage and retrieval of recordable information and knowledge. At this time, such technologies include, but are not limited to, computers, software, high-capacity storage, networks, telecommunications, databases, data warehouses, multimedia, training, the internet and its world wide web, geographic information systems (GIS), computer aided design (CAD), online services, video conferencing, executive information systems (EIS), electronic mail, and expert systems in short, all technologies related to the acquisition, storage, recovery, transfer, manipulation, and delivery of data, sound and graphics, including video (Zazueta and Vergot, 2003).

Present scenario of IT

- Networking is growing at a fantastic speed of 10-15 per cent per month or about 200 per cent a year.
- The farming community has more readily embraced the Internet than general population in countries like USA, Canada, UK, etc.
- Connectivity to all SAUs in the country via VSAT, lease lines, etc. for information sharing.
- About 99 per cent of the districts are having desired bandwidth for Internet connectivity for e-Governance application in the country.
- Specialists forecast that, in less than 10 years from now Internet terminals would be as common as telephone instrument but more useful.
- The mobile Internet is overtaking the wired Internet. NOKIA predicts that the number of Internet connected mobile phones will exceed the number of Internet connected PCs by 2005 (Rathod *et. al.*, 2004)

IT and its components

Induction of IT as a strategic tool for agricultural development and welfare of rural India requires necessary IT infrastructure in place. The rapid changes and downward trend in prices in various components of IT makes it feasible to achieve target on large scale of IT penetration in rural India. Some of the broad factors to be noted with respect to various components of IT are listed below.

Input devices : Radical improvements are witnessed with respect to the means of communication by human beings. In computers, components like keyboards, mouse devices, scanners and the advent of touch screen monitors allow users to give input to computer by touching the appropriate location of the monitor. All this has made possible to develop a user-friendly interface for farmers which is easy, intuitive and at the same time provides a relaxed environment to the users.

Output devices : Printers and plotters, data projectors support high resolution and good quality output.

IT in Agriculture

In the context of agriculture, the potential of information technology (IT) can be assessed broadly under two heads : (a) as a tool for direct contribution to agricultural productivity and (b) as an indirect tool for empowering farmers to take informed and quality decisions which will have positive impact on the way agriculture and allied activities are conducted. Precision farming, popular in developed countries, extensively use IT to make direct contribution to agricultural productivity. The technique of remote sensing using satellite technologies, grographical information systems, agronomy and soil sciences are used to increase the agricultural output. This approach is capital intensive and useful where large tracts of land are involved. Consequently it is more suitable for farming taken up on corporate lines.

The indirect benefits of IT in empowering Indian farmer are significant and remains to be exploited. The Indian farmer urgently requires timely and reliable sources of information inputs for taking decisions. At present, the farmers depends on trickling down of decision inputs from conventional sources which are slow and unreliable. The changing environment faced by Indian farmers makes information not merely useful, but necessary to remain competitive.

Unique features of IT

1. Access to the storehouse of information is easy.
2. Information is available instantaneously.
3. Communication is interactive
4. Information from any point in the globe is available.
5. Information is dynamic and ever growing.

The Key players for utilization of IT In Agriculture

- The farmers who is the actual person who can directly bring about an improvement in efficiency and productivity in agriculture.
- Various industries that provide inputs to agriculture
- Various industries that deal with agriculture output
- Institutions /organizations and NGOs working for the benefit of farmers such as agricultural universities and research centres
- Central and State governments

The key players listed above can make a big contribution to the economy with the assistance of IT.

Inputs required by farmers

- Awareness databases :
  Facilitating farmers for proper understanding of implications of the WTO on Indian agriculture.
- Decision support systems :
  Information that facilitates farmer to make proper SWOT (strengths, weakness, opportunities and threats) analysis to take appropriate decision
- Information on new opportunities
- Monitoring systems for corrective measures

How actually IT helps in Agricultural production

1. As a tool for direct contribution to agricultural productivity
2. As an indirect tool for empowering farmers to take informed and quality decisions, which will have, positive impact on the way agriculture and allied activities are conducted.

Information technology helps indirectly in the way of :

- Precision agriculture
- Remote sensing
- Expert systems
- e-agribusiness

Indian Society of Agricultural Information Technology (INSIT) Mandates :

- To mobilize farmers, scientists, institutions and organizations.
- To encourage teaching, research and extension activities.
- To provide a forum for information exchange and dissemination
- To organize training programme

Information technology has a major role to play in all facets of Indian agriculture in addition to facilitating farmers in improving the efficiency and productivity of agriculture and allied activities, the potential of information technology lies in bringing about an over all qualitative improvement in life by providing timely and quality information inputs for decision making. It can be argued that the revolution in urgent need of focus is IT revolution in field of Indian farming.

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Effect of Levamisole on Body Weight Gain in Experimentally Immunosuppressed Broiler Birds

Increase in pollution through air and water is a great problem to the poultry farmers and even residual toxicity through feed due to extensive use of the insecticides and pesticides on crops leading to immunosuppression in birds. As a result, these birds are easily exposed to the infectious disease. Immunosuppression also causes dysfunction of the liver leading to poor body growth and body weight gain in broilers. Levamisole is a anthelmenthic drug used to treat the number of internal parasites in poultry (Thienpont *et. al.*, 1968 and Jonhes, 1982). It has also immunomodulating properties (Brunner and Charles, 1980 and Shrinivasa Rao *et. al.*, 1996). In present study the effect of levamisole has been evaluated in terms of body weight gain in broiler birds.

Sixty broiler birds of 3 week age were divided equally and randomly into three groups. These birds were maintained at standard and identical managemental conditions at Poultry Research Station, PGIVAS, Akola. One group of birds was kept as normal control (T1) i.e. without immunosuppression and without treatment. Second group of birds was kept as untreated control (T2) in which birds were immunosuppression with cyclophosphamide @ 150 mg kg^{-1} body weight I/V once and kept without treatment .Third group of birds (T3) was immunosuppressed with cyclophosphamide @ 150 mg kg^{-1} body weight I/V once at 3 week of age and then treated with levamisole @ 2.5 mg kg^{-1} body weight in feed for 2 week from 4 to 6 week of age. Body weight gain in all birds were recorded from 4 week to 6 week of age at weekly interval (7 days).

Data collected were analyzed with FCRD as described by Snedecor and Cochran (1994).

Body weight gain of birds before treatment and after treatment is depicted in Table 1. The study indicated that the cyclophosphamide reduces the body weight gain in poultry birds due to its immunosuppresive effect. (Hennessy *et. al.*, 1987). It seems that the increased body weight gain in week was more in the group treated with levamisole as compared to the untreated immunosuppressed birds and normal control birds at 5th week of age. The weight gain was also significantly more in levamisole treated birds (T3) at 6 week of age. It seems that levamisole not only restored the normal function of the birds but also enhanced the immune system, improved the health status and increased in feed conversion ratio in broiler birds. Improvement in health status might be the result of deworming in birds thereby improving the digestive system, better feed conversion leading to increasing in body weight gain (Giambrone and Klesius,1985). In present study improvement in body weight gain might be of worm free status of the birds.

Present finding indicated that regular deworming should be done with levamisole in broiler birds to improve the health status, immune status and body weight gain of broiler birds.

Table 1. Showing body weight gain (g) in normal control, untreated immunosuppressed control and levamisole treated group in broiler birds

Treatments	Weeks		
	4	5	6
T_1 (Normal Control)	$415.5^{b} \pm 15.71$	$412.5^{b} \pm 31.17$	$315^{a} \pm 22.39$
T_2 (Untreated Control)	$367^{b} \pm 19.79$	$418.5^{c} \pm 28.24$	$307.5^{a} \pm 25.20$
T_3 Levamisole treated	$367.5^{a} \pm 16.35$	$477.5^{b} \pm 21.29$	$360^{a} \pm 23.11$

Mean valeus with different alphabets indicating significant difference

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Studies on Prevalence and Etiology of Bovine Mastitis in and Around Akola Region

Subclinical form of mastitis is the most common disease in dairy cows. The losses due to mastitis are attributed to both qualitative and quantitative changes in the milk. Therefore, early detection of mastitis in subclinical form is most important to facilitate its early effective treatment and minimizing further financial losses to the dairy farmers. Reports suggest that bovine mastitis accounts for 12-16 per cent of all maladies of cows whereas surveys on incindence of mastitis in most countries have revealed a morbidity rate of 40 per cent and quarter infection rate of 25 per cent (Pachauri *et. al.*, 2001). Thus, keeping in view the importance of mastitis in direct economic loss of dairy farming, an experiment was undertaken to study the prevalence and etiological agent of mastitis in crossbred lactating cows in and around Akola region.

Total 72 crossbred lactating cows aged between 4-6 years in and around Akola region were screened by using Modified California Mastitis Test (MCMT). Out of which 36 cows were found positive for SCM indicating 50 per cent animalwise incidence of SCM as shown in Table 1. Pal and Verma(1991) also reported 50 per cent incidence of SCM in cows in 4th lactation. Out of 283 quarters of 72 cows examined for SCM, 101 quarters were found positive for SCM on the basis of MCMT and overall quarterwise incidence was recorded 35 per cent as shown in Table1. Gosh *et. al.* (2004) also reported 34.14 per cent incidence of SCM in cows. The quarterwise incidence for left fore (LF), left hind (LH), right fore (RF), and right hind (RH) quarters were recorded 26.73, 27.72, 19.80 and 25.74 per cent, respectively as shown in Table 1. Nauriyal and Pachauri (2003) also recorded quaterwise incidence for RH, RF, LH and LF quarter as 30.27, 22.70, 22.16 and 24.80 per cent, respectively.

Out of 101 positive milk samples from 36 cows, 24 milk samples were subjected to cultural examination for isolation and identification of organisms as per the method described by Cowan and Steel(1970).

A total 29 bacterial isolates were recovered in pure culture during the investigation. The isolation pattern of different organism revealed majority of *Staphylococcus* spp. (82.76%) out of which coagulase negative *Staphylococci* (83.33 %), coagulase positive *Staphylococci* (16.66 %), followed by *Streptococcus* spp.

Table 1.Showing animalwise and quarterwise prevalence of SCM in cows by MCMT

Number of cows examined	72 (283quarters)			
Number of positive cows	36(50%)			
Number of positive quarters	101(35%)			
	LF	LH	RF	RH
	27 (26.73)	28 (27.72)	20 (19.80)	26 (25.74)

Figures in parenthesis indicate percentage

LF- Left fore quarter, LH-Left hind quarter,

RF- Right fore quarter RH Right hind quarter,

Table 2 : Showing per cent of organisms from 29 isolates recovered from 24 milk samples of subclinical mastitic cows in and around Akola region

Isolates	No .of samples cultured	Organisms isolated from No. of sample
Staphylococcus sp.	24	24 (82.76%)
Coagulase negative *Staphylococci*		20(83.33%)
Coagulase positive *Staphylococci*		4 (16.66%)
Streptococcus sp.	24	2 (8.33%)
E. coli	24	1(4.16%)
Salmonella	24	1 (4.16%)
Unidentified bipolar organism	24	1 (4.16%)
Total		29 isolates

(8.33%), *E. coli* (4.16%) *Salmonella* (4.16%) and unidentified bipolar organism (4.16%) as presented in Table 2. These findings are in close agreement with the findings of Laffranchi *et. al.* (2001). Amongst 24 milk samples, 21(87.50%) pure single isolates of *Staphylococcus* spp. and 3 (12.5%) mixed isolates were recorded. Out of 3 mixed isolates, one was *Staphylococci* + *Streptococci* and *E. coli*, one was *Staphylococci* + *Streptococci* + *Salmonella* and one was *Staphylococci* + unidentified bipolar organisms. Ramchandraiah *et. al.* (1990) also recorded 90 per cent pure and mixed cultural isolates as an etiological agent of subclinical mastitis in cows.

From above study it is concluded that, the prevalance of SCM in cows in and around Akola region was recorded 50 per cent and 35 per cent on animalwise and quarterwise basis, respectively. Whereas bacteriological study revealed majority of *Staphylococcus* spp. (82.76%) followed by *streptococci* (8.33%), *E. coli* (4.16%), *Salmonella* (4.16%) and unidentified bipolar organisms (4.16%) as an etiological agent for SCM in cows.

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