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Effect of Integrated Nutrient Management on Growth and Yield of African Marigold (*Tagetes erecta* L.) Cultivers

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Abstract

In all the varieties tested, the plant growth characters such as plant height, plant spread, and number of branches plant^{-1} showed viguorness with treatment of 60 per cent organic + 40 per cent inorganic fertilizers over all other treatments. The treatment 100 per cent inorganic was significantly superior to the 100 per cent organic and the control. Moreover, the 100 per cent organic was also significantly superior to the control. The days to 1st flowering were significantly reduced with 60 per cent organic + 40 per cent inorganic fertilizer in all the cultivars than other all treatment combinations. Similarly number of flowers plant^{-1}, diameter of flower, flower yield plant^{-1} and yield of flowers hectare^{-1} was significantly superior in all the cultivars under 60 per cent organic + 40 per cent inorganic fertilizer.

Key words : Integrated nutrient management, organic fertilizer, inorganic fertilizer, growth and yield characters, African marigold.

For maximization of yield and quality of any flower crop various cultural and management practices like irrigation, plant density per unit area, season of growing, proper dose of manures and fertilizers, plant protection etc. are to be properly followed. Among these, organic fertilizers is the cost effective renewable source of plant nutrients to supplement chemical fertilizers. Its use has become an essential input in the intensive agriculture. In addition, they exhibit several advantages like their one time application, efficient uptake, no leaching, balanced nutrition of crops, no destruction of soil qualities, enhancing soil binding, allowing effective nitrogen and phosphorus have major effects on plant growth and development. The present investigation was therefore undertaken to screen out the practical means to maintain soil fertility and to supply plant nutrition in balanced proportion for integrated plant nutrient supply system through the combined use of organic and inorganic fertilizers to marigold.

Materials and Methods

The experiment was laid out during *kharif*, 2006-07 and 2007-08 at the Floricultural Farm, Division of Floriculture and Landscaping, Navsari Agricultural University, Navsari. The investigation was conducted by using six different organic and inorganic fertilizer treatments such as 100 per cent organic 100 per cent castor cake, 100 per cent neem cake, 100 per cent inorganic (NPK @ 100:40:40 kg ha^{-1}), 40 per cent organic + 60 per cent inorganic, 60 per cent organic + 40 per cent inorganic and no fertilizer (control) on three different varieties of African marigold viz., African Double Orange, Pusa Narangi Gainda and Pusa Basanti Gainda.

The seeds of these cultivars were sown in nursery which were transplated to the field after a month in factorial randomized block design using three replications. Each treatment consisted of single row of 4.5 m length

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accommodating 30 plants in a row. The planting distance was 30 x 45 cm. On the 10 reddomized plants, the different characters recorded were plant height, plant spread, number of branches plant^{-1}, days to 1st flowering, number of flowers plant^{-1}, diameter of flower, flower yield plant^{-1} and flower yield hectare. The data were analysed according to methods given by Panse and Sukhatme (1967).

Results and Discussion

The results indicated that growth and flowering characters of the all three cultivars significantly responded to different doses of fertilizer application (Table 1-2).

During both the years, the cultivar Pusa Narangi Gainda showed increase in plant height and plant spread along with maximum number of branches plant^{-1} with 60 per cent organic + 40 per cent inorganic fertilizer, followed by 40 per cent organic + 60 per cent inorganic fertilizer. The use of 100 per cent organic fertilizer like farmyard manure, castor cake and neem cake exhibited the slightly decrease in all the growth and flowering characters as compaired to use of 100 per cent inorganic fertilizer. A constant decrease in number of days required to first flowering was observed in all three cultivars with 60 per cent organic + 40 per cent inorganic fertilizer, followed by 40 per cent organic + 60 per cent inorganic fertilizer. The use of 100 per cent organic or 100 per cent inorganic fertilizer also showed the slight decrease for this trait, in all three cultivars. Also, the 100 per cent inorganic was significantly superior to the 100 per cent organic and the control. Moreover, the 100 per cent organic was also significantly superior to the control. Similar results in African marigold were reported by Mathew and Singh (2003) and Suthar (2005), and in crossandra by Bhavanisankaf and Vanangamudi (1999b) and Raju and Haripriya (2001).

The application of nitrogen at optimum level attributed to acceleration in development of growth and reproductive phases. Moreover, higher content of nitrogen might have accelerated protein synthesis, thus promoting earlier floral primordial development. There results are in confirmation with Anuradha *et al.* (1990) who reported that flowering and yield characters significantly influenced with higher level of nitrogen and sources of application in African marigold.

Table 1. Effect of organic and inorganic fertilizers on growth and yield characters of african marigold cultivers.

Fertilizers (%)	Plant height (cm)			Plant spread (cm)			Branches plant^{-1}			Days to 1st flowering		
	PNG	PBG	ADO	PNG	PBG	ADO	PNG	PBG	ADO	PNG	PBG	ADO
No fertilizer (control)	137.70	61.36	91.30	79.85	31.08	55.86	31.15	7.93	19.86	56.56	54.36	57.25
100 organic	144.00	70.38	109.16	87.50	35.83	62.59	37.45	10.09	23.82	45.75	45.71	49.25
100 castor cake	158.10	79.75	120.02	86.35	39.67	65.36	38.10	12.90	25.41	50.36	47.97	48.70
100 neem cake	155.50	80.06	121.08	91.10	40.72	66.97	35.75	12.93	23.83	46.20	46.77	48.10
100 inorganic*	148.25	80.96	126.65	91.85	43.96	73.52	35.05	13.91	26.08	47.70	44.71	44.80
40 organic + 60 inorganic	160.65	82.33	131.86	94.00	40.90	78.76	39.20	15.16	28.22	45.85	41.72	44.00
60 organic + 40 inorganic	168.40	87.36	136.00	81.60	35.02	75.51	42.85	15.66	29.88	43.40	40.17	43.50
S. Em. ±	5.93	2.22	4.23	3.60	1.33	2.26	2.86	1.32	2.00	1.52	0.81	1.15
C. D. at 5%	14.85	9.56	11.41	10.52	9.28	12.51	7.62	6.89	7.73	8.44	11.71	9.10

* = NPK @ 100:40:40 kg ha^{-1}. PNG=Pusa Narangi Gainda, PBG=Pusa Basanti Gainda, ADO=African Double Orange

Table 2. Effect of organic and inorganic fertilizers on growth and yield characters of african marigold cultivers.

Fertilizers (%)	Flowers plant^{-1}			Diameter of flower (cm)			Flower yield plant^{-1}			Yield of flowers ha^{-1} (q)		
	PNG	PBG	ADO	PNG	PBG	ADO	PNG	PBG	ADO	PNG	PBG	ADO
No fertilizer (control)	32.16	41.71	37.48	4.30	3.77	4.09	108.65	185.90	146.96	89.40	84.95	72.10
100 organic	38.45	50.39	43.48	5.45	4.49	4.87	112.75	252.45	177.08	100.00	114.90	93.73
100 castor cake	35.70	59.95	46.59	5.90	4.44	5.47	143.05	332.85	198.15	110.60	139.55	104.18
100 neem cake	33.95	65.31	51.15	5.85	5.25	5.80	123.75	281.90	206.25	122.95	139.65	109.53
100 inorganic*	38.00	74.73	57.53	5.55	5.85	6.82	130.00	318.35	221.53	114.60	154.00	122.60
40 organic + 60 inorganic	39.80	77.88	57.90	6.05	5.26	5.70	137.20	331.50	231.78	133.90	173.55	128.63
60 organic + 40 inorganic	43.15	80.11	62.45	6.50	6.13	6.94	148.60	386.00	263.23	146.30	180.05	134.70
S. Em. ±	2.77	2.03	2.76	0.31	0.53	0.36	7.26	5.18	7.11	8.03	7.06	7.14
C. D. at 5%	7.42	14.98	13.63	0.89	10.16	5.36	20.58	14.57	18.97	19.45	18.06	16.51

* = NPK @ 100:40:40 kg ha^{-1}. PNG=Pusa Narangi Gainda, PBG=Pusa Basanti Gainda, ADO=African Double Orange

The application of 60 per cent organic + 40 per cent inorganic fertilizer increased flower diameter, number of flowers plant^{-1}, flower yield plant^{-1} and yield of flowers hectare^{-1} followed by 40 per cent organic + 60 per cent inorganic fertilizer and 100 inorganic fertilizer, during both the years. However, the cultivar Pusa Narangi Gainda gane better response among the cultivars for different growth and flowering characters except for days to first flowering. For the character days to first flowering, cultivar Pusa Basanti Gainda was earlier than Pusa Narangi Gainda and African double orange under the dose of 60 per cent organic + 40 per cent inorganic fertilizer. It could also be attributed due to fact that after proper decomposition and mineralization, the organic manure supplied available nutrients directly to the plant and also had solubilizing effect on fixed form of nutrients in soil and thus improvement in physical and biological properties of the soil. The similar effects were reported by Singh (2005) in rose.

The treatment 60 per cent organic + 40 per cent inorganic fertilizer gave higher flower yield plant^{-1} and maximum yield of flowers hectare^{-1} of the cultivar Pusa Basanti Gainda which was followed by Pusa Narangi Gainda and African double orange. But for other growth and flowering characters Pusa Narangi Gainda responded very well as compared to Pusa Basanti Gainda and African double orange under the fertilizer dose of 60 per cent organic + 40 per cent inorganic. Present finding is also experimentally supported with the observations made by various workers in different flower crops (Rathod *et al*., 2002; Singh and Singh 2003; Singh and Jauhari, 2005, Singh, 2006; and Swaminathan and Sambanda multhi, 2000).

Thus, the present investigation revealed that the application of 60 per cent organic + 40 per cent inorganic fertilizer significantly influenced all the growth and flowering characters in all three cultivars.

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Effect of Intercropping of Marigold and Okra on Yield of Ragi and Nitrogen Balance Under Lateritic Soils of Konkan

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Abstract

The significantly higher grain yield of finger millet (24.08 q ha-1) was obtained in sole finger millet than all other intercropping ratios followed by intercropping of figer millet + marigold in 3:1 ratio (21.81 q ha^{-1}). Maximum total uptake of nitrogen was recorded under sole crop of okra (74.87 kg ha^{-1}) while minimum total uptake of nitrogen was recorded under sole finger millet (38.76 kg ha^{-1}). There was no gain of nitrogen in soil due to sole as well as different intercropping ratios of finger millet with marigold and okra.

Key words : Intercropping, finger millet, okra, marigold, yield, N-balance sheet.

Ragi (*Eleusine coracana* G.) is the second most important food crop next to rice in Konkau, which, is grown on an area of 145 thousand hectares with average annual grain production of 851 thousand tones (Anonymous, 2003). It is commonly grown on

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the uplands and hill slope due to which there is lot of soil erosion and runoff The applied nutrients are therefore not utilized efficiently which is one of the most important reasons for the poor grain yield of *ragi*. It is necessary to grow this crop with some other crops like legumes, oil seed crop, vegetable or flower crop so that additional income from these intercrop could be obtained, Growing of okra as an intercrop in finger millet recorded higher monetary returns than sole finger millet in Konkan under *kharif* season (Jadhav *et al.*,1992). Cereal crops like maize, rice, finger millet or antagonistic crops like marigold, onion, and sesame can be fitted well into rotation, sequence, or as an intercrops with local agronomic practices in Konkan. In view of this, the present investigation was undertaken to study the performance of marigold (T*agetis erecta*) and okra (*Abelmoschus esculentus*) as intercrops in *ragi*.

Materials and Methods

The field experiment was conducted in lateritic soils of Konkan region at Agronomy farm, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during *kharif* season of 2006-07. The soil was clay loam in texture, slightly acidic in reaction, high in available N (387.50 kg ha^{-1}), medium in available P_2O_5 (22.75 kg ha^{-1}) and K_2O (142.50 kg ha^{-1}). Experiment was laid out in a randomized block design with treatments replicated thrice. Two intercrops viz. marigold and okra were taken in the main crop of finger millet in three different ratios. The gross plot size was 4.8 x 6m^2 for 1:1 and 3:1 ratio and 5.4 x 6 m^2 for 2:1 ratio and net plot size for finger millet, marigold and okra was 5.6 x 4.5 m^2, 5.20 x 4.2 m^2, and 4.8 x 4.8 m^2 respectively. The variety Dapoli - 1 of finger millet, Giant Double African Tall of Marigold and Arka anamika of okra were used in this investigation. For raising the seedlings of linger millet and marigold, raised beds of 5 x 1 m^2 size were prepared. Nursery was fertilized with 1 kg urea and 2 kg single super phosphate per Are at the time of sowing. The seed of finger millet and marigold were sown on raised bed in lines drawn and 20 cm apart, respectively. Sowing was done on 20th June 2006. In order to have healthy and vigorous seedling, top dressing was done with urea at the rate of 1 kg per Are and one weeding was given 15 days after sowing. The healthy and vigorous seedlings of 30 days old were used for transplanting one seedling per hill. Transplanting of finger millet and marigold seedling were done at spacing of 20 x 15 cm^2 and 30 x 40 cm^2, respectively. In case of okra two seeds were dibbled per hill at the spacing 30 x 60 cm^2. Seed rate used for okra was 10 kg ha^{-1}. Keeping the space for transplanting of finger millet, transplanting of intercrops was done as per row proportions. The recomanded fertilizer dose of 100:50:50, 100:50:30 and 80:40:40 kg NPK ha^{-1} was applied to okra, marigold and finger millet respectively. For all the crops, nitrogen was applied in two equal halves i.e. 50 per cent basal dose and remaining 50 per cent one month after sowing or transplanting. Nitrogen, phosphorus and potash were applied through urea, single super phosphate and muriate of potash, respectively.

Results and Discussion

Grain yield : From the data (Table 1) it was evident that the yield level of sole crop was more than their respective intercrop ratios of 3:1, 2:1 and 1:1. Further, yield of finger millet was significanty more under 3:1 than 2:1 and 1:1 ratios with marigold. Similar trend was observed under finger millet + okra. In intercropping, the yield of finger millet was significantly higher under finger millet + marigold in 3:1 ratio than the rest of the intercropping treatments. Zhang and Li (1987) and More (1990) also obtained similar results in

Table 1. Mean values of available nitrogen, added nitrogen, uptake by plant, expected nitrogen content and actual nitrogen content in soil (kg ha^{-1}).

Treatment	Grain yield (q ha^{-1})	Initial available nitrogen (kg ha^{-1})	Added nitrogen (kg ha^{-1})	Total nitrogen (kg ha^{-1})	Uptake (kg ha^{-1})	Balance		Net loss or gain (kg ha^{-1})
						Expected	Actual	
Sole finger millet	24.08	387.50	80.00	467.50	38.76	428.74	289.22	-139.52
Sole marigold	61.32	387.50	100.00	487.50	32.33	454.17	267.17	-188.00
Sole okra	89.57	387.50	100.00	487.50	74.87	412.63	289.12	-123.51
Finger millet + marigold (1:1)	16.47	387.50	90.00	477.50	41.79	435.71	295.12	-140.59
Finger millet + okra (1:1)	15.54	387.50	90.00	477.50	57.63	419.87	298.37	-121.87
Finger millet + marigold (2:1)	17.50	387.50	87.33	474.83	38.32	436.51	317.12	-119.39
Finger millet + okra (2:1)	16.87	387.50	87.33	474.83	35.43	419.40	325.37	-94.07
Finger millet + marigold (3:1)	21.81	387.50	85.00	472.50	42.08	430.50	323.00	-107.50
Finger millet + okra (3:1)	20.09	387.50	85.00	472.50	53.91	418.59	340.15	-78.59
SE m ±	0.23	-	-	-	-	-	-	-
CD at 5%	0.70	-	-	-	-	-	-	-

case of maize and soybean intercropping. From the intercropping system tried, it was observed that the finger millet yield increased with increase in the proportion of finger millet irrespective of the intercrop.

Total nitrogen : The added nitrogen was higher under marigold and okra, therefore the total nitrogen was also more under these treatments than sole finger millet treatment. The data of added nitrogen for marigold and okra were similar. Therefore, the total nitrogen under two crops and their respective intercropping ratio with finger millet was similar. Sole finger millet received lowest added nitrogen.

Nitrogen uptake : In all intercropping systems, the total nitrogen uptake was more than the sole finger millet except finger millet + marigold (2:1 ratio). Among the intercropping, finger millet + okra at 1:1 ratio recorded higher total nitrogen uptake followed by 2:1 arid 3:1 ratio. In case of finger millet + marigold intercropping system in 3:1 ratio recorded higher total nitrogen uptake followed by 2:1 and 1:1 ratio. Similar type of results were also reported earlier by Mahadkar and Khanvilkar (1990).

Expected and actual balance of nitrogen in the soil : Data regarding expected and actual balance of nitrogen in the soil as affected by various treatments are presented in Table 1. Expected balance was calculated by substracting nitrogen uptake from total nitrogen in soil and actual balance was recorded from the chemical analysis of soil samples after harvesting the crops.

From the data, it is clear that among the sole crops marigold showed the higher net loss in nitrogen than expected balance. Sole okra resulted into the lowest net loss in nitrogen balance than sole crops of finger millet and marigold. Among the different intercropping systems also, it is clear that there was net loss in nitrogen than expected balance. Irrespective of row proportions, finger millet + okra intercropping recorded comparatively less net loss in the nitrogen balance of soil than finger millet + marigold intercropping.

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Effect of Post Biomethanated Spent Wash on Micronutrient Availability in Entisol, Inceptisol and Vertisol

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Abstract

The pot culture experiment was conducted with three main treatments of soil types and four levels of post biomethanated spent wash (PBSW) incubated for 30, 60 and 90. The Fe, Mn and Zn content in soil was significantly altered due to application of different levels of PBSW. Application of PBSW @ 160 m^3 ha^{-1} significantly increased DTPA-Fe (5.17 mg kg^{-1}), Mn (5.81 mg kg^{-1}) and Zn (1.03 mg kg^{-1}) content in soil at 90 days incubation period in all the type of soil as compared to rest of the treatments. However, DTPA-Cu content in soil decreased with the increasing levels of PBSW in Entisol, Inceptisol and Vertisol.

Key word: Micronutrients, Entisol, Inceptisol and Vertisol, Neubauer study.

The method of conversion of spentwash to the fertilizer is a useful alternative for spentwash and post methanation effluent disposal (Kulkarni *et al*., 1987). Ramadurai and Gerard (1994) reported that the distillery effluent, which comes out after biomethanation is rich source of macro and micronutrients. One cubic meter of primary treated distillery effluent contained 1.5 kg N, 0.25 kg P, 10 kg K and 15 kg digested organic matter. The BOD and COD levels of this effluent can be lowered by composting it with the press mud obtained as waste product from sugar industry. The compostion of this press mud varied with the quality of cane and process of cane juice clarification. It contains approximately 1.0-1.6 per cent N, 1.0-3.0 per cent P_2O_5, 1.0-2.02 per cent K_2O, 1.0-4.0 per cent CaO, 0.5-1.5 per cent MgO and traces of iron 59 mg L^{-1}, manganese 0.45 mg L^{-1}, copper 13.60 mg L^{-1} and zinc 8.30 mg L^{-1}. These nutrients can be effectively tapped and use for sustainable agricultural production.

Looking to the scope and potential of post biomethanated spent wash use in agriculture as source of plant nutrient, it is necessary to study

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effect of post biomethanated spent wash application on soil properties, nutrient uptake and biomass.

Materials and Methods

The incubation study of post biomethanated spentwash and neubauer studies were carried out in pot culture experiment in laboratory under ambient condition during *rabi* 2008. The representative surface soil sample were collected from Entisol, Inceptisol and Vertisol soils. The treatment includes three soil types A1: Entisol, A2: Inceptisol, A3: Vertisol and applications of four levels of post biomethanated splent was (PBSW) viz; B1 : Control, B2 : PBSW @ 40 m^3 ha^{-1}, B3 : PBSW @ 80 m^3 ha^{-1}, B4 : PBSW @ 120 m^3 ha^{-1} and B5 : PBSW @160 m^3 ha^{-1}.

Treatment was replicated three times, requisite amount of PBSW as per treatment was added in 2 kg soil in plastic container and mixed thoroughly. The soil was brought to field capacity and incubated at ambient temperature. The nutrient release of micronutrients were assessed at 0, 30, 60 and 90 days of an incubation by following standard analytical procedure (Tabatabai, 1982). The wheat seed (cv. Trimbak) was sown in plastic bucket after 90 days of incubation. The wheat seedling were grown for 30 days and then harvested (Neubauer studies). These harvested seedlings were dried in diffuse sunlight and then oven dried at 65°C till constant weight and analyzed for total micronutrient. Representative surface soil samples collected are slightly alkaline (7.9), moderately alkaline (8.20) and strongly alkaline (8.65) in Entisol, Inceptisol and Vertisol respectively (Table 1). However all soil samples were low in soluble salt content, EC ranged from 0.21 to 0.28 dSm^{-1}, The soils were deficient in DTPA-Fe in Entisol and Inceptisol and deficient in DTPA Zn in Entisol. The DTPA Mn and Cu in all the soils were sufficient (Table 1).

Table 1. Chemical properties of soil.

Chemical properties	Entisol	Inceptisol	Vertisol
pH (1:2.5)	7.90	8.20	8.65
EC (dSm^{-1})	0.21	0.23	0.28
Organic carbon (%)	0.30	0.49	0.37
Available N (kg ha^{-1})	196	316	278
Available P (kg ha^{-1})	18.0	14.0	15.0
Available K (kg ha^{-1})	258	370	448
Exchangeable cations :			
Ca (cmol (p^+) kg^{-1})	30.0	21.5	40.0
Mg (cmol (p^+) kg^{-1})	4.8	8.5	10.2
Na+ (cmol (p^+) kg^{-1})	0.98	0.95	1.00
Available S (mg kg^{-1})	10.5	11.2	13.45
DTPA micronutrient (mg kg^{-1}) :			
Fe	2.37	4.00	7.56
Mn	2.87	9.43	4.56
Cu	0.39	2.73	2.60
Zn	0.35	1.01	0.90

The chemical composition of PBSW showed that it was mildly alkaline in reaction (pH 7.48). The soluble salt content was very high (EC 38.90 dSm^{-1}). The BOD and COD of PBSW was 5621 and 23820 mgL^{-1} respectively, which indicating high organic load. The PBSW is a good source of nutrient K (1.06%) and micronutrient Fe (43 mgL^{-1}), Mn (0.43 mgL^{-1}), Cu (12.7 mgL^{-1}) and Zn (8.56 mgL^{-1}).

Results and Discussion

Effect of levels of PBSW on available micronutrients : The content of DTPA-Fe in soil was deficient in Entisol and Inceptisol before application of PBSW. The application of different levels of PBSW significantly increased the DTPA-Fe in Inceptisols with sufficient range (4.94 mg kg-1) at 90 days of incubation period. However, Fe content increased in all types of soil with incubation period upto 90 days and thereafter it decreased at harvest due to uptake of Fe by wheat seedlings (Table 2).

Table 2. The periodical soil availability of Fe (mg kg^{-1}) as influenced by soil type, level of PBSW and their interactions.

PBSW applied (m^3 ha^{-1})	30 days				60 days				90 days				After harvest of neubauer seedlings			
	A_1	A_2	A_3	Mean	A_1	A_2	A_3	Mean	A_1	A_2	A_3	Mean	A_1	A_2	A_3	Mean
B_1. Control	2.377	4.203	7.550	4.710	2.400	4.417	7.577	4.798	2.417	4.337	7.587	4.780	2.113	3.563	6.653	4.110
B_2. 40	2.403	4.317	7.627	4.782	2.440	4.457	7.610	4.836	2.540	4.560	7.640	4.913	2.160	3.793	6.683	4.212
B_3. 80	2.450	4.473	7.637	4.866	2.547	4.620	7.700	4.956	2.600	4.643	7.750	4.993	2.193	3.883	6.907	4.328
B_4. 120	2.533	4.663	7.830	4.978	2.603	4.800	7.830	5.078	2.690	4.843	7.857	5.130	2.227	3.993	7.093	4.438
B_5. 160	2.590	4.77	7.853	5.066	2.690	4.827	7.853	5.123	2.710	4.937	7.887	5.178	2.333	4.097	7.180	4.537
Mean	2.471	4.487	7.683		2.536	4.624	7.714		2.591	4.664	7.744		2.205	3.866	6.903	
	A	B	A x B		A	B	A x B		A	B	A x B		A	B	A x B	
S.E±	0.018	0.024	0.041		0.023	0.029	0.051		0.025	0.033	0.057		0.047	0.060	0.105	
C.D. at 5%	0.053	0.069	0.120		0.066	0.085	NS		0.074	0.095	NS		0.135	0.175	NS	

A : Different soil types, B: Different levels of PBSW, A x B : Interaction between soil type and levels of PBSW.

Table 3. The periodical soil availability of Mn (mg kg^{-1}) as influenced by soil type, level of PBSW and their interactions.

PBSW applied (m^3 ha^{-1})	30 days				60 days				90 days				After harvest of neubauer seedlings			
	A_1	A_2	A_3	Mean	A_1	A_2	A_3	Mean	A_1	A_2	A_3	Mean	A_1	A_2	A_3	Mean
B_1. Control	2.867	9.432	4.562	5.620	2.867	9.433	4.564	5.621	2.850	9.430	4.566	5.614	3.373	8.974	3.458	5.268
B_2. 40	2.673	9.439	4.602	5.571	2.943	9.438	4.624	5.669	2.953	9.495	4.622	5.690	2.423	9.115	3.562	5.034
B_3. 80	2.900	9.463	4.655	5.670	2.977	9.470	4.651	5.699	2.983	9.498	4.628	5.703	2.457	9.220	3.687	5.121
B_4. 120	2.940	9.475	4.627	5.680	3.087	9.484	4.698	5.756	3.093	9.541	4.633	5.756	2.470	9.241	3.781	5.169
B_5. 160	3.007	9.519	4.723	5.750	3.143	9.533	4.790	5.822	3.207	9.550	4.676	5.811	2.520	9.224	3.878	5.070
Mean	2.877	9.465	4.634		3.003	9.472	4.665		3.017	9.503	4.624		2.469	9.155	3.673	
	A	B	A x B		A	B	A x B		A	B	A x B		A	B	A x B	
S.E±	0.0351	0.045	0.078		0.016	0.021	0.037		0.012	0.016	0.028		0.125	0.161	0.280	
C.D. at 5%	0.101	NS	NS		0.048	0.062	NS		0.0369	0.047	0.082		0.361	NS	NS	

A : Different soil types, B: Different levels of PBSW, A x B : Interaction between soil type and levels of PBSW.

Table 4. The periodical soil availability of Cu (mg kg^{-1}) as influenced by soil type, level of PBSW and their interactions.

PBSW applied (m^3 ha^{-1})	30 days				60 days				90 days				After harvest of neubauer seedlings			
	A_1	A_2	A_3	Mean	A_1	A_2	A_3	Mean	A_1	A_2	A_3	Mean	A_1	A_2	A_3	Mean
B_1. Control	0.250	2.697	2.620	1.855	0.363	2.663	2.600	1.876	0.347	2.350	2.575	1.757	0.267	2.220	2.325	1.604
B_2. 40	0.270	2.733	2.606	1.869	0.350	2.633	2.584	1.856	0.320	2.203	2.567	1.697	0.237	2.197	2.300	1.578
B_3. 80	0.237	2.759	2.584	1.868	0.287	2.684	2.584	1.851	0.250	2.197	2.544	1.664	0.197	2.160	2.272	1.543
B_4. 120	0.300	2.784	2.599	1.886	0.237	2.723	2.549	1.836	0.227	2.170	2.528	1.642	0.177	2.127	2.264	1.522
B_5. 160	0.267	2.814	2.559	1.880	0.213	2.740	2.513	1.822	0.203	2.147	2.496	1.615	0.150	2.083	2.278	1.504
Mean	0.265	2.758	2.594		0.290	2.689	2.566		0.269	2.213	2.542		0.250	2.157	2.288	
	A	B	A x B		A	B	A x B		A	B	A x B		A	B	A x B	
S.E±	0.034	0.044	0.076		0.029	0.037	0.065		0.0113	0.014	0.025		0.016	0.020	0.036	
C.D. at 5%	0.098	NS	NS		0.084	NS	NS		0.032	0.042	NS		0.046	0.059	NS	

A : Different soil types, B: Different levels of PBSW, A x B : Interaction between soil type and levels of PBSW.

Table 5. The periodical soil availability of Zn (mg kg^{-1}) as influenced by soil type, level of PBSW and their interactions.

PBSW applied (m^3 ha^{-1})	30 days				60 days				90 days				After harvest of neubauer seedlings			
	A_1	A_2	A_3	Mean	A_1	A_2	A_3	Mean	A_1	A_2	A_3	Mean	A_1	A_2	A_3	Mean
B_1. Control	0.353	0.790	0.897	0.680	0.320	0.820	0.882	0.674	0.323	0.873	0.868	0.688	0.311	0.813	0.846	0.657
B_2. 40	0.370	0.873	0.907	0.717	0.390	0.907	0.934	0.743	0.357	0.947	0.903	0.735	0.323	0.820	0.838	0.661
B_3. 80	0.390	0.970	0.961	0.774	0.437	1.047	0.981	0.822	0.410	1.007	0.917	0.778	0.348	0.845	0.857	0.683
B_4. 120	0.643	1.090	0.990	0.908	0.493	1.067	1.010	0.864	0.653	1.110	1.039	0.934	0.348	0.926	0.874	0.716
B_5. 160	0.743	1.120	1.127	0.997	0.723	1.090	1.163	1.012	0.770	1.180	1.153	1.034	0.408	0.947	0.889	0.748
Mean	0.500	0.969	0.976		0.503	1.003	0.994		0.503	1.023	0.976		0.348	0.870	0.861	
	A	B	A x B		A	B	A x B		A	B	A x B		A	B	A x B	
S.E+	0.031	0.040	0.070		0.019	0.025	0.043		0.030	0.039	0.068		0.0153	0.019	0.034	
C.D. at 5%	0.090	0.116	NS		0.056	0.073	NS		0.088	0.114	NS		0.044	0.057	NS	

A : Different soil types, B: Different levels of PBSW, A x B : Interaction between soil type and levels of PBSW.

The content of Mn was sufficient in all the type of soil (Table 3) and it increased significantly at 90 days of incubation period due to application different levels of PBSW. However, Mn content in soil was higher in Inceptisol (9.50 mg kg^{-1}) followed by Vertisol (4.62 mg kg^{-1}) and Entisol (3.01 mg kg^{-1}) at 90 days incubation period and thereafter, it decreased at harvest due to uptake by wheat seedling.

The content of Zn in soil was deficient in Entisol and sufficient in Inceptisol and Vertisol before application of PBSW. However, the application of PBSW @ 120 and 160 m^3 ha^{-1} also significantly increased the DTPA-Zn in soil at all the incubation period and thereafter decreased and deficient at harvest due to uptake of Zn by wheat seedling (Table 5). The content of Zn in soil was highest in Inceptisol (1.023 mg kg^{-1}) followed by Vertisol (0.976 mg kg^{-1}) and Entisol (0.503 mg kg^{-1}) at 90 days of incubation period.

The content of Cu did not show variation due to any of the treatments and incubation period.

Effect of PBSW on micronutrient content at harvest of Neubauer seedling : The content of Fe, Mn, Zn and Cu by wheat seedlings were found significantly increased due to application of different levels of PBSW over control (Table 6). However, application of PBSW @ 160 m3 ha-1 significantly increased the micronutrient content Fe (776.9 mg kg^{-1}), Mn (85.67 mg kg^{-1}), Zn (56.75 mg kg^{-1}) and Cu (34.83 mg kg^{-1}) over control. The interaction results between different levels of PBSW and soil type in respect of micronutrients content were non significant.

Thus, the one time application of post biomethanated spent wash @ 160 m^3 ha^{-1} found to be beneficial for micronutrients (Fe,

Table 6. Effect of different level of PBSW on micronutrients content in Neubauer seedlings of wheat at harvest ($mgKg^{-1}$).

PBSW applied (m^3 ha^{-1})	Fe				Mn				Zn				Cu			
	A_1	A_2	A_3	Mean	A_1	A_2	A_3	Mean	A_1	A_2	A_3	Mean	A_1	A_2	A_3	Mean
B_1. Control	635.6	706.3	717.6	686.5	61.97	78.28	81.17	73.18	33.83	44.90	47.75	42.16	16.98	23.95	27.10	22.68
B_2. 40	652.3	720.6	733.3	702.1	63.93	79.19	83.67	75.59	35.50	47.69	48.22	48.80	18.55	24.69	33.27	25.50
B_3. 80	663.3	745.6	754.0	721.0	66.81	87.09	87.16	80.35	39.19	57.67	49.92	48.92	24.05	28.86	37.64	30.18
B_4. 120	713.3	793.3	779.0	761.9	73.02	89.07	89.21	83.76	43.72	63.44	56.91	54.68	25.26	31.28	40.88	32.47
B_5. 160	691.7	836.7	802.3	776.9	74.94	90.11	91.97	85.67	46.73	63.24	60.29	56.75	26.84	33.58	44.06	34.83
Mean	671.2	760.5	757.2		68.13	84.74	85.12		39.79	55.38	52.62		22.34	28.47	36.59	
	A	B	A x B		A	B	A x B		A	B	A x B		A	B	A x B	
S.E±	5.53	7.14	12.3		1.60	2.06	3.57		0.892	1.15	1.99		0.919	1.18	2.05	
C.D. at 5%	15.9	20.6	NS		4.61	5.96	NS		2.57	3.32	NS		2.65	3.42	NS	

A : Different soil types, B: Different levels of PBSW, A x B : Interaction between soil type and levels of PBSW.

Mn, Zn) availability in soil at 90 days incubation period. The total content of nutrients by wheat seedling (Neubauer technique) were more in the soil order of Inceptisol followed by Vertisol and Entisol as reported earlier by Joshi *et al.* (1994).

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Effect of Row Ratios and Nitrogen Levels on Yield and Yield Attributes of Popcorn Maize (*Zea mays everta* l.) and Rajmash (*Phaseolus vulgaris* l.) Intercropping System

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Abstract

The treatment paired row popcorn (100% RDN) + rajmash (100%R DN) with 2:2 ratio performed better than other treatments by producing maximum number of cobs plant^{-1}, number of grain rows cob^{-1}, number of grains row^{-1}, number of grains cob^{-1}, test weight (g), seed and stover yields (q ha^{-1}), harvest index of popcorn, along with highest number of pods plant^{-1}, number of seeds pods^{-1} and seed and straw yields (q ha^{-1}) of rajmash.

Key words : Popcorn maize, rajmash, intercropping, row ratio, nitrogen levels, yield.

Popcorn or popping corn is a type of corn which puffs up when it is heated in oil or by dry heat cultivated strain (*Zea mays everta* L.) has a special kind of *flint corn*. It is a low cost snack and also has nutritional values. For obtaining nutritional security with food security intercropping of legumes in between the longer duration *rabi* maize offers a good option. Intercropping is attracting more interest in developed countries, primarily due to claims that it can provide increased yields in an environmentally sustainable manner. For successful and profitable intercropping system, there must be proper row ratio of component crops in order to avoid limitation of reduced plant population of base crop under traditional intercropping system (Pandey *et al.* 1999). Rajmash is considered as an ideal crop for intercropping with maize owing to its comparative tolerance for shade and drought, efficient light utilization and less competitiveness for soil moisture (Meena *et al.* 2006). Hence, with an object to enhance the

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productivity of popcorn maize and rajmash intercropping system, various row ratios and nitrogen levels were tried in the present investigation.

Materials and Methods

The experiment was conducted during *rabi* 2008 at Crop Research Farm, Department of Agronomy, Allahabad Agricultural Institute, Allahabad (Uttar Pradesh). The soil of the experimental plot was sandy loam having an organic carbon content of 0.39 per cent, pH of 7.4 and the available NPK of the experimental plot were analysed to be 185.5, 36 and 98 kg ha^{-1}, respectively. The experiment was laid out in a randomized block design with three replications having fifteen treatment combinations. The treatment consisted of two intercropping systems *viz*., conventional intercropping of popcorn maize + rajmash (2:1 and 2:2 row ratios) where the row to row distance between the popcorn maize rows was 60 cm and paired row intercropping with two cropping systems of popcorn maize + rajmash (2:1 and 2:2 row ratios) where the row to row distance between the two paired rows was reduced to 40 cm and the distance between two paired rows was maintained at 80 cm, along with three nitrogen levels i.e. 100 % RDN to popcorn maize + 75 per cent RDN to rajmash, 75 per cent RDN to popcorn maize + 100 per cent RDN to rajmash and 100 per cent RDN to popcorn maize + 100 per cent RDN to rajmash and the observations were compared to paired rows sown sole popcorn maize, conventional sown sole popcorn maize and sole rajmash each fertilized with 100 per cent RDN. The recommended dose of NPK for popcorn maize was 150:80:60 kg NPK ha^{-1} and for rajmash was 120:60:40 kg NPK ha^{-1}, respectively. Sowing was done on 6th Nov. 2008. Thinning and gap filling was done at 15 days after sowing in both the crops to keep the plant-to-plant spacing of 25 cm in popcorn maize and 10 cm in rajmash. The crops were fertilized according to treatment details and phosphorus and potassium were as blanket dose in all the treatments. Nitrogen was applied through urea, phosphorus through single super phosphate and potassium through muriate of potash. One-third nitrogen along with full dose of phosphorus and potassium were applied as basal and remaining dose of nitrogen was applied in two splits *viz*., first at knee-high stage (35 days after sowing) and second at pre-tasseling stage in maize. In rajmash, half nitrogen was applied basally and half was applied 40 days after sowing. In popcorn maize, the yield parameters *viz*. number of cobs $plant^{-1}$, grain rows cob^{-1}, number of grains row^{-1}, number of grains cob^{-1}, test weight, grain yield, stover yield and harvest index and in rajmash number of pods $plant^{-1}$, number of grains pod^{-1}, grain yield and straw yield were analysed after the harvest of crops.

Results and Discussion

Popcorn maize : All the characters except grain rows cob-1 differed significantly amongst the various treatments (Table 1). Data revealed that higher values for all the yield contributing characters *viz*., number of cobs $plant^{-1}$, number of grain rows cob^{-1}, number of grains row^{-1}, number of grains cob^{-1}, test weight and seed yield, stover yield and harvest index were obtained with paired row sown popcorn maize fertilized with 100 per cent RDN + paired row sown rajmash fertilized with 100 per cent RDN (2:2 ratios), although the values for number of cobs $plant^{-1}$, number of grains cob^{-1}, seed and stover yields were found to be statistically at par to the values obtained under paired row sown popcorn maize fertilized with 100 per cent RDN + paired row sown rajmash fertilized with 75 per cent RDN (2:2 ratios) and the values of number of grains row^{-1} and harvest index was found to be statistically at par to the values obtained for treatment paired row sown popcorn maize fertilized with 100 per cent RDN + paired row sown rajmash fertilized with 75 per cent RDN (2:2 ratios) and treatment paired row sown maize fertilized with 100 per cent RDN + single row rajmash fertilized with 100 per cent RDN (2:1 ratios) respectively. The test weight obtained under paired row sown popcorn maize fertilized with 100 per cent RDN + paired row sown rajmash fertilized with 100 per cent RDN (2:2 ratios) was statistically at par with the paired row sown popcorn maize fertilized with 100 per cent RDN + paired row sown rajmash fertilized with 75 per cent RDN (2:2 ratios), paired row sown maize fertilized with 100 per cent + single row rajmash fertilized with 100 per cent RDN (2:1 ratios) and paired row sown maize fertilized with 100 per cent RDN + single row rajmash fertilized with 75 per cent RDN (2:1 ratios) respectively.

The higher number of cobs plant^{-1}, number of grain rows cob^{-1}, number of grains row^{-1}, number of grains cob^{-1}, test weight, seed and stover yields and harvest index obtained under 2:2 paired row system of planting as compared to conventional sowing might be due to better sunlight receptivity by the maize plants of paired row system sown due to wider distance in between two paired rows as compared to conventional sowing and hence higher photosynthesis and higher dry matter accumulation. The paired row sown maize intercropped with rajmash and both fertilized with 75 per cent RDN did not perform better because of absence of nodulation in rajmash in plains due to which it has a high nitrogen requirement as of maize which might have resulted in mutual competition in both the crops as compared to those intercropping systems where both maize and rajmash have been provided with 100 per cent of their RDN. Tripathi *et al.* (2008) reported that the number of cobs plant^{-1} tended to be more under higher nitrogen level application because of the

Table 1. Effect of different row ratios and nitrogen levels on yield attributes of popcorn maize (*Zea mays everta* L.) under intercropping with rajmash (*Phaseolus vulgaris* L.).

Treatments	Number of cobs plant^{-1}	Grains rows cob^{-1}	Number of grains row^{-1}	Number of grains cob^{-1}	Test weight (g)	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Harvest index
Maize (100*) Conventional sole	1.89	12.89	32.11	413.80	147.17	22.50	63.37	26.20
Maize (100*) Paried row sole	2.22	14.44	34.22	494.26	150.00	24.23	65.13	27.12
Rajmash (100*) Conventional sole	-	-	-	-	-	-	-	-
Maize (100*) + Rajmash (100*) Conven. 2:1	1.89	13.55	33.11	448.73	148.33	23.33	64.28	26.63
Maize (75*) + Rajmash (100*) Conven. 2:1	1.11	11.78	28.11	331.03	144.17	20.18	61.00	24.86
Maize (100*) + Rajmash (75*) Conven. 2:1	1.66	13.22	32.33	427.40	147.53	22.90	63.77	26.42
Maize (100*) + Rajmash (100*) Conven. 2:2	2.11	14.22	33.89	481.86	149.33	24.00	64.88	27.00
Maize (75*) + Rajmash (100*) Conven. 2:2	1.22	12.00	28.89	346.64	145.00	21.20	61.89	25.51
Maize (100*) + Rajmash (75*) Conven. 2:2	1.89	13.71	33.44	458.54	148.83	23.73	64.75	26.82
Maize (100*) + Rajmash (100*) Paired 2:1	2.77	15.11	35.33	533.83	151.00	24.73	65.57	27.39
Maize (75*) + Rajmash (100*) Paired 2:1	1.33	12.22	29.55	361.43	145.93	21.53	62.37	25.66
Maize (100*) + Rajmash (75*) Paired 2:1	2.44	14.66	34.44	505.04	150.67	24.43	65.50	27.17
Maize (100*) + Rajmash (100*) Paired 2:2	3.33	15.89	36.44	578.96	151.83.	25.35	66.05	27.73
Maize (75*) + Rajmash (100*) Paired 2:2	1.55	12.66	30.78	389.14	146.13	22.20	62.87	26.10
Maize (100*) + Rajmash (75*) Paired 2:2	3.11	15.55	35.89	558.00	151.50	24.99	65.93	27.41
S. Ed. (±)	0.13	0.30	0.59	12.33	0.79	0.18	0.21	0.19
C. D. at 5%	0.26	NS	1.22	25.26	1.61	0.38	0.43	0.39

* = Per cent recommended dose of nitrogen, Conven. = Conventional, Paired = Paired row

adequate translocation of carbohydrates for the initiation to the development of cobs. Kumar and Bangarva (1997) proved that enhanced cob yield might be due to increased LAI leading to higher photosynthetic rate and accumulation of more assimilates which in turn increased the sink size due to higher nutrient uptake under wider row spacing. Hence, the increase in seed yield observed with 2:2 paired row ratio and 100 per cent nitrogen for both crops might have been due to reduced inter-row specific competition for solar radiation and plant nutrients.

Rajmash : A perusal of the Table 2 clearly shows that amongst the intercropping treatments all the values for observations under treatment paired row sown popcorn maize fertilized with 100 per cent RDN + paired row sown rajmash fertilized with 100 per cent RDN (2:2 ratios) were highest. The values of number of pods plant^{-1} and number of seeds pod^{-1} were at par to that obtained under treatment, paired row sown popcorn maize fertilized with 100 per cent RDN + paired row sown rajmash fertilized with 75 per cent RDN (2:2 ratios) and the values of seed yield and straw yield were statistically at par to the values obtained under paired row sown popcorn maize fertilized with 75 per cent RDN + paired row sown rajmash fertilized with 100 per cent RDN (2:2 ratios).

The higher number of pods plant^{-1}, number of seeds pods^{-1}, seed and straw yields of rajmash in paired row sowing fertilized with 100 per cent RDN seems to be the cumulative effect of increased growth, nutrient uptake higher photosynthat and dry matter accumulation as a result of minimum shading effect of maize under wider, paired row sowing. These findings are in corroboration of the findings of Makhdoomi and Wani *et al*. (2005).

From the above findings, it may be concluded that for obtaining higher yields from popcorn maize and rajmash intercropping, two

Table 2. Effect of different row ratios and nitrogen levels on yield attributes of rajmash (*Phaseolus vulgaris* L.) under intercropping with popcorn mazie (*Zea mays everta* L.).

Treatments	Numbers of pods plant^{-1}	Number of seeds pod^{-1}	Yield (q ha^{-1})	
			Seed	Stover
Maize (100*) Conventional sole	-	-	-	-
Maize (100*) Paried row sole	-	-	-	-
Rajmash (100*) Conventional sole	7.98	5.50	12.36	15.53
Maize (100*) + Rajmash (100*) Conven. 2:1	7.33	5.10	5.06	6.36
Maize (75*) + Rajmash (100*) Conven. 2:1	6.66	4.55	4.80	6.18
Maize (100*) + Rajmash (75*) Conven. 2:1	6.11	3.89	4.10	6.11
Maize (100*) + Rajmash (100*) Conven. 2:2	7.66	5.32	9.12	12.46
Maize (75*) + Rajmash (100*) Conven. 2:2	6.89	4.84	8.56	12.34
Maize (100*) + Rajmash (75*) Conven. 2:2	6.44	4.19	8.40	11.70
Maize (100*) + Rajmash (100*) Paired 2:1	9.66	6.09	5.24	6.95
Maize (75*) + Rajmash (100*) Paired 2:1	8.33	5.54	5.19	6.82
Maize (100*) + Rajmash (75*) Paired 2:1	9.33	5.92	5.22	6.53
Maize (100*) + Rajmash (100*) Paired 2:2	10.33	6.49	9.72	12.73
Maize (75*) + Rajmash (100*) Paired 2:2	8.66	5.67	9.66	12.67
Maize (100*) + Rajmash (75*) Paired 2:2	10.11	6.37	9.30	12.26
S. Ed. (±)	0.20	0.10	0.07	0.10
C. D. at 5%	0.40	0.20	0.14	0.21

* = Per cent, recommended dose of nitrogen, Conven. = Conventional, Paired = Paired row

rows of rajmash should be sown in between the paired rows of popcorn maize (sown at a row to row spacing of 40/80 cm) and both the crops should be fertilized with the recommended dose of nitrogen in addition to the recommended dose of phosphorus and potassium.

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Effect of Irrigation Regimes and Integrated Nutrient Management on Yield of Sweet Corn (*Zea mays saccharata*)

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Abstract

The effect of irrigation regimes on cob yield of sweet corn was significant. The treatment I_1 recorded significantly higher cob yield (86.64 q ha^{-1}) over rest of the irrigation regimes. In case of INM treatments, the treatment F_5 i.e. 25 per cent RDN + 75 per cent N through FYM recorded significantly higher cob yield (100.34 q ha^{-1}) over rest of the treatments except F_6, which was at par. The maximum water use efficiency (291.50 kg ha^{-1} cm) was observed in treatment I_3F_5 while the treatment I_1F_5 gave the highest net returns of Rs. 59,017/- with maximum B:C ratio of 1.97.

Key words : Sweet corn, irrigation regimes, integrated nutrient management, yield and economics.

Sweet corn responds well to better management factors especially irrigation and fertilizers. It requires regular watering throughout growth for best production. Water needs are critical during tasseling, silking and ear formation. Stress during ear development not only decrease yield but lowers kernel quality and flavour. As the product is freshly consumed, the quality of the corn is considered to be the most important. It is well established that the improvement of quality and productivity in cereals could be made possible with combined application of organic manure and balanced chemical fertilizers. Use of organic and

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inorganic sources not only help in maintaining good physio-chemical characteristics but also increase the yields markedly.

Presently greater emphasis is given on cultivation of sweet corn to augment the income of farming community dwelling in the outskirts of big cities and metropolis. Taking into account good yield potential and short duration it can be very well suited either for sequential cropping or intercropping. Sweet corn can be a promising cash crop for the Konkan region. Considering increasing tourism in the region and availability of well irrigation up to March, its cultivation can be very well taken for cob purpose. However, information on water management and efficient integrated nutrient management in sweet corn production is lacking especially under lateritic soils of Konkan. Looking to the importance of organic manures and inorganic fertilizers and their integrated effect on crop production, the present investigation was undertaken to study the effect of irrigation regimes and INM on yield of sweet corn.

Materials and Methods

A field experiment was conducted during *rabi* seasons of 2005-2007 on newly developed terraced land at Central Experiment Station, Wakawali. The experimental soil was sandy loam in texture, slightly acidic in reaction (pH 5.8), medium in organic carbon content (0.59 %), low in available nitrogen content (275.25 kg ha^{-1}), medium in available phosphorus content (15.3 kg ha^{-1}) and low in available potassium content (147.0 kg ha^{-1}). The experiment was laid out in split plot design replicated thrice. The main plot treatments comprised of three irrigation regimes i.e. I_1 - Irrigation at 1.0 IW/CPE, I_2 - irrigation at 0.8 IW/CPE, I_3 - irrigation at 0.6 IW/CPE. While sub plot treatments comprised of six levels of nutrients i.e. F_1 - Control (Absolute control), F_2 - 100 per cent RDF (120:60:60 kg N : P_2O_5 : K_2O ha^{-1}), F_3 - 75 per cent RDN + 25 per cent N through FYM, F_4 - 50 per cent RDN + 50 per cent N through FYM, F_5 - 25 per cent RDN

Table 1. Effect of various treatments on the yield of sweet corn (q ha^{-1}).

Treatments	**Corn yield (q ha^{-1})**
Irrigation regimes (I)	
I_1 - Irrigation at 1.00 IW/CPE	86.64
I_2 - Irrigation at 0.8 IW/CPE	78.17
I_3 - Irrigation at 0.6 IW/CPE	69.29
SE ±	1.132
CD at 5%	3.487
Integrated nutrients (F)	
F_1 - Control	61.68
F_2 - 100% RDF	63.51
F_3 - 75% RDF + 25% N through FYM	78.55
F_4 - 50% RDF + 50% N through FYM	83.07
F_5 - 25% RDF + 75% N through FYM	100.34
F_6 - 100% N through FYM	94.92
SE ±	2.344
CD at 5%	6.768
Interaction (I x F)	
I_1F_1	40.35
I_1F_2	72.54
I_1F_3	86.09
I_1F_4	86.44
I_1F_5	113.55
I_1F_6	106.00
I_2F_1	45.53
I_2F_2	70.71
I_2F_3	76.31
I_2F_4	82.67
I_2F_5	91.44
I_2F_6	105.85
I_3F_1	49.18
I_3F_2	47.28
I_3F_3	75.32
I_3F_4	80.09
I_3F_5	96.04
I_3F_6	72.90
SE ±	7.081
CD at 5%	NS

+ 75 per cent N through FYM, F_6 - 100 per cent N through FYM. In case if integrated nutrient levels the recommended dose of P and K was applied. The net plot size was 3.60 x 3.00 m. The sweet corn variety Madhu was dibbled on flat beds with 45 x 30 cm spacing. Half N through inorganic source (30 kg N ha^{-1}) and full dose of organic N, P and K fertilizers was given as basal dose and remaining half dose of inorganic N (30 kg N ha^{-1}) was applied in bands as top dressing 35 days after sowing. The depth of irrigation was 5 cm and irrigation was applied as per the treatments during entire period of growth. The yield was recorded and considering the present market prices economics was worked out.

Results and Discussion

Irrigation regimes : The effect of irrigation regimes on yield of sweet corn (Table 1) was significant. The treatment I_1 i.e. 1.0 IW/CPE recorded significantly higher cob yield (86.64 q ha^{-1}) over rest of the irrigation regimes. Increase in the cob yield due to treatment I_1 was to the tune of 9 and 20 per cent than the treatments I_2 and I_3, respectively. This might be due to the maintenance of soil moisture near field capacity throughout the growth stages of crop while yield levels decreased at lower regimes due to the water stress. This finding corroborates the findings of Ramchandrappa *et al*. (2004).

Integrated nutrients : Significant increase in sweet corn yield was found owing to supply of nutrients in more synchronized way from organic manures along with inorganic fertilizers. It could be seen from data presented in Table 1 that the treatment F_5 i.e. 25 per cent RDN + 75 per cent N through FYM recorded significantly higher cob yield (100.34 q ha^{-1}) over rest of the treatments and found to be at par with treatment F_6 (94.92 q ha^{-1}). While the

Table 2. Mean number of irrigations, quantity of water applied, cob yield, economics of sweet corn and water use efficiency as influenced by different treatments (year 2005-2007).

Treatments	Number of irrigation	Quantitiy of water applied (cm)	Yield (q ha^{-1})	Cost of cultivation (Rs)	Gross return (Rs.)	Net return (Rs.)	B : C ratio	WUE (kg ha^{-1}-cm)
I_1F_1	10.33	51.67	40.35	43856	62028	18172	1.42	79.69
I_1F_2	10.33	51.67	72.54	47253	72297	25044	1.53	145.12
I_1F_3	10.33	51.67	86.09	50032	81053	31021	1.62	174.32
I_1F_4	10.33	51.67	86.44	50959	84083	33124	1.65	172.43
I_1F_5	10.33	51.67	113.55	60842	119859	59017	1.97	230.16
I_1F_6	10.33	51.67	106.00	57754	108000	50246	1.87	212.72
I_2F_1	9.00	45.00	45.53	44164	63155	18991	1.43	105.71
I_2F_2	9.00	45.00	70.71	46017	68566	22549	1.49	169.90
I_2F_3	9.00	45.00	76.31	48179	75160	26981	1.56	177.10
I_2F_4	9.00	45.00	82.67	49724	80055	30331	1.61	198.47
I_2F_5	9.00	45.00	91.44	52503	89256	36753	1.70	219.38
I_2F_6	9.00	45.00	105.85	57136	105702	48566	1.85	257.40
I_3F_1	7.67	38.33	49.18	42929	59671	16742	1.39	151.32
I_3F_2	7.67	38.33	47.28	41694	56287	14593	1.35	143.07
I_3F_3	7.67	38.33	75.32	47562	73245	25683	1.54	230.38
I_3F_4	7.67	38.33	80.09	49106	78079	28973	1.59	242.72
I_3F_5	7.67	38.33	96.04	55592	100065	44473	1.80	291.50
I_3F_6	7.67	38.33	72.90	72362	119397	47035	1.65	215.38

lowest cob yield (45.02 q ha^{-1}) was recorded by the treatment control (no fertilizer application) followed by recommended dose of fertilizer. The treatment F_5 showed increase in yield of 122.88 and 57.99 per cent, respectively over control (F_1) and RDF (F_2). This indicated that sweet corn responds well to integrated nutrient management, which might be owing to the favourable soil condition and synchronized release of plant nutrients throughout the crop growth period. The results confirm the findings of Sahoo and Panda (2000), Luikham *et al.* (2003), Mithun and Mondal (2006) and Pinjari *et al.* (2009).

The interaction effect between irrigation regimes and INM were non-significant, and the treatment combination I_1F_5 has produced highest (113.55 q ha^{-1}) cob yield.

Water use efficiency : The maximum water use efficiency (Table 2) was observed in treatment I_3F_5 i.e. irrigation at 0.6 IW/CPE with 25 per cent RDN + 75 per cent N through FYM (291.50 kg ha^{-1} cm) while the minimum water use efficiency (79.69 kg ha^{-1} cm) was noticed in I_1F_1 treatment (Table 2).

Economics : The data presented in Table 2 revealed that the treatment I_1F_5 (Irrigation at 1.0 IW/CPE with 25 per cent RDN + 75 per cent N through FYM) gave the highest net returns of Rs. 59,017/- with maximum B:C ratio 1.97. While the lowest net returns of Rs.14, 593/- with B:C ratio 1.35 was found in the I_3F_1 treatment i.e. irrigation at 0.6 IW/CPE without fertilizer application.

From the three years pooled data, it is concluded that, in Konkan region on the newly developed terraced land, *rabi* sweet corn (Variety Madhu) can be irrigated with 50 mm irrigation depth at 10 days interval for obtaining higher yield. Also the fertilizer dose of 30 kg N (urea) along with 18 tones of FYM + 60 kg P_2O_5 and 60 kg K_2O can be applied to obtain higher cob yield and monetary returns from sweet corn.

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Effect of Organic Applications and Foliar Sprays on Seed Quality of Soybean [*Glycine max* (L.) Merill]*

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Abstract

The study revealed that the organic applications during the crop growth influenced the seed quality and storability significantly. The maximum increase in seed storability was observed under the treatment FYM (T_3) @ 5 t ha^{-1}. All organic applications had significant effect on seed quality and storability. Seed quality parameters *viz*., germination percentage, seedling length, vigour index were significantly increased with FYM @ 5 t ha^{-1} and vermicompost @ 5 t ha^{-1} before one month of sowing when compared to other organic treatments.

Key words : Soybean, organic, foliar spray, seed storage.

Average yield of soybean in India as well as in Maharashtra is very low as compared to world average (Anonymous, 2008). Therefore, it is necessary to increase the productivity of crop by adopting improved production technology and using quality seed of improved varieties. Availability of good quality seed is the first and foremost requirement to achieve impact of high yielding variety.

In soybean, seed quality is deteriorated by many reasons, which result in poor germination. In order to improve seed quality there are many management practices which have been suggested. Among the several management practices, use of organic matter either as a soil incorporation or foliar spray plays a decisive role for getting higher seed yield as well as better seed quality. Therefore, the present investigation was undertaken to study the effects of organic applications through soil and foliar sprays on seed quality of soybean during storage.

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Materials and Methods

The present investigation was undertaken at Seed Technology Research Unit, Mahatma Phule Krishi Vidyapeeth, Rahuri during 2007-2008. The field trial was laid out in a randomized block design with three replications involving soybean variety JS-335 and eight treatments *viz*., absolute control (T_1), recommended dose of fertilizer (T_2), FYM @ 5 t ha^{-1} before one month of sowing (T_3), vermicompost @ 5 t ha^{-1} before one month of sowing (T_4), sunhemp incorporation before one month of sowing (T_5), neemcake @ 25 kg ha^{-1} before one week of sowing (T_6), spray of jeevamrut @ 50 ml lit^{-1} of water at 50 per cent flowering stage and spray of cow urine @ 50 ml lit^{-1} of water at 50 per cent flowering stage. After harvest of the crop, the treatment wise seed samples were collected, sun dried to safe storage moisture and kept for storage studies in separate gunny bags at room temperature in rodent and insect proof racks in godown. The obtained seeds were used for laboratory experiment with same treatments and layout in Factorial CRD with three replications. The observations *viz*., germination (%), moisture content (%), root-shoot length, vigour index and seed microflora were recorded before keeping the seeds for storage experiment and 30 days interval after storage up to 240 days.

Results and Discussion

The data revealed that the mean germination percentage, moisture content (%), root-shoot length, vigour index and seed microflora differed significantly during all the periods of storage. The effect of organic applications and foliar sprays on germination of soybean seed and moisture content during storage is presented in Table 1. The germination percentage due to different organic applications and foliar sprays during different crop growth stages differed significantly during all the periods of storage. It was noticed that the germination percentage decreased with the advancement of storage period. Among all the treatments, FYM applied @ 5 t ha^{-1} before one month of sowing (T_3) recorded higher germination percentage (79.28%) irrespective of storage period, followed by the recommended dose of fertilizers (RDF) at the time of sowing (T_2) and vermicompost application @ 5 t ha^{-1} before one month of sowing (T_4). The interaction between treatments and storage periods was statistically significant. The application of FYM (T_3) recorded significantly higher germination (88.25%) at initial stage (0 days of storage) and

Table 1. Effect of organic applications and foliar sprays on germination (%) and moisture content (%) of soybean seed during storage.

Treatments	Germination percentage (storage days)									
	Initial	30	60	90	120	150	180	210	240	Mean
T_1 Control	86.25 (68.46)	83.00 (65.64)	81.50 (64.49)	80.00 (63.31)	78.00 (62.03)	74.25 (59.51)	68.00 (55.55)	60.00 (49.41)	55.75 (48.30)	74.11 (59.63)
T_2 (RDF)	87.50 (69.31)	86.00 (67.81)	84.00 (66.47)	82.50 (65.28)	81.00 (64.16)	78.50 (62.38)	74.25 (59.50)	69.75 (57.15)	62.25 (52.09)	78.41 (62.68)
T_3 (FYM)	88.25 (69.96)	86.25 (68.15)	84.25 (66.62)	83.00 (65.65)	81.75 (64.71)	79.25 (62.91)	75.25 (60.17)	72.00 (59.28)	63.50 (52.83)	79.28 (63.36)
T_4 (Vermicompost)	87.75 (69.52)	85.50 (67.62)	83.75 (66.24)	82.25 (65.09)	80.75 (63.98)	78.25 (62.20)	74.25 (59.50)	70.00 (57.92)	62.75 (52.38)	78.36 (62.72)
T_5 (Sunhemp)	87.00 (69.01)	84.25 (66.52)	82.75 (65.47)	80.75 (63.98)	80.25 (63.67)	76.00 (60.68)	72.25 (57.94)	64.50 (52.94)	61.75 (51.79)	76.64 (61.33)
T_6 (Neemcake)	87.50 (69.31)	84.75 (68.25)	83.50 (66.04)	82.00 (64.90)	81.00 (64.16)	76.75 (61.17)	74.00 (59.34)	69.25 (56.85)	61.75 (51.79)	77.83 (62.42)
T_7 (Jeevamrut)	86.75 (68.67)	84.00 (66.32)	82.00 (64.90)	81.50 (64.50)	79.25 (62.91)	76.50 (61.01)	72.25 (57.94)	63.25 (51.87)	61.00 (51.35)	76.28 (61.05)
T_8 (Cow urine)	86.50 (68.46)	83.25 (65.74)	81.75 (64.68)	81.50 (64.50)	78.75 (62.56)	75.50 (60.34)	71.00 (57.42)	60.75 (50.25)	61.50 (51.65)	75.61 (60.62)
Mean	87.25 (69.09)	84.62 (67.01)	82.94 (65.61)	81.69 (64.72)	80.09 (63.52)	76.87 (61.27)	72.65 (58.49)	66.19 (54.46)	61.28 (51.52)	
	SE ±	CD at 5%								
Treatment	0.137	0.383								
Storage period	0.145	0.407								
Interaction	0.411	1.151								

(Figures in parenthesis are arcsin values)

Table 1. Contd.

Treatments	Moisture content (percentage) storage days									
	Initial	**30**	**60**	**90**	**120**	**150**	**180**	**210**	**240**	**Mean**
T_1 Control	11.23	10.36	9.57	9.15	8.77	8.35	7.99	7.00	6.51	8.77
T_2 (RDF)	10.26	9.75	9.18	8.78	8.25	8.05	7.68	6.86	6.00	8.31
T_3 (FYM)	10.20	9.38	8.99	8.63	8.18	7.90	7.60	6.68	6.10	8.18
T_4 (Vermicompost)	10.25	9.41	9.04	8.70	8.21	7.98	7.64	6.72	5.98	8.21
T_5 (Sunhemp)	10.59	9.91	9.24	8.84	8.45	8.10	7.70	6.90	6.04	8.42
T_6 (Neemcake)	10.49	9.81	9.28	8.79	8.33	8.13	7.77	6.87	6.15	8.40
T_7 (Jeevamrut)	10.87	9.98	9.35	8.91	8.56	8.20	7.79	6.97	6.33	8.55
T_8 (Cow urine)	10.96	10.17	9.48	8.99	8.65	8.27	7.85	6.95	6.12	8.60
Mean	10.61	9.85	9.27	8.85	8.43	8.12	7.75	6.87	6.15	
	SE ±	CD at 5%								
Treatment	0.094	0.283								
Storage period	0.100	0.280								
Interaction	0.28	NS								

Table 2. Effect of organic applications and foliar sprays on root shoot length (cm) and vigour index of soybean seed during storage.

Treatments	Root shoot length (cm) storage days									
	Initial	**30**	**60**	**90**	**120**	**150**	**180**	**210**	**240**	**Mean**
T_1 Control	29.87	29.13	27.79	26.33	24.85	22.57	21.17	19.21	14.54	23.94
T_2 (RDF)	31.96	31.54	30.76	27.46	26.79	24.29	23.04	22.42	20.92	26.57
T_3 (FYM)	33.31	32.53	30.90	29.92	28.02	25.75	23.25	22.49	21.48	27.52
T_4 (Vermicompost)	32.43	31.57	29.47	29.05	26.31	25.03	23.04	20.79	19.68	26.37
T_5 (Sunhemp)	31.08	30.08	28.50	27.42	25.44	23.65	21.25	20.71	19.21	25.26
T_6 (Neemcake)	31.16	30.68	28.91	27.45	25.92	24.53	22.22	20.65	19.56	25.68
T_7 (Jeevamrut)	31.14	30.18	28.00	24.14	25.81	24.02	21.93	19.72	19.16	25.23
T_8 (Cow urine)	30.05	29.86	28.39	27.04	25.13	22.89	21.41	19.22	18.88	24.76
Mean	31.37	30.69	29.09	27.72	26.03	24.09	22.16	20.34	19.49	
	SE ±	CD at 5%								
Treatment	0.285	0.797								
Storage period	0.302	0.845								
Interaction	0.854	2.39								

was at par with that of application of vermicompost (T_4 - 87.75%), RDF (T_2 - 87.50%) and application of neemcake @ 25 kg ha^{-1} (T_6 - 87.50%). The findings are in conformity with Goudar *et al.* (1998), who also observed that highest per cent survival of plants was recorded when FYM was applieol to soil which might be due to improved physio-chemical properties of soil. There was gradual decrease in germination percentage of soybean seeds during storage irrespective of treatments and storage periods which could be ascribed to the seed deterioration during storage. These findings are in consonance with those of Abdul-

Table 2. Contd.

Treatments	Vigour index storage days									
	Initial	**30**	**60**	**90**	**120**	**150**	**180**	**210**	**240**	**Mean**
T_1 Control	2583.76	2417.79	2264.89	2106.40	1938.30	1675.82	1439.56	1152.60	810.61	1821.08
T_2 (RDF)	2796.50	2712.44	2583.84	2265.45	2169.99	1906.77	1710.72	1459.17	1395.65	2111.17
T_3 (FYM)	2939.61	2805.71	2603.33	2483.36	2290.64	2040.69	1749.56	1546.56	1428.12	2898.50
T_4 (Vermicompost)	2845.73	2699.24	2468.11	2389.36	2124.53	1958.60	1710.72	1455.30	1234.92	2209.73
T_5 (Sunhemp)	2711.73	2534.24	2358.38	2214.17	2041.56	1797.40	1535.31	1335.80	1186.22	1968.31
T_6 (Neemcake)	2726.50	2600.13	2413.99	2250.90	2099.52	1882.68	1644.28	1430.01	1207.83	2028.43
T_7 (Jeevamrut)	2701.40	2535.12	2296.00	2211.91	2045.44	1837.53	1584.44	1247.29	1168.76	1958.65
T_8 (Cow urine)	2599.33	2485.85	2320.88	2203.76	1978.99	1728.20	1520.11	1167.62	1161.12	1907.32
Mean	2738.07	2598.82	2413.68	2265.66	2086.12	1853.46	1611.84	1349.29	1199.15	
	SE ±	CD at 5%								
Treatment	09.57	26.80								
Storage period	10.15	28.42								
Interaction	28.71	80.39								

Baki and Anderson (1973); Kabeerf and Taligoola (1983) and Kurdikeri *et al*. (1996).

The application of FYM recorded significantly lower moisture content as compared to control. The decreasing moisture content of seeds during storage could be ascribed to low humidity and high temperature during storage might have resulted in decreased moisture content of seed as compared to initial moisture content. The equilibrium moisture content (EMC) in seed at given RH decreased slowly with increasing temperature. The hydrophilic nature of high protein content of soybean (Hortwing and Potts, 1987) helps in more absorption of water and high oils content in seed increases deterioration of seed (Potts, 1972) by increased hydrolytic enzyme activity, enhanced respiration and an increase in free fatty acids.

The application of FYM (T_3) recorded significantly lower moisture content (8 . 18%) which was at par with moisture content due to application of vermicompost (T_4) i.e. 8. 21%, application of RDF (T_2) i.e. 8.31% and application of neemcake (T_6) i.e. 8.40%. Moisture content due to RDF (T_2) was at par with sunhemp incorporation (T_5), neemcake application (T_6) and foliar spray of jeevamrut (T_7). The treatment absolute control recorded the highest moisture content (8.77%) which was at par with jeevamrut (T_7) and cow urine (T_8) treatments. In all the treatments moisture content ranged between 8-9 per cent to irrespective of storage period. The moisture content decreased slightly with the advancement of storage period irrespective of treatments. The highest moisture content (10.61%) was recorded at initial stage and lowest moisture content (6.15%) was observed at 240 DAS, irrespective of treatments. The interaction between treatments and moisture content was non significant throughout the storage period.

The data regarding root-shoot length and vigour index ofv soybean seed are presented in Table 3. The treatment FYM (T_3) recorded significantly higher (27.52 cm) root-shoot length. The root-shoot length (24.76 cm) due to spraying of cow urine (T_8) was at par with spraying of Jeevamrut (T_7) and sunhemp incorporation (T_5). The root-shoot length

Table 3. Effect of organic applications and foliar sprays on seed mycoflora(%) of soybean seed during storage.

Treatments	**Root shoot length (cm) storage days**									
	Initial	**30**	**60**	**90**	**120**	**150**	**180**	**210**	**240**	**Mean**
T_1 Control	12.50	17.50	20.00	20.00	30.00	30.00	40.00	45.00	50.00	29.44
	(20.47)	(24.16)	(26.20)	(25.82)	(32.84)	(33.06)	(38.95)	(42.05)	(45.00)	(32.09)
T_2 (RDF)	10.00	15.00	12.50	20.00	25.00	32.50	37.50	37.50	45.00	26.11
	(18.43)	(22.50)	(20.47)	(26.20)	(29.14)	(34.50)	(37.45)	(37.45)	(42.05)	(29.80)
T_3 (FYM)	7.75	10.50	15.25	20.00	22.50	30.00	35.00	40.00	42.50	24.83
	(13.85)	(15.89)	(19.59)	(25.67)	(27.86)	(32.84)	(36.22)	(39.17)	(40.55)	(27.97)
T_4 (Vermicompost)	10.25	12.50	17.50	22.50	22.50	32.50	35.00	40.00	45.00	26.42
	(15.89)	(20.47)	(24.16)	(27.86)	(27.33)	(34.50)	(35.94)	(38.89)	(42.27)	(29.70)
T_5 (Sunhemp)	10.25	15.00	17.50	22.50	27.50	32.50	37.50	40.00	45.00	27.53
	(15.89)	(22.50)	(24.16)	(27.33)	(31.02)	(34.50)	(37.45)	(38.73)	(41.90)	(30.39)
T_6 (Neemcake)	8.00	10.25	15.00	20.00	22.50	27.50	32.50	40.00	40.00	23.97
	(13.87)	(15.80)	(22.13)	(26.20)	(28.23)	(30.80)	(33.97)	(38.95)	(40.18)	(27.80)
T_7 (Jeevamrut)	10.00	17.50	17.50	25.00	27.50	32.50	37.50	47.50	47.50	29.17
	(18.43)	(24.16)	(24.16)	(29.36)	(31.02)	(34.34)	(37.29)	(43.50)	(43.50)	(31.76)
T_8 (Cow urine)	10.25	15.00	17.50	25.00	27.50	37.50	40.00	45.00	45.00	29.19
	(15.86)	(22.50)	(24.16)	(29.36)	(31.60)	(37.66)	(39.17)	(42.05)	(43.56)	(31.74)
Mean	9.88	14.16	16.59	21.88	25.63	31.88	36.88	41.88	45.00	
	(16.58)	(21.01)	(23.13)	(27.22)	(29.85)	(34.02)	(37.05)	(40.11)	(42.37)	
	SE ±	CD at 5%								
Treatment	1.49	4.13								
Storage period	1.58	4.38								
Interaction	4.45	12.40								

Figures in parenthesis are in arcsin values.

(25.68 cm) due to neemcake application (T_6) was at par with vermicompost application (T_4). The root-shoot length (26.37 cm) due to application of vermicompost was at par with RDF (T_2). Lowest root-shoot length (23.94 cm) was recorded due to absolute control (T_1). The root-shoot length at different storage periods differed significantly. The highest root-shoot length (31.37 cm) was recorded at initial stage. Lowest root-shoot length (19.49 cm) was recorded at 240 DAS which was at par with that of at 210 DAS. It was observed that root-shoot length decreased significantly throughout the storage period. At initial stage the highest root-shoot length (33.31 cm) due to FYM application (T_3) was decreased to 22.49 cm at 240 DAS, while the lowest root-shoot length (29.87 cm) due to control (T_1) was decreased to 14.54 cm at 240 DAS.

The data revealed that the treatment FYM application (T_3) recorded highest vigour index (2898.50) followed by RDF (T_2), vermicompost (T_4), neemcake (T_6), sunhemp incorporation (T_5), foliar spray of jeevamrut (T_7) and cow urine (T_8). The vigour index decreased significantly as the storage period increased. The vigour index recorded at initial stage decreased from 2738.07 to 1199.15 at 240 DAS. The interaction between treatment and storage period were statistically significant. The treatment FYM (T_3) recorded higher vigour index during all the periods of storage which was at par with vigour index due to RDF (T_2) at 60, 180 and 210 DAS. At initial stage higher vigour index (2939.61) was recorded in treatment of FYM (T_3) which decreased to 1428.12 at 240 DAS.

The root-shoot length and vigour index was higher when FYM was applied over the control and followed by remaining treatments. Raguchander *et al*. (1998) reported that application of FYM @ 3 t ha^{-1} and neemcake @ 5 kg ha^{-1} supported high growth of seedlings. Patil (2009) also supported that root-shoot length and vigour index was Ijighest in FYM application @ 5 t ha^{-1} before one month of sowing.

The neemcake application @ 5 t ha^{-1} (T_6) recorded lowest seed mycoflora (23.97 %) which was at par with FYM (T_3), vermicompost (T_4) and sunhemp incorporation (T_5). The absolute control (T_1) recorded highest seed mycoflora (29.44 %) which was at par with foliar spray of jeevamrut (T_7) and cow urine (T_8). The effects of storage period on seed mycoflora were differed significantly irrespective of treatments. It was observed that seed mycoflora increased with the advancement of storage period. Seed mycoflora was less at initial stage (9.88%) which increased to 45 per cent at the end 240 DAS irrespective of treatments. Seed mycoflora count at 30 DAS was at par with 60 DAS. The seed mycoflora at 90 DAS was at par with seed mycoflora at 120, 210 and 240 DAS. The interaction between treatments and storage period were non-significant during all the storage period. Ushamalini *et al*. (1997) concluded that neemcake registered the minimum population of Mycoflora phaseolina both in rhizosphere and non-rhizosphere.

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Effect of Spacing and Sulphur Levels on Productivity of Sesame (*Sesamum indicum* L.) Under Summer Condition

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Abstract

The growth and yield attributes *viz*., plant height, plant spread, number of branches, dry matter weight of capsules and seed weight plant^{-1}, 1000 seed weight and seed yield were favorably influenced by application of 45 kg S ha^{-1} through elemental sulphur than rest of the treatments. All above growth and yield parameters and seed yield of sesame increased significantly at 45 x 10 cm spacing during summer season. The interaction effect of sulphur and spacing on seed yield was found significant and positive. The maximum yield was recorded by application of 45 kg S ha^{-1} and adoption of 45 x 10 cm spacing (11.53 q ha^{-1}) than rest of the combinations. However, it was at par with application of 30 kg S ha^{-1} with same plant spacing (10.85 q ha^{-1}).

Key words : Elemental sulphur, spacing, growth, yield, quality and economics.

Sesame [*Sesamum indicum* (L.)] is the most important oilseed crop in India, ranking next to groundnut and mustard. In Maharashtra sesame is cultivated over an area of 88700 hectares with productivity of 247 kg ha^{-1}, where in rabi it is cultivated on an area of 3700 ha with productivity of 263 kg ha^{-1} (2007-08). Existing levels of productivity in the state is lower than the potential yield. Several biotic and abiotic stresses lead to low productivity. The productivity of crop is low as the crop is normally grown on marginal and sub marginal lands with poor fertility and rainfed conditions, without giving the due importance to choice of appropriate season, high yielding varieties, nutrient management and new agro technological packages (Singh and Chaubey, 1999). Sesame yields better in summer season under assured irrigation facilities than in *kharif* due to favorable weather parameters such as photoperiod and temperature. Yield potential of this crop can be exploited by the use of agronomic techniques. Among the standardized agronomic practices required for realizing yield potential of summer sesame, plant geometry and nutrition are the most important factors in determining yield. The planting geometry helps in altering canopy architecture affecting light interception and CO_2 assimilation which further affects productivity (Brar, *et al*. 1998). Plant nutrition is key input to increase the productivity and sulphur plays an important role in the nutrition of oilseed crops and is constituent of sulphur bearing amino acids (Gangadhara, *et al*. 1990). In view of above consideration the present investigation on response of sesame to spacing and sulphur levels under summer condition was planned and conducted during summer season.

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Materials and Methods

An experiment was conducted in a randomised block design (factorial concept) with fifteen treatment combinations and three replications during summer 2008 at Agriculture College, Pune. The soil was clay with pH 8.2, organic carbon 0.58 per cent, N, P and K content in soil was 238, 27.2 and 475 kg ha^{-1}, respectively and medium in available sulphur (10.42 ppm), The treatments comprised three plant spacings *viz*., 22.5 x 20 cm, 30 x 15 cm and 45 x 10 cm with five levels of sulphur *viz*., 0, 15, 30, 45 kg S ha^{-1} and in RDF (control) amount of sulphur received through SSP was accounted. The sowing of sesame (Phule til 1) was done on 27th February, 2008 and harvested on 8th June, 2009. The field capacity and permanent wilting point values of the soil were 35.07 and 18.45 per cent, respectively. The bulk density was 1.23 g cm^{-3}. The basal dose of recommended fertilizer (30kg N + 60 kg P_2O_5 + 30 kg K_2O ha^{-1}) was applied through urea, diammonium phosphate (DAP) and muriate of potash at the time of sowing while sulphur was applied through elemental sulphur four weeks before sowing of sesame to treatment S_1 to S_4. Amount of sulphur received through SSP was quantified in treatment of RDF.

Results and Discussion

Effect of spacing : Growth parameters (Table 1) were significantly influenced by different spacing. The spacing 45 x 10 cm recorded significantly the highest plant height (107.91 cm), plant spread (49.64 cm), number of branches (8.97) and dry matter (26.44 g) plant^{-1} than rest of the treatments. Similarly, the yield parameters *viz*., weight of capsules plant^{-1} (24.29 g), weight of seeds plant^{-1} (12.13 g) and 1000 seed weight (3.45 g) were significantly increased due to growing of sesame with 45 x 10 cm spacing compared to rest of the spacing (Table 1). Wider plant spacing of 45 x 10 cm markedly influenced the yield attributes over closer spacing owing to better geometric arrangement resulted in better absorption of moisture and nutrients and more photosynthesis which consequently resulted in better manifestation of yield attributes. The mean seed yield (9.63 q ha^{-1}) and stover yield (11.13 q ha^{-1}) was significantly higher in spacing of 45 x 10 cm as compared to other spacings. The increase in seed yield of summer sesame in case of 45 x 10 cm spacing was 27 and 16 per cent over 22.5 x 20 cm and 30 x 15 cm spacing, respectively. The seed yield of sesame at 30 x 15cm spacing was increased to the tune of 8 per cent over 22.5 x 20 cm

Table 1. Growth and yield parameters of summer seasame as influenced by spacing and sulphur levels.

Treatments	Plant height (cm)	Plant spread (cm)	Branches plant^{-1}	Dry matter plant^{-1} (g)	Weight of capsules plant^{-1} (g)	Seed weight plant^{-1} (g)	1000 seed weight (g)
Plant spacing (cm) :							
22.5 x 20	97.80	44.45	7.65	22.76	18.79	9.39	2.73
30 x 15	101.44	48.67	8.48	25.25	20.62	10.30	3.10
45 x 10	107.91	49.64	8.97	26.44	24.29	12.13	3.45
SE ±	2.17	1.03	0.28	0.40	0.44	0.37	0.07
CD at 5%	6.27	2.98	0.80	1.17	1.27	1.08	0.20
Sulphur levels (kg ha^{-1}) :							
0	87.40	42.47	5.89	21.14	14.67	7.47	2.82
15	101.27	46.42	8.47	25.05	22.38	11.18	3.08
30	112.64	52.22	9.82	27.60	23.98	11.98	3.14
45	115.53	52.80	10.40	27.96	24.81	12.40	3.37
RDF	95.07	44.02	7.27	22.35	20.04	10.01	3.04
SE ±	2.42	1.15	0.31	0.45	0.49	0.42	0.08
CD at 5%	7.01	3.33	0.90	1.31	1.42	1.21	0.23

Table 2. Yield and quality parameters of summer seasme as influenced by different spacing and sulphur levels.

Treatments	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Oil content (%)	Oil yield (q ha^{-1})	Gross monetary returns (Rs. ha^{-1})	Net monetary returns (Rs. ha^{-1})	Benefit : cost ratio (B:C ratio)
Plant spacing (cm) :							
22.5 x 20	7.56	8.12	48.57	3.68	52888	38310	3.62
30 x 15	8.24	9.19	49.22	4.07	57693	43026	3.93
45 x 10	9.63	11.13	49.11	4.76	67433	52666	4.56
SE ±	0.11	2.53	0.27	0.73	1075	1075	0.07
CD at 5%	0.44	7.35	NS	2.11	3134	3134	0.21
Sulphur levels (kg ha-1) :							
0	6.29	6.47	46.12	2.91	44063	29870	3.10
15	8.87	9.92	49.26	4.37	62087	47561	4.27
30	9.44	10.78	50.23	4.74	66074	51447	4.52
45	9.72	11.44	50.59	4.92	68045	53286	4.60
RDF	8.06	8.78	48.63	3.92	56422	41174	3.70
SE ±	0.17	2.83	0.31	0.81	1202	1202	0.08
CD at 5%	0.49	8.22	0.88	2.35	3482	3482	0.24

spacing. This could be owing to beneficial effect on yield attributes of sesame which in turn resulted in higher seed yield. The different plant spacings did not showed any significant effect on seed oil content of sesame. However, oil yield (4.76 q ha^{-1}) was increased significantly in spacing of 45 x 10 cm than rest of spacing.

Malik *et al*. (1992) also reported that higher seed yield of sesame was obtained when grown at 45 cm row spacing compared to narrow row spacing. This emphasized the growing of sesame with wider spacing. The spacing of 45 x 10 cm registered significantly higher gross monetary returns (Rs. 67433 ha^{-1}), net monetary returns (Rs. 52666 ha^{-1}) and benefit : cost ratio (4.56). The magnitude of increase in gross return and net return at spacing of 45 x 10 cm were 28 and 37 per cent more over 22.5 x 20cm and 17 and 22 per cent over 30 x 15 cm spacing, respectively. These results are in conformity with the finding of Ramanathan and Chandrashekharan (1998).

Effect of sulphur : Different levels of sulphur significantly influenced growth, yield and yield attributes. Sulphur level at 45 kg ha^{-1} maintained significantly higher plant height (115.53 cm), plant spread (52.80 cm), number of branches (10.40) and dry matter $plant^{-1}$ (27.96 g). Similarly, application of sulphur at 45 kg ha^{-1} significantly increased weight of capsules $plant^{-1}$ (24.81 g), weight of seeds $plant^{-1}$ (12.40 g) and 1000 seed weight (3.37 g) than other sulphur levels. Highest seed yield (972 kg ha^{-1}) was obtained with sulphur

Table 3. Interaction effect of spacing and sulphur levels on seed yield (q ha^{-1}) of summer sesame.

Sulphur levels (kg ha^{-1})	Plant spacing (cm)		
	22.5 x 20	**30 x 15**	**45 x 10**
0	5.53	6.37	7.17
15	8.19	8.65	9.75
30	8.49	8.96	10.85
45	8.46	9.16	11.53
RDF	7.28	8.04	8.84
SE ±	0.34	CD at 5%	0.80

application at 45 kg ha^{-1} than other levels of sulphur application. However, these values were at par with 30 kg S ha^{-1} (9.44 q ha^{-1}). Similar trend was also observed in stover yield. Application of 15, 30 and 45 kg S ha^{-1} increased seed yield over 0 kg S ha^{-1} by 41, 50 and 54 per cent, respectively. Application of 45 kg S ha^{-1} was at par with 30 kg S ha^{-1}. The increase in seed yield may be attributed to stimulatory effect of applied sulphur on the synthesis of protein, which in turn promoted accelerated photosynthesis, improved most of the yield contributing components which ultimately resulted in significantly higher seed yield. The results are in conformity with the findings of Tripathi *et al.* (2007) who concluded that maximum seed yield of sesame obtained at 45 kg S ha^{-1} may be due to favorable effect of sulphur on plant height and 1000 seed weight. Application of 45 kg S ha^{-1} recorded significantly higher oil content (50.59 %) and oil yield than rest of treatments, but it was at par with 30 kg S ha^{-1}. The increase in oil content with sulphur application might be because of role of sulphur in oil synthesis as S is constituent of aminoacid that play a vital role in oil synthesis.

The application of elemental sulphur at 45 kg ha^{-1} registered significantly higher gross (Rs.68045 ha^{-1}) and net monetary returns (Rs.53286 ha^{-1}) and B:C ratio (4.60) than rest of sulphur levels. However, it was at par with application of 30 kg S ha^{-1} which clearly shows that economic viability of 30 kg S ha^{-1} over control.

The gross and net monetary returns were increased by 50 and 72 per cent higher by application of 30 kg S ha^{-1} while it was 54 and 78 per cent due to application of 45 kg S ha^{-1} over 0 kg S ha^{-1}. Tripathi *et al*. (2007) reported that application of 45 kg S ha^{-1} was found more economical followed by 30 kg and 15 kg S ha^{-1}.

Interaction effect : Plant spacing and sulphur levels interacted significantly in respect of seed yield of sesame (Table 3). Adoption of sesame at 45 x 10 cm spacing with sulphur application of 45 kg ha^{-1} recorded significantly higher seed yield (11.53 q ha^{-1}) than rest of the combinations. However, it was at par with application of 30 kg S ha^{-1} with same spacing (10.85 q ha^{-1}). Sarkar and Banik (2002) have reported that planting of sesame at 45 x 15 cm along with 50 kg S ha^{-1} may achieve higher productivity of sesame in spring season.

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Effect of Integrated Nutrient Management on Growth ,Yield and Economics of Summer Groundnut*

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Abstract

The growth and yield contributing characters, yield and economics were favourably influenced by the application of 100 per cent RDF through DAP. The second best treatment was found with the application of 75 per cent RDF plus 25 per cent N and P_2O_5 each through farm yard manure and rock phosphate, respectively.

Key words : Integrated nutrient management, growth and yield, summer groundnut.

Groundnut (*Arachis hypogaea* L.) is one of the important leguminous oilseed cash crop of the country. During 2004-2005, the area under summer groundnut in Maharashtra was 1.50 lakh hectares with production of 1.99 lakh metric tonnes and the average productivity of 1990 kg ha^{-1}. Integrated nutrient management involves judicious use of organic, inorganic and biofertilizers to maintain soil fertility and productivity may ultimately cause a significant reduction in chemical fertilizer which is cost effective. The aim is ecological safety, exploitation of local resources which can produce desired yield and maintain soil health on long term basis.

The bulky organic manures such as farm yard manure, compost etc. plays an important role in plant nutrition especially for nitrogen and rock phosphate for phosphorus. The decomposition of organic matter results into formation of humus which can bring about physical and chemical changes in soil and plays an important role in maintaining soil fertility and increased yield. With this view , the present experiment was conducted.

Materials and Methods

An experiment was conducted in a randomized block design with three replications during summer 2005-2006 at Agronomy farm, College of Agriculture, Pune. The soil was sandy clay loam in texture, low in available nitrogen (230.5 kg ha^{-1}), moderate in phosphorus (30.7 kg ha^{-1}) and very high in potassium (430.08 kg ha^{-1}) with neutral in reaction (pH 7.4). Eight combinations of organic and inorganic fertilizers *viz*., absolute control, RDF through DAP (25:50:00 kg N: P_2O_5 : K ha^{-1}) , 50% RDF + 50 per cent N and P_2O_5 each through farm yard manure and rock phosphate, 75 per cent RDF + 25 per cent N and P_2O_5 each through farm yard manure and rock phosphate, 100 per cent RDN and P_2O_5 each through farm yard manure and rock phosphate, 50 per cent RDF + 50 per cent N and P_2O_5 each through RDF + 25 per cent N and P_2O_5 each through vermicompost and rock phosphate, 100 per cent RDN and P_2O_5 each through vermicompost and rock phosphate were considered under study.

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The sowing of groundnut variety TAG-24 was done on 3rd March 2005. Single seed was dibbled per hill by maintaining spacing of 30 cm between rows and 10 cm between plants. The groundnut seed was treated with thirum @ 2.5 g kg^{-1} of kernels. Then these fungicide treated kernels were treated with *Rhizobium* + PSB culture @ 250 g 10 kg^{-1} of kernels.

Results and Discussion

Growth parameters : Growth parameters were significantly influenced by different integrated nutrient management treatments at harvest (Table 1). Application of 100 per cent RDF through DAP produced maximum plant height (15.82 cm) and was found significantly superior over rest of the treatments. However, it was at par with the application of 75 per cent RDF + 25 per cent N and P_2O_5 each through vermicompost and rock phosphate (15.48 cm). Similar trend was observed in case of plant spread (35.75 cm). Maximum number of branches $plant^{-1}$ (9.71) were recorded with the application of 100 per cent RDF through DAP and was found significantly superior over rest of the treatments. However, it was at par with the application of 75 per cent RDF + 25 per cent N and P_2O_5 each through vermicompost and rock phosphate (9.55), 75 per cent RDF + 25 per cent N and P_2O_5 each through farm yard

Table 1. Growth and yield attributes and yield of summer groundnut as influenced by integrated nutrient management.

Treatment	Growth attributes					Yield attributes				
	Plant height (cm)	Plant spread (cm)	Number of bran-ches	Leaf area index	Total dry matter (g $plant^{-1}$)	Total number of pods $plant^{-1}$	Dry pod weight $plant^{-1}$ (g)	Hundred kernel weight (g)	Dry pod yield (q ha^{-1})	Haulm yield (q ha^{-1})
Absolute control	12.37	24.50	7.50	0.77	24.40	21.18	17.10	39.10	26.50	40.03
RDF through DAP	15.82	35.75	9.71	0.97	38.14	31.11	24.02	43.45	38.40	50.95
50% RDF + 50% N and P_2O_5 each through FYM and RP	13.46	30.60	8.91	0.90	34.17	29.70	22.03	40.60	34.22	46.72
75% RDF + 25% N and P_2O_5 each FYM and RP	13.95	33.20	9.40	0.76	36.25	29.91	22.90	41.68	36.47	50.48
100% N and P_2O_5 each through FYM and RP	12.50	25.00	7.90	0.78	26.15	24.44	17.90	39.50	28.61	40.52
50% RDF + 50% N and P_2O_5 each through VC and RP	13.70	31.40	9.20	0.91	35.27	29.75	22.24	41.05	36.10	48.09
100% N and P_2O_5 each through VC and RP	15.48	34.40	9.55	0.95	37.20	30.53	23.10	43.03	37.00	50.50
75% RDF + 25% N and P_2O_5 each VC and RP	13.10	25.35	8.00	0.81	26.40	24.79	18.60	39.35	29.40	40.90
S. Em $\pm$	0.25	1.08	0.32	0.05	1.81	0.63	0.38	0.28	0.23	0.16
C. D. at 5%	0.75	3.28	0.97	0.15	5.49	1.91	1.14	0.86	0.71	0.48

FYM : Farmyard manure, RP = Rock Phosphate, VC = Vermicompost manure and rock phosphate (9.40) and 50 per cent RDF + 50 per cent N and P_2O_5 each through vermicompost and rock phosphate (9.20). Leaf area index (0.97) and total dry matter (38.14 g) plant^{-1} also followed similar trend.

Yield parameters : Similarly, the yield contributing characters *viz*., total number of pods (31.11), dry pod weight plant^{-1} (24.02 g), 100 kernel weight (43.5 g) were significantly superior over rest of the treatments in RDF through DAP (Table 1). However, it was at par with the application of 75 per cent RDF + 25 per cent N and P_2O_5 each through vermicompost and rock phosphate, 75 per cent RDF + 25 per cent N and P_2O_5 each through farm yard manure and rock phosphate.

The mean dry pod yield of groundnut recorded was 33.29 q ha^{-1}. Application of 100 per cent RDF through DAP produced maximum dry pod yield (38.40 q ha^{-1}) and it was found significantly superior over rest of the treatments. However, it was at par with the application of 75 per cent RDF + 25 per cent N and P_2O_5 each through vermicompost and rock phosphate (37.80 q ha^{-1}). It might be due to easily availability of nitrogen and phosphorus through the inorganic fertilizer as compared to natural organic sources for the nitrogen and phosphorus which enhances the growth attributing characters and finally resulted into higher pod yield of groundnut. The mean haulm yield of groundnut was 46.04 q ha^{-1}. Significantly higher haulm yield (50.95 q ha^{-1}) was observed with the application of RDF through DAP compound to other treatments. However, it was at par with the application of 75 per cent RDF + 25 per cent N and P_2O_5 each through vermicompost and rock phosphate (50.50 q ha^{-1}) and 75 per cent RDF + 25 per cent N and P_2O_5 each through farm yard manure and rock phosphate (50.48 q ha^{-1}). Application of DAP released available nitrogen and phosphorus helped in increasing the vegetative growth of the plants and also plant dry matter. More meristematic activities of the plant produced more number of leaves which ultimately increased haulm yield. These findings were supported by Sabale (2002), Thakare *et al*. (2003) and Shaikh *et al*. (2004).

Economics : The mean gross monetary returns, cost of cultivation and net monetary

Table 2. Effect of integrated nutrient management on yield and economics of summer groundnut.

Treatment	**Dry pod yield (q ha^{-1})**	**Haulm yield (q ha^{-1})**	**Gross monetary returns (Rs. ha^{-1})**	**Cost of cultivation (Rs. ha^{-1})**	**Net monetary returns (Rs. ha^{-1})**	**B:C ratio**
Absolute control	26.50	40.03	45755	20573	25182	2.22
RDF through DAP	38.40	50.95	65243	21827	43416	2.99
50% RDF + 50% N and P_2O_5 each through FYM and RP	34.22	46.72	58338	22848	35490	2.56
75% RDF + 25% N and P_2O_5 each FYM and RP	36.47	50.48	62278	22337	39941	2.79
100% N and P_2O_5 each through FYM and RP	28.61	40.52	48993	24100	24893	2.03
50% RDF + 50% N and P_2O_5 each through VC and RP	36.10	48.09	61363	25425	35938	2.41
100% N and P_2O_5 each through VC and RP	37.00	50.50	64425	23698	40427	2.72
75% RDF + 25% N and P_2O_5 each VC and RP	29.40	40.90	50235	29206	21029	1.72
S. Em $\pm$	0.23	0.16	344	-	344	0.015
C. D. at 5%	0.71	0.48	1044	-	1043	0.05

FYM : Farmyard manure, RP = Rock Phosphate, VC = Vermicompost returns were Rs.57,079 ha^{-1}, Rs.23,752 ha^{-1} Rs.33,327 ha-1, respectively. The mean benefit cost ratio was 2.43.

The data presented in Table 2 revealed that the application of 100 per cent RDF through DAP recorded the highest gross monetary returns of groundnut (Rs. 65,242 ha^{-1}) and it was found significantly superior over all the treatments. However, it was at par with the application of 75 per cent RDF + 25 per cent N and P_2O_5 each through vermicompost and rock phosphate (Rs. 64,425 ha^{-1}). The lowest gross monetary returns (Rs. 47,755 ha^{-1}) was recorded with the absolute control.

Cost of cultivation : The application of 100 per cent N and P_2O_5 each through vermicompost and rock phosphate recorded the highest cost of cultivation (Rs. 29,206 ha^{-1}) over all the treatments due to higher market prices of vermicompost than other organic sources. The mean cost of cultivation recorded was Rs. 23,752 ha^{-1}. The lowest cost of cultivation (Rs. 20,573 ha^{-1}) was recorded with the absolute control.

Net monetary returns : The highest net returns of groundnut (Rs. 43,416 ha^{-1}) was obtained with the application of 100 per cent RDF through DAP and was found significantly superior over rest of the treatments. The lowest net returns of groundnut (Rs. 21,029 ha^{-1}) were obtained with the application of 100 per cent N and P_2O_5 each through vermicompost and rock phosphate.

Benefit cost ratio : The application of 100 per cent N through RDF through DAP recorded the highest benefit cost ratio (2.99) and was found significantly superior over all other treatments. The lowest benefit cost ratio (1.72) was obtained with the application of 100 per cent N and P_2O_5 each through vermicompost and rock phosphate. Similar findings were supported by Mishra (2000) and Shaikh *et al*., (2004).

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Divergence Studies in Restorer and Maintainer Lines of Pearl Millet

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Abstract

Sixty one restorers and 44 maintainers lines were grouped into 19 and 11 clusters respectively. The D^2 statistics showed adequate diversity among the genotypes with D^2 value ranging from 23 to 1405 in case in restorers and 22 to 484 in maintainers. Among the twelve quantitative characters studied days to maturity, was the most important character contributing to the divergence in both restorers and maintainers. The divergent pairs (IP-17144 vs. IP-13154 and IP-1094 vs. IP-16402) in maintainers group can be used for creating variability and isolating better 'B' lines on diverse sources of cytoplasmic male sterility. In restorers group, maximum diversity was observed between IP-8276 and IP-10839, followed by IP-8276 and IP-19388, IP-8276 and IP-18742.

Key words : Genetic diversity, restorers, maintainers, D^2 statistics.

A successful breeding programme is facilitated by the diversity of the parents. More diversity, better the chances of improving the economic characters under consideration in the segregating generations of crosses. Genetic diversity analysis helps to identify the genetically diverse genotypes for their use in breeding programmes. The D^2 statistics has been found to be a powerful tool to estimate genetic divergence among populations (Arunachalam and Ram, 1967 and Singh and Ram, (1988).

Mahalanobis's D^2 statistics has been followed by several workers on a wide range of crop species, including pearl millet, to measure the genetic distance among the breeding lines and to identify characters responsible for such divergence. The present investigation aims to determine the genetic diversity among 61 restorers of pearl millet.

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Materials and Methods

Sixty one restorer and forty four maintainer lines of pearl miliet were evaluated in a randomized block design with three replication at Regional Agricultural Research Station, Bijapur, Karnataka during *kharif* 2005. The plant to plant distance of 15 cm was maintained within rows which were spaced at 50 cm of 4 m length. The data on days to 50 per cent flowering, days to maturity, plant height, ear length, ear girth, flag leaf area, peduncle length, ear weight, grain yield ear^{-1}, grain yield plant^{-1} and 1000 seed weight were recorded on five randomenly selected for all the entries in each replication. All the observations except days to 50 per cent flowering were taken at maturity. Mahalanobis D^2 statistic was used to assess genetic divergence. The accessions were grouped on the basis of minimum generalized distances using the Tocher's method (Rao, 1952).

Results and Discussion

Based on D^2 values, 44 restorers and 63 maintainers' genotypes were grouped into 11 and 19 clusters respectively indicating the presence of large amount of diversity among the genotypes (Table. 1 and 4). Of the 11 clusters in maintainer group, maximum number of genotypes (18) was observed in cluster II, six each in cluster III and V and of the 19 clusters in restorers group cluster II had 16 genotypes and cluster III having 15, cluster V had 6, and cluster I and VI had four genotypes.

The inter cluster distance among restorers (Table 5) in general were high while, the corresponding distance among maintainers (Table 2) were low. In the earlier, D^2 analysis studies on pearl millet genotypes were not systematically grouped into restorers or maintainers before estimating D^2 values. However, such studies can be compared with D^2 analysis made here by involving both maintainers and restorers. Presence of diversity among pearl millet genotypes of the present study is in accordance with earlier reports (Yadav, 1994; Hepziba, *et al*., 1995; and Hendre, 1998). Table 2 and 5 indicated that the range of D^2 values were less (22 to 484) in maintainer group as compared with the range of D^2 values in restorers group (23 to 1405). Restorer group was flexible since it involved the restorers, which has restoring ability on any one of the cytoplasm. As compared to this, maintainers group was formed with the stringent requirement.that the genotypes must maintain sterility on all the three diverse cytoplasm. Hence, these 44 maintainer genotypes share greater genetic commonness

Table 1. Grouping of 44 pearl millet genotypes (maintainers) into different clusters by Tocher's method.

Cluster No.	Genotypes in cluster	Genotypes included in the clusters	Origin
I	4	IP-3799, IP-3150 IP-10186 IP-10820	India = 2 Mali = 1 Sudan = 1
II	18	IP-17566, IP-17753 IP-11503, IP-13875 IP-10761 IP-17144, IP-16911, IP-16402 IP-13154, IP-13137 IP-19361 IP-6545 ICTP-8203, WC-C75, IP-15520, IP-4331, IP-8540	Togo = 1 Burkina faso = 3 Sudan = 1 Zimbabwe = 3 Nigeria = 2 Namibia = 1 Mali = 1 India = 5
III	6	IP-17978 IP-10945, IP-10914, IP-11680 IP-6125 IP-4759	ICRISAT = 1 Sudan = 3 Camerron = 1 India = 1
IV	2	IP-17144 IP-10339	Zimbabwe = 1 Nigeria = 1
V	6	IP-8818, IP-16690 IP-8069 IP-12474, IP-15256 IP-17493	Zimbabwe = 2 ICRISAT = 1 India = 2 Togo = 1
VI	1	IP-11577	Burkina faso = 1
VII	1	IP-16638	Zimbabwe = 1
VIII	2	IP-17028, IP-10488	Zimbabwe = 2
IX	1	IP-17690	Togo = 1
X	1	IP-15817	Tanzania = 1
XI	2	IP-1648, IP-12476	Zimbabwe

among themselves because they are required to maintain sterility on diverse cytoplasm and that is why, they may be showing lesser genetic diversity. The intra and inter cluster distance revealed that the genetic diversity among the maintainers (Table 2) the maximum intra cluster distance (0=23.1) was observed in cluster V and in case of restorers (Table-5), maximum intra. cluster distance (D-22.8) was observed in cluster XVIII. Selection with this cluster might be exercised based on the highest mean for the desirable traits.

Table 2. Average inter and intra cluster distances (D^2 values) for twelve characters in 44 pearl millet maintainers genotypes.

Cluster	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
I	12.9	224.5	245.6	239.5	229.7	240.0	234.5	221.0	245.9	235.8	256.7
II		21.6	30.7	40.9	32.4	32.4	30.0	38.4	41.0	36.6	46.3
III			20.4	38.0	37.9	30.8	28.5	48.6	35.9	35.0	30.3
IV				10.5	59.1	47.7	31.8	45.2	65.9	44.7	30.5
V					23.1	31.5	42.8	42.4	33.8	53.1	58.4
VI						00.0	44.5	37.4	45.2	52.6	44.8
VII							00.0	45.5	42.6	33.1	38.8
VIII								22.8	64.6	65.2	57.4
IX									00.0	42.4	57.7
X										00.0	44.5
XI											00.0

Under lined figures indicates intra cluster distance.

Per cent contribution of characters towards divergence

Characters	Days to 50% flowe-ring	Days to matu-rity	Plant height (cm)	Produc-tive tillers plant^{-1}	Ear length (cm)	Ear girth (cm)	Flag leaf area (cm^2)	Pedu-ncle length (cm)	Ear weight (g)	Grain yield ear^{-1} (g)	Grain yield plant^{-1} (g)	1000 grain weight (g)
% contribution	0.11	32.16	0.32	0.95	6.00	0.00	6.13	20.06	0.00	31.92	1.40	0.85

Table 3. Cluster means for twelve different growth parameters in 44 (maintainers) pearl millet genotypes.

Cluster	Days to 50% flowe-ring	Days to matu-rity	Plant height (cm)	Produc-tive tillers plant^{-1}	Ear length (cm)	Ear girth (cm)	Flag leaf area (cm^2)	Pedu-ncle length (cm)	Ear weight (g)	Grain yield ear^{-1} (g)	Grain yield plant^{-1} (g)	1000 grain weight (g)
I	48.25	86.00	169.53	2.37	22.38	8.56	73.67	24.78	43.01	26.03	57.63	8.33
II	50.28	86.69	172.41	2.11	22.30	7.46	79.44	21.42	47.12	25.95	62.56	10.34
III	50.22	87.72	178.74	1.96	25.72	7.46	86.64	22.27	47.07	25.93	56.35	8.78
IV	50.33	84.33	174.45	2.37	26.92	6.12	79.43	17.80	55.90	29.28	60.32	9.58
V	49.61	86.33	168.36	2.07	24.91	7.98	78.99	21.43	51.29	26.36	60.36	9.22
VI	50.33	90.00	175.50	2.27	23.80	6.77	88.10	25.00	46.67	17.30	30.70	7.00
VII	44.67	85.00	181.33	1.40	20.97	7.13	80.97	21.97	51.17	20.27	38.13	7.40
VIII	48.83	86.50	179.42	2.15	23.48	9.73	78.82	22.72	49.08	26.30	63.55	9.62
IX	51.67	85.33	143.60	2.33	24.47	6.83	87.53	19.90	59.83	31.83	47.17	8.30
X	48.33	85.67	171.17	2.63	20.97	8.43	76.53	28.03	46.90	25.17	55.93	11.00
XI	47.55	88.50	178.40	2.00	22.40	7.60	75.60	22.60	48.20	24.50	41.60	9.20

Table 4. Grouping of 61 pearl millet restorer genotypes into different clusters by Tocher's method.

Cluster No.	Genotypes in cluster	Genotypes included in the clusters	Origin
I	4	IP-3799, IP-3150	India = 2
I	4	IP-9140 IP-15857, IP-15899 IP-9286	India = 1 Tanzania = 2 Togo = 1
II	15	IP-17979, IP-12682 IP-4779, IP-14942, IP-13645 IP-18621, IP-18625, IP-19388, IP-18742 IP-13833 IP-14778 IP-9301 IP-15681 IP-6510 IP-10811	ICRISAT = 2 India = 3 Namibia = 4 Burkino fusa = 1 Camerron = 1 Togo = 1 Tanzania = 1 Mali = 1 Sudan = 1
III	16	IP-14026 IP-11211, ICMV-221, IP-15364, IP-9149, IP-16196 IP-14497, IP-14644 IP-18389, IP-19426, IP-18800 IP-10839 IP-7838, IP-8276 IP-6460 IP-5275	Zimbabwe = 1 India = 5 Camerron = 2 Namibia = 3 Sudan = 1 ICRISAT = 2 Mali = 1 Nigeria = 1
IV	1	IP-7468	Tanzania = 01
V	5	IP-6417, IP-10085 IP-18355 IP-7440, IP-15879	Mali = 2 India = 1 Tanzania = 2
VI	4	IP-15273 IP-8429 IP-10085 IP-19243	India = 1 Nigeria = 1 Mali = 1 Namibia = 1
VII	3	IP-12901 IP-19321, IP-18657	Camerron = 1 Namibia = 2
VIII	1	IP-19067	Namibia = 1
IX	1	IP-12768	ICRISAT = 1
X	1	IP-10394	India = 1
XI	1	IP-14038	Zimbabwe = 1
XII	1	IP-12779	ICRISAT = 1
XIII	1	IP-16197	India = 1
XIV	1	IP-4695	India = 1
XV	1	IP-15710	Tanzania = 1
XVI	1	IP-14028	Zimbabwe = 1
XVII	1	IP-4169	India = 1
XVIII	2	IP-17979 IP-13840	ICRISAT = 1 Burkino fusa = 1
XIX	1	IP-9416	Ghana = 1

Among the twelve quantitative characters studied the most important characters contributing to the divergence was days to maturity, in both restorers and maintainers. The traits like productive tillers plant^{-1}, grain yield ear^{-1}, peduncle length, grain yield plant^{-1},

Table 5. Average inter and intra cluster distances (D^2 values) for twelve characters in pearl millet restorer genotypes.

Clusters	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX
I	13.1	228.2	248.3	248.4	240.7	257.6	226.1	248.0	223.0	253.7	240.8	209.9	236.8	240.0	237.5	245.4	261.4	221.0	235.8
II		19.3	30.3	37.6	39.3	36.5	32.9	31.0	27.7	38.7	38.3	34.3	33.0	31.0	45.5	39.4	44.4	37.0	35.1
III			20.4	27.1	34.5	26.9	40.5	26.3	38.7	26.6	34.2	50.2	41.4	30.4	47.3	36.5	37.1	51.8	36.6
IV				00.0	31.1	33.5	30.5	43.3	41.8	28.9	15.3	50.1	52.6	23.0	32.9	31.2	52.6	50.9	51.6
V					20.0	50.3	35.7	49.7	31.3	43.8	36.7	38.9	63.3	43.3	55.6	54.6	59.6	61.8	37.8
VI						00.0	47.3	25.2	51.5	29.0	37.9	62.5	30.3	31.5	43.0	26.1	28.3	46.7	51.8
VII							19.7	52.6	31.3	46.9	26.2	31.2	51.6	31.1	34.4	40.5	63.2	37.9	53.0
VIII								00.0	46.8	29.0	48.5	58.1	28.3	37.1	55.7	39.7	26.8	52.1	35.3
IX									00.0	53.6	45.3	17.3	51.7	43.7	57.5	55.2	54.0	46.6	34.3
X										00.0	32.7	61.5	44.7	26.7	42.2	32.8	47.9	57.3	46.6
XI											00.0	49.2	51.4	21.9	21.7	27.0	60.4	45.3	57.4
XII												00.0	58.7	49.0	58.9	61.5	68.6	46.8	43.7
XIII													00.0	38.0	49.2	34.1	36.1	33.9	53.8
XIV														00.0	24.9	20.5	50.8	37.4	52.6
XV															00.0	22.1	67.7	38.4	71.5
XVI																00.0	49.7	37.3	63.4
XVII																	00.0	59.2	48.4
XVIII																		22.8	65.2
XIX																			00.0

Under lined figures indicates intra cluster distance.

Per cent contribution of characters towards divergence

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	Productive tillers $plant^{-1}$	Ear length (cm)	Ear girth (cm)	Flag leaf area (cm^2)	Peduncle length (cm)	Ear weight (g)	Grain yield ear^{-1} (g)	Grain yield $plant^{-1}$ (g)	1000 grain weight (g)
% contribution	0.11	41.42	0.60	0.66	3.61	0.50	6.56	20.00	0.00	20.67	0.67	0.38

1000 seed weight were next in the order (Table 2 and 5). The above results implied that in order to select genetically diverse parents among these maintainers and restorers, one should classify the materials on the basis of such traits as days to maturity, productive tillers $plant^{-1}$, grain yield ear^{-1}, peduncle length, grain yield $plant^{-1}$ and 1000 seed weight. These observations are in line with the observations of earlier workers (Singh and Gupta, 1979; Singh *et al.*, 1981; Hepziba *et al.*, 1995; Quendeba *et al.*, 1995; Hendre, 1998).

There was wide range of variation in the cluster mean value for most of the characters under study in both maintainers and restorers (Table 3 and 6). In maintainers cluster VIII (63.55) exhibited highest mean value followed by cluster II (62.56) for grain yield $plant^{-1}$ and in restorers, maximum mean value for grain yield plant-1 was observed in cluster IV (82.03) followed by cluster XII (75.83). Thus the genotypes exhibited highest mean value hold greater promise as parent to obtain promising hybrids and create further variability for this character.

The divergent pairs (IP-17144 vs. IP-13154

Table 6. Cluster means for twelve different growth parameters in 61 pearl millet restorer genotypes.

Clusters	Days to 50% flowe-ring	Days to matu-rity	Plant height (cm)	Produc-tive tillers	Ear length (cm)	Ear girth (cm)	Flag leaf area (cm^2)	Pedu-ncle length (cm)	Ear weight (g)	Grain yield ear^{-1} (g)	Grain yield $plant^{-1}$ (g)	1000 grain weight (g)
I	51.33	86.83	182.24	2.58	20.98	7.51	85.36	21.10	35.02	22.18	61.72	11.28
II	51.67	87.49	177.50	2.13	23.43	7.63	79.69	21.95	54.08	28.40	66.67	9.58
III	49.36	86.36	175.45	2.22	24.44	7.39	81.97	20.88	47.91	26.53	63.09	9.53
IV	47.67	85.00	166.50	1.97	21.00	6.87	68.33	22.17	50.27	29.17	82.03	9.47
V	50.33	86.20	176.78	2.11	23.92	8.47	76.08	24.58	45.97	22.90	58.59	9.34
VI	51.00	85.25	179.56	2.36	25.23	8.08	92.13	22.60	48.89	24.66	62.72	10.13
VII	19.20	84.50	176.50	2.30	23.80	6.92	82.20	22.60	49.25	23.50	62.50	10.80
VIII	48.67	92.33	178.97	2.37	20.93	7.97	60.53	21.90	42.13	23.00	39.50	7.57
IX	49.00	89.00	175.07	2.13	17.03	6.73	98.23	26.73	68.40	30.07	71.50	10.77
X	48.33	84.67	172.27	2.03	24.93	9.07	88.70	24.17	52.83	29.80	74.50	10.00
XI	50.33	89.00	189.90	2.80	27.47	8.27	85.23	25.00	41.93	23.00	50.20	6.80
XII	52.33	85.67	170.83	1.93	23.47	6.67	98.80	24.03	62.67	26.37	75.83	11.27
XIII	51.33	89.00	171.23	2.23	29.17	8.23	67.93	19.03	53.07	21.43	37.53	6.80
XIV	55.33	89.33	166.77	2.33	30.17	6.27	76.03	19.57	50.83	22.33	40.60	7.53
XV	51.33	87.00	172.47	2.13	30.47	6.90	62.90	19.93	51.47	21.83	46.67	9.17
XVI	52.00	87.67	165.57	2.03	25.67	8.20	70.90	20.90	49.67	25.53	53.37	10.43
XVII	47.67	85.00	165.77	2.00	21.20	6.77	79.00	20.47	47.97	26.33	73.33	10.00
XVIII	50.00	87.83	195.62	1.92	24.00	8.35	86.07	24.65	41.98	22.72	53.98	8.98
XIX	49.00	83.33	174.17	1.93	21.57	10.73	114.33	19.67	51.50	30.47	61.37	7.60

and IP-1094 vs. IP-16402) in maintainers group can be used for creating variability and isolating better 'B' lines on diverse sources of cytoplasmic male sterility. In restorers group, maximum diversity was observed between IP-8276 and IP-10839, followed by IP-8276 and IP-19388, IP-8276 and IP- 18742. Since, these pairs are restorer on different sources of cytoplasm, segregating population can be used for selecting genotypes, which restores fertility on diverse sources bf cytoplasms.

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Effect of Depth of Root Pruning and Coppicing Height of *Gliricidia sepium* on Growth and Yield of *Rabi* Sorghum in Alley Cropping System in Northern Dry Zone of Karnataka

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Abstract

Among depths of root pruning, pruning at 45 cm depth found beneficial in higher plant height, length and width of earhead of rabi sorghum. The grain and stover yield ofrabi sorghum were significantly maximum in 45 cm depth of root pruning (1047.7 and 1677.5 kg ha^{-1}, respectively). Among coppice height, coppicing at 20 cm height noticed higher growth and yield attributes. Significantly maximum grain (1019.0 kg ha^{-1}) and stover yield (1529.5 kg ha^{-1}) were recorded by 20 cm coppicing height and also same treatments were shown higher net returns (7825.50 ha^{-1}) and B:C ratio (2.25).

Key words : Agroforestry, alley cropping system, coppicing, economics, *Gliricidia sepium*, root pruning.

In an alley cropping system, there will be always competition for underground and above ground resources between the hedge row species and field crop. It is necessary to minimize the competition by creating niche separation through silvicultural manipulation and use of proper plant ideotypes. The silvicultural manipulation like root pruning of hedge row species will minimize the competition between component species for moisture and nutrients. Further, the above ground competition for light can be manipulated by practicing suitable cutting height/coppice height of hedge row species. The arable crops grown with hedge row species in an alley cropping model tend to interact with each other. There should be niche separation between the arable species and hedge row species for optimization of yield from the system. To achieve such optimization certain silvicultural manipulation like root pruning and coppicing of hedge row species is essential. This is essential to reduce the competition between component species for light, moisture and nutrient.

According to Gaddanakeri (1991) and Korwar and Radder (1994) root pruning of hedge rows increased the grain and stover yield of alley cropped rabi sorghum compared to unpruned. Therefore, keeping in view of identifying alternative hedge row species to replace leucaena and appropriate rabi sorghum variety compatible to the system present investigation was carried out to study the effect of coppicing height and root pruning depth of *Gliricidia sepium* on growth, yield and economics of rabi sorghum in alley cropping pattern in vertisol of Northern dry zone of Karnataka.

Materials and Methods

The experiment was conducted at Regional Agricultural Research Station, Bijapur farm of University of Agricultural Sciences, Dharwad, Karnataka state during *rabi* season of 2001-02 and 2002-03. The soil of experimental field was medium black soil, having pH 7.9 and EC

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0.32 dS m-1. The soil was low is available nitrogen (105.1 kg ha^{-1}) medium in phosphorus (15.2 kg ha^{-1}) and rich in available potassium (398.0 kg ha^{-1}) with 0.45% of organic caron.

The experiment was laid out in factorial randomized block design with four replications consisted of 12 treatment combinations, comprising three root pruning depths *viz*., D_1 : no root pruning (control), D_2 : 30 cm and D_3 : 45 cm depth and four coppicing height *viz*., C_1: 5 cm, C_2 : 10 cm, C_3 : 15 cm and C_4 : 20 cm above ground level of *Gliricidia sepium* hedge row on the alley cropped *rabi* sorghum (M 35-1) sorghum was sown on 22 September and 7 October at a spacing of 65 x 15 cm during 2001 and 2002, respectively. The observations on growth and yield were recorded for both the years using standard techniques (Gomez and Gomez, 1984) and the mean/pooled analysis was taken for interpreting results and data was subjected to statistical analysis.

Results and Discussion

Growth parameters : The plant height of sorghum (Table 1) due to depth of root pruning and coppicing height of stem was significantly influenced. The sorghum plant height at harvest was significantly more due to 45 cm depth of of root pruning (145.36 cm) and the minimum value was noticed with no root pruning (117.53 cm). The effect of coppicing height on *rabi* sorghum plant was found to be significant. The maximum plant height was recorded in case of 20 cm coppice height (149.30 cm) followed by 15 cm (143.72 cm) and the minimum value was recorded with 5 cm coppice height (106.50 cm). The interaction effect of root pruning depth and coppicing height on sorghum plant height was not significant.

Table 1. Growth and yield characters as influenced by root pruning depth and coppice height of *Gliricidia* hedge row (Pooled mean at harvest).

Treatment	Plant height (cm)	Leaves plant-1	Length of ear head (cm)	Girth of ear head (cm)	1000 grain weight (g)	Grain earhead^{-1}
Depth of root pruning (D)						
No root pruning (control)	117.53	5.32	12.24	4.82	26.10	694
30 cm. depth	127.35	5.43	14.26	5.00	30.48	796
45 cm. depth	145.36	5.66	16.04	5.96	37.55	980
S. Em ±	4.76	0.25	0.56	0.22	1.08	31
CD (5%)	14.25	NS	1.66	0.63	3.16	91
Coppice height (C)						
5 cm height	106.50	4.87	10.91	4.15	27.18	694
10 cm height	126.00	5.39	13.66	5.65	31.25	807
15 cm height	143.72	5.44	15.64	5.78	33.52	871
20 cm height	149.30	5.92	16.68	6.09	34.98	917
S. Em ±	5.34	0.28	0.64	0.23	1.02	34
CD (5%)	16.23	NS	1.87	0.68	2.92	105
Interaction (D x C)						
S. Em ±	9.76	0.46	1.12	0.40	2.03	60
CD (5%)	NS	NS	NS	NS	NS	NS
C.V. (%)	12.4	15.74	15.25	12.72	15.10	13.94

NS = Not-significant

The number of green leaves produced by *rabi* sorghum plants as influenced by depth of root pruning and coppicing height was not significant. However, maximum value was recorded in case of 45 cm depth of root pruning (5.66) and minimum with no root pruning (5.32). Among coppicing height, higher number of green leaves was recorded with 20 cm height of coppicing (5.92) followed by 15 cm height (5.44) and the lowest value was recorded in case of 5 cm height of coppicing (4.87). None of interactions were shown significant.

Yield parameters : There was significant difference in the length and width of earhead due to the depth of root pruning and coppicing height (Tabie 1). Among depth of root pruning, the maximum length and width of earhead were recorded in case of 45 cm depth of root pruning (16.64 and 5.96 cm, respectively) and lowest were produced by no root pruning (12.24 and 4.82 cm, respectively). Among coppicing height, the maximum length and width of earhead were recorded with 20 cm coppicing height (16.68 and 5.09 cm, respectively) followed by 15 cm height (15.64 and 5.78 cm, respectively) which were on par with each other. The minimum value was with 5 cm coppicing height (10.91 and 4.15 cm, respectively). The interaction effect due to different treatment combinations was not significant.

The 1000 grain weight and grain number per plant of *rabi* sorghum was significantly highest with 45 cm depth of root pruning (37.55 g and 980, respectively) and lowest were observed by no root pruning (26.10 g and 694, respectively). Among coppicing height, the 1000 grain weight and grain number per plant of *rabi* sorghum produced significantly highest value in 20 cm coppicing height (34.98 g and 917, respectively) closely followed by 15

Table 2. Yield and economics of *rabi* sorghum as influenced by root pruning depth and coppice height of *Gliricidia* hedge row.

Treatments	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Net returns (Rs. ha^{-1})	B:C ratio
Depth of root pruning (D)				
No root pruning (control)	744.5	1125.0	5653.50	1.59
30 cm. depth	881.5	1336.6	6481.50	1.68
45 cm. depth	1047.7	1677.5	7805.25	1.90
S. Em ±	51.2	83.2	480.50	-
CD (5%)	152.4	226.3	876.40	-
Coppice height (C)				
5 cm height	739.5	1180.5	5730.00	1.65
10 cm height	866.0	1367.0	6801.25	1.95
15 cm height	878.0	1482.5	7767.00	2.23
20 cm height	1019.0	1529.5	7825.50	2.25
S. Em ±	63.6	109.4	276.71	-
CD (5%)	171.4	308.0	566.69	-
Interaction (D x C)				
S. Em ±	39.6	138.6	581.28	-
CD (5%)	NS	NS	NS	-
C.V. (%)	12.38	15.36	16.75	-

NS = Not-significant

cm height (33.52 gand 871, respectively). The different treatment combinations did not produce any significant differences.

Grain and stover yield : The grain and stover yield of *rabi* sorghum was significantly influenced by the depths of root pruning and coppicing height of *G. sepium* (Table 2). The maximum grain and stover yield was recorded in 45 cm depth of root pruning (1047.7 and 1677.5 kg ha^{-1}, respectively) and minimum by no root pruning (744.5 and 1125 kg ha^{-1}, respectively). maximum grain and stover yield was recorded by 20 cm coppicing height (1019.0 and 1529.5 kg ha^{-1}, respectively) followed by 15 cm height (878.0 and 1482.5 kg ha^{-1}, respectively) which were on par with each other it is mainly due to its superior growth and yield components because of stagnation of water along the bund. Thus in case of 45 cm depth of root pruning there was no moisture stress for crop growth and development throughout the growing season besides it was also important that the effect of lateral roots of gliricidia on the companion sorghum crop was least. The results are in conformity with the findings of Home *et al.* (1986), Muthiah; Korwar and Radder (1994) and Govindarajane *et al*. (1996).

Economics of system : The important aspect of decision making to select a system or practice mainly depends on the net returns and benefit cost ratio of system (Table 2). Maximum net returns and B:C ratio was obtained in *G. sepium* with 45 cm depth of root pruning (Rs. 7,805.25 ha^{-1} and 1.90, respectively) followed by 30 cm depth (Rs. 6,481.50 ha^{-1} and 1.68, respectively). Significantly minimum net returns and B:C ratio were recorded by no root pruning (Rs. 5,653.50 ha^{-1} and 1.59, respectively). Among the different heights of coppice significantly maximum net returns and B:C ratio was abtained by 20 cm coppice height (Rs. 7,825 ha^{-1} and 2.25, respectively) closely followed by 15 cm height (Rs. 7,767 ha^{-1} and 2.23, respectively) which were on par.

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Character Association and Path Analysis in Blackgram (*Vigna mungo* (L.) Hepper)*

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Abstract

Grain yield plant^{-1} exhibited significant positive correlation with numbers of clusters plant^{-1}, harvest index, number of pods plant^{-1} pod length, number of branches plant^{-1} and 100 seed weight. Yield was negatively correlated with number of nodules plant^{-1}, days to 50 per cent flowering and protein content at both the levels. Path analysis revealed that pod length, number of clusters plant^{-1}, harvest index and number of branches plant^{-1} exhibited high direct effects in desirable direction. Their association with grain yield was significant and positive indicating the factor that there exists a true and perfect association between these traits.

Key words : Correlation, direct and indirect effects, blackgram.

Yield is a complex character, which depends upon many determining characters, hence, the information on the correlation between yield and its component character is prerequisite for crop improvement. The phenotypic correlation indicate the extent of observed relationship between the two characters while genotypic correlation provides information about linkage for the gene controlling the pair of characters. Therefore, the correlation coefficient at genotypic and phenotypic levels were considered, however, they do not provide the exact picture of direct and indirect causes of such association, which can be cleared through path analysis (Dewey and Lu 1959). Thus path analysis is very useful to pinpoint the important yield, components which can be utilized for recommending selection indices. In the present studies, attempt was therefore, made to obtain such information in blackgram.

Materials and Methods

The experimental material for present study was comprised of 40 indigenous genotypes of black gram (*Vigna mungo* (L.) Hepper), collected from NBPGR, New Delhi and Agriculture Research Station, Badnapur, Marathwada Agricultural Universitiy, Parbhani. The field experiment was carried out in a randomized block design with three replications at Botany farm, College of Agriculture Pune. Each plot consisted of single row of 5 m length with a spacing of 30 cm between plants. One border row was planted at both the side to reduce the border effect. The recommended package of practices of crop production and protection were followed for successful crop growth.

The observations regarding the grain yield plant^{-1} and yield determining attributes were recorded on randomly selected five competitive plants from each genotype in each replication for thirteen characters. The correlation coefficients were worked out to understand the association among characters by adopting

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method described by Singh and Chaudhari (1977) and path analysis was done according to the procedure suggested by Dewey and Lu (1959).

Results and Discussion

From the correlation studies (Table 1), it was evident that, the characters *viz*., number of clusters plant^{-1}, harvest index, number of pods plant^{-1}, pod length, number of branches plant^{-1}, 100 seed weight and plant height showed significant positive association with grain yield plant^{-1} at genotypic and phenotypic level, indicating possibility of improving these characters simultaneously. Similar results were reported by Anuradha and Krishnamurty (1990), for harvest index, Amanullah and Mirhatam (2000) and Sanjeev *et al*. (2001) for number of pods plant^{-1}, Natarajan and Rathinasamy (2000) for number of branches plant^{-1}. However, number of seeds pod^{-1} recorded positive but non-significant association with grain yield plant^{-1} confirming the earlier finding of Sanjeev *et al*. (2001). The association between grain yield and number of nodules plant^{-1} (-0.0349)., days to 50 per cent flowering (-0.0497), per cent protein content (-0.0666) and days to maturity (-0.2908) were non-significant and negative at genotypic level, suggesting the absence of any relation of these traits with grain yield plant^{-1}. The association between days to maturity (0.2820) and number of seeds pod^{-1} (0.2816) with grain yield was positive but non-significant at phenotypic level. Whereas number of nodules plant^{-1} (-0.0348), days to 50 per cent flowering (0.0497) and protein content (-0.0665) showed negative but non-significant association with seed yield.

Association of various characters with the trait of major interest like yield is the consequence of their direct and indirect effect. Therefore, it is essential to partition such association into direct and indirect effect of component traits through path analysis. Results of path analysis revealed (Table 2) that among thirteen characters studied, number of nodules plant^{-1} (0.9226) exhibited maximum direct effect with grain yield plant^{-1} followed by pod length (0.7924), number of cluster plant^{-1} (0.6542), harvest index (0.4135) and days to 50 per cent flowering (0.3732). The association between grain yield and all these characters was significant and positive except for number of nodules plant^{-1} and days to .50 per cent flowering indicating the true and perfect relationship between these characters, suggesting direct selection based on these characters would help in selecting high yielding genotype in black gram. These results were in agreement with the earlier findings of Nagarjunsagar and Reddishekhar (2001) and Vaithiyalingan *et al.* (2002) for harvest index, Pooran and Chand (1999) for number of clusters plant^{-1}, Issacs *et al*. (2000) for harvest index and pod length. The trait protein content (-0.9510) had maximum negative direct effect followed by number of seeds pod^{-1} (-0.5816), plant height (-0.2702) and number of seeds plant^{-1} (-0.0582). Number of pods plant^{-1} showed, negative direct effect but its positive and significant association with the yield was due to presence of higher indirect effect through number of cluster plant^{-1}, number of branches plant^{-1} and number of nodules plant^{-1}. The trait pod length also exhibited positive significant association with seed yield and high direct effect. Issacs *et al.* (2000) reported similar results for number of pods plant^{-1} and pod length.

Plant height exhibited negative direct effect however, its association with yield was positive and significant contributed via pod length, number of cluster plant^{-1} and 100 seed weight. These results are in conformity with those of Santha and Veluswamy (1997).

Number of cluster and harvest index exerted

Table 1. Genotypic (above diagonal) and phenotypic (below diagonal) correlation of 13 characters in black gram.

Cha-ract-ers	Days to 50% flowering	Days to maturity	Plant height (cm)	Branches plant^{-1}	Pods length (cm)	Pod plant^{-1}	Seeds pod^{-1}	Nodules plant^{-1}	Clusters plant^{-1}	Protein content (%)	Harvest index (%)	100 seed wt. (g)	Correlation with grain yield plant^{-1} (g)
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1	-0.0864	0.2322	0.0489	-0.0525	-0.0349	0.164	0.2907	-0.0341	0.3527*	-0.3088	-0.0096	-0.0497
2	-0.0642	1	-0.1442	0.1877	-0.4737*	0.2046	-0.1461	0.1716	0.1057	0.1515	-0.5253	-0.3765*	-0.2948
3	0.2305	-0.1396	1	0.1921	0.4234	0.2069	0.2888	-0.0009	0.4080*	-0.0624	0.0255	0.6522*	0.4091*
4	0.0492	0.1862	0.1891	1	-0.0100	0.9714*	0.1303	0.1864	0.8829*	0.2416	0.0362	-0.1013	0.5202*
5	-0.0535	-0.4558*	0.4175*	-0.0059	1	0.0511*	0.7881*	-0.3847*	0.0860	-0.4833*	0.3936*	0.5526*	0.5319*
6	-0.0320	0.2024	0.2037	0.9531*	0.0501	1	0.1357	0.1493	0.8991*	0.1971	0.0861	-0.0643	0.5760*
7	0.1478	-0.1365	0.2702	0.1225	0.7606*	0.1384	1	-0.2675	0.1601	-0.3686*	0.0685	0.3557*	0.2909
8	0.2828	0.1631	-0.0010	0.1835	-0.3787	0.147	-0.2551	1	0.0540	0.9361*	-0.2142	-0.1704	-0.0348
9	-0.0275	0.1103	0.3929*	0.8452*	0.0786	0.8725*	0.1439	0.0489	1	0.1017	0.0734	0.0910	0.6157*
10	0.3454	0.1469	-0.0622	0.2403	0.4793*	0.1937	-0.3527*	0.9309*	0.0993	1	-0.3216*	-0.3002	-0.0665
11	-0.2988	-0.5037*	0.0228	0.0345	0.3827	0.0953	0.0738	-0.2128	0.0810	-0.3169*	1	0.3491*	0.5881*
12	-0.0073	-0.3643	0.0643*	-0.1001	0.5455*	-0.0642	0.3373*	-0.1886	0.0848	-0.2989	0.3459	1	0.4606
13	-0.0464	0.2820	0.4044	0.5113*	0.5201	0.5719	0.2816	-0.0365	0.5945	-0.0666	0.5865	0.4544	1

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

Table 2. Direct (diagonal) and indirect (above and below diagonal) path effects of different characters towards grain yield in black gram..

Cha-ract-ers	Days to 50% flowering	Days to maturity	Plant height (cm)	Branches plant^{-1}	Pod length (cm)	Pods plant^{-1}	Seeds pod^{-1}	Nodules plant^{-1}	Clusters plant^{-1}	Protein content (%)	Harvest index (%)	100 seed wt. (g)	Correlation with grain yield plant^{-1} (g)
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0.3732	0.0143	-0.0629	0.0079	-0.0417	0.0020	-0.0954	0.2682	-0.0223	-0.3354	-0.1277	-0.0015	-0.0493
2	0.0323	0.1654	0.0391	0.0303	-0.3754	-0.0119	0.0850	0.1584	0.0692	-0.1442	-0.2172	-0.0572	-0.2908
3	0.0867	-0.0239	-0.2707	0.0310	0.3355	-0.0120	-0.1680	-0.0009	0.2669	0.0594	0.0106	0.0991	0.4091**
4	0.0183	0.0310	-0.0520	0.1616	-0.0080	-0.0565	-0.0758	0.1720	0.5776	-0.2298	0.0150	-0.0154	0.5203**
5	-0.0196	-0.0784	-0.1130	-0.0010	0.7924	-0.0030	-0.4584	-0.3549	0.0563	0.4596	0.1628	0.0840	0.5320**
6	-0.0130	0.0339	-0.0560	0.1540	0.0397	-0.0582	-0.0790	0.1378	0.5882	-0.1875	0.0356	-0.0098	0.5761**
7	0.0612	-0.0242	-0.0782	0.0195	0.6027	-0.0080	-0.5816	-0.2468	0.1048	0.3506	0.0283	0.0541	0.2910
8	0.1085	0.0284	0.0003	0.0297	-0.3001	-0.0086	0.1484	0.9226	0.0354	-0.8903	-0.886	-0.0259	-0.0349
9	-0.0127	0.0175	-0.1104	0.1366	0.0622	-0.0507	-0.0837	0.0451	0.6542	-0.0968	0.0304	0.0138	0.6158**
10	0.1316	0.0251	0.0169	0.0388	-0.3798	-0.0113	0.2051	0.8588	0.0650	-0.9510	-0.1330	-0.0456	-0.0666
11	-0.1153	-0.0869	-0.0069	0.0056	0.3033	-0.0055	-0.0429	-0.1963	0.0530	0.3014	0.4135	0.0531	0.5881**
12	-0.0036	-0.0623	-0.1765	-0.0162	0.4323	0.0037	-0.1962	-0.1556	0.0555	-0.3290	-0.1236	0.1520	0.4602**

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

high direct effect and also showed positive, significant association with yield plant^{-1} at genotypic level in which number of clusters contributed via number of branches plant^{-1}, pod length and number of nodules plant^{-1} and harvest index contributed via pod length, protein content and 100 seed weight (Nagarjunsagar and Reddishekhar, 2001).

The trait number of seeds plant^{-1} possessed positive correlation with yield however, showed negative direct effect which could be contributed via pod length, protein content and number of clusters plant^{-1}.

Present investigation clearly revealed that the traits *viz*. number of cluster plant^{-1}, harvest index, number of pods plant^{-1}, pod length and number of branches plant^{-1} had strong association with yield plant^{-1} and also showed the high positive direct contribution through indirect effects of other component traits. This indicated, that direct selection for these traits would be more effective to enhance the breeding efficiency for seed yield in black gram.

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Effect of Sowing Dates and Spacing on the Growth and Yield of Rice bean (*Vigna umbellata*) under Lateritic Soils of Konkan

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Abstract

A field study revealed that rice bean sown on 46 MW produced significantly higher growth and yield attributes and yield than delayed sowing of subsequent meteorological weeks. The spacings of 22.5 x 15 cm^2 recorded significantly higher grain and straw yield over other levels of spacing i.e. 45 x 15 cm^2 and 30 x 15 cm2. The treatment combination of sowing during 46 MW with spacing of 22.5 x 15 cm^2 produced significantly higher grain and straw yield of rice bean than rest of the treatment combinations.

Key words : Sowing dates, spacing, rice bean, growth, yield.

Pulse production can greatly be increased to the extent of 50-100 per cent by popularizing some: non-conventional pulse crops with improved production technology. A non-conventional grain legume, now being in front of India, is rice bean with a high production potential of 13-25 q ha^{-1} (Chandel *et al*. 1998). This crop is fairly resistant to the attack of insect pest and diseases both in field and storage conditions. Though cultivation of rice bean is confined to a limited area, production can be increased to a greater extent by fitting it into crop rotation and extending its cultivation to other areas. Proper sowing time is the most important non-monetory input in crop production, which affects the crop growth, yield and quality to greater extent. Delay or early sowing not only, provides the optimum conditions of climate but resulted in reduced growth and ultimately yield of the crop. A small change in sowing time leads to significant change in performance of crop. Rice bean being a newly introduced in Konkan region requires development of production technology especially determination of optimum sowing time and plant spacing for higher yield. Plant spacing (planting geometry) has been recognized as a factor that determining the degree of competition between plants. The optimum plant density produces the maximum yield par unit area under the given environmental conditions without affecting the quality. Inadequate as well as high plant population leads to low productivity and poor quality. Keeping this in view, the present study was undertaken.

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Materials and Methods

An experiment was conducted at Agronomy farm, College of Agriculture, Dapoli during rabi 2008-09 in split plot design with three replications. The main plot treatment consists of six sowing dates *viz*. D_1 (46^{th} MW), D_2 (48^{th} MW), D_3 (50^{th} MW), D_4 (52^{th} MW), D_5 (2^{nd} MW), D6 (4th MW), and sub plot treatment comprised three levels of spacing, i.e, S_1 (45 x 15 cm^2), S_2 (30 x 15 cm^2), and S_3 (22.5 x 15 cm^2). The soil was sandy clay loam, slightly acidic in reaction pH 6.35, high in available nitrogen (197.69 kg ha^{-1}), low in available phosphorus (16.18 kg ha^{-1}) and potassium (138.66 kg ha^{-1}). The rice bean variety RB-10 was used for experimentation. The gross plot size was 4.5 x 3.6 m^2 and net plot sizes were varying according to the spacing such as 3.60 x 3.30 m^2, 3.90 x 3.30 m^2 and 4.05 x 3.30 m^2, The crop was sown by dibbling and spacing was maintained as per treatments. The recommended dose of fertilizer @ 25 kg N and 50 kg P_2O_5 ha^{-1} was applied as basal, through urea and single super phosphates in furrow at 5 cm depth by dibbling. Well decomposed FYM@ 10 tones ha^{-1} was incorporated into the soil 10 days before sowing.

Results and Discussion

Effect of sowing dates : Sowing of rice bean on 46 MW favourably influenced all the growth and yield attributes. Sowing on 46 MW (D_1) recorded maximum plant height, number of functional leaves and number of branches per plant (Table 1). These results were inconformity of those reported by Jangre *et al.* (2008). The more number of functional leaves and branches per plant and more plant height under early sowing reflected into significantly higher dry matter production $plant^{-1}$ than subsequent sowings. Similar findings were reported by Kumar and Singh (1998), Dass *et al*. (2005) and Yadahalli *et al*. (2006). The higher growth under early sowing recorded significantly more number of pods and grains per plant as compared to other sowing dates. The higher growth and yield attributes under early sowing of 46 MW (D1) resulted significantly in higher grain and straw yield of rice bean. This might be due to favourable climatic conditions during early sowing of rice bean which enhanced the growth and yield attributes. These findings are in conformity of those restarted by Dass *et al*. (2005) and Jangre *et al.* (2008).

Effect of spacing : Closer spacing of 22.5 x 15 cm^2 (S_3) recorded significantly taller plants because plant might have adjusted its canopy in the vertical space for increasing the height

Table 1. Effect of sowing dates and spacings on growth and yield attributes of rice bean at harvest.

Treatments	Plant height (cm)	Leaves $plant^{-1}$	Branches $plant^{-1}$	Dry matter $plant^{-1}$ (g)	Pods $plant^{-1}$	Grains $plant^{-1}$	Yield (q ha^{-1})	
							Grain	Straw
Sowing dates :								
D_1 46^{th} MW	27.31	11.99	7.72	23.43	16.43	105.89	13.22	24.04
D_2 48^{th} MW	26.86	11.37	7.60	22.56	15.69	92.78	12.01	20.13
D_3 50^{th} MW	26.37	9.29	7.23	21.76	14.63	82.33	9.75	17.88
D_4 52^{th} MW	24.36	8.92	6.83	20.57	13.62	75.11	8.8	15.87
D_5 2^{nd} MW	23.93	7.39	5.99	19.81	12.69	65.74	7.98	13.66
D_6 4^{th} MW	23.09	6.93	5.79	18.88	12.10	57.17	7.10	12.62
S. E. (m) ±	0.03	0.06	0.03	0.05	0.03	0.51	0.07	0.26
C. D. at 5%	0.11	0.20	0.11	0.15	0.11	1.62	0.22	0.83
Spacing (cm) :								
S_1 45 x 15	23.94	10.81	7.57	21.92	16.42	95.83	8.00	13.65
S_2 30 x 15	25.19	9.31	6.84	21.13	13.91	78.28	9.69	16.81
S_3 22.5 x 15	26.82	7.83	6.19	20.46	12.25	65.40	11.74	21.65
S. E. (m) ±	0.03	0.02	0.01	0.02	0.05	0.32	0.04	0.07
C. D. at 5%	0.10	0.07	0.04	0.06	0.16	0.94	0.12	0.20
Interaction :								
D x S	NS	NS	NS	NS	Sig	Sig	Sig	Sig

while in case of wider spacing of 45 x 15 cm^2 (S_1) under less competition resulted in greater horizontal space which resulted into more number of leaves, branches and dry matter per plant than other spacings. Similar finding were reported by Khanda and Mishra, 1998) and Rudragouda et al. (2008). The yield attributing characters such as number of pods and grains $plant^{-1}$ were significantly more under wider spacing of 45 x 15 cm^2 (S_1) than the other two spacing. Similar results were obtained by Khande *et al*. (2001). However, the trend was reversed in grain and straw yields where the grain and straw yields were significantly increased under closer spacing of 22.5 x 15 cm^2 (S_3). This was due to obtimum plant population per unit area under closer spacing that contributed higher grain and straw yields on hectare basis. Similar results were reported by Rath *et al.* (1997), Khanda and Mishra (1998) and Rudragounda *et al.* (2008).

Interaction effect : The interaction between sowing dates and spacing was found to be significant in case of yield attributes and yield of rice bean, whereas, all the growth attributes did not reach to the level of significance. It is clear from the data presented in Table 2 that the sowing of rice bean during 46 MW with 45 x 15 cm^2 spacing (D_1S_1) recorded significantly higher number of pods and grains per plant over all other treatment combinations, which was followed by sowing in (48 MW) with 45 x 15 cm^2 spacing. (D_2S_1). The lowest number of grains and number of pods per plant was recorded due to sowing of crop in 4^{th} MW with 22.5 x 15 cm^2 spacing (D_6S_3). Further, the treatment combination of sowing during 46 MW with spacing of 22.5 x 15 cm^2 (D_1S_3) produced significantly higher grain and straw yield of rice bean over all other treatment combinations. However, the treatment combination of sowing of rice bean in 48 MW with 30 x 15 cm^2 spacing (D_2S_2) and 50 MW with 22 x 15 cm^2 (D_3S_3) were statistically at par with each other and produced significantly higher grain yield over rest of the treatment combinations. The lowest grain yield was recorded due to sowing of rice bean during 4 MW with spacing of 45 x 15 cm^2 treatment combination (D_6S_1). The treatment combination of sowing of rice bean during 46 MW with 22.5 x 15 cm^2 spacing (D_1S_3) produced significantly higher straw yield over all other treatment combinations. The lowest straw yield of rice bean was produced due to sowing during 4 MW with spacing of 45 x 15 cm^2 (D_6S_1), which was statistically at par with

Table 2. Effect of interaction between sowing dates and spacing on number of pods and grains per plant and grain and straw yields of rice bean.

Treatments Sowing dates	Spacing (cm^2)											
	Pods $plant^{-1}$			Grains $plant^{-1}$			Grain yield (q ha^{-1})			Straw yield (q ha^{-1})		
	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3
D_1	21.23	15.40	12.67	124.33	104.33	89.00	10.62	13.46	15.59	20.48	23.20	28.43
D_2	20.60	14.60	11.87	115.33	85.00	78.00	9.31	12.13	14.58	17.68	19.94	22.78
D_3	16.93	14.00	12.97	101.00	80.00	69.00	8.04	9.10	12.12	13.75	18.11	21.79
D_4	13.87	13.70	13.30	82.33	77.00	63.00	7.57	8.71	10.13	13.19	13.98	20.45
D_5	13.33	12.80	11.93	79.67	66.33	51.23	6.75	7.86	9.33	8.81	13.46	18.71
D_6	12.97	12.57	10.77	72.33	57.00	42.17	5.71	6.90	8.68	7.97	12.17	17.71
S. E. (m) ±	0.50			2.36			0.29			0.84		
C. D. at 5%	0.62			6.89			0.86			2.46		

sowing during 2 MW with spacing of 45 x 15 cm^2 (D_5S_1) treatment combination. The higher grain and straw yield was obtained might be due to higher and optimum plant density per unit area.

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Response of Bt Cotton Hybrids to Different Plant Spacing Under Rainfed Condition*

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Abstract

The results indicated that sowing of Bt cotton hybrids with the spacing of 180 x 30 cm and 150 x 30 cm were found at par with each other and recorded significantly higher value for plant height as compared with rest of the plant spacings. Significantly higher number of sympodial branches, leaf area, total dry matter, number of picked bolls, seed cotton yield plant^{-1} and seed cotton yield hectare^{-1} was reported with the closer spacing of 90 x 60 cm and 120 x 45 cm than 180 x 30 cm and 150 x 30 cm. Number of monopodial branches, functional leaves plant^{-1} and weight boll^{-1} of Bt cotton hybrid was not influenced due to different spacing. Among the Bt cotton hybrids, *Ajit 155 Bt* recorded significantly higher values for growth attributes, yield attributes and seed cotton yield than RCH 2 Bt and Bunny Bt Ginning percentage, lint index, seed index and harvest index were not significantly influenced due different plant spacing and Bt cotton hybrids. The interaction effect was found to be non significant.

Key words : Bt cotton hybrids, plant spacing, growth, yield quality

Cotton (*Gossypium hirsutum* L.) is an important fibre crop of global significance and cultivated in tropical and sub-tropical regions of more than seventy countries of the world. With the introduction of Bt cotton hybrids there has been a significant change in the cotton cultivation scenario of India. Bt cotton occupies 40 per cent area in India and 53 per cent area in Maharashtra. Amongst the different agronomic practices variety, time of sowing, optimum plant population and planting geometry are the important non-monetary inputs responsible for profitable cotton production. There is a positive relationship between plant population and seed cotton yield in cotton crop (Rao, 1982). Sharma and Tomar (1994) reported that, cotton varieties at higher plant population gave significantly higher seed cotton yield than at normal plant population. Besides planting geometry, genotype have also a very significant and decisive role for sustainable cotton production (Prasad and Prasad, 1993).

It is essential to find out suitable plant density for Bt cotton hybrids to realize the maximum yield potential. Hence, the present study was undertaken to find out the effect of spacing on productivity of different Bt cotton hybrids.

Materials and Methods

A field experiment was conducted during *kharif* season of 2008-09 at the research farm of Department of Agronomy, Marathwada Agricultural University, Parbhani (MS) India. The experiment was laid out in split plot design with three replications consisting of four spacings *viz*. S_1 : 90 x 60 cm, S_2 : 120 x 45 cm, S_3 : 150 x 30 cm and S_4 : 180 x 30 cm as main plot treatments and three Bt cotton hybrids *viz*. V_1 : Bunny Bt, V_2 : Ajit 155 Bt and V_3 : RCH 2 Bt as sub plot treatments. The

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gross plot size was 10.80 x 5.40 m and net plot size was 7.20 x 4.20 m. The soil of the experimental field was clayey (56.20 %) in texture with low in available nitrogen (110 kg ha^{-1}), moderately high in available phosphorus (22.56 kg ha^{-1}), rich in available potash (425.50 kg ha^{-1}), medium in organic carbon content (0.53 per cent) with slightly alkaline (7.95 pH) in reaction. The total rainfall of 629.5 mm was received in 41 rainy days during the experimental period (23^{rd} MW to 6^{th} MW). The sowing was undertaken in the last week of June by dibbling. Half dose (40.00 kg ha^{-1}) of nitrogen and full dose of P_2O_5 and K_2O was applied as basal dose. The remaining half dose of nitrogen was given after 30 days after sowing by ring method. The periodical agronomic observations taken were tabulated, analyzed and are interpreted herein.

Results and Discussion

Growth attributes : The perusal of data presented in Table 1 revealed that sowing of Bt cotton hybrids with the different spacing significantly influenced all the growth attributes except number of monopodial branches and functional leaves $plant^{-1}$. However, sowing of Bt cotton hybrids with the spacing of 180 x 30 cm and 150 x 30 cm were found at par with each other and recorded significantly higher value for plant height as compared with rest of the plant spacings. Increase in plant height might be due to the competition for solar radiation among the plants. The results are in harmony with those reported by Moola Ram and Giri (2006) and Singh *et al*. (2007). Significantly higher number of sympodial branches per plant were reported with the closer spacing of 90 x 60 cm and 120 x 45 cm than 180 x 30 cm and 150 x 30 cm.

Among the Bt cotton hybrids, *Ajit-155 Bt* recorded significantly higher values for plant height and leaf area $plant^{-1}$ as compared to Bunny Bt and RCH 2 Bt. The Bt hybrids *Ajit 155 Bt* and Bunny Bt recorded significantly higher number of number of sympodial

Table 1. Effect of different plant spacing on growth and yield attributes of Bt cotton hybrids.

Treatments	Growth attributes				Yield attributes				
	Plant height (cm)	Monopodial branches $plant^{-1}$	Sympodial branches $plant^{-1}$	Functional leaves $plant^{-1}$	Leaf area $plant^{-1}$ (dm^2)	Dry matter $plant^{-1}$ (g)	Picked bolls $plant^{-1}$	Weight $boll^{-1}$ (g)	Yield $plant^{-1}$ (g)
Plant spacing (cm) :									
S_1 - 90 x 60	123.03	1.69	19.99	107.82	37.40	147.22	26.54	4.02	107.16
S_2 - 120 x 45	125.07	1.64	19.70	105.38	35.70	143.00	26.23	3.89	105.73
S_3 - 150 x 30	128.06	1.52	18.43	103.44	35.30	133.11	24.03	3.85	97.13
S_4 - 180 x 30	130.04	1.42	18.23	100.71	33.48	128.00	23.43	3.81	94.13
SE ±	1.19	0.08	0.34	2.13	0.28	0.61	0.13	0.16	0.55
CD at 5%	3.57	NS	1.17	NS	0.83	1.84	0.39	NS	1.63
Bt hybrids :									
V_1 - Bunny Bt	126.55	1.54	19.03	104.03	36.26	136.92	25.07	3.79	100.23
V_2 - *Ajit 155 Bt*	129.07	1.64	19.99	111.08	37.22	142.83	25.55	4.10	105.15
V_3 - RCH 2 Bt	124.03	1.52	18.24	97.90	32.92	133.75	24.56	3.78	98.14
SE ±	0.54	0.09	0.36	3.33	0.21	0.59	0.16	0.10	0.64
CD at 5%	1.60	NS	1.06	9.96	0.61	1.75	0.47	0.30	1.91
Interaction (S x V) :									
SE ±	1.07	0.17	0.71	6.66	0.40	1.17	0.32	0.20	1.28
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
Mean	126.55	1.57	19.09	104.34	35.47	137.83	25.06	3.89	101.17

branches and number of functional leaves plant^{-1} than RCH 3 Bt RCH 2 Bt cotton hybrid exhibited significantly lower values for growth attributes over all other hybrids. Number of monopodial branches was not significantly influenced among different Bt cotton hybrids.

Yield attributes : Plant spacing of 90 x 60 cm recorded significantly the higher total dry matter production plant^{-1} than other plant spacing. Sowing of Bt cotton hybrids with 90 x 60 cm and 120 x 45 cm spacing recorded significantly higher values for number of picked bolls and seed cotton yield plant^{-1} as compared with rest of the spacings. The boll weight per plant of Bt cotton hybrids was not influenced significantly due to different plant spacings. Similar results were reported earlier by Moola Ram and Giri (2006).

Ajit 155 Bt recorded significantly the highest values for total dry matter, number of picked bolls, seed cotton yield plant^{-1} and weight boll^{-1} than Bunny Bt and RCH 2 Bt. However, *Ajit 155 Bt* was at par with Bunny Bt for recording similar values for total dry matter plant^{-1} and number of picked bolls plant^{-1}. RCH 2 Bt cotton hybrid recorded significantly lower values for yield attributes and seed cotton yield plant^{-1}. Similar results are reported by Hallikeri *et al.* (2008).

Yield and quality : Sowing Bt cotton hybrids (Table 2) with the plant spacing of 90 x 60 cm (1760 kg ha^{-1}) was found to be at par with 120 x 45 cm (1706 kg ha^{-1}) and recorded significantly higher seed cotton yield over 150 x 30 cm (1648 kg ha^{-1}) and 180 x 30 cm (1479 kg ha^{-1}) However, plant spacing of 120 x 45 cm was at par with 150 x 30 cm and recorded significantly higher seed cotton yield over 180 x 30 cm. The higher seed cotton yield at 90 x 60 cm spacing might be attributed due to more number of bolls per unit area as compared to wider spacing of 90 x 120 cm and 90 x 90 cm spacing (Bhalerao *et al.* 2008).

Table 2. Effect of different plant spacing on quality parameters and seed cotton yield of Bt cotton hybrids.

Treatments	Ginning (%)	Lint index	Seed index	Harvest index (%)	Seed cotton yield (kg ha^{-1})
Plant spacing (cm)					
S_1 - 90 x 60	38.47	4.88	7.50	43.23	1760
S_2 - 120 x 45	36.99	4.74	7.47	42.51	1706
S_3 - 150 x 30	36.03	4.49	7.34	41.06	1648
S_4 - 180 x 30	35.64	4.38	7.14	39.73	1479
SE ±	0.69	0.19	0.17	1.23	32.51
CD at 5%	NS	NS	NS	NS	97.43
Bt hybrids :					
V_1 - Bunny Bt	36.69	4.69	7.36	40.82	1648
V_2 - *Ajit 155 Bt*	37.83	4.83	7.39	44.52	1832
V_3 - RCH 2 Bt	35.83	4.34	7.34	39.56	1464
SE ±	0.73	0.15	0.16	1.24	19.09
CD at 5%	NS	NS	NS	NS	57.22
Interaction (S x V)					
SE ±	1.47	0.29	0.31	2.48	38.19
CD at 5%	NS	NS	NS	NS	NS
Mean	36.78	4.62	7.36	41.63	1648

Nehra *et al.* (2004) also reported higher seed cotton yield in Bt cotton with closer spacing as compared to wider spacing.

Ajit 155 Bt recorded significantly highest seed cotton yield than Bunny Bt and RCH 2 Bt. RCH 2 Bt recorded significantly the lowest seed cotton yield as compared with rest of the Bt cotton hybrids. The results are in accordance with those reported by Anand *et al.* (2008).

The quality parameters *viz.* ginning percentage lint index, seed index and harvest index were not significantly influenced due to different plant spacing and Bt cotton hybrids.

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Estimation of Heterosis and Inbreeding Depression for Seed Yield and its Components in Indian Mustard (*Brassica juncea* L.)

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Abstract

The trend of inbreeding depression and heterosis was quite variable and dependent on the characters as well as genotypic background of the crosses. Relatively high mean heterobeltiosis was observed for siliquae on main shoot, the highest being 31.4 per cent in the cross BPR 511. Only two crosses, BPR 517 (28.8%) and BPR 520 (39.4%) showed high positive heterobeltiosis for seed yield plant^{-1}. High positive standard heterosis for three important characters, primary branches plant^{-1}, secondary branches plant^{-1} and siliquae on main shoot was observed, which implied more siliquae plant^{-1} was associated with standard heterosis for seed yield plant^{-1}. Except the cross BPR 520, which exhibited high heterosis and inbreeding depression, the remaining crosses, had high heterosis and moderate inbreeding depression for primary branches plant^{-1}. Very high heterosis was associated with relatively high inbreeding depression for secondary branch plant^{-1} and seed yield plant^{-1}. The role of both additive (high heterosis and low inbreeding depression) as well as non-additive type (high heterosis and high inbreeding depression) of gene action for expression of standard heterosis was evident in these crosses. The promising crosses BPR 517 and BPR 520 showing high standard heterosis and heterobeltiosis but high inbreeding depression, might be exploited for heterosis breeding whereas, the cross BPR 510 having high standard heterosis and relatively lower inbreeding depression could be used for selection following pedigree method.

Key words : *Brassica juncea*, heterosis, inbreeding depression, Indian mustard and yield components.

Among the rapeseed-mustard group of crops Indian mustard (*Brassica juncea* L.) occupies the largest cropped area in the

1., 2. and 3. Dir., Tech. Offi. and former Dir country. Indian mustard although predominantly a self-pollinated crop but with the availability of *mori* CMS system with restorer, commercial exploitation of heterosis is very much feasible. Further, heterosis can be used to assess the potential crosses for obtaining superior recombinants in later segregating generations. Heterosis coupled with inbreeding depression provides an insight in to the genetic architecture of a character, which enables to know whether observed heterosis is due to additive gene effects (fixable component) and the vigour is maintained or broken down in later generations. It is therefore, pertinent to study the performance of F_1 and F_2 generations simultaneously to select parents for hybridization, and heterotic crosses both for handling segregating generations with a view to obtain transgressive segregants or for commercial exploitation of heterosis. Many studies in Indian mustard dealt with estimation of heterosis for seed yield, its contributing characters and oil content (Banga and Labana. 1984, Kumar *et al.* 1990, Pradhan *et al.* 1993, Tyagi *et al.* 2000, 2001, Kumbhalkar *et al.* 2000, Gosh *et al.* 2002, Monalisa *et al.* 2005). However, limited information is available for both heterosis and inbreeding depression (Verma *et al.* 1998). Therefore, the present investigation attempts to study the nature and magnitude of heterosis for oil content, seed yield and its components in Indian mustard.

Materials and Methods

The experimental materials consisted of fi, F2 and parental generations of 5 crosses, *viz.*, 5F5-2-3-2 x JM1 (BPR 510), 5F5-2-3-2 x PCR 7 (BPR 511), MDOC 8 x JM 1 (BPR 515), MDOC 8 x Bio 772 (BPR 517), MDOC 8 x Bio 902 (BPR 520). The experimental materials were sown in a randomized complete block design with two replications during 2002-03 *rabi* season. Each F_1 and parental generation was sown in a single-row plot and there were 10 rows for each F_2 generation. Each row was 3 m long, spaced 30 cm apart. Plant-to-plant distance was maintained at 10-15 cm within-a-row by thinning. 40 kg N and 40 kg P_2O_5 ha^{-1} applied at the time of sowing and the rest of 40 kg N applied after first irrigation. One irrigation was given at 38 days after sowing. Need based plant protection measures were adopted. Observations were recorded on five competitive randomly taken plants for each F_1, parental genotype and 40 F_2 plants in each replication on plant height, primary branches, secondary branches, main shoot length, siliquae on main shoot, siliqua length, seeds siliqua^{-1}, 1000-seed weight, oil content, seed yield plant^{-1} and harvest index. The mean values were used for analysis of variance. Heterobeltiosis and standard heterosis over variety Varuna and inbreeding depression were computed using standard methods.

Results and Discussion

Mean performance of the parents and hybrids : The parents were quite variable for most of the characters except siliqua length, 1000-seed weight and oil content for which low coefficients of variability were observed (Table 1). The parents showed high variability for secondary branches plant^{-1} with CV of 59.5 per cent and the mean ranging from 4.2 (Bio 902) to 19.5 (JM 1) followed by seed yield plant^{-1}. Genotype JM 1 had the shortest plant stature among the parents whereas PCR 7 was the tallest. Primary branches plant^{-1} varied from 3.3 for variety Bio 902 to 7.5 for genotype Bio772 with high CV. The mean main shoot length among the parents was 64.7 ± 8.9 cm, the maximum and minimum being for genotype 5F5-2-3-2 and Bio 902, respectively. Variety PCR 7 had the maximum number of siliquae on main shoot and this character showed moderately high variability (CV 17.2%). Further, among the parents, variety JM 1 had the longest siliquae. the highest seeds siliqua^{-1} and oil content. Nevertheless, variability was low to moderate for these characters (Table 1). The parents were quite variable showing high CV for seed yield plant^{-1} (57.4%) and genotype MDOC 8 had the maximum seed yield. The maximum 1000-seed weight (5.4 g) and harvest index (35.6%) were recorded for variety PCR 7.

Among the F_1 hybrids, the means for all the characters were higher than that of the parents except for 1000-seed weight and oil content (Table 1). The plant height varied from 155.4 (BPR 515) to 187.6 cm (BPR 520). Further, the cross BPR 520 also had the highest means for main shoot length (94 cm) and oil content (41.1%). The cross BPR 517 exhibited the highest seeds siliqua^{-1}, main shoot length and 1000-seed weight. The highest number of siliquae on main shoot and secondary branches plant^{-1} were observed in the cross BPR 511. The primary branches plant^{-1} ranged from 5.0 (BPR 511) to 10.0 (BPR 520). The cross BPR 520 also showed the highest mean seed yield plant^{-1} (46.2 g). The observed harvest index was maximum (39.7%) in the cross BPR 510.

Heterobeltiosis : The highest mean heterobeltiosis was recorded for secondary branches plant^{-1} (42.4%) with a range of 20.3 (BPR 515)-63.2 per cent (BPR 517). All the crosses except BPR 511 showed low negative but desirable heterobeltiosis for plant height, BPR 510 had the highest value (-9.4%). Nevertheless, none of the crosses had shorter plant stature than the shortort parent variety JM 1. Kumbhlkar *et al*. (2000) also recorded low but negative better parent heterosis for this trait. The cross BPR 520 had the maximum heterosis for primary branches plant^{-1} (Table 2). The heterobeltiosis for main shoot length varied from 4.9 (BPR 515) to 16.1 per cent (BPR 510). Relatively high mean heterobeltiosis was observed for siliquae on main shoot, the highest being 31.4 per cent in the cross BPR 511. Most of the crosses exhibited negative heterobeltiosis except the cross BPR 517. This cross too had very low positive heterobeltiosis for siliqua length. For 1000-seed weight, high negative heterobeltiosis was observed indicating no improvement for this character over the better parent in all the crosses (Table 2). Maximum of 4 per cent heterobeltiosis for seeds siliqua was recorded in the cross BPR 520. Khulbe *et al.* (1998) and Tyagi *et al.* (2001) also reported low magnitudes of heterobeltiosis, in general, for harvest index, seed weight, main shoot length, siliqua length

Table 1. Mean peformance of parents and F_1 hybrids for seed yield and its components in Indian mustard.

Character	Parents			F_1 hybrids		
	Range	Mean ± SEM	CV (%)	Range	Mean ± SEM	CV (%)
Plant height (cm)	123.5 - 171.5	159.6 ± 17.3	15.3	155.4 - 187.6	171.6 ± 7.4	5.2
Primary branches plant^{-1}	3.3 - 7.5	5.2 ± 1.0	27.8	5.0 - 10.0	7.1 ± 1.2	23.9
Secondary branches plant^{-1}	4.2 - 19.5	9.3 ± 3.6	59.5	10.2 - 28.6	19.6 ± 4.1	30.3
Main shoot length (cm)	40.3 - 85.7	64.7 ± 8.9	31.9	58.4 - 94.0	78.1 ± 6.6	11.9
Siliquae on main shoot	25.5 - 47.7	37.2 ± 4.5	17.2	41.0 - 61.0	50.7 ± 3.9	10.9
Siliqua length (cm)	3.7 - 4.6	4.1 ± 0.2	6.8	3.7 - 4.8	4.3 ± 0.2	5.6
Seeds siliqua^{-1}	11.8 - 16.8	14.2 ± 1.0	10.7	14.4 - 19.5	16.4 ± 0.8	7.2
1000-seed weight (g)	4.4 - 5.4	4.8 ± 0.2	7.0	4.2 - 5.6	4.7 ± 1.8	7.5
Seed yield plant^{-1} (g)	6.5 - 30.5	14.7 ± 1.6	57.4	10.7 - 46.2	27.0 ± 6.3	43.1
Oil content (%)	38.8 - 41.6	40.2 ± 0.6	2.0	37.9 - 41.1	39.7 ± 0.6	2.2
Harvest index (%)	24.7 - 35.6	29.8 ± 2.5	11.8	27.3 - 39.7	32.9 ± 2.7	11.9

and oil content. Lack of heterobeltiosis in these crosses could be due to presence of genes with oppositional dominance or no dominance. Only two crosses, BPR 517 (28.8%) and BPR 520 (39.4%) showed high positive heterobeltiosis for seed yield plant^{-1}. But, very high levels of heterobeltiosis for seed yield plant^{-1} were reported in earlier studies (Banga and Labana, 1984, Kumar *et al*. 1990; Pradhan *et al.* 1993, Tyagi *et al*. 2001). Oil content is an economic important character in this crop. But in these crosses, negative heterobeltiosis for oil content revealed no improvement over the better parent. Except the cross BPR 520 which had relatively moderate heterobeltiosis (16.1%). the rest of the crosses had negative values. However, Verma et al. (1998) and Ghosh *et al*. (2002) observed highly significant better parent heterosis for oil content.

In general, there was moderate to high positive heterosis in these crosses except siliqua length, oil content and 1000-seed weight (Table 2). High positive standard heterosis for three important characters, primary branches plant^{-1} secondary branches plant^{-1} and siliquae on main shoot was observed, which implied more siliquae plant^{-1}. The cross BPR 517 exhibited the highest heterosis for primary branches plant^{-1} (82.1%) and secondary branches plant^{-1} (253.2%) whereas, the cross BPR 511 had the highest heterosis of 78.4 per cent for siliquae on main shoot. However, in previous investigations, moderate levels were reported for these characters (Tyagi *et al.*, 2000; Rai and Verma, 2005). None of the crosses showed desirable negative heterosis for plant height. Negative low standard heterosis was recorded for siliqua length in all the crosses except the crosses BPR 517 (4.6%) and BPR 520 (0.7%) that exhibited low but positive heterosis. The seedsteiliqua and main shoot length also showed moderately high positive heterosis, the highest being 34.1 per cent in the cross BPR 520 and 22.3 per cent in the cross BPR 511, respectively. Except the crosses BPR 511 (1.4%) and BPR 515 (1.7%) for oil content and BPR 517 (6.5%) for 1000-seed weight that showed positive heterosis, the negative heterosis was recorded in the remaining crosses. Similar trend of standard heterosis for these characters was observed in

Table 2. Estimates of heterobeltiosis, standard heterosis and inbreeding depression for seed yield and its components in Indian mustard.

Characters	Heterobeltiosis (%)		Standard heterosis (%)		Inbreeding depression (%)	
	Range	Mean±SEM	Range	Mean±SEM	Range	Mean±SEM
Plant height (cm)	-9.4* - 2.7	-3.7 ± 2.1	3.3 - 17.2**	9.3* ± 2.3	-2.7 - 18.3	6.7 ± 3.9
Primary branches plant^{-1}	1.6 - 26.3**	13.7** ± 4.6	42.5** - 82.1**	63.1** ± 7.1	15.0 - 48.9	25.2 ± 6.1
Secondary branches plant^{-1}	20.3** - 63.2**	42.4** ± 7.7	52.7** - 53.2**	175.9** ± 34.6	27.9 - 111.4	65.8 ± 13.7
Main shoot length (cm)	4.9 - 16.1**	9.0* ± 2.5	1.9 - 22.3**	12.3* ± 3.2	6.8 - 49.2	22.6 ± 7.4
Siliquae on main shoot	9.6* - 31.4**	22.1* ± 3.6	49.4** - 78.4**	66.3** ± 4.8	7.2 - 37.7	26.0 ± 5.2
Siliqua length (cm)	-9.9* - 1.6	-4.0 ± 1.9	-7.2* - 4.6	-1.2 ± 1.9	0.3 - 13.8	6.6 ± 2.2
Seeds siliqua^{-1}	-8.6* - 4.0	-0.8 ± 2.2	17.8** - 34.1**	27.9** ± 2.9	-8.3 - 17.5	5.5 ± 4.5
1000-seed weight (g)	-43.4** - (-)4.8	-30.0** ± 7.5	-36.8* - 6.5	-22.0** ± 8.4	-10.9 - 78.8	18.0 ± 16.0
Seed yield plant^{-1} (g)	-20.6** - 39.4**	5.5 ± 12.1	42.7** - 13.4**	128.1** ± 32.4	34.8 - 185.8	100.7 ± 33.7
Oil content (%)	-5.6 - (-)1.8	-3.9 ± 0.6	- 2.6*1.7	0.1 ± 0.8	-6.0 - 3.9	-2.7 ± 1.7
Harvest index (%)	-7.0* - 16.1**	-0.7 ± 4.2	7.7* - 34.5**	14.8** ± 5.0	5.1 - 42.6	16.8 ± 6.8

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

earlier studies (Tyagi *et al.*, 2000; Rai and Verma 2005). The range of heterosis for seed yield plant^{-1} was quite high. The lowest (42.7%) and the highest (213.4%) was recorded in the crosses BPR 511 and BPR 520, respectively. Tyagi *et al.* (2001) also recorded standard heterosis up to 206.1 per cent for seed yield plant^{-1}. The heterosis for harvest index was though positive but low varying from 7.7 to 34.5 per cent the highest being in the cross BPR 520.The results confirmed the previous findings of Khulbe *et al*. (1998) and Tyagi *et al*. (2001).

The results revealed that high heterosis for seed yield in the crosses was associated with moderate to high heterosis in primary branches plant^{-1}, secondary branches plant^{-1}, siliquae on main shoot and seeds siliqua^{-1}. Gosh *et al*. (2002) also observed the similar findings.

Inbreeding depression : A high heterosis in a cross for any character largely due to prevalence of non - additive component of variance, i.e. dominant effects and their interactions (non-fixable) in the inheritance of the character, thereby, leading to considerable reduction in the mean performance of the cross in F_2 generation (inbreeding depression). However, there might be some crosses where heterotic effects of F_1 generation are quite visible in. F_2 and later generations (low inbreeding depression). Low inbreeding depression is expected owing to the fact that heterotic effects might be predominantly due to fixable component of variance (additive effects and their interact). Further, crosses and characters showing tolerance to inbreeding depression are reliable for early generation selection.

In the present investigation trends of standard heterosis and inbreeding depression for different characters was analyzed (Table 2). The inbreeding depression for plant height ranged from -2.7 (BPR 520) to 18.3 per cent (BPR 511) with a mean value of 6.7 per cent. In general, low heterosis coupled with low inbreeding depression was observed for plant height and siliqua length. However, BPR 511 showed relatively high positive heterosis for plant height (17.2 %) accompanied with high inbreeding depression. High heterosis for seed siliqua^{-1}, in general, appeared due to additive gene effects as evident by low inbreeding depression. Except the cross BPR 520, which exhibited high heterosis and inbreeding depression, the remaining crosses, had high heterosis and moderate inbreeding depression for primary branches plant^{-1}. Very high heterosis was associated with relatively high inbreeding depression for secondary branches plant^{-1} except the crosses BPR 510 which showed moderate estimates for both and BPR 520 which had very high inbreeding depression and heterosis. For siliquae on main shoot and main shoot length, the inbreeding depression was low for the crosses BPR 517 (7.2%) and BPR 515 (6.8%), respectively and high in the cross BPR 510 for both the traits. In general, low heterosis for main shoot length was associated with moderate inbreeding depression whereas high heterosis for siliquae on main shoot was coupled with high inbreeding depression. Negative inbreeding depression for 1000-seed weight was recorded in the crosses BPR 510 and BPR 515; in the remaining crosses it was positive ranging from 8.9-78.8 per cent. Seed yield plant^{-1} invariably showed high inbreeding depression, the very high heterosis for seed yield in the crosses BPR 517 (189.7%) and BPR 520 (213.4%) was associated with equally high inbreeding depression being 179.9 and 185.8 per cent, respectively. The trend of estimates of heterosis and inbreeding was similar in these crosses for oil content. Low to moderate heterosis for harvest index was accompanied with similar magnitude of inbreeding depression except the cross BPR 520 where both were high. The trend of inbreeding depression and heterosis was quite variable and as expected dependent on the characters as well as genotypic background of the crosses. The role of both additive (high heterosis and low inbreeding depression) as well as non-additive type (high heterosis and high inbreeding depression) of gene action for expression of standard heterosis was evident in these crosses. The promising crosses BPR 517 and BPR 520 showing high standard heterosis and heterobeltiosis but high inbreeding depression might be exploited for heterosis breeding whereas, the cross BPR 510 having high standard heterosis and relatively lower inbreeding depression could be used for selection following pedigree method.

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Variability and Genetic Diversity Studies in Grain Amaranth (*Amaranthus* spp.)

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Abstract

Wide range of PCV and GCV were observed for harvest index, seed yield plant^{-1}, number of branches plant^{-1}, dry weight of stem and dry weight of panicle. The per cent mean genetic advance was high for number of leaves, number of branches, panicle fresh weight and number of spikelets panicle^{-1}. Higher heritability coupled with high genetic advance was observed for number of leaves, number of branches, number of spikelets panicle^{-1}, dry weight of panicle, fresh weight of stem, harvest index and seed yield plant^{-1}. Following Mahalanobis (1936) D^2 statistics genotypes were grouped into 10 clusters. Seed yield plant^{-1}, fresh weight of stem, number of leaves, number of branches, days to maturity, panicle length, fresh weight of panicle and dry weight of panicle were identified as potential variability which can be used as parameters while selecting diverse parents in the hybridization programme for yield improvement.

Key words : Genetic variability, grain amaranth, heritability, diversity.

Grain amaranth is one of the important under utilized plants of food and has multiple uses. It has potential to withstand adverse weather changes, particularly severe moisture stress. Besides, it can be grown in wide ranges of agro-climatic conditions *viz*., high to low rainfall, from seashore to high altitudes and suitable for sustainable agriculture (Joshi, 1986).

The availability of genetic variability is the basic pre-requisite for genetic improvement in a systematic breeding programme. There is more genetic potentiality in the genetically variable population and thus the chances to achieve the desired types are increased. The estimates of variability and other parameters are helpful to a plant breeder to predict the performance of genotypes in the subsequent generation. So, it is necessary to split the phenotypic variability into heritable and non-heritable components such as genotypic and phenotypic coefficient, heritability and genetic advance. Keeping these objectives in view, the present study was made.

Materials and Methods

Fifty two genotypes of grain amaranth were evaluated in a randomized block design following three replications at the Regional Agricultural Research Station, Raichur, UAS, Dharwad. Data on 15 characters were recorded from 5 plants per replication and the average was taken for analysis. Protein content was determined by the conventional Kjeldhal method. Genetic variability parameters as proposed by Johnson *et al.* (1955) and Dewey and Lu (1959) and the genetic divergence among genotypes was computed by means of Mahalanobi's (1936) D^2 technique and genotypes were grouped into clusters by following Tocher's method as described by Rao (1952).

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Results and Discussion

A perusal of the results revealed that the magnitude of phenotypic coefficient of variability was higher than the genotypic coefficient of variability for all the characters. The character with wider range of variation had comparatively higher estimates of genotypic and phenotypic coefficients of variability, showing the wide scope of bringing improvement in such characters.

Number of leaves, number of branches plant^{-1}, number of spiklets panicle^{-1}, dry weight of panicles, fresh weight of stem, harvest index and seed yield plant^{-1} showed high heritability coupled with high genetic advance (Table 1), which indicated the presence of high additive gene effects (Panse, 1957) suggesting that direct selection for these traits would be fruitful. Similar findings of high heritability together with high genetic advance were earlier reported by Joshi (1986) and Patgar (2003). However Revanappa and Madalageri (1997) observed high heritability with low genetic advance for the number of branches plant^{-1}, stem girth and dry weight of stem.

High heritability coupled with moderate genetic advance in the character indicates that the variability is due to both additive and non-additive interaction of genes. The characters exhibited low heritability with moderate genetic advances indicates a non-additive gene effect in governing these characters. Selection of genotypes on the basis of these characters makes less effective in further breeding programme. The character with high genotypic variance and high heritability coupled with high genetic gain would be effective for selection in improvement of the crop. Hence, the selection may be made in the desirable direction based on phenotypic performance.

The genetic divergence was estimated by Mahalanobi's (1936) D^2 statistic and the genotypes were grouped into 10 clusters using Tocher's method. The intra-cluster D^2 values ranged from 0.00 to 222.82. The intra -cluster D^2 values among 10 clusters (Table 2) revealed that maximum genetic diversity has been observed with cluster-VIII (222.82) followed by

Table 1. Genetic parameters for 15 different characters in grain amaranth.

Characters	Range		Mean	PCV	GCV	H2 (%)	GA	GAM (%)
	Min.	Max.						
Days to 50% flowering	33.33	71.97	58.76	13.64	11.15	66.4	11.00	18.72
Days to maturity	105.31	150	128.08	6.06	4.90	65.4	10.46	8.16
Stem girth at collar (cm)	5.03	9.75	7.89	16.51	10.07	37.2	1.00	12.67
Number of leaves	73.37	27.33	50.25	23.42	19.68	70.6	17.11	34.04
Branches per plant	3.67	14.40	8.30	35.23	30.47	74.8	4.51	54.33
Plant height (cm)	195.83	106.67	166.59	13.20	8.65	42.9	19.44	11.66
Panicle fresh weight (g)	122.90	280.67	199.75	27.41	17.82	42.2	47.63	23.89
Panicle length (cm)	45.78	84.57	67.76	18.64	11.05	35.1	9.14	13.48
Spike lets per panicle	69.75	262.8	155.73	26.92	24.49	82.8	71.48	45.89
Dry weight of panicle (g)	51.96	236.22	102.72	30.72	24.82	65.3	42.43	41.30
Fresh weight of stem (g)	117.67	431.20	210.88	27.46	23.01	70.2	83.78	39.72
Dry weight of stem (g)	39.10	145.67	87.99	31.65	24.20	58.5	33.55	37.78
Protein content (%)	9.74	15.96	13.46	8.65	8.50	98.5	2.34	17.38
Harvest index (%)	3	23.17	10.30	47.10	43.05	83.5	8.35	81.06
Seed yield per plant (g)	4.97	46.47	18.55	46.33	42.18	82.9	14.68	79.13

Table 2. Average inter-cluster (above diagonal) and intra-cluster (diagonal) D^2 values for 10 clusters in grain amaranth.

Clusters	I	II	III	IV	V	VI	VII	VIII	IX	X
I	**109.623** 10.47	**449.507** 21.20	**425.939** 20.63	**440.651** 20.99	**419.038** 20.47	**293.022** 17.121	**540.280** 23.24	**462.390** 21.50	**282.550** 16.80	**312.339** 17.67
II		**129.033** 11.35	**309.557** 17.59	**318.779** 17.85	**304.240** 17.44	**390.928** 19.77	**444.378** 21.08	**469.354** 21.66	**376.656** 19.40	**436.582** 20.89
III			**98.640** 9.93	**263.064** 16.40	**398.610** 19.96	**386.976** 19.67	**572.190** 23.92	**405.349** 20.13	**381.248** 19.40	**419.375** 20.90
IV				**107.769** 10.38	**409.518** 20.13	**389.614** 19.73	**584.874** 24.18	**399.252** 19.98	**412.825** 20.31	**437.177** 20.90
V					**116.267** 10.78	**418.068** 20.18	**258.486** 16.07	**488.460** 22.10	**283.734** 16.84	**443.237** 21.05
VI						**136.752** 11.69	**581.018** 24.10	**346.605** 18.61	**330.491** 18.17	**259.917** 16.72
VII							**0.000** 0.00	**622.055** 24.94	**358.702** 18.93	**580.411** 24.09
VIII								**222.824** 14.95	**437.884** 20.92	**426.497** 20.65
IX									**0.000** 0.00	**337.289** 18.36
X										**0.000** 0.00

cluster VI (136.75), cluster II (129.03), cluster V (116.26), cluster I (109.62), cluster IV (107.76) and cluster III (98.64). The maximum amount of heterosis is expected in cross combination involving the genotypes of most divergent cluster. The inter-cluster D^2 values varied from 258.48 to 622.055. It indicated that the genotypes in the cluster VIII were more diverse than the genotypes in the above clusters. Maximum inter-cluster distance was between cluster VII and VIII (622.055). The minimum inter-cluster distance was observed between cluster V and VII (258.48). Genotypes present in this cluster may be used as parents in hybridization programme to obtain desirable recombinants. The cluster VII and cluster VIII were strictly more diverse from the rest of the clusters followed by cluster IV and cluster VII with value of 584.874 inter-cluster distance. The criteria used for selection of varieties as parents for hybridization using D^2 analysis is the inter-cluster distance. Hence, it would be logical to incorporate genotypes from these clusters in further breeding programmes.

Table 3. Per cent contribution of the characters towards genetic divergence in grain amaranth.

Characters	Rank	Contribution in per cent
Days to 50% flowering	2	0.15
Days to maturity	128	9.65
Stem girth at collar (cm)	27	2.04
Number of leaves	179	13.50
Branches per plant	117	8.82
Plant height (cm)	64	4.83
Panicle fresh weight (g)	70	5.28
Panicle length (cm)	106	7.99
Spike lets per panicle	40	3.02
Dry weight of panicle (g)	47	3.54
Fresh weight of stem (g)	186	14.03
Dry weight of stem (g)	5	0.38
Protein content (%)	42	3.17
Harvest index (%)	24	1.81
Seed yield per plant (g)	289	21.79

The seed yield plant^{-1} contributed more (21.79 per cent) towards divergence (Table 3). These observations were also in accordance with earlier workers, for seed yield plant^{-1} (Joshi and Rana, 1995; Waghmode *et al*. 1997), dry weight of panicle (Patgar, 2003) and protein content (Joshi and Rana, 1995). It is evident from the above results that, selection of genetically diverse genotypes for hybridization, material should be screened for the seed yield plant^{-1}, fresh weight of stem and number of leaves, branches, days to maturity, panicle length and fresh weight of panicle and dry weight of panicle.

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Gene Action Analysis with Different Cytoplasmic Genetic Male Sterile Sources in Rice (*Oryza sativa* L)

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Abstract

Combining ability analysis was carried out for .grain yield and its components traits in Line x Tester crosses. The magnitudes of SCA variances were higher than the GCA variances for all the characters which indicated preponderance of non-additive gene action in the inheritance of these traits. The SCA variances were more sensitive to environmental fluctuations as evident by the significance of mean squares due to females x males x locations interaction for all the characters except days to 50 per cent flowering. Among females, RTN-3B and RTN-2B and among males, IR-63879-195-195-2-2-3-2, NVSR-20, BL-184AR, GR-7 and IR-8866 were observed good general combiner for yield and most of the yield contributing characters. Correlation studies indicated the comparison of mean performance of hybrids and their SCA effects showed higher performance of crosses was associated with their SCA effects for all most all the characters. The cross combinations, RTN-3A x BL-184AR (38.39%), RTN-13A x GR-7 (17.23%) and RTN-2A x NVSR-20 (14.08%) crosses exhibited positive significance SCA effects for grain yield plant^{-1} and some associated characters. Among these, RTN-3A x BL-184AR was found to be the best combination involving good x good general combiner parents and also exhibited significant highest SCA effects, significant heterobeltiosis and standard heterosis for grain yield plant^{-1} and most of other traits, could well be utilized for commercial cultivation after extensive testing in state and national trials.

Key words : GCA and SCA effects, general combiners, heterotic combinations, combining ability analysis.

Combining ability analysis is an important tool in the hands of breeders to identify good lines in their breeding material and further to develop suitable hybrids from them. The relative amount of GCA and SCA effects play vital role in planning the appropriate breeding programme. The present investigation bas been carried out to study combining ability effects and type of gene action governing for grain yield and its contributing traits of five CMS lines of diverse sources, twenty five proven restorers and their combinations.

Materials and Methods

One hundred twenty five crosses were made in line x tester mating design by using five CMS lines from different CMS sources (KJTCMS-6A - WA sources, RTN 2A -ARC source, RTN 3A - Mutant of 1R 62829B source, RTN 13A - Gambiaca source and RTN 17A -Dissi source) and twenty five males by hand pollination at National Agricultural Research Project Farm, Navsari during *rabi*-2007-2008. Before pollination- sterility of female plants was checked and insured to have 100 per cent pollen sterility. The 125 F_1s, were evaluated in randomized block design, replicated thrice in the three different locations viz., Navsari (Loc-I), Bardoli (Loc-II) and Vyara (loc-IIT) by planting a single row plot of 30 plants, placed at 20 x 15 cm during *kharif*-2008. All the agronomical practices and plant protection measures were followed as per recommendations. The observations were recorded on five randomly

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selected plants in each replication for 125 hybrids, their respective parents and three checks *viz*., Java (coarse variety check, SC-I), Sahyadri (hybrid check, SC-II) and GR-11 (fine variety check, SC-III) on ten characters *viz*. days to 50 per cent flowering, productive tillers plant^{-1}, plant height, panicle length, number of filled spikelets panicle^{-1}, grain yield plant^{-1}, straw yield plant^{-1}, harvest index (%), pollen fertility (%), spikelet fertility (%). For the estimation of general and specific combining ability variances, the line x tester analysis as outlined by Kempthorne (1957) was followed.

Results and Discussion

The analysis of variance for combining ability (Table 1) analysis over environments revealed that mean squares due to females were significant, for all the characters except days to 50 per cent flowering, panicle length, harvest index, pollen fertility and spikelet fertility, whereas mean sum of squares due to males

Table 1. Analysis of variance for combining ability (pooled over three environments).

Source	df	Days to 50 % flowering	Productive tillers plant^{-1}	Plant height (cm)	Panicle length (cm)	Filled spikelets panicle^{-1}	Grain yield plant^{-1} (g)	Straw yield plant^{-1} (g)	Harvest index (%)	Pollen fertility (%)	Spikelet fertility (%)
Replications	6	18.98	0.86	44.83	1.15	94.42	18.35	16.48	3.21	2.87	23.45
Locations (l)	2	1109.31**	145.77**	8340.81**	43.34**	19580.57**	7311.06**	23765.41**	322.41**	0.28	265.28**
Females (f)	4	732.59	140.64**	2516.02**	7.33	22630.39**	984.97*	710.50**	46.97	226.00	155.99
Males (m)	24	355.20	25.95	792.06**	19.16**	8767.67*	505.97*	255.70	68.52	188.62	204.71
Females x males (f x m)	96	302.42**	22.68**	339.70**	7.48**	4806.95**	296.81**	174.63**	50.71**	152.78**	146.49**
Females x locations (f x l)	8	461.72**	34.14	715.69**	25.71*	2705.37	105.34	132.01	59.96*	165.03	163.06
Males x locations (m x l)	48	223.41*	10.26	279.49	8.20	2334.19	61.23	114.14	21.44	75.29	63.72
Females x males x locations (f x m x l)	192	144.69	21.80**	220.49**	7.47**	1962.59**	68.44**	120.21**	29.54**	111.22**	102.59**
Pooled error	744	11.73	0.51	22.19	0.97	56.67	10.56	22.15	7.91	9.71	11.97
Estimates :											
$\sigma^2 l$		1.22	0.26*	16.27**	0.4	35.49*	15.51**	50.83**	0.58*	-0.28	0.30
$\sigma^2 f$		0.50	0.47*	7.47	-0.08	75.91*	2.89*	2.33*	-0.15	0.09	-0.23
$\sigma^2 m$		-0.58	0.33*	8.74*	0.24*	79.76*	4.80*	1.94	0.58	1.59	2.16*
σ^2GCA		0.323	0.446	7.68**	0.276	76.555*	3.214*	2.264*	-0.031	0.338	0.171
σ^2SCA		17.525**	0.098	13.246**	1.2**	316.040**	25.374**	6.046**	2.352**	4.618*	4.877*
σ^2GCA / σ^2SCA		0.018	0.457	0.580	0.23	0.242	0.127	0.374	0.013	0.073	0.035
$\sigma^2 f \times l$		4.23**	0.16	6.60**	0.24**	9.90	0.49	0.16	0.41*	0.72	0.80
$\sigma^2 m \times l$		5.25*	-0.77	3.93	0.05	24.77	-0.48	-0.41	-0.54	-2.40	-2.59
σ^2GCA x l		4.40*	0.009	6.16*	0.21**	12.38	0.33	0.06	0.25	0.20	0.24
σ^2SCA x l		44.32**	7.10**	66.10**	2.17**	635.31**	19.29**	32.70**	7.21**	33.84**	30.21**
σ^2GCA x l / σ^2SCA x l		0.099	0.001	0.093	0.097	0.019	0.017	0.002	0.035	0.006	0.008

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

were significant, for all the characters except days to 50 per cent flowering, productive tillers plant^{-1}, straw yield plant^{-1}, harvest index, pollen fertility and spikelet fertility. Mohanty and Mahapatra (1973) reported the pollen sterility is one of the constraints in hybrid nee

Table 2. General combining ability (GCA) effects of parents for different characters .

Parent	Days to 50 % flowering	Productive tillers plant^{-1}	Plant height (cm)	Panicle length (cm)	No. of filled spikelets panicle^{-1}	Grain yield plant^{-1} (g)	Straw yield plant^{-1} (g)	Harvest index (%)	Pollen fertility (%)	Spikelet fertility (%)
Females :										
KJTCMS-6B	-0.76**	-0.82**	-2.33**	0.03	-3.99**	-2.22**	-2.41**	-0.21	0.58**	0.38
RTN-2B	0.77**	1.14**	-1.99**	-0.11	0.50	1.43**	1.08**	0.35	0.41	0.11
RTN-3B	2.79**	0.22**	-2.13**	0.25**	16.59**	2.89**	2.25**	0.59**	0.59**	0.58*
RTN-13B	-1.62**	0.14**	0.98**	-0.23**	-10.09**	-1.12**	-0.19	-0.52**	-1.77**	-1.46**
RTN-17B	-1.19**	-0.67**	5.46**	0.05	-3.01**	-0.98	-0.74*	-0.21	0.18	0.39
S. E. (gi) ±	0.23	0.05	0.31	0.07	0.50	0.22	0.31	0.19	0.21	0.23
CD 5%	0.490	0.107	0.661	0.149	1.066	0.469	0.661	0.405	0.448	0.490
Males :										
IR-8866	-2.63**	-0.64**	-2.34**	0.48**	16.08**	2.08**	0.51	1.06*	2.14**	0.87
IR-22273	-4.69**	0.62**	-0.33	0.49**	1.97	-1.96**	-4.39**	1.00*	-2.01**	-1.85**
BL-184AR	-3.05**	0.66**	11.75**	0.91**	11.21**	7.06**	6.07**	1.19**	0.88	0.94
IET-13840-RP-66-67	0.28	-0.6	2.17**	-0.72**	-0.65	-2.00**	1.45*	-1.76**	-1.65**	-2.23**
KJT-11-1-26-5-11	3.61**	0.55**	4.31**	-0.19	15.41**	-2.94**	1.26	-2.10**	0.24	0.17
KJT-3-2-861-25-15-5	2.93**	0.44**	-3.32**	-0.34*	-13.83**	-0.89	-0.50	-0.51	-3.05**	-2.43**
RDN-97-3-2-37-14	1.01*	0.09	-1.43*	0.12	14.71**	4.12**	1.86**	1.48**	2.75**	2.69**
GR-3	1.17*	-0.09	-6.38**	-0.55**	-27.40**	-4.78**	-1.07	-2.43**	2.26**	2.14**
PR-115	-2.14**	-0.59**	-5.71**	-1.13**	7.41**	-2.33**	-1.72*	-0.50	0.33	0.51
PKV-Makarand	-3.16**	-1.15**	-1.19	-1.29**	-0.45	0.38	0.16	0.18	-1.11*	-1.32*
GR-7	-1.81**	-0.47**	-2.16**	0.04	-3.35**	0.98*	1.67*	-0.51	0.55	0.76
IR-54742-22-19-3	1.08*	-0.60**	0.73	0.93**	-13.45**	2.04**	0.52	1.15**	2.09**	0.75
Pusa Sugandh-5	-0.09	-1.35**	-0.15	0.38*	1.95	-1.90**	-1.19	-0.73	3.03**	3.52**
Super Basmati	0.39	-0.06	7.36**	0.82**	10.35**	0.56	-1.02	0.79	1.92**	2.74**
PR-114	0.66	-0.95**	0.45	-0.003	6.58**	-1.56**	-0.63	-0.76	-0.46	-0.49
PR-116	-3.36**	1.70**	-4.03**	-0.46**	-14.79**	-2.75**	-3.27**	0.11	-3.63**	-3.51**
NVSR-20	-1.89**	0.14	6.25**	1.45**	13.11**	8.83**	3.68**	3.05**	0.75	1.31*
CR-57-MR-1523	2.5**	0.99**	-3.67**	-0.84**	-23.65**	-3.94**	-3.66**	-0.60	-5.37**	-6.04**
IR-63879-195-195-2-2-3-2	3.26**	0.98**	-0.80	0.04	9.38**	4.59**	3.25**	1.06*	1.41**	1.95**
Dandi	-2.92**	-1.29**	-3.22**	-0.04	14.59**	2.10**	0.99	0.91*	0.42	0.52
RP-BIO-226	2.24**	0.54**	1.37	-0.35*	23.08**	-0.70	1.45*	-0.73	0.87	1.01*
INP-19	-4.25**	-0.92	-0.98	0.07	-15.20**	-2.27**	-0.54	-0.97	-1.18*	-1.34**
GR-11	5.17**	0.42**	-2.62**	-0.13	-5.48**	-1.58**	-2.87**	0.34	-0.58	0.22
Phule Radha	3.54**	0.29	-0.45	0.001	-8.14**	2.47**	-1.55*	-0.51	-0.34	-0.73
PKV-Ganesh	2.17**	0.004	4.31**	0.33*	-19.45**	-0.66	-0.48	-0.21	-0.29	-0.15
S. E. (gi) +	0.51	0.11	0.70	0.15	1.12	0.48	0.70	0.42	0.46	0.52
CD 5%	0.873	0.188	1.198	0.257	1.916	0.821	1.198	0.719	0.787	0.890

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

breeding programme. In their study the hybrid ER 58025 A/FH 444 showed lowest heterosis over better parent and lowest standard heterosis for pollen sterility and as such could be considered as the most desirable hybrid in respect of pollen fertility.

Females x males sum of squares were significant for all the characters which exhibited high significant differences among the genotypes (parents and crosses). The magnitudes of SCA variances were higher than the GCA variances for all the characters which indicated preponderance of non-additive gene action in the inheritance of these traits. This was further supported by low magnitude of σ^2GCA : σ^2SCA ratios. Preponderance of non-additive variance in the expression of different traits in rice have also been reported by Ram *et al.* (1991). Banumathy and Prasad (1991), Ramalingam *et al.* (1993), Singh *et al.* (1996), Rogbell and Subbaraman (1997), Shunmugavlli *et al.* (1999). Annadurai and Nadarajan (2001) and Khirsagar (2002). Preponderance of additive gene action for productive tillers plant^{-1} was also reported by Rao *et al.* (1980), Manuel and Palanisamy (1989), Ghosh (1993), Chakraborty *et al.* (1994). Singh *et al.* (1996) and Lavanya (2000). Mean squares due to males x locations were found non-significant for all the traits except days to 50 per cent flowering while as mean squares due to females x locations were found non-significant for productive tillers plant^{-1}, filled spikelets panicle^{-1}, grain yield plant^{-1}, straw yield plant^{-1}, pollen fertility, spikelet fertility which indicated that GCA variances of females and males were not so much influenced by the environments in above said traits. The SCA variances were more sensitive to environmental fluctuations as evident by the significance of mean squares due to females x males x locations interaction for all the characters except days to 50 per cent flowering.

The parents were characterized for their ability to transmit desirable genes to their progenies (Table 2). Female RTN-3B was found to be good general combiner for all the traits except days to 50 per cent flowering and among males. IR-63879-195-195-2-2-3-2 was found to be good general combiner for most of the characters except 50 per cent flowering whereas it also showed average performance in plant height, panicle length and head rice recovery. The genotype, NVSR-20, was found

Table 3. Correlation between the parental mean and GCA effects and hybrid mean performance with SCA effect in rice.

Charcters	**Correlation between the parental mean and GCA effect ('r' values)**				**Correlation between hybrid mean performance with SCA effects ('r' values)**			
	LOC-I	**LOC-II**	**LOC-III**	**Pooled**	**LOC-I**	**LOC-II**	**LOC-III**	**Pooled**
Days to 50% flowering	-0.5248	0.0067	0.3130	0.2618	-0.5268**	0.3875**	0.4299**	0.4268**
Productive tillers plant^{-1}	6.9611**	0.0995	-0.4405*	-0.4718**	0.5347**	0.2539**	0.4848**	0.2866**
Plant height	-0.9761**	-0.3878*	0.0526	-0.0384	0.3985**	0.6964**	0.5165**	0.4154**
Panicle length	0.2829	0.0902	0.1287	0.6221**	0.5023**	0.1715	0.4726**	0.3414**
Filled spikelets panicle^{-1}	0.0145	-0.9996*	-0.8190**	-0.8214**	0.2565**	-0.2154*	0.0284	0.2379**
Grain yield plant^{-1}	0.0627	0.0337	0.7847**	0.2029	0.4003**	0.3060**	0.4403**	0.2924**
Straw yield plant^{-1}	-0.1545	-0.2764	-0.2818	-0.2884	0.7622**	0.6084**	0.6699**	0.4775**
Harvest index	-0.2222	0.0658	-0.2282	-0.1769	0.7203**	0.7626**	0.7445**	0.5584**
Pollen fertility	0.5454**	-0.1736	0.5617**	0.7442**	0.5637**	0.1510	0.4161**	0.6116**
Spikelet fertility	0.0338	-0.1732	-0.2442	0.6552**	0.6687**	0.1202	0.5171**	0.5850**

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

to be good general combiner for all the traits except it showed poor performance in plant height, and protein content while it was average combiner for productive tillers plant^{-1} and pollen fertility. The GCA effects for grain yield plant^{-1} in NVSR-20, IR-63879-195-195-2-2-3-2, BL-184AR, were associated with filled grains panicle^{-1}, panicle length, productive tillers plant^{-1} and straw yield plant^{-1}. The genotypes, NVSR-20 and BL-184AR possessed negative (desirable) GCA effects for days to 50 per cent flowering. Among females, RTN-3B and RTN-2B and among males IR-63879-195-195-2-2-3-2. NVSR-20, RL-184AR. GR-7 and IR-8866 were observed good general combiner for yield and most of

Table 4. Best performing cross conbinations along with their SCA effects and estimates of heterobeltosis and standard heterosis for various traits.

Character	Best performing hybrids	GCA effect		SCA effects	Hetero-beltiosis (%)	Standard heterosis over		
		P_1	P_2			SC-I	SC-II	SC-III
Days to 50 % flowering	KJTCMS-6A X NVSR-20	G	G	-7.91**	-8.70**	-10.87**	-11.74**	-11.39**
	RTN-2A X IR-547 42 -22-19-3	P	P	-12.19**	-12.19**	-10.65**	-11.52**	-11.18**
	RTN-17AXIR-8866	G	G	-6.40**	-0.72	-10.55**	-11.41**	41.07**
Productive tillers plant^{-1}	RTN-2A X IR-63879-195-195-2-2-3-2	G	G	3.22**	70.41**	67.53**	26.04**	69.30**
	RTN-2AXPR-116	G	G	1.75**	24.94**	60.40**	21.25**	62.09**
	RTN-BAX PR-116	G	G	2.25**	21.29**	55.71**	17.71**	57.30**
Plant height (cm)	RTN-3A X GR-3	G	G	-16.65**	-16.15**	-26.17**	-30.85**	-21.12**
	RTN-3AXPR-115	G	G	-7.01**	-0.53	-16.86**	-22.13**	-11.18**
	KJTCMS-6AXGR-11	G	G	-7.23**	1.66	-14.47**	-19. 39**	-8.62**
Panicle length (cm)	RTN-3AX1R-8866	G	G	1.66**	6.39**	17.72**	8.63**	33.89**
	RTN- PAX NVSR-20	A	G	0.32	11.12**	15.34**	6.43**	31.19**
	RTN-3AX NVSR-20	G	G	0.07	10.88**	15.09**	6.20**	30.90**
Filled spikelets panicle^{-1}	RTN-3AXBL-184AR	G	G	35.56**	45.73**	48.44**	25.04**	39.30**
	RTN-3A XRDN-97-3-2-37-14	G	G	24.84**	37.51**	43.45**	20.84**	34.62**
	RTN-3AX NVSR-20	G	G	26.17	40.64**	43.26**	20.68**	34.44**
Grain yield plant^{-1} (g)	RTN-3AXBL-184AR	G	G	18.39**	66.85**	86.60**	58.03**	102.65**
	R.TN-2AX NVSR-20	G	G	14.08**	77.75**	75.48**	48.61**	90.57**
	RTN-UAXGR-7	G	G	17.23**	66.31**	55.33**	31.54**	68.68**
Straw yield plant^{-1} (g)	RTN-3AXBL-1S4AR	G	G	13.42**	28.96**	51.00**	47. 40**	61.80**
	RTN-2AX NVSR-20	G	G	10.65**	29.73**	37.80**	34.52**	47.65**
	RTN-13AXGR-7	G	G	10.95**	18.18**	31.58**	28.44**	40 98**
Harvest index (%)	RTN-2AX NVSR-20	A	G	2.09*	14.64**	13.03**	5.25	14.45**
	RTN-2AXKJT-3-2-S6S-25-15-5	A	A	5.39**	9.51**	13.02**	4.69	13.84**
	RTN-3AXBL-184AR	G	G	2.99**	14.41**	11.95**	3.70	12.76**
Pollen fertility CV)	RTN-3AXGR-3	G	G	6.58**	7.44**	16.65**	12.40**	15.35**
	RTN-13A XIR- 54742-22-19-3	P	G	7.35**	6.25**	14.45**	10.29**	13.18**
	RTN-UAX Phule Radha	P	A	8.96**	9.29**	13.45**	9.32*	12.19**
Spikelel fertility (%)	RTN-3A.XGR-3	G	G	4.76**	4.88*	16.31**	7.42**	13.74**
	KJTCMS-6A X Pusa Sugandh-5	A	G	3.29**	0.80**	15.94**	7.03**	13.37**
	RTN-3A X Pusa Sugandh-5	G	G	2.77**	4.15*	15.50**	6.67**	12.94**

*,** Significant at 5 and 1 per cent probability levels, respectively; G = Good parent having significant GCA effect in desired direction; A = Average per cent having either positive or negative but non-significant GCA effecs;
P = Poor parent having significant GCA effects in undesired direction; SC-I-Jaya; SC-II-Sahyadri; SC-III-GR-11

the yield contributing characters. The crosses exhibiting higher *per se* performance, high heterosis and significant desirable SCA effects for various traits in. all possible combinations *viz*., good x good, good x average, good x poor, average x good, average x average, average x poor, poor x good. poor x average and poor x poor combining parents. Thus, crosses exhibiting high SCA effects did not always involve parents with high GCA effects. It may be due to interallelic interactions between the parent involved in the cross. Chakraborty *et al.* (1994), Rao *et al.* (1996), Rogbell and Subbaraman (1997), Annadurai and Nadarajan (2001b), Shirsagar (2002) Narasimman *et al.* (2007) and Sharma and Mani (2008) reported that SCA effect of crosses does not depend upon GCA effects of the parental lines. It might be due to differential expression of component traits in specific genetic background may to be due to complementary type of gene action.

The performance of some selected crosses (best three crosses for each characters) in related parameters are presented in Table 4. The cross. RTN-3A x BL-184AR (18.39) exhibited highest positive significance SCA effects for grain yield plant^{-1} followed by RTN-13A x GR-7 (17.23) and RTN-2A x NVSR-20 (14.08) crosses. These three crosses were found to be the best combinations involving good x good general combiner parents and also exhibited high mean performance and high heterotic potential for grain yield plant^{-1}. The cross, RTN-3A x BL-184AR (13.42) was observed to be the best combination for straw yield plant^{-1} followed by the cross combinations RTN-13A x GR-7 (10.95) and RTN-2A x NVSR-20 (10.65). All these three crosses were found to be the best combinations involving good x good general combiner parents and also exhibited high mean performance and high heterotic potential for straw yield plant^{-1}. The cross, RTN-2A x KJT-3-2-861-25-15-5 (5.39) exhibited highest positive significance SCA effects for harvest index followed by the cross combinations RTN-3A x BL-184AR (2.99) and RTN-2A x NVSR-20 (2.09). The cross RTN-2A x IR-54742-22-19-3 (-12.19) exhibited significant and highest SCA effects for days to 50 per cent flowering, RTN-2A x IR-63879-195-195-2-2-3-2 (3.22) for productive tillers plant^{-1}, RTN-3A x GR-3 (-16.65) for plant height, RTN-3A x IR-8866 (1.66) for panicle length, RTN-3A x BL-184AR (35.56) for number of filled spikelets panicle^{-1}. RTN-13A x Phule Radha (8.96) for pollen fertility (%) and RTN-3A x GR-3 (4.76) for spikelet fertility.

The crosses with high SCA effects were in general combinations of parents with good x good and good x poor or good x average GCA effects. This was represented in best three hybrids for grain yield plant^{-1} *viz*., RTN-3A x BL-184AR (good x good). RTN-2A x NVSR-20 (good x good) and RTN-13A x GR-7 (poor x good) had significant desired SCA effects and significant desired heterotic response over better parent as well as all three standard checks. Kalita and Upadhaya (2000) reported the superiority of average x average combinres as parent might be due to the concentration and interaction between favorable genes contributed by the parents. The frequency of good x good was more. Among top 10 hybrids, five hybrids *viz*., RTN-3A x BL-184AR, RTN-2A x NVSR-20, RTN-3A x NVSR-20, RTN-3A x RDN-97-3-2-37-14 and RTN-2A x IR-8866 exhibited both of their parents with good combiners.

Correlation studies indicated (Table-3) the comparison of mean performance of hybrids and their SCA effects showed higher performance of crosses was associated with their SCA effects for all most all the characters while close association between mean performance of parents and their GCA effects was observed only for the traits *viz*., productive tillers plant^{-1}, panicle length, number of filled spikelets panicle^{-1}, pollen fertility and spikelet fertility. Rao *et al*. (1980) reported that, the selection of hybrids should be based on *per se* performance couples with SCA effects. Lavanya (2000) and Yadav *et al.* (2004) reported that the high performance hybrids need not be the ones with high SCA effect and vice versa. Mohan Rao *et al*. (1996); Narasimman *et al*. (2007); Acharya and Pandey (2000); Bidan Roy and Mandal (2001); Krishnaveni and Shobha Rani (2003); Manonmani and Khan (2003) and Sharma and Mani (2008) reported that no correspondence between the *per se* performance of parents and crosses GCA effects of parents and SCA effects of crosses suggested that *per se* parental or hybrid performance did not necessarily correspond with GCA and SCA effects.

Thus, in the present investigation non-additive genes appeared to play a significant role in controlling the expression of all the traits except productive tillers plant^{-1} under the investigations. This suggests that there is scope for improvement for these characters by using hybrid breeding programme for exploitation of the non additive gene action. Chakraborty *et al*. (1994), Rao *et al.*, (1996), Rogbell and Subbaraman (1997), Annadurai and Nadarajan (2001b), Khirsagar (2002), Narasimman et al. (2007) and Sharma and Mani (2008) reported significant maximum non additive gene action in various cross combinations in their study-could be exploited for heterosis breeding.

The cross combination, RTN-3A x BL-184AR exhibited significant highest SCA effects, significant good x good GCA effects of the parents, significant heterobeltiosis and standard heterosis for grain yield and most of the traits under the investigations. The cross combination, RTN-3A x BL-184AR could well be utilized for commercial cultivation after extensive testing in state and national trials.

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Biological Management of Bacterial Blight of Cotton Caused by *Xanthomonas axonopodis* pv. *malvacearum* (Smith) Dye

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Abstract

The efficacy of *Pseudomonas fluorescens* Pf1 was assayed against bacterial blight (*Xanthomonas oxanopodis* pv. *malvacearum*) of cotton for three. consequtive *kharif* seasons of 2006-2009. Seed pelletization followed with seven sprays (10 g kg^{-1} and 0.2 %), starting from 30 DAS followed with six sprays at an interval of 10 days recorded minimum disease intensity under field condition. Three sprays of copper oxychoride @ 0.3 per cent + streptomycine sulphate 100 ppm was equally efficient to the earlier one. Seed treatment (10 g kg^{-1}) with bacterial bioagent followed by three and four sprays @ 0.2 per cent at 30 and 20 days interval recorded highest cost : benefit ratios 1:2.17 and 1: 2.16 respectively. However the disease intensity was minimum in all other treatments i.e. seed treatment of *Pseudomonas fluorescens* followed with 7, 4 and 3 sprays of bioagent and chemicals. Thus three sprays @ 0.2 per cent at thirty days interval on cotton pretreated with seed @ 10 g kg^{-1} is efficient ecofriendlly and economical treatment for management of bacterial blight of cotton, while the more number of sprays are uneconomical

Key words : Cotton, biological control, *Pseudomonas fluorescens*, bacterial blight.

Cotton (*Gossypium* spp) is the ancient and important commercial crop. Bacterial blight incited by *Xanthomonas axonopodis* pv. *malvacearum* is one of the most important disease of cotton. It affects both irrigated and rainfed cotton. The quality of lint is deteriorated, the oil content in seed is also reduced due to disease. Mishra *et al.* (1984) reported about 20 per cent losses, whereas Meshram and Sheo Raj (1988) estimated up to

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27 per cent yield loss in L-147 cultivar. Patil *et al*. (2001) reported yield losses with in the range of 10.81 to 37.38 per cent in different varieties hybrids. The disease is major in Vidarbha region of Maharashtra state and the losses are often very high (Patil *et al.* 2003). Hence keeping in view the importance of disease, the studies were conducted to assess the efficacy of seed treatment with frequency of sprayings of bioagent and chemicals in controlling bacterial blight disease of cotton.

Materials and Methods

The experiment was carried out at Cotton Research Unit Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola for three years during 2006-07, 2007-08 and 2008-09 under rainfed conditions on susceptible variety LRA 5166. Experiment was laid out in a randomized block design. Five treatments with four replication were maintained with plot size of 5.4 x 4.8 m^2 adopting 60 x 60 cm spacing.

The seed treatment was given before sowing and foliar application were undertaken as per scheduled dates of foliar sprays of bioagents and chemicals, initiated after 30 DAS and repeated with requisite intervals. The observations on per cent disease intensity (PDI) of bacterial blight were recorded from appearance of disease. Ten plants were randomly selected from each plot. Two lower, middle and upper leaves were observed and categorized in 0-4 point scale for calculating disease intensity (Sheo Raj 1988). The seed cotton yield was recorded at harvest.

Results and Discussion

The intensity of bacterial blight ranged between 20.57 to 27.50 per cent with an average of 23.02 per cent for three seasons. However the maximum disease pressure was during 2008-09 i.e. 27.50 per cent.

The pooled data for three *kharif* season indicated that, (Table 1 and 2) minimum per

Table 1. Effect of bioagent against bacterial blight of cotton (pooled of three years 2006-07, 2007-08 and 2008-09).

Treatment	Per cent disease intensity (PDI)			
	2006-07	**2007-08**	**2008-09**	**Pooled mean**
T_1	9.95 (3.16)	11.52 (3.39)	12.60 (3.55)	11.36 (3.37)
T_2	10.12 (3.18)	12.16 (3.49)	13.23 (3.64)	11.84 (3.44)
T_3	11.46 (3.39)	13.06 (3.61)	14.79 (3.85)	13.10 (3.62)
T_4	10.07 (3.17)	11.77 (3.43)	13.02 (3.60)	11.62 (3.40)
T_5	20.52 (4.54)	20.99 (4.58)	27.50 (5.24)	23.02 (4.78)
CD (P=0.05)	0.10	0.18	0.23	0.07

T_1 : Seed treatment with *Pseudomonas fluorescens* Pf I@ 10 g kg seed + foliar spray @ 0.2% on 30, 40, 50, 60, 70, 80 and 90 DAS (7 sprays of 10 days interval).

T_2 : Seed treatment with *Pseudomonas fluorescens* Pf I@ 10 g kg seed + foliar spray @ 0.2% on 30, 50, 70 and 90 DAS (4 sprays of 20 days interval).

T_3 : Seed treatment with *Pseudomonas fluorescens* Pf I@ 10 g kg seed + foliar spray @ 0.2% on 30, 60 and 90 DAG (3 sprays of 30 days interval).

T_4 : Spraying of copper oxychloride @ 0.3% + Streptomycien sulphate 100 ppm (Steptocycline) on 30, 60 and 90 DAG (3 sprays of 30 days interval)

T_5 : Control

Figures in parenthesis are arcsin values.

Table 2. Effect of bioagent on yield of seed cotton (pooled of three years 2006-07, 2007-08 and 2008-09.

Treat-ment	Yield of seed cotton (kg ha^{-1})				C:B ratio
	2006-07	**2007-08**	**2008-09**	**Pooled mean**	
T_1	1002	1378	1194	1192	1:1.59
T_2	996	1301	1120	1139	1:2.16
T_3	966	1261	1051	1093	1:2.17
T_4	998	1321	1142	1153	1:1.39
T_5	847	1083	918	949	-
CD (P=0.05)	87	116	129	74	-

cent disease intensity (PDI) of bacterial blight was recorded (11.36%) in seed treatment with *Pseudomonas fluorescens* Pf I @ 10 g kg^{-1} seed followed by seven foliar sprays @ 0.2 per cent at 30, 40, 50, 60, 70, 80 and 90 DAS. This treatment was statistically at par with three foliar sprays of copper oxychloide @ 0.3 per cent + 100 ppm streptomycine sulphate on 30, 60 and 90 DAS (11.62%).It was followed by seed treatment of *Pseudomonas fluorescens* + four foliar sprays (11.84%). Maximum per cent disease intensity was recorded in control treatment (23.02%). Antibiotics and metabolites might have given the resistance to plant for avoiding the infection of pathogen i.e. *Xanthomonas malvacearum*. The results are in accordance with those obtained by Chattannavar *et al.* (2001), Govindappa *et al.* (2008) and Anonymous (2009).

Maximum yield (1192 kg ha^{-1}) was recorded in seed treatment with *Pseudomonas fluorescens* Pf I + seven foliar sprays @ 0.2 per cent. It was at par with treatment of three foliar sprays of copper oxychloride @ 0.3 per cent + 100 ppm streptomycin sulphate (1153 kg ha-1) and seed treatment of *Pseudomonas fluorescens* Pf I 10 g kg^{-1} seed + four foliar sprays @ 0.2 per cent on 30, 50, 70 and 90 DAS (1139 kg ha^{-1}). Whereas, lowest yield was obtained in control (949 kg ha^{-1}).

As regards cost:benefit ratio (Table 2) seed treatment with *Pseudomonas fluorescens* followed with three sprays and four sprays recorded more monitory return i.e. 1:2.17 and 1:2.16 respectively. Seed treatment and seven sprays and three sprays of copper oxychloride recorded 1.59 and 1.39 C:B ratio respectively. The present findings are in confirmatory with the results of Suriachandraselvan *et al.* (2002), Govindappa *et al.* (2008), who reported the efficacy of bioagents in increasing the yield levels. It can be concluded that seed treatment of *Pseudomonas fluorescens* PPI @ 10 g kg^{-1} followed with three foliar sprays at an interval of 30 days initiated after thirty days recorded highest C:B ratio i.e. 2.17 was efficient and economical for management of bacterial blight of cotton. The present finding confirms the results published (Anonymous 2009).

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Awareness of Fruit Growers About Horticultural Development Programme under Employment Guarantee Scheme

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Abstract

The majority (70.00 per cent) of fruit growers had medium level awareness about horticultural development programme under employment guarantee scheme. A large majority (92.50 per cent) aware about that beneficiary farmers himself incurred the additional expenditure. The characteristics of fruit growers *viz*., education, size of land holding, social participation, extension contacts, risk taking ability and sources of information had positive association with awareness, while age, caste and annual income did not show any association with awareness.

Key words : Awareness, horticultural development programme EGS.

In order to increase area under fruit cultivation and to generate the employment opportunities on massive scale, government had taken decision to implement horticultural cultivation programme through Employment Guarantee Scheme from 1990-91. Therefore it was felt necessary to know the behavioural pattern and responses of the beneficiary farmers. For assessing the success of horticultural development programme under employment guarantee scheme the study was undertaken to assess the association between characteristics of fruit growers and awareness about horticultural development programme under employment guarantee scheme.

Materials and Methods

List of tahasils and villages having maximum area under horticultural development programme under employment guarantee scheme was obtained from Directorate of Agriculture and Horticulture. The first three tahasils and four villages having maximum area under fruit crop were selected. The list of farmers who availed benefit of horticultural development programme under employment guarantee scheme before 2000 was prepared. From each village ten farmers were selected randomly. Thus, total sample size of the study was 120. Keeping in view the objectives of study an interview schedule was prepared and data were collected.

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Results and Discussion

Awareness : It is observed from Table 1, that majority (70.00 per cent) of the fruit growers had medium level of awareness while 17.50 per cent had low level of awareness knowledge and only 12.50 per cent of the fruit

Table 1. Distribution of fruit growers according to their awarness about horticultural development programme under employment guarantee scheme.

Awareness	Respondents (N=120)	
	Number	Percentage
Low (upto 31)	21	17.50
Medium (32 to 49)	84	70.00
Hight (50 and above)	15	12.50
Total	120	100

growers had high level of awareness. The findings are in accordance with findings of Gurav and Kamble (1996).

Aspect wise awareness : It is observed from Table 2 that majority of fruit growers (92.50 per cent) aware about that beneficiary farmer himself has to incur the additional expenditure. While 84.17 per cent of them knew that amount of subsidy given through cheque and not in cash. Slightly less than three fourth (72.50 per cent) fruit growers were aware about rate of subsidy entitled to big farmers on input components while about 72.50 per cent of them knew besides inputs on which aspects subsidy is given. The 71.67 per cent of them knew that amount of subsidy is not directly given to farmer and 70.83 per cent

Table 2. Aspect wise awareness of fruit growers about Horticultural Development Programme under Employment Guarantee Scheme.

Aspects	Awareness (N=120)		
	Fully aware	**Partially aware**	**Unaware**
Year of implementing EGS in M. S.	19 (15.83)	5 (4.17)	96 (80.00)
Year of linking HDP under EGS	85 (70.83)	6 (5.00)	29 (24.17)
Fruit crops planted	71 (59.17)	45 (37.50)	4 (3.33)
Fruit crops not allowed	44 (36.67)	62 (51.66)	14 (11.67)
Minimum area tobe planted	57 (47.50)	40 (33.33)	23 (19.17)
Area can be planted	63 (52.50)	44 (36.67)	13 (10.83)
Can farmer take benefit of more than one fruit crops	58 (48.33)	46 (38.33)	16 (13.34)
Documents for proposal	62 (51.67)	46 (38.33)	12 (10.00)
Necessiry of EGS registration	59 (49.17)	38 (31.67)	23 (19.16)
Nesessiry of family member to register under EGS	56 (46.67)	40 (33.33)	24 (20.00)
Preparatory work before agricultural officer measured plantation	62 (51.67)	38 (31.67)	20 (16.66)
Authority for supply of fertilizers and insecticides	29 (24.17)	35 (29.17)	56 (46.66)
Authority for supply of seedlings or grafts	42 (35.00)	29 (24.17)	49 (40.83)
Disease free and high quality seedlings grafts made available	48 (40.00)	32 (26.67)	40 (33.33)
Planting material made available	58 (48.33)	36 (30.00)	26 (21.67)
Rate of subsidy	84 (70.00)	32 (26.67)	4 (3.33)
Aspects of subsidy given	87 (72.50)	25 (20.83)	8 (6.67)
From whom subsidy given	61 (50.83)	24 (20.00)	35 (29.17)
Subsidy entitled to big farmers on inputs components	87 (72.50)	28 (23.33)	5 (4.17)
Years the subsidy tobe given	78 (65.00)	30 (25.00)	12 (10.00)
Survival percentage binding			
First year %	69 (57.50)	47 (39.17)	4 (3.33)
Second year %	30 (25.00)	80 (66.67)	10 (8.33)
Third year %	33 (27.50)	74 (61.67)	13 (10.83)
Subsidy to the survival percentage below the prescribed norms	68 (56.67)	38 (31.67)	14 (11.66)
Provision for gap filling	38 (31.67)	45 (37.50)	37 (30.83)
Subsidy for gap filling	57 (47.50)	37 (30.83)	26 (21.67)
Action taken against survival below the prescribed norms	45 (37.50)	38 (31.67)	37 (30.83)
Whether the amount of subsidy directly given to beneficiary farmer	45 (37.50)	38 (31.67)	37 (30.83)
Form of subsidy given cash/cheque	101 (84.17)	15 (12.5)	4 (3.33)
Who will incur additional expenditure	111 (92.50)	7 (5.83)	2 (1.67)

Figures in parenthesis indicate the percentages.

fruit growers were aware about year of implementing of HDP under EGS. The 65.00 per cent fruit growers knew that subsidy is given for three year after fruit crop plantation. The 57.50 per cent respondents knew that the survival percentage is binding for first year. While 47.50 per cent were aware that the subsidy is not being given for gap filling.

Majority (59.17 per cent) of the fruit growers knew that the fruit crops like mango, cashew, ber, custard apple, aonla, tamarind, jackfruit, jamun, wood apple, coconut, orange, guava, arecanut, fig, pomegranate, sapota can be planted under the scheme. Slightly more or less of 50.00 per cent of the respondents were aware about maximum and minimum area to be planted under the fruit crop. They also know that one can take benefit of more than one fruit crop under the scheme and documents necessary with the proposal.

More than half per cent beneficiary knew that Agricultural Officer from Department of Agriculture measure the plantation of fruit crop. Considerable number (49.17 and 46.67 per cent) of fruit growers were aware about registration of his name under EGS and one of the eligible family members as a labour under the scheme respectively. The results are similar with the results of Waghmare et al. (1988).

Variables association : Table 3 revealed that, characteristics *viz*., education, size of land holding, social participation, extension contacts, risk taking ability and sources of information had positive association with awareness while age, caste and annual income did not show any association with awareness of fruit growers about HDP under EGS. The findings are similar to the findings of Bhopale *et al*. (1998).

Table 3. Relationship between the personal and socio-economic characteristics of the fruit growers with their level of awarness knowledge.

Characteristics of fruit growers	correlation coefficient r' value awarness
Age	0.105
Education	0.556**
Caste	0.111
Land holding	0.278**
Annual income	0.099
Social participation	0.355**
Extension contact	0.285**
Risk taking ability	0.460**
Sources of information	0.234*

df = 118, *, ** Significant at one and five per cent level respectively, NS = Non significant.

From the study, it is concluded that, the Department of Agriculture should organize the campaign, farmers rally, group discussion and farmers-scientists intervention to create more awareness about Horticultural Development Programme. Also the Department of Agriculture should prepare print material viz. folder, bulletin, and handouts in consultation with scientists from Agricultural University and distribute it among farming community on large scale as a ready reference material.

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Knowledge of Dairy Farmers About Improved Dairy Technology

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Abstract

A large majority of dairy farmers (80.42 per cent) were knowing about milk purpose breeds of cow, 37.08 per cent had knowledge about daily requirement of green fodder of cow, while 34.18 per cent of the cow owners had knowledge about quantity of mineral mixture required per cow per day. About the housing, 88.75 per cent dairy farmers had knowledge about number of times dung and urine to be removed from the byre in a day, while 84.58 per cent of the crossbred cow owners had knowledge about proper location of byre. Regarding the health care, 77.92 per cent dairy farmers had knowledge about need of daily washing of cow, while 75.42 per cent of the possessed knowledge about care required for sick animals. In case of utilization of technology, 90.42 per cent dairy farmers had knowledge about base product for preparation of butter, while 88.75 per cent of the dairy farmers had knowledge about -base product for preparation of ghee.

Key words : Knowledge, dairy technologies.

India has a livestock population of about 218.80 million cattle, 93.77 million buffaloes, 57.96 milllion sheeps, 123 million goats, 160 million swan and 402 million poultry as per the livestock census. India ranks first in cattle and buffaloes, second in goat, third in sheep and seventh in poultry population in the world. Since 2001-2002, India has emerged as the world's largest milk producing country with estimated milk production of 84.6 million tonnes. Constant significant growth is maintained by India during last 50 years. India's share of global milk production at present stands at 13.6 per cent. In India, per capita availability of milk is 226 ml day^{-1}, while that in Maharashtra it is 123 ml day^{-1}, which is less than 284 ml day^{-1} recommended by National Advisory Committee of Indian Council of Medical Research. The average lactation milk yield of indigenous cow is only 445 lit as against 5000 lit of cow in advanced countries. So, the study was undertaken, to measure the knowledge of dairy farmers about milk production and utilization technologies.

Materials and Methods

The Sangamner and Shrigonda tahsils from Ahmednagar district and Baramati and Indapur tahsils from Pune district were selected on the basis of maximum cattle population, From each of the selected tahsil, five villages were selected on purposive basis considering the criterion of having largest population of cattle. A list of villages in each tahsil was obtained from the Livestock Development Officer of Panchayat Samiti. From the selected villages, list of dairy farmers was prepared with the help of Livestock Development Officer and village level functionaries *viz*., Talathi and Gramsevak on population of crossbred cows they possessed. Twelve respondents from each village were selected randomly. Accordingly, 240 crossbred cow owners from twenty villages were the respondents for the study.

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Results and Discussion

Practice-wise knowledge of the dairy farmers : Information pertaining to the practicewise knowledge of dairy farmers was collected and analyzed. The results are presented in Table 1.

Milk production technologies

Breeding management : It is observed from Table 1 that a large majority of dairy farmers (80.42 per cent) were knowing about milk purpose breeds of cow. About 57.08 per cent had partial knowledge about signs of heat of cow, while 42.92 per cent farmers had complete knowledge about signs of heat of cow. Oestrus duration of cow was known to 75.42 per cent of the dairy farmers.

All the respondents (100.00 per cent) were knowing the best method (Artificial Insemination) of breeding, while, 61.25 per cent had knowledge about proper time of artificial insemination. Most of the dairy farmers 91.25 per cent had knowledge about time of insemination of cow after parturation. The findings are in accordance with findings of Dhumal (1974).

Feeding management : More than one-third of the dairy farmers (37.08 per cent) had knowledge about daily requirement of green fodder of cow, while 34.18 per cent had knowledge about quantity of mineral mixture required per cow per day. Few dairy 21.25 per cent farmers were knowing the daily requirement of dry fodder of cow and daily requirement of production ration of cow (20.42 per cent), while 17.08 per cent had knowledge about crops required for preparation of silage and daily requirement of maintenance ration.

Majority (71.67 per cent) of the dairy farmers possessed partial knowledge about daily requirement of production ration, while 67.08 per cent had partial knowledge about daily requirement of maintenance ration for cow. These findings are similar to the findings of Dixit *et al*. (1990).

Housing management : Large majority of the dairy farmers (88.75 per cent) had knowledge about number of times dung and urine to be removed from the byre in a day, while 84.58 per cent had knowledge about proper location of byre. About 64.00 per cent of the dairy farmers possessed knowledge about proper requirement of space for cow, drainage system and ventilation of byre, while 40.42 per cent had knowledge about different types of housing. Only 27.92 per cent possessed knowledge about type of facilities needed for ideal byre. Two third of the dairy farmers (67.08 per cent) had partial knowledge about type of facilities needed for ideal byre.

Health care management : Table 1 revealed that about three fourth of the dairy farmers (77.92 per cent) had knowledge about need of daily washing of cow, while 75.42 per cent possessed knowledge about care required for sick animals. One third of the dairy farmers (32.92 per cent) were knowing different disinfectants for maintenance of hygienic byre. Few dairy farmers (30.42 per cent) were knowing control of indo and ecto parasltes and different diseases of cow (25.83 per cent).

Nearly three fourth of the dairy farmers (74.17 per cent) had partial knowledge about different diseases of cow, while 41.25 per cent had partial knowledge about different disinfectants for maintaining hygienic byre. These findings are in accordance with findings of Kokate and Tyagi (1991).

Milk utilization technologies

Marketing of milk : It was observed that a large majority of the dairy farmers (79.58 per cent) possessed complete knowledge about maximum time gap to reach raw milk to chilling

Table 1. Distribution of dairy farmers according to their knowledge about dairy management practices.

Dairy management practices	Knowledge (N=240)		
	Complete	Partial	No
Milk production technologies			
Breeding management :			
Milch purpose breeds of cow	193 (80.42)	47 (19.58)	-
Signs of heat	103 (42.92)	137 (57.08)	-
Oestrus duration of cow	181 (75.42)	59 (24.58)	-
Best method of breeding	240 (100.00)	-	-
Proper time of artificial insemination after onset of oestrus	147 (61.25)	93 (38.75)	-
When cow is inseminated after parturition	219 (91.25)	21 (8.75)	-
Feeding management :			
Crops used for preparation of silage	41 (17.08)	59 (24.58)	140 (58.34)
Daily requirement of green fodder of cow	89 (37.08)	119 (49.58)	32 (13.34)
Daily requirement of dry fodder of cow	51 (21.25)	79 (32.92)	110 (45.83)
Daily requirement of production ration	49 (20.42)	172 (71.67)	19 (7.91)
Daily requirement of maintenance ration	41 (17.08)	161 (67.08)	38 (15.84)
Quantity of mineral mixture offered to cow	82 (34.18)	67 (27.92)	90 (37.50)
Housing management :			
Proper location of byre	203 (84.58)	37 (15.42)	-
Proper requirement of space for cow, drainage system and ventilation in byre	153 (63.75)	68 (28.33)	19 (7.92)
Different types of housing	97 (40.42)	126 (52.50)	17 (7.08)
Facilities needed for ideal byre	67 (27.92)	161 (67.08)	12 (5.00)
Frequency of removing dung and urine from byre in a day	213 (88.75)	27 (11.25)	-
Health care management :			
Different diseases in cow	62 (25.83)	178 (74.17)	-
Control of indo and ectoparasites	73 (30.42)	86 (35.83)	81 (33.75)
Care required for sick animals	181 (75.42)	59 (24.58)	-
Disinfecants for maintaining hygienic byre	79 (32.92)	99 (41.25)	62 (25.83)
Need of daily washing of cow	187 (77.92)	53 (22.08)	-
Milk utilization technologies			
Marketing of milk :			
Maximum time gap to reach raw milk to chilling/ processing plant from milking of the animal	191 (79.58)	49 (20.42)	-
Preparation of milk product/Khoa :			
Quantity of khoa obtained from one liter of milk	37 (15.42)	49 (20.42)	154 (64.16)
Curd/Dahi :			
Starter used for souring of boiled milk	69 (28.75)	81 (33.75)	90 (37.50)
Ghee :			
Base product for preparation of ghee	213 (88.75)	-	27 (11.25)
Butter :			
Base products for preparation of butter	217 (90.42)	-	23 (9.58)
Shrikhand :			
Base product for preparation of Shrikhand	189 (78.75)	-	51 (21.25)

Figures in the parentheses indicate percentages plant or collection centre from milking of the animals, while 20.42 per cent of them had partial knowledge about the same.

Preparation of milk products : Most of the dairy farmers (90.42 per cent) had knowledge about base product for preparation of butter, while 88.75 per cent had knowledge about base product for preparation of ghee. About three fourth of the dairy farmers (78,75 per cent) possessed knowledge about base product for preparation of shrikhand. Twenty nine per cent of the dairy farmers were knowing about starter used for souring of boiled milk, while 15.42 per cent had knowledge about quantity of khoa obtained from one liter of milk. These findings are similar to the findings of Dhepe (2001).

The study revealed that relatively higher proportion of the dairy farmers possessed medium level of knowledge. In this regard, the dairy farmers are advised to visit ideal dairy units. The extension agencies concerned with livestock development need to orient their programme towards educating the dairy farmers regarding these practices of dairy farming and management by organizing field tours and conducting demonstrations. Also intensive training should be arranged at village level in order to update them with knowledge about the breeding, feeding, housing and health care management practices.

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Intensity of Training Needs of Rural Women in Thane District of Maharashtra

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Abstract

Out of sixty villages in College Development Block, fifteen villages were randomly selected for the purpose of the study. Ten families from each of the viflage to taling to 150 women who actively engaged in the farm and home activities were considered as the respondents. Due to training, the professional competence of the people can be improved which ultimately helps in better management of the activities performed by them. From the study, it was revealed that age, education, family size and family income of rural women influence the intensity of training needs.

Key words : Training needs, rural women.

In the modern age, training has been considered as one of the most important non monetary input in all aspects of development programme including agricultural sector. Training is the process of imparting skill, improving knowledge and changing attitude for better job performance. A few studies conducted earlier have brought out the areas wherein the participation of rural women was maximum. However, no systematic study has been carried with regards to the personal and socio economic characteristics of the rural women.

Materials and Methods

The study was conducted in the development Block of the College of Agriculture, Saralgaon, dist. Thane. The block comprises sixty villages of Murbad taluka. Out of which fifteen were randomly selected for the purpose of the study. Ten families who actively engaged in the farm and home activities were randomly selected from each of the village. One woman from each family was selected, making the sample of 150 rural women. Dependent variable (training needs) and independent variables (age, education, family size, family type, annual income, land holding, social participation, farming experience and marital status) were elaborated for this study.

Results and Discussion

The information about chronological age of the respondents at the time of interview, formal education by the respondent, the area in hectares of land owned, cultivated and managed by family of respondent and the number of years actually spent by the respondents in farming is given in Table 1.

Age : Age denotes the chronological completed calendar years by the respondents. Age influences behavior of an individual by exposing to varied situation for a number of times. Therefore, the age of the farm women was considered as a essential aspect in the study. Majority of the farm women (55.33 per cent) were from middle age group and about 30.00 per cent from young group. The remaining 14.67 per cent farm women were

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from old age group of 46 and above. The similar results were obtained by Kadam (1989) and Shirolkar (1993).

Kadam (1989) reported that 66.19 per cent of the farm women labourers were in middle age category while 18.70 per cent of the farm women labourers were in old age category. The average age of the farm women labourers was 37 years. Shirolkar (1993) studied the participation and decision making of farm in dairy occupation reported that more than half of the respondents (52.58 per cent) were upto 30 years age groups.

Education : Education enhances comprehensive ability and skill in problem solving capacity of an individual. Educated persons can analyze cause and effect relationship of different phenomenon. Considering this aspect, the formal level of education of the farm women was studied. It is seen that 26.00 per cent farm women were illiterate whereas 21.33 per cent and 18.00 per cent of them had pre primary and primary education respectively. Only 14.00 .per cent and 4.00 per cent farm women had higher secondary and college education respectively.

Family size : Majority (52.00 %) of the rural women belonged to medium size family while 32.67 per cent of them had small size family and 15.33 per cent large size family. On an average, the rural women had five members in their family.

Family type : Family types are likely to influence the farm women in their decision marking and participation work activity and likely to face problems in their work. It was therefore, felt necessary to determine the type of family of the respondent farm women. Majority of the farm women (59.33 per cent) belonged to individual family while remaining 40.67 per cent belonged to joint family.

Table 1. Distribution of respondents according ot their different characters.

Categories	Percentage
Age :	
Upto 30 years	30.00
31 to 45 years	55.33
46 years and above	14.67
Formal education :	
Illiterate (No education)	26.00
Pre primary (Upto 4th)	21.33
Primary (5th to 7th)	18.00
Secondary (8th to 10th)	16.67
Higher secondary (11th to 12th)	14.00
College (F.Y. and above)	4.00
Family size :	
Small (Upto 3)	32.67
Medium (4 to 6)	52.00
Large (7 and above)	15.33
Family type :	
Individual (Married couple)	59.33
Joint (Two or several related individual familes)	40.67
Annual income (Rs) :	
Lower (25000)	29.33
Low (250001 to 50000)	38.00
Medium (50001 to 100000)	26.67
High (Above 100000)	06.00
Land holding (ha) :	
Marginal (Upto 1.00)	56.66
Small (1.01 to 2.00)	38.00
Large (2.01 and above)	5.34
Social participation (score) :	
Non participant (0)	56.00
Low (Upto 3)	19.33
High (4 and above)	24.67
Farming experience (yr) :	
Low (Upto 10)	20.00
Medium (11 to 30)	68.00
High (Above 31)	12.00
Marital status :	
Married	96.00
Widow	04.00

Annual income : Annual income refers to the total annual income in a year of all family members of farm women taken together from all sources. Majority (38.00 per cent) of the rural women had low annual income while only 06.00 per cent women had high annual income.

Land holding : The data revealed that, 56.66 per cent of the farm women had marginal size of land holding. While 38.00 per cent of them had small size of land holding and only 5.34 per cent of them had large size of the land holding. Similar results were also obtained by Satyawati *et al*. (1993).They reported that more than half (54.00 per cent) of the rural women were landless, while about two fifth (21.00 per cent) had small (2.25 acres) size of land and about 15 per cent of farm women had medium size (5 to 10 acres) land holding.

Social participation : Social participation refers to participation of the farm women in various formal and informal organizations. It is seen that 56.00 per cent of the rural women had no social participation while 19.33 per cent of them had low social participation while 24.67 per cent of them had high social participation.

Farming : It is seen that 68.00 per cent of the rural women had medium farming experience while 20.00 per cent of the rural women had low experience and only 12 per cent of them had higher farming experience.

Similar results were also obtained by Dalvi (1988) who observed that majority (62.71 per cent) of the farm women had medium farming experience while 22.88 per cent farm women had low farming experience and 14.41 per cent farm women had high farming experience.

Marital status : It is observed that majority (96.00 per cent) of rural women were married while 04.00 per cent of rural women were widow. It means those women had to shoulder the responsibilities of the family were occupying the key positions in the family.

Table 2. Intensity of training needs of the rural women on the basis of different characteristics.

Charact-eristics	Intensity of training needs		Total
	Low (N=60)	High (N=90)	
Age :			
Young	26 (57.77)	19 (42.23)	45 (100)
Middle	28 (33.74)	55 (66.26)	83 (100)
Old	6 (27.27)	16 (72.73)	22 (100)
χ^2=8.75, Significant at 0.10 level, d.f.=2			
Education :			
Illiterate	10 (25.64)	29 (74.36)	39 (100)
Pre primary	12 (37.5)	20 (62.5)	32 (100)
Primary	11 (40.74)	16 (59.26)	27 (100)
Secondary	12 (48.00)	13 (52.00)	25 (100)
Higher secondary	11 (52.38)	10 (47.62)	21 (100)
College	4 (66.67)	2 (33.33)	06 (100)
χ^2=7.23, Significant at 0.10 level, d.f.=5			
Family size :			
Small	22 (42.86)	28 (57.14)	49 (100)
Medium	29 (37.18)	49 (62.82)	78 (100)
Large	10 (43.47)	13 (56.53)	23 (100)
χ^2=0.02, Non-significant, d.f.=2			
Family type :			
Individual	37 (41.57)	52 (58.43)	89 (100)
Joint	23 (37.70)	38 (62.30)	61 (100)
χ^2=0.22, Non-significant, d.f.=1			
Annual income :			
Lower	16 (36.36)	28 (63.64)	44 (100)
Low	23 (40.35)	34 (59.65)	57 (100)
Medium	16 (40.00)	24 (60.00)	40 (100)
High	5 (55.56)	4 (44.44)	09 (100)
χ^2=1.14, Significant at 0.10 level, d.f.=3			
Land holding :			
Marginal	34 (40.00)	51 (60.00)	85 (100)
Small	23 (40.35)	34 (59.65)	57 (100)
Large	3 (37.50)	5 (62.50)	08 (100)
χ^2=0.02, Significant at 0.10 level, d.f.=2			
Social participation :			
Non participant	30 (35.71)	54 (64.29)	84 (100)
Low	13 (44.83)	16 (55.17)	29 (100)
High	17 (45.95)	20 (54.05)	37 (100)
χ^2=1.146, Significant at 0.10 level, d.f.=2			
Farming experience :			
Low	14 (46.67)	16 (53.33)	30 (100)
Medium	40 (39.21)	62 (60.79)	102 (100)
High	6 (33.33)	12 (66.67)	18 (100)
χ^2=0.93, Non-significant at 0.10 level, d.f.=2			
Marital status :			
Married	58 (40.27)	86 (59.73)	144 (100)
Widow	2 (33.33)	4 (66.67)	06 (100)
χ^2=0.11, Non-significant, d.f.=2			

Relationship between personal and socio economic characteristics : Relationship between personal and socio economic characteristics of the rural women and their intensity of training needs about selected farm and home pursuits was ascertained and the data in this regards are presented in table 2.

Majority (57.77 per cent) of the rural women from young age group had low intensity of training needs while 72.73 per cent of rural women from old age category had high intensity of training needs. This indicates that the age of rural women increased with their intensity of training needs. The middle age and old age persons are enough mature to critically think of the new propositions.

The association between education and intensity of training needs of rural women was significant at 1.00 per cent level of probability. It means the rural women who had more formal education had less intensity of training needs pertaining to farm and home pursuits.

Due to training, the professional competence of the people can be improved which ultimately helps in better management of the activities performed by them. It can be inferred from the observations of the present study that the desire to have training was more or less same in all the rural women irrespective of their family size. The non significant results of the association between family type and intensity of training needs (Table 2) reveal that the rural women from both the categories of family needs with respect to farm and home pursuit.

The association between annual income and intensity of training needs was significant at 10.00 per cent level of probability. The rural women (63.64 per cent) from lower income category had higher intensity of training needs while 55.56 per cent of the rural women from higher income category had lower intensity of training needs. It means the intensity of training needs was more among the lower income group, while it was low among the higher income group.

Majority of rural women from all the three land holding categories had high intensity of training needs in farm and home pursuits. It could therefore be said that the size of land holding did not influence the intensity of training needs of the rural women. Majority (64.29 per cent) of the rural women from 'non participant' category had high intensity of training needs. The association between the farming experience and intensity of training needs of the rural women found to be non significant.

A woman irrespective of her marital status, is consulted by the head of family while taking the vital decision regarding farm and home affairs. Similarly, whatever may be the marital status of the rural women, she has to shoulder the responsibility of the family.

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Physiological Cost of Mopping the Floor with Selected Types of Mop

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Abstract

The findings revealed that mopping the floor with sponge mop was better than wick and felt mops as the percentage reduction of all the physiological variables was more as compared to other types of mop. The use of the improved mops reduced the drudgery of women considerably mainly because of change in the posture while mopping, from squatting to standing with a slight bend at lumbar point. The squatting posture used for mopping the floor with cloth is more cumbersome as it involves static muscular efforts which may increase the heart rate out of proportion that may lead to irreparable damage to the body. Hence use of long handled mops is recommended in order to reduce the drudgery of the activity.

Key words : Physiological cost, mops, floor.

There are various tools available for mopping of the floor, eventhough it is carried out in traditional method by majority of women with the help of wet rag. It was also reported as one of the most strenuous cleaning activity and demands much energy and time (Varghese *et al*. 1989, Sujata *et al.* 2000)

It was also reported as one of the disliked activity by the home maker due to its dirty work and repetitive task (Gupta 1996). It is most fatiguing due to the use of inefficient tools and methods for performance of the task. The scope of ergonomics includes fitting the demands of work to the efficiency of a person in order to reduce stress and designing equipment, so that they can be operated with great efficiency, accuracy and safety. Keeping this observation in mind a physiological study was undertaken to study the drudgery of mopping operations in both traditional and improved methods in terms of heart rate, energy expenditure, postural deviation of the body, perceived exertion etc.

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Materials and Methods

The study was undertaken in selected houses of Parbhani town in the year 2002. A sample of 20 non pregnant, non lactating women with normal body temperature and blood pressure in the age range of 25-35 years was randomly selected for the study. Similar type of polished mosaic tiled flooring, covering a fixed area of 10x12 ft. was selected to conduct the experiment. The most commonly available and sold mops in local market namely wick, felt and sponge mops were selected for the assessment of physiological cost of mopping the floor. Measurement of heart rate was done by using polar sports tester heart rate monitor. Resting and working heart rate while performing the activity was recorded continuously for 5-6 min. The energy expenditure was calculated from the heart rate responses of the subjects using the formulae given by Varghese (1994).

Flexi curve was used to measure the postural alignment of the body of women at cervical and lumbar while performing the activity with each mop. The extent of postural deviation was expressed in angle degree. The subjective perception of exertion was recorded by using a five point scale developed by Varghese *et al.* (1994) adopted from Borg's RPE scale after performing the activity with each type of mop. The scale was quantified on five point psychological continuum by scoring 1 to 5 from very light to very heavy. 'T' test was applied to find out the difference between means of selected physiological variables while performing the activity with cloth and improved mops.

Results and Discussion

The physiological parameters selected to appraise workers input in both traditional and improved method were average heart rate, peak heart rate, average energy expenditure, peak energy expenditure, rated perceived exertion and postural deviation of the body at cervical and lumbar point while mopping the floor with selected types of mop.

It is evident from the Table 1 that the reduction in physiological parameters ranged from 8.94 to 46.98 per cent while mopping the floor with wick mop over the cloth mop. Among the various physiological parameters selected for the study higher percentage change was found in case of postural deviation at lumbar point of the body (46.98%) followed by postural deviation at cervical point by 24.24 per cent. The percentage reduction in case of peak energy expenditure was higher (20.86%) than average energy expenditure of 17.87 per cent. The peak and average working heart rate was reduced by 11.20 and 8.94 per cent which in turn reduced the perceived exertion of the women by 36.92 per cent. Statistically the difference in the percentage reduction of selected physiological parameters between cloth and wick mops was highly significant. Highly significant percentage reduction in postural deviation may be attributed to the fact that use of wick mop changed the posture from squatting to standing with slight bend at lumbar point.

It is clear from the data on cloth mop v/s felt mop that reduction in physiological parameters selected for the study ranged from 8.97 to 49.67 per cent while mopping the floor with felt mop in comparison with the cloth mop. The highest percentage reduction was noticed in postural deviation of body at lumbar point (49.67%) followed by postural deviation at

Table 1. Reduction in physiological cost of work while mopping the floor with differnet mops.

Mopping of the house	A.H.R. (bpm)	P.H.R. (bpm)	A.E.E. (kg min^{-1})	P.E.E. (kg min^{-1})	R.P.E. (Mean)	P.D.L. (degree)	P.D.C. (degree)
Cloth mop	110.74	117.8	8.90	10.02	3.25	7.45	4.95
Wick mop	100.84	104.70	7.31	7.93	2.05	3.80	3.95
% change over existing	-8.94 (t=6.65**)	-11.20 (t=7.47**)	-17.87 (t=6.91**)	-20.86 (t=8.04**)	-36.92 (t=7.05**)	-46.98 (t=4.10**)	-24.24 (t=2.27**)
Felt mop	100.82	104.40	7.88	7.88	2.00	3.75	3.60
% change over existing	-8.97 (t=6.72**)	-11.45 (t=7.73**)	-21.35 (t=6.91**)	-21.35 (t=8.26**)	-38.46 (t=6.94**)	-49.67 (t=5.0**)	-27.27 (t=3.92**)
Sponge mop	99.19	102.25	7.05	7.54	1.65	4.45	4.30
% change over existing	-10.43 (t=7.92**)	-13.27 (t=8.97**)	-20.79 (t=8.04**)	-24.75 (t=9.54**)	-49.23 (t=9.41**)	-40.27 (t=3.29**)	-16.16 (t=1.32NS)

A.H.R. = Average heart rate; P.H.R. = Peak heart rate; A.E.E. = Average energy expenditure; P.E.E. = Peak energy expenditure; R.P.E. = Rated perceived exertion; P.D.L. = Postural deviation at lumber point; P.D.C. = Postural deviation at cervical point. *,** = Significant at 1 and 5 per cent respectively.

cervical point (27.27%). The significant percentage difference in the peak and average heart rate and energy expenditure brought significant reduction in perceived exertion while mopping the floor with felt mop as compared to cloth mop. Statistically a highly significant difference in percentage reduction of all the physiological variables between the cloth and improved felt mop was recorded. The long handled felt mop reduced the drudgery of women while mopping the floor as it reduced almost all the physiological parameters studied.

It is obvious from the data on mopping the floor with cloth and sponge mop that the percentage reduction in various physiological variables ranged from 10.43 to 49.23 while mopping the floor with sponge mop as against the cloth mop. Similarly like the other two mops among all the physiological parameters, reduction in postural deviation of the body at lumbar point was higher (40.27%) followed by reduction in peak and average energy expenditure by 24.75 and 20.79 per cent respectively. The perceived exertion was decreased by 49.23 per cent indicating half of the exertion is reduced with the use of the improved mop. Statistically significant difference was found in the means of selected physiological parameters between cloth and sponge mop.

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Design and Performance Evaluation of Hydrocyclone Separators for Micro-Irrigation Systems

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Abstract

The six hydrocyclone models were designed, fabricated and tested for its performance evaluation. The models were designed for the removal of particulate matter of size 48microns and larger sizes from irrigation water. The models were designed with combination of 20° and 26° cone angles and 0.04, 0.05 and 0.065 m underflow cylinder diameters. These hydrocyclones were fabricated with 3mm thick mild steel sheet. The clean water pressure drop and the percentage of sand trapped in hydrocyclone were recorded. It was found that, the model Ma with 26° cone angle and 0.065 m underflow cylinder diameter was the best model with the removal efficiency of 95.68 per cent among all the six models.

Key words : Hydrocyclone filter, vortex finder, micro irrigation.

Hydrocyclone is a simple mechanical device, with no moving parts, where solid particles or immiscible liquids are separated from liquid (hydro). Hydrocyclones are also known as sand separators, centrifugal filters or cyclone separators. A typical hydrocyclone consists of a cylindrical section, a conical section, an underflow cylinder section and a sand collection basket. Separation is based on density difference between the liquid and the matter to be separated. They use the principle of centrifugal separation to remove or classify solid particles from a fluid, based on particle size, shape and density. Hydrocyclones are used for separation of larger sized particulate matter in irrigation water before it is passed through the screen filters or sand filters. These primary filters are basically meant to reduce the workload on the secondary filters. The hydrocyclones that are presently used in drip irrigation are those that have been designed and used in other industrial applications and there is a good scope for improving their efficiency. For this purpose, there is a need to design hydrocyclones that are meant to be specifically used in drip irrigation systems, taking into account the needs of the system.

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Materials and Methods

Design parameters : A standard cyclone is defined as, a cyclone which has the proper geometrical relationship between the cyclone diameter, inlet area, vortex finder and apex orifice, and has sufficient length to provide retention time in order to properly classify the particles. There are various parameters to design those are as follows:

Cone angle : For design purpose, 20° and 26° cone angles were chosen. Arterburn (1976) reported that the larger the hydrocyclone diameter, the coarser the separation. The included angle of the cone section is normally between 10° and 20°.

Inlet and overflow section diameters : The inlet and overflow pipe diameter values were fixed at 0.05 and 0.05m respectively for a flow rate of 25 m^3 h^{-1}. Svarovsky (1984) reported that to increase the intake capacity of a hydrocyclone, its inlet diameter has to be increased.

Underflow cylinder diameter : To know the effect of change of underflow cylinder diameter on the performance efficiency of hydrocyclone, the three diameters of underflow cylinder section were chosen i.e. 0.04, 0.05 and 0.065 m.

Cylinder section diameter : In the present study, all the six models including the control model had a diameter of 0.198 m (I.D.) which was 3.73 times the overflow pipe diameter. Zhao and Abrahamson (1999) reported on the dimensions of cyclone, wherein they suggested that the diameter of cylinder section of the cyclone should be 2 times the overflow pipe diameter.

Cylinder section length : Typically hydrocyclones have a cylinder section length equal to or greater than the hydrocyclone diameter. Zhao and Abrahamson (1999) reported on the dimensions of cyclone, wherein they suggested that the length of cylinder section should be 3 times the overflow pipe diameter. Larger (660-840mm diameter) hydrocyclones typically have shorter cylinder sections height (Olson and Turner, 2002). In the present study, the cylinder section length was chosen as 3 times the overflow pipe diameter for models M_1, M_2, M_3, M_4, M_5 and M6 and the length of the cylinder section for the control model was 4.01 times the overflow pipe diameter.

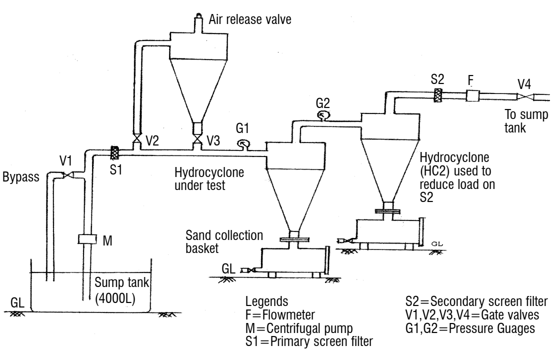

Fig. 1. Experimental set-up for testing of hydrocyclone.

Cone section length : The length of cone depends upon the underflow cylinder diameter and cone angle. The length of the cone was calculated by using a simple formula i.e.

$$\tan\frac{\theta}{2} = \frac{\text{opposite side (B)}}{\text{adjuscent side (A)}} \qquad (1)$$

$$\therefore A = \frac{B}{\tan\frac{\theta}{2}} \quad \text{and} \quad B = \frac{D}{2} - \frac{Du}{2}$$

Where,

θ = cone angle of hydrocyclone, degrees.

A = length of cone, m.

D = diameter of cylinder, m.

D_u = diameter of underflow pipe diameter, m.

Length of the underflow cylinder section : The length of underflow cylinder section varies with the cone length and cone angle. The underflow cylinder section starts at the point where it joins the cone section at one end and ends where the apex of the imaginary cut off portion of the cone is located namely at the entrance of the sand collection basket. This cone was cut at the selected underflow cylinder section diameter values i.e. 0.04, 0.05 and 0.065 m.

Height of hydrocyclone : The height from the top of the outflow pipe to the end of the underflow cylinder section is referred to as total height of hydrocyclone.

Vortex finder design : Vortex finder takes the clean water and delivers it to the outlet. If the length of vortex finder increases, it is likely to disturb the vortex and result in coarser separation of particles. So the length of the vortex finder should be optimum and is found by a trial and error method. In the study, the length of the vortex finder was kept at 0.398m for control model and 0.335m for the other six models. Arterburn (1976) reported that the diameter of the vortex finder was equal to 0.35 times the hydrocyclone diameter.

Cut size : The cut size is defined as the diameter (d_p) of a particle, which has a probability of n% to end up in the underflow section (Svarovsky, 1984). The design probability (n) of trapping of particles in the collection basket was taken as 95%. Particle separation,is based on the density difference between the liquid and the matter to be separated. A higher density difference results in a finer Reparation. For this investigation, silica sand with a specific gravity of 2.65 g cc^{-1} was selected. The hydrocyclones were designed by using the mathematical expression given by Anonymous, (2005a).

Material of fabrication of hydrocyclone : The cylinder section and cone section of the hydrocyclones were fabricated by using M.S. (mild steel) sheet of 3mm thickness. Commercially available 0.05m diameter, class-B mild steel pipe was used to fabricate the inlet and outlet sections of the hydrocyclone. To fabricate the underflow cylinder section, the commercially available 0.04, 0.05 and 0.065m diameter, class-B mild steel pipes were used as needed. All the hydrocyclones were coated with pure polyster powder.

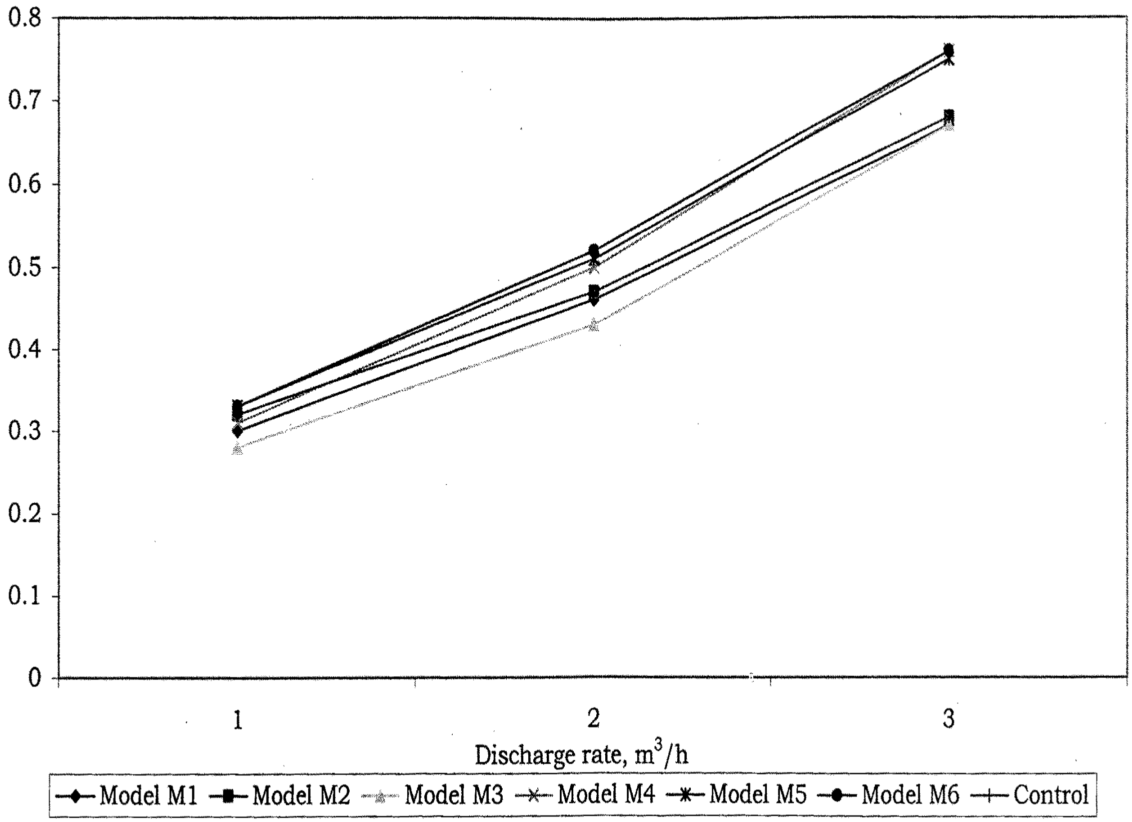

Fig. 2. Pressure drop across all seven hydrocyclone model.

Testing and performance of hydrocyclone : The clean water pressure drops for each model of hydrocyclone was recorded at discharge rates of 20, 25 and 30 $m^3 h^{-1}$. The hydrocyclone system was tested at each of the discharge rates with clean water, only. The pressure drop values in the hydrocyclones were tested according to IS: 14743:1999. The silica sand material trapped in collection baskets of respective hydrocyclone models were collected and analyzed for their particle size distribution. The experimental set-up for testing the hydrocyclone performance is illustrated in the Fig. 1. These values were then compared with the particle size distribution of the sand that was fed into the system. Based on this, the hydrocyclone with the maximum trapping efficiency was selected as the best model. The dimensions of this model of the hydrocyclone were selected as the best combination of dimensions.

The overall trapping efficiency of the hydrocyclone was calculated by using the formula given by Anonymous, (2005a):

Results and Discussion

Design of hydrocyclone : The design dimensions of the six hydrocyclone models (i.e. M_1, M_2, M_3, M_4, M_5 and M_6) calculated by using equation Anonymous (2005a) are presented in Table 1. The cone angle and the underflow cylinder diameter were the main variables for the design of these hydrocyclones. The control model was the earlier model and the same is in use by the farmers in drip irrigation systems. The control model was designed to remove particles of size 51.67 microns and more. Likewise, the models M_1, M_2, M_3, M_4, M_5 and M_6 were designed to remove particles of 48.73, 50.03, 52.21, 54.24, 55.61 and 57.90 microns and larger size respectively (Table 1).

Table 1. Design dimensions of hydrocyclone models.

Model	Cone angle (0/2), degrees	Flow, (%) $m^3 h^{-1}$	D_i = D_0,	Under flow cylinder dia, (D_u), m	Cylinder dia (D), m	Probability (λ) %	Viscosity of water, (n), kg $m s^{-1}$	Flow velocity, (V) (m/s)	Acceleration of water at vortex, (a), (m^2/s)	Cone length (m)	Cylinder length (m)	Cyclone height upto inlet (m)	Residence time (λ), (s)	ρ_s-ρ_1 (kg m^3)	D-Do (m)	Particle diameter dp, (μ)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Contol	10	25	0.053	0.053	0.198	95	0.00089	3.14	99.43	0.4412	0.213	0.6121	2.52	1650	0.1449	51.67
M_1	10	25	0.050	0.040	0.198	95	0.00089	3.54	126.48	0.4480	0.150	0.5480	2.27	1650	0.1480	48.73
M_2	10	25	0.050	0.050	0.198	95	0.00089	3.54	126.48	0.4197	0.150	0.5197	2.16	1650	0.1480	50.03
M_3	10	25	0.050	0.065	0.198	95	0.00089	3.54	126.48	0.3771	0.150	0.4771	1.98	1650	0.1480	52.21
M_4	13	25	0.050	0.040	0.198	95	0.00089	3.54	126.48	0.3422	0.150	0.4422	1.83	1650	0.1480	54.24
M_5	13	25	0.050	0.050	0.198	95	0.00089	3.54	126.48	0.3205	0.150	0.4205	1.74	1650	0.1480	55.61
M_6	13	25	0.050	0.065	0.198	95	0.00089	3.54	126.48	0.2880	0.150	0.3880	1.61	1650	0.148	57.90

Effect of change in cone angle on clean water pressure drop : The clean water pressure drops were recorded for all the seven hydrocyclones at three flow rates namely 20, 25 and 30 m^3 h^{-1}. The graphical representation of the pressure drop versus the cone angles for all the designed six models including control model is presented in Fig. 2. It was seen that at 25 m^3 h^{-1} flow rate, the models M_1, M_2 and M_3 which had a lower cone angle of 20 had a lower pressure drop of 0.46, 0.47 and 0.43 kg cm^{-2} and the models M_4, M_5 and M_6 which had a higher cone angle of 26° had a higher pressure drop of 0.50, 0.51 and 0.52 kg cm^{-2} respectively. Hence, as the cone angle increases the pressure difference between inlet and outlet increases and hence lower the cone angle, lower the pressure drop.

Effect of change in cone angle on performance : The results from the experiments showed that the models M_1, M_2 and M_3 with a cone angle of 20° had greater performance efficiency as compared with the models M_4, M_5 and M_6 which had cone angle of 26°. The results of the hydrocyclone performance in terms of the cumulative sand trap efficiency showed a decreasing trend with increasing cone angle (Table 2). This can be attributed to the fact that a smaller cone angle ensures a more gradual increase in the swirling velocity of water as it passes through the hydrocyclone, which in turn leads to a more perfect separation of larger particles. As the models were designed for separation of particles of size greater than 48microns, the silica sand of 56-106 microns size range assumes special significance. It was seen that the ms model with a cone angle of 20° could remove sand of 56-106 microns range with the maximum efficiency of 62.78 per cent among the models M_1, M_2 and M_3 with the same cone angle. The models M_4, M_5 and M_6 with the cone angle of 26 could remove the same size range particles with efficiencies of 58.64, 60.63 and 60.26 per cent respectively (Table 2).

Effect of change in underflow cylinder section on performance : A larger diameter of underflow cylinder section increases the fluid flow out through the underflow cylinder section, carrying more of particulate matter to the collection basket. If the underflow cylinder diameter is larger than the vortex finder diameter, the cyclone will often drain itself through the underflow cylinder section and perform no separation function. However, if the underflow cylinder diameter is too small, much of the heavier particulate matter may

Table 2. Cumulative average percentage of sand trapped in all hydrocyclone models.

Mesh size	Particle size (μ)	Cumulative initial percentage of sand taken (%)	Average cumulative percentage of trapped sand, %						
			20° cone angle				26° cone angle		
			Control	M_1	M_2	M_3	M_4	M_5	M_6
400-250	38-56	8	8.85	6.03	10.98	11.98	7.23	8.98	11.74
250-150	56-106	66	58.62	60.76	61.68	62.78	58.64	60.63	60.26
150-100	106-150	74	68.48	68.64	69.57	70.74	66.51	68.63	68.68
100-85	150-180	81	75.48	75.73	75.66	77.38	73.23	75.18	75.53
85-60	180-250	87	81.12	81.40	81.66	83.60	78.33	81.11	81.17
60-30	250-500	92	85.46	85.83	86.17	87.93	83.15	85.56	85.56
30-16	500-1000	96	89.38	89.64	89.96	91.83	86.81	89.38	89.54
16-8	1000-2000	100	93.22	93.32	93.73	95.68	90.43	93.18	93.33

discharge with the light particulate matter through the underflow cylinder section. In the present experiment, the three different diameters (i.e. 0.04, 0.05 and 0.065m) were chosen to see the effect of change in underflow diameter on the performance of hydrocyclone. It was observed that the models with 0.04m underflow cylinder diameter (i.e. model M_1 and M_4) were less efficient (sand trapping efficiencies 93,32 and 90.43 per cent respectively) than the models with 0.05m underflow cylinder diameter (i.e. models M2 and M5 having sand trapping efficiencies 93.73 and 93.18 per cent respectively) followed by the models with 0.065m underflow cylinder diameter (i.e. models M_3 and M_6 having 95.68 and 93.33 respectively) (Table 2).

The percentage of trapped sand for the models M_1 and M_4 were recorded as 60.76 and 58.64 per cent respectively in the 56-106 microns range particles (Table 2). Similarly, it was for the models M_2 and M_5 were recorded as 61.68 and 60.63 per cent respectively and for the models M_3 and M_6 were recorded as 62.78 and 60.26 per cent (Table 2) respectively in the 56-106 microns range particles.

Thus from the study, the following dimensions for a good hydrocyclone for the purpose of removal of solid particles from the water to be used for micro-irrigation :

Inlet and outlet diameter = 0.05 m (2")

Cylinder section diameter = 0.198m (I.D.)

Cylinder section height = 0.213 m

Vortex finder length = 0.335 m

Cone angle = 20°

Cone section length = 0.3771m

Underflow cylinder diameter = 0.065 m, if significant damage due to abrasion is expected (higher load of particulate matter in irrigation water).

Underflow cylinder diameter = 0.05 m, if the excepted damage is insignificant.

Underflow cylinder length = 0.184 m (if underflow diameter is 0.065 m).

Underflow cylinder length = 0.090 m (if underflow diameter is 0.05 m).

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Development and Performance Evaluation of Mist Blower with Air Sleeve Boom Attachment*

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Abstract

In order to have advantages of sleeve boom spraying with conventional mist blower, the horizontal flexible air duct of 1 m length was designed and developed with PVC material to generate an air for conventional ASPEE BOLO sprayer. The blower speed at 5250 rpm and the boom height of 50 cm, have shown better droplet density and droplet diameter with better coverage. The higher droplet diameter and droplet density were observed at top surface of leaf which were followed by middle and followed by bottom surface. The sprayer also reduced the drift in the range of 29.41 to 100 per cent as compared to conventional sprayer when it was operated at different blower speeds.

Key words : Air assisted sprayer, mist blower, sleeve boom sprayer, droplet diameter, droplet density

Precise application techniques are more important now than when pesticides were first introduced because of narrow margins of selectivity and more public concern about environment. The control of pest can only be achieved effectively if pesticides are properly applied at the correct rate, at the right time, on the target by appropriate equipment. Our greatest concern is about loss of pesticides during its movement from atomizer to the target area. Droplets may evaporate to become air borne and drift away at considerable distances from the target areas. A high percentage of drifting droplets is deposited adjacent to the target area in conventional sprayers. Some droplets become airborne and may move several kilometers before they are deposited, while other air-borne drops may not be deposited at all (Bode and Butter 1981). Therefore, it is of great importance to find means of minimizing drift losses from all pesticide applications.

Air assisted or air blast sprayer is now common used for orchard crops. Sleeve boom spraying technology, based on air assisted spraying, is suitable for field crop has land and economical constraints. Portable mist blowers now a days are common. In order to achieve better performance, usually it should be operated with greater skill. Under spraying or over spraying may occur if spraying is continued over a particular target for shorter time or longer time. It is also needed to direct the flexible boom properly and operated with optimum forward speed. Hence to have advantages of sleeve boom spraying technology, the work was undertaken on development of sleeve boom attachment suitable for portable mist blower.

Materials and Methods

Development of sleeve boom attachment : This work was undertaken ASPEE Agricultural Research and Development Foundation,

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Mumbai during 2006-07. The flexible hosepipe of the ASPEE Bolo sprayer was replaced with newly developed sleeve attachment (Fig. 1). The sleeve attachment consists of a duct or sleeve, a boom, accessories and nozzles. The horizontal flexible tapering type air duct was developed to generate an air curtain with a uniform air velocity profile from the outlets throughout the length of the boom. The length of the air sleeve was decided to be 1m. At the bottom of the duct, the two orifices of 40 mm diameter spaced at a distance of 450 mm. The air duct was kept 60 mm in diameter at inlet. Based on earlier research (Thakare, 2004) at every 20 cm interval from the inlet, the respective diameters of the taper sleeve were obtained as 54, 50, 45 and 40 mm (Table 1). At the end the sleeve was converging to zero diameter.

In order to reduce the weight of attachment system, the sleeve was fabricated with fiber reinforced PVC material. It was sewed to distribute air over the full length of the boom. The sleeve was fixed to outlet of the blower with the help of clamp fitted with thread. A boom of one-meter length was fabricated from 15 x 15 x 1mm MS square pipes. The boom was mounted on the base plate with the help of nuts and bolts. It was supported at the end with the help of wire rope of diameter 2 mm. The three circular rings of diameter 65 mm were attached to the boom to support flexible air sleeve sewed from fiber reinforced PVC material. The control valve was fixed immediately below the pesticide tank to regulate the flow of liquid. The sleeve was fixed to outlet of the blower with the help of clamp fitted with thread. The flow pipe was attached to the upper side of the air duct and tied to the boom. It was connected to the nozzles with tee joints. The nozzles were spaced at a distance of 450 mm and clamped to the sleeve. Two nozzles were fixed on the boom at 45 cm distance. These nozzles were kept inclined at

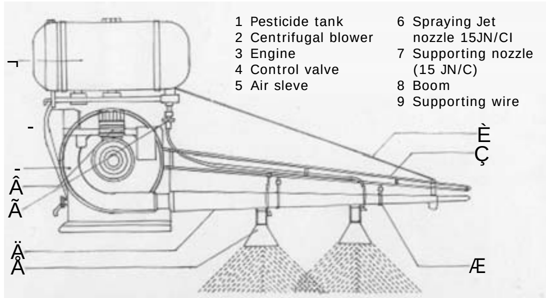

Fig. 1. Newly developed sprayer with sleeve attachment.

35° to the opposite direction of travel based on the earlier study (Thakare, 2004).

The performance of newly developed sprayer was studied at different blower speeds and different heights of sleeve boom on brinjal plants. The characteristics of the sprayer and plant parameters under this study are as given in Table 2. To evaluate the performance, spray droplet diameter and droplet density were determined at six sections of brinjal plant i.e. top position of the plant and upper leaf surface (TU), middle position of the plant and upper leaf surface (MU), bottom position of the plant and upper leaf surface (BU), top position of the plant and lower leaf surface (TL), middle position of the plant and lower leaf surface (ML), bottom position of the plant and lower leaf surface (BL). To collect spray deposition

Table 1. The dimensions of air sleeve.

Particulars	**Dimensions (mm)**
Length of sleeve	1000
Inlet diameter of sleeve	60
Number of orifices on the sleeve	2
Diameter of sleeve at distance X from inlet	
X = 0.2 m	54
X = 0.4 m	50
X = 0.6 m	45
X = 0.8 m	40
X = 1.0 m	0.2
Center to center distance of orifices	450

the glossy papers 60 x 44 mm were positioned on the different sections of the plant. For monitoring the drift, the collectors in form of stand were erected and glossy papers (6.2 mm x 30 mm) were placed in the direction of travel at 0.90 cm spacing all over the field plot. After the experiment, the glossy papers were carefully removed and then taken for further analysis in the laboratory.

Results and Discussion

Effect of blower speed on droplet diameter and droplet density : The newly developed sprayer was tested in the field. Its blower was operated at the speeds of 4750, 5000, 5250, 5500 rpm and droplet diameter (VMD) was measured. The effect of speed on droplet diameter as well as droplet density was found statistically significant at 95 per cent

Table 2. The characteristics of sprayer and plants under study.

Sprayer		Plants	
Parameters	**Characteristics**	**Parameters**	**Characteristics**
Blower type :	Centrifungal	Name of the crop :	Brinjal (*Solanum melongena*)
Impeller :	Aluminium	Variety :	Kalpataru
No. of blades	3	Maximum height of plant :	900 mm
Diameter of blower outlet :	60 mm	Row to row spacing :	600 mm
Engine capacity :	535 cc	Plant to plant spacing :	600 mm
Maximum output in KW :	0.90	Average No. of leaves per plant :	283
Speed range :	2500-5500 rpm	Average width of plant :	500 mm

Table 3. Combined effect of blower speeds, boom heights on droplet diameter.

Blower speeds (rpm)	Boom heights (cm)	Mean droplet diameter (VMD), µm					
		Plant positions					
		TU	MU	BU	TL	ML	BL
4750	30	232.45	214.83	195.17	233.77	205.74	197.41
	40	219.06	208.02	164.03	219.07	198.89	154.37
	50	184.34	183.63	145.34	187.86	180.50	143.57
	60	196.68	197.00	134.77	180.50	176.27	138.28
5000	30	221.02	211.97	167.26	211.57	202.27	167.26
	40	210.89	199.46	182.73	208.22	186.25	173.29
	50	98.63	194.71	160.60	192.05	181.08	143.66
	60	186.60	180.39	139.58	177.70	177.02	139.58
5250	30	166.67	161.92	136.37	167.77	150.83	129.65
	40	165.91	153.34	133.79	146.44	129.26	126.63
	50	146.32	143.22	126.39	139.76	125.70	121.25
	60	130.49	129.34	123.80	114.12	108.56	117.19
5500	30	150.99	143.56	126.87	142.64	130.06	126.87
	40	139.24	138.43	123.12	135.26	124.50	106.89
	50	130.52	126.42	108.36	114.80	121.01	98.59
	60	125.57	120.79	99.90	109.20	113.06	89.25

LSD at 5% = 0.666

Table 4. Combined effect of blower speeds, boom heights on droplet density.

Blower speeds (rpm)	Boom heights (cm)	Mean droplet diameter (Nos. cm^{-2})					
		Plant positions					
		TU	TL	MU	ML	BL	BL
4750	30	14.75	14.00	11.50	10.00	5.25	2.75
	40	15.25	14.25	15.00	13.25	5.25	4.75
	50	15.50	14.75	15.50	15.00	5.50	4.50
	60	17.25	16.50	18.00	15.75	6.75	4.50
5000	30	19.25	17.50	14.00	11.00	6.25	4.50
	40	20.50	19.50	18.75	15.75	7.25	5.75
	50	20.25	20.00	19.75	18.00	8.25	6.00
	60	21.75	20.75	22.00	20.00	9.25	6.25
5250	30	21.50	20.00	20.00	20.00	7.00	6.00
	40	24.25	21.75	23.50	21.00	8.00	6.50
	50	24.75	22.00	24.50	23.00	8.25	7.75
	60	25.50	24.75	24.75	22.50	9.00	8.00
5500	30	25.00	24.50	21.75	21.50	8.50	7.00
	40	26.75	27.25	26.75	24.50	9.50	8.50
	50	29.50	27.00	29.50	25.50	9.75	9.00
	60	32.50	30.25	28.50	27.00	12.00	10.00

SE_m = 4.723, LSD at 0.05 = 0.222

confidence level. The slope of the curve showed that the droplet diameter decreased linearly with blower speed from 4750 to 5500 rpm with in the tested range of boom height and leaf surface. This might be due to increase in air velocity of the blower resulting into disintegration of droplets. The data were analyzed to develop a relationship between droplet diameter and blower speed for different positions of the plant. The relationship was found linear and expressed as $D = a + bN$; where, D = Droplet diameter (VMD) at different positions of plant, µm; N = Blower speeds, rpm; and a and b are regression coefficient.

The slope of the curve showed that the droplet density increased with blower speed from 4750 to 5500 rpm with in the tested range of boom height and leaf surface. The data analysis showed that it increased linearly at all the boom heights for upper surfaces of leaves , and polynomialy at boom heights of 30 and 40 cm for lower surfaces of leaves. The relationship was expressed as: $D = a + bN + cN^2$; where, D = droplet density; a, b, and c are regression coefficients.

Table 5. Comparative performance of newly developed sprayer and existing sprayer.

Plant positions	Droplet diameters (µm)		Droplet density (Nos. cm^{-2})	
	Newly developed sprayer	ASPEE BOLO sprayer	Newly developed sprayer	ASPEE BOLO sprayer
TU	146.32	139.73	24.75	23.00
TL	139.76	134.63	22.00	19.80
MU	143.22	134.68	24.50	20.50
ML	125.88	119.78	22.50	21.50
BU	126.39	122.95	8.25	7.00
BL	121.50	109.06	7.75	5.25

Effect of boom height on droplet diameter and droplet density : The newly developed sprayer was tested for the effect of boom heights on droplet diameter and droplet density. The boom heights were set at predetermined levels ranging from 30, 40, 50 and 60 cm and droplet diameter (VMD) and droplet density were determined. The relationship was developed for droplet diameter with boom heights at different blower speeds for different leaf surface. As the boom height increased the droplet diameter was found to be decreased for all the tested speeds and plant surface. The relationship was found linear type and expressed as : $S = a + bH$; where, S = Droplet diameter (VMD) at different positions of plant, um; H = Boom heights, cm; and a and b are regression coefficient. The data showed that the effect of boom height on droplet diameter and droplet density was statistically significant at 95 per cent confidence level.

It showed the relationship for droplet density with boom height at different blower speeds for different positions of leaf surface. The droplet density was found increased with boom height at all the blower speed and plant positions under tests. It was found linear at the blower speeds of 4750, 5250 and 5500 rpm for upper leaf surface, and also for blower speed of 5000 rpm for lower leaf surface. The relationship was found polynomial type at blower speed of 4750, 5250 and 5500 rpm for lower leaf surface and also for blower speed of 5000 rpm for upper leaf surface. The relationship was expressed as : $p = a + bH + cH^2$ where, D = droplet density Nos/cm^2 at different plant positions.

Combined effect of blower speeds, boom heights on droplet diameter and droplet density : The data shows that (Table 3 and 4) the combined effect of blower speed and boom height on droplet diameter as well as density was statistically significant at 95 per cent confidence level at all the plant positions. It was found that the droplet diameter decreased, with increase in blower speed and boom height. It was observed that towards the higher working speeds of blower i.e. 5250 and 5500 rpm and higher boom height i.e. 40, 50 and 60 cm, the size of droplets was decreased and attained the droplet size below the specified range of 125-150 µm. This effect was pronounced in case of lower positions of plant at bottom, middle and top surface of leaves and also for bottom positions for upper and middle leaf surface. Here, the droplet diameter (VMD) was obtained below 125 µm (Anonymous 1984). The higher droplet diameter was obtained at upper position of plant as compared to middle and bottom position. Also at top leaf surface the higher droplet diameter were obtained as compared to bottom surface of leaves.

Table 6. Comparative performance of drift for newly developed sprayer and conventional ASPEE BOLO sprayer.

Blower speeds (rpm)	Distance of drift collectors from rows	Droplet density (Nos. cm^{-2})	
		Newly developed sprayer	ASPEE BOLO
4750	90	12	20
	180	6	12
	270	2	7
	360	-	-
5000	90	16	23
	180	8	17
	270	4	6
	360	-	4
5250	90	17	28
	180	9	22
	270	4	12
	360	2	7
5500	90	24	34
	180	9	26
	270	6	15
	360	2	9

It was observed that (Table 4) the droplet density increasesd with increase in blower speed and boom height. The higher droplet density was obtained at upper position of plant as compared to middle and bottom position. Also at upper leaf surface the higher droplet density was obtained as compared to lower side of leaves. At higher blower speed i.e. 5250 rpm and at higher boom height i.e. 50 and 60 cm, the droplet density was obtained within the specified range for top upper and for higher speed of 5500, at top and middle position of upper and lower leaf surface.

The results indicated that newly developed sprayer at 50 cm boom height at 5250 rpm blower speed gave the best performance and resulted into droplets of required diameter and of better droplet density. The performance of newly developed sprayer at 50 cm height and at speed of 5250 rpm was compared with conventional ASPEE BOLO mist blower. The droplet densities obtained from newly developed were within optimum range, for top and middle position of plant, which is missing in case of existing sprayer (Table 5). For all the plant positions the droplet densities of the developed sprayer were of higher as compared to the droplet densities by conventional sprayer. Considering the advantages of air-assisted sprayer i.e. coverage of lower canopy of leaf surface, it is noted that the newly developed sprayer has resulted in to 11.11, 4.65 and 47.61 per cent, higher number of droplets respectively on lower surface of leaf *viz*., top, middle and bottom, respectively.

The drift for newly developed sprayer was found to be less than the conventional sprayer. The drifts reduction obtained (Table 6) by newly developed sprayer over ASPEE BOLO sprayer was in the range of 40 to 71.42; 30.43 to 100; 39.28 to 71.42 and 29.41 to 77.77 per cent for blower speed of 4750, 5000, 5250, 5500 rpm separately indicated that the newly sprayer is better to control environmental pollution.

The above study revealed that the blower speed of 5250 rpm and boom height of 50 cm are found to be best combination of operating parameters for newly developed knapsack type sleeve boom sprayer for better coverage on upper as well as lower leaf surface with better drift control.

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Development and Performance Testing of Mechanical Fruit Washer (Stirrer Type)

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Abstract

A prototype of mechanical fruit washer was developed and evaluated for its performance. The effect of three different rotor speeds (1466, 1476 and 1486 rpm) and rotor types (A.B.C.) with 20 cm (110 lit) depth of water was studied on capacity and performance index was evaluated for mango, potato and tomato fruits. Highest capacity (833.17 kg hr^{-1}) was found with 98.09 per cent washing efficiency and 3.90 performance index at 1486 rpm using rotor C in case of tomato washing. The ratio of cost of manual to mechanical washing for mango, potato and tomato was found 4.26:1, 5.89:1 and 7.58:1, respectively. The average cost of mechanical washing was found Rs. 24.80 per tonne. The overall dimensions of machine were 1000 x 560 x 750 mm.

Key words : Fruit washer, rotor speed, capacity, performance index, efficiency.

There are attractive opportunities for entrepreneurs in the field of fruit and vegetables processing. The installed capacity of fruit and vegetable processing industries has increased from 21 lakh tonnes in 1979 to 22 lakh tonnes in 2000. The production of processed fruits and vegetables in the country has increased from 9.8 lakh tonnes in 1999 to 9.9 lakh tonnes in 2000 (Rasul,2002). Productivity of fruits $hectare^{-1}$ has nearly doubled from the level of 5.52 to 10.28 t ha^{-1}. Presently the areas under fruits and vegetables production are 5.63 and 5.6 million hectares, respectively (Ranganna, 2003).

Washing of fruits and vegetables is vital steps in any processing operation, which give attractive and chemical free fruits. At present washing of fruits is carried out manually which is very tedious and time consuming. In view of this, a prototype of mechanical fruit washer (stirrer type) was developed at Dr. A. S. College of Agricultural Engg. and Technology, Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra). The fruit washer was tested for mango, potato and tomato washing.

Materials and Methods

The machine works on the principle of turbulent flow of water created by different rotors in the machine chamber. The fruits kept in washing tray would come in contact with the vortex created by water in the chamber and fruit get washed. The turbulence of water is available from the sides and bottom of tray, which effectively wash the fruit without any mechanical damage.

The fruit washing machine (stirrer type) (Fig. 1) consisted mainly; washing unit, body and lid, rotor assembly, main frame and power transmission unit and drive mechanism.

Washing unit : Washing unit consisted of washing tray. The tray was fabricated using M.S. angle and iron netting, rectangular in

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shape. The overall dimensions of tray were 280 x 370 x 550 mm. The tray was painted with special enamel paint to avoid rusting by water. The tray was fitted in the chamber by supporting frame at distance of 150 mm from the bottom. The tray was fitted exactly at the centre of chamber by keeping equal distance (100 mm) from all the four sides.

Body and lid : The body of the washer was fabricated with 20 gauge G.I. sheet (1.2 mm). The overall body dimensions were 850 x 560 x 650 mm. The machine was covered with a lid made up of G.I. sheet of 1.2 mm thickness. The lid was kept close during washing operation. The inlet pipe (10 mm) for incoming water and outlet pipe (25 mm) for discharge of contaminated water was also fitted to the body of machine.

Rotor assembly : The rotor assembly consisted of rotor blade, shaft and pulley. The various shapes (Fig. 2) of rotor were used for conducting the trials. The rotor was fitted at the end of vertical shaft by groove arrangement. The provision of replacement of rotor was made by key and pin arrangement. The shaft was rotated by pulley (50mm) arrangement at rated speed and created vortex in the water.

Main frame : The main frame of washer was made in rectangular shape by using 25 mm M.S. angle and G.I. sheet. The overall dimensions of main frame were 1000 x 560 x 750 mm. The main frame was kept on rigid platform at height of 100 mm from the ground.

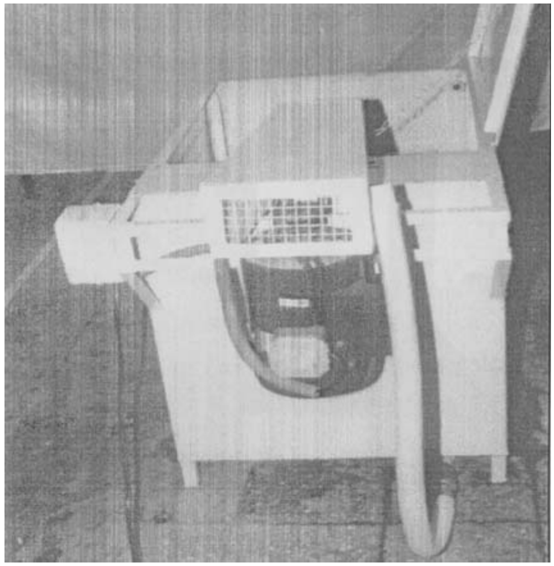


Fig. 1. Mechanical fruit washer

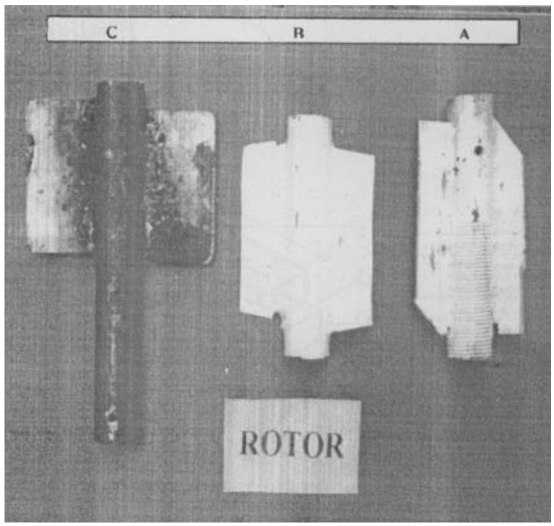


Fig. 1. Types of rotors

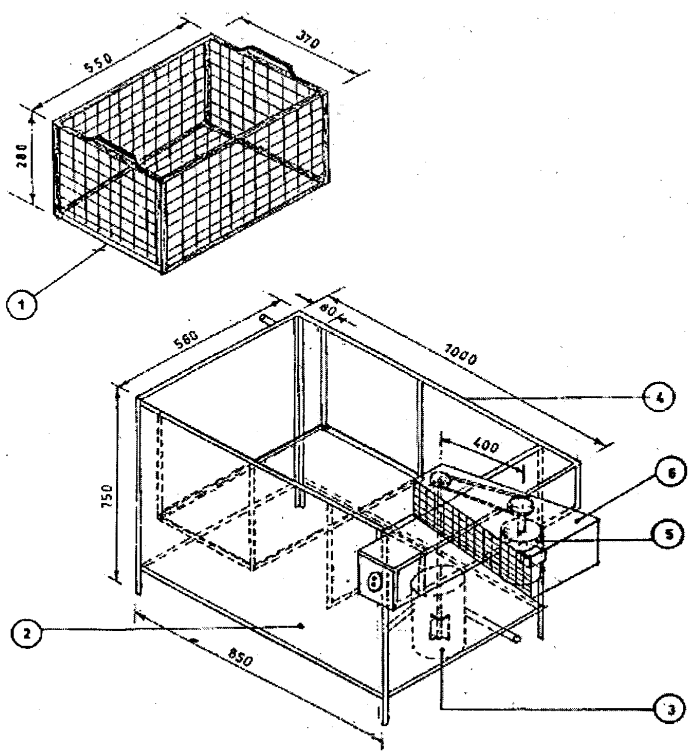
Power transmission mechanism and drive mechanism : The power transmission unit-frame was fabricated by using M.S. angle and fitted to the water chamber from outside in such a way that motor will fit vertically on the frame. The power transmission unit could be divided into two parts. The stirrer power assembly and motor shaft assembly or speed reduction unit including 1 HP single phase (1440 rpm) electric motor. The blade was fitted to the vertical shaft with the help of support and two bearing (No.6204). Power was given from motor to shaft by V-belt and speed reduction was achieved with the help of pulley combination. The motor pulley was 75mm while shaft pulley was 50 mm.

Experimental variables : Three blades of different specifications were used for creating desired vortex in the water. a. Type of rotor : A. Height (110 mm), width (65 mm) and effective width (55 mm); B. Height (110 mm), width (75 mm) and effective width (65 mm); C. Height (110 mm), width (100 mm) and effective width (90 mm). b. Rotor speed : 1466, 1476 and 1486 rpm. C. Type of fruit : mango, potato and tomato

Experimental technique : The speed of rotor (1466, 1476 and 1486 rpm) was kept variable while conducting the trials. The optimum rotor speed and time was worked out. Minimum depth of water in the washer was kept 20 cm (0.11 m^3 volume). Minimum water required for the trial per hour was 110 lit. The washing efficiency was calculated by using equations given by Ranganna, (1991) and Dauthy, (1995).

Results and Discussion

Washing efficiency of mango fruit : The washing efficiency of washer was tested for three speeds of 1466, 1476 and 1486 for three rotors at 20 cm water depth (1 10 lit water). It was observed from Table 1, that higher (97.07%) efficiency was. observed for rotor C at 1486 rpm, followed by rotor A (96.98%) and rotor B (96.59%).It was observed during the trial that there was less vortex created by rotor A and rotor B. It may be due to its configuration. It was also observed that three to four times stirring was required for rotor A and rotor B after every minute. However, in case of rotor C, stirring was not required. It may be due to greater turbulence created by rotor C.



Sr.	Name of the Parts	Mat.	Qty.
1	Cleaning unit	M.S Angle	1
2	Body and laid	G.I. Sheet	1
3	Rotary Assembly i) Rottor blade ii) Rottor shaft Pully	 M.S. STD.	 1 1
4	Main Frame 25 mm T.	M.S. Angle	
5	Power Transmission Unit [Motor 1HP Single phase 1486 rpm]	STD.	1
6	Motor Guard	M.S.	1

Fig. 3. Line diagram of mechanical fruit washer.

Washing efficiency of potato : The higher efficiency (98.18%) was recorded by rotor C at 1486 rpm. Lower efficiency (97.43%) was recorded for rotor B followed by rotor A (97%). It also observed that there was no significant increase in efficiency for different rotor speeds in case of potato washing.

Washing efficiency of tomato : The higher efficiency (98.09%) was recorded for rotor C followed by rotor A (98.07%) and rotor B (97.92%). It was observed that no stirring is required for tomato which may be due to sufficient vortex created by different rotors. The tomatoes were found bouncing in the washing tray due to higher turbulence of water and got washed without any mechanical damage. Similar results were reported by Sehgal and Arora (2003) for washing of carrot in a rotary vegetable washing machine.

Capacity of machine for mango washing : Capacity of machine to wash mango was worked out for three rotors at different speed (Table 2). The capacity of 391.2, 396.69 and 779.85 kg hr^{-1} was

Table 1. Washing efficiency of mango, tomato and potato.

Sample used for washing	Speed of rotor (rpm)	Rotor A				Rotor B				Rotor C			
		Wt (g)	Ww (g)	Time (min)	Eff.	Wt (rpm)	Wt (g)	Time (min)	Eff.	Wt (g)	Ww (g)	Time (min)	Eff.
Mango :	1466	5375	5165	1.20	96.09	5349	5130	0.85	95.90	3.22	5115	0.71	96.11
	1476	5347	5155	0.90	96.40	5302	5115	0.81	96.47	5320	5138	0.49	96.59
	1486	5378	5216	0.80	96.98	5340	5157	0.78	96.59	5356	5199	0.40	97.07
Potato :	1466	5356	5170	0.91	96.52	5346	5160	0.71	96.52	5320	5156	0.42	96.54
	1476	5344	5150	0.75	96.36	5340	5148	0.69	96.40	5318	5135	0.39	96.54
	1486	5340	5180	0.60	97.00	5340	5203	0.60	97.43	5300	5204	0.35	98.18
Tomato :	1466	4135	4040	0.45	97.70	4120	4035	0.55	97.93	4140	4030	0.35	97.37
	1476	4125	4036	0.42	97.84	4135	4031	0.51	97.24	4126	4029	0.31	97.64
	1486	4110	4031	0.39	98.07	4115	4029	0.42	97.92	4105	4027	0.29	98.09

Eff. = Ww/wt x 100

Table 2. Effect of speed and type of rotor on washing capacity, efficiency and performance index for washing mango, potato and tomato.

Rotor type	Speed rotor (rpm)	Mango			Potato			Tomato		
		Capacity (kg hr^{-1})	Efficiency (%)	P.I.	Capacity (kg hr^{-1})	Efficiency (%)	P.I.	Capacity (kg hr^{-1})	Efficiency (%)	P.I.
A	1466	258.25	96.09	0.92	340.87	96.52	2.10	538.66	97.70	1.46
	1476	343.66	96.40	1.22	412.00	96.36	2.25	576.57	97.84	1.77
	1486	391.20	96.98	1.40	512.00	97.00	2.42	620.15	98.07	2.21
B	1466	362.11	95.90	1.28	436.05	96.52	1.72	440.18	97.93	1.87
	1476	378.88	96.47	1.35	447.65	96.40	1.84	474.23	97.24	1.94
	1486	396.69	96.59	1.42	520.03	97.43	2.25	575.57	97.92	2.26
C	1466	432.25	96.11	1.54	733.71	96.54	2.68	690.85	97.34	3.16
	1476	629.14	96.59	2.25	790.00	96.54	3.04	779.80	97.64	3.14
	1486	779.85	97.07	2.80	892.11	98.18	3.26	833.17	98.09	3.90

observed for rotor A, B and C respectively at 1486 rpm speed. Maximum capacity (779.8 kg hr^{-1}) for mango washing was recorded at 1486 rpm for rotor C. It was observed that as speed increased, capacity of machine increased. It was also observed that further changes in machine speed beyond 1486 rpm may increase the capacity.

Capacity of machine for potato washing : Maximum capacity (892.11 kg hr^{-1}) was observed with 98.18 per cent washing efficiency for rotor C at 1486 rpm followed by 520.03 kg hr^{-1}, capacity with 97.43 per cent washing efficiency for rotor B and 512 kg hr^{-1} capacity with 97 per cent washing efficiency at same rpm for rotor A. As rotor speed increased, efficiency did not show any significant increase (Table 2).

Capacity of machine for tomato washing : It was observed from the Table 1 that, highest washing (833.17 kg hr^{-1}) with 98.09 per cent efficiency at 1486 rpm for rotor C. Capacity 575.57 kg hr^{-1} (97.91%); 620.15 kg hr^{-1} (98.07%) was recorded in rotor B and rotor A at same speed.

Performance index of washer : It was observed from the Table 2 that, the performance index was found maximum at the highest rotor speed (1486 rpm) with rotor 'C'. It was 3.90 for tomato, 3.26 for potato and 2.80 for mango. This may be because of higher washing efficiency and capacity obtained with tomato due to higher turbulence created by rotor with the fruits.

Cost of fruit washing : The total cost of machine including motor was evaluated to be Rs.14, 650/-. Table 3 indicates that ratios of cost of manual washing against machine washing were 4.26:1, 5.89:1 and 7.58:1 for mango, potato and tomato respectively. It means that developed fruit washer saved 76.57, 83.02 and 86.82 per cent of money on mango, potato and tomato washing over manual washing.

Table 3. Cost of manual washing and machine washing.

Sample	Manual washing (per tonne)	Washing by maching (per tonne)	Ratio
Mango	Rs. 115/-	Rs. 26.94/-	4.26:1
Potato	Rs. 132/-	Rs. 22.41/-	5.89:1
Tomato	Rs. 190/-	Rs. 25.04/-	7.58:1

The washing capacity, efficiency, and performance index was found maximum in case of tomato mango and potato by using rotor C at 1486 rpm speed.

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Influence of Tool Shape and Operating Parameters on Soil Disruption of Reversible Shovels for Tractor Drawn Cultivator in Sandy Loam Soil

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Abstract

Furrow parameters such as furrow bottom, soil throw, soil disturbance in vicinity of tool in relation to speed and depth of operation were affected by tool parameters like shape and size. Tool shape, depth and speed of operation affects soil profile, spoil and trench area significantly. Wider spoil furrows were obtained by shovel 2 at higher speeds, whereas at lower speeds and depths both shovels behaved in similar manner. Shovel 1 resulted in higher spoil furrow depth and more crescent height especially when working at higher depths. The depth was affected more spoil and trench area for both the shovels. However, shovel I gave more spoil area whereas shovel 2 resulted in higher trench area.

Key words : Shovels, soil disruption, soil profile.

The field cultivators are often used as secondary tillage tools for seedbed preparation. Reversible shovel, sweep, half sweep, furrower etc. are the different types of tool that can be attached to a cultivator shank for different applications. Soil disruption, which is a measure of effectiveness of tillage implement is affected by type of tillage tool, speed and depth of operation. Soil profile or soil redistribution after tillage operation is important in several aspects such as seed placement and covering, incorporating manure and crop residues, protecting soil from wind and water erosion etc. (Liu and Kushwaha, 2006). The study of soil profile and soil redistribution by tillage has progressed slowly due to its complexity which involves many factors, such as soil types and properties, types of tillage tools and their operational parameters. Furrow parameters such as furrow bottom, soil throw, soil disturbance in vicinity of tool in relation to speed and depth of operation are affected by tool parameters like shape, size and spacing, operating parameters such as speed and depth of operation and soil parameters like soil type, moisture content, compaction etc. and are studied by various researchers (Dowell *et al*. 1988, Raper and Sharma, 2004, Raper, 2005, Darmora and Pandey, 2006, Godwin and O'Dogherty. 2006. Liu and Kushwaha, 2006, Manuwa and Ademosun, 2007). Keeping these points in view the study was conducted with the objective to study the influence of shape of reversible shovels, speed and depth of operation on soil disruption.

Materials and Methods

The experiments using RBD design were conducted in indoor circular soil bin filled with locally available sandy loam soil at College of Technology and Engineering, Udaipur, Rajasthan, India. It had an outer diameter of 5520 mm, inner diameter of 3490 min and a depth of 900 mm. Thus annular width of 1010 mm was available for operating the too! frame. A DC variable shunt wound motor of 20 hp was coupled to worm gear for speed reduction in the ratio of 5:1. The vertical powered shaft was clamped to the horizontal beam of 3150

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mm length and 65 mm diameter. A pneumatic wheel was provided at the outer end of the horizontal beam out side the soil bin for continuous support during operation. A rectangular tool frame was clamped to the horizontal beam at 2420 mm distance from center. A control panel consisting of electrical switch, voltmeter and a regulator was used to increase or decrease the rpm of motor for obtaining the desired operating speed of the shovels. The forward speed of the tool was calculated as : $V = \omega \times r$ (1)

where, V is forward speed of tool (m/s), ω is angular velocity of horizontal shaft (rad/s), r is radius of rotation (m).

A MS cylindrical roller of 310 mm diameter and 610 mm length was hinged to the tool frame by metal strip. The purpose of roller was to maintain uniform compaction and soil level through out the test to simulate the soil conditions observed in the field having average cone index value 1160 kPa. It was measured up to a depth of 0.15 m by field scout digital cone penetrometer (ASAE standards, 1998 and Wilkinson *et al.*, 2002). Soil moisture level of 10.5 per cent (db) was maintained during the experiments as agricultural operations are usually performed at this moisture level. Two types of commonly used reversible shovels in tractor drawn cultivator for in the region were selected for the experiments (Fig 1). They are: Shovel 1 (Reversible shovel) and Shovel 2 (Spear shape shovel).

These shovels were clamped on the shank (Fig. 2) which was mounted on the tool frame. The selected cultivator shovels are normally used for tillage sowing and intercultural operations. Keeping these three operations in view the experiments were conducted with in the range of 0.04 to 0.16 m depth and 0.97 to 1.81 m/s speed of operation. These operations are normally performed within this range.

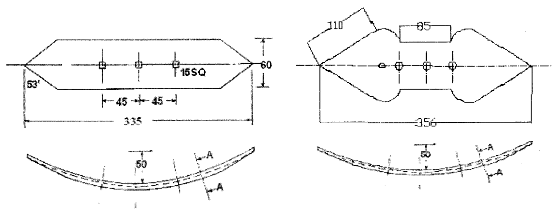


Fig. 1. Reversible shovels used in the study.

Table 1. Various parameters considered in the study.

Parameters	Levels	Particulars
Tools parameters :		
Tools type	2	shovel 1, shovel 2
System parameters :		
Speed, m/s	4	0.97, 1.25, 1.5, 1.8
Depth of operation, m	4	0.04, 0.08, 0.12, 0.16
Soil parameters :		
Soil type	1	Sandy loam soil
Moisture content	1	10.5%, (db)
Parameters to be observed		
Soil disruption		
1. Soil profile :		
Spoil furrow width		
Spoil furrow depth		
Crescent height		
2. Spoil area		
3. Trench area		

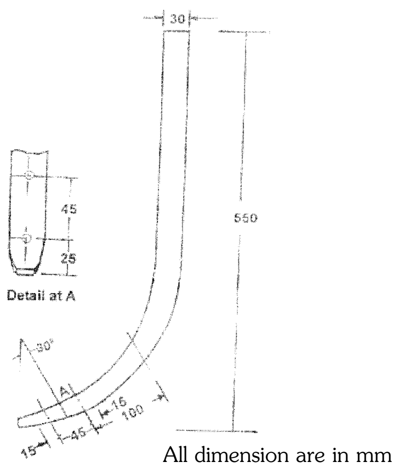
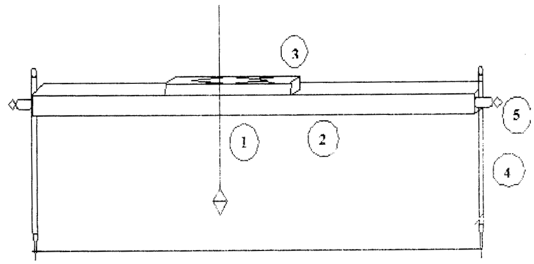


Fig. 2. Dimensional details of shank.

Experimental parameters of the study are given in Table 1.

Soil disruption : It was classified as surface and subsurface soil disturbance. The surface soil disturbance or spoil is a measurement of the amount of soil displaced above the original soil surface by the tillage process and subsurface soil disruption or trench is the area that is disrupted below the soil surface (Raper 2005).

Soil disruption was measured with the help of soil profilometer (Fig 3). The profilometer was fixed across the trench and the main scale was adjusted with knobs and spirit level to keep it horizontally leveled. With the help of plum bob the vertical depth or height of the soil surface was determined at every 2 cm horizontal distance on the main scale. Replicated observations of soil disruption were recorded for each of the tillage tools. After completion of surface disruption measurement the profilometer was kepi installed and the manipulated soil mass was removed from the trench below the profilometer with hand without disturbing the instrument and care was taken to ensure that only soil loosened by tillage was removed. The performance of shovels were compared on the basis of geometric parameters of spoil and trench profiles (Fig 4) and their areas of disruption. The data were statistically analyzed using SPSS software.



1. Plumb bob 2 Horizontal scale 3. Spirit level
4. Supporting rod 5. Knob

Fig. 3. Schematic view of profilometer for measurement of soil disruption

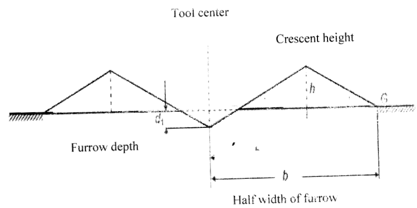


Fig. 4. Geometric parameters used to determine soil profile after tillage.

Results and Discussion

ANOVA showed that tool shape, speed and depth of operation and their interactions affected spoil and trench area significantly.

Effect of tool speed and depth of operation on soil profile : The spoil and trench profiles created by two shovels at different speeds and depths. It is clear from the Figs, that spoil furrow width (2b) and spoil furrow depth (d) increased with increase in either speed or depth for both the shovels. This may be attributed to increase in tillage speed and depth which resulted in loosening of more soil and redistributing it in a wider length outside the trench. Similar findings are also reported by Liu and Kushwaha (2006).

At lower speeds and depths of operation both shovels resulted in about same spoil furrow width (0.24 m) whereas at higher speed shovel 2 resulted in 20 per cent more furrow width than shovel 1 (0.30 m). At higher depths of operation both shovels behaved in a similar way under similar conditions. At lower depths shovel I resulted in about 52 per cent and 34 per cent higher spoil furrow depth as compared to shovel 2 (0.021 and 0.027 m) at lower (0.97 m/s) and higher (1.81 m/s) speeds of operation respectively. At higher depths of operation (0.16 m) similar behavior was observed resulting in about 7.32 per cent increase in furrow depth than shovel 2 (0.078 and 0.085

m) for the same increase in forward speed. This suggests that shovel 1 gives less seed cover during sowing operations than shovel 2. It was observed that at lower depths and speeds of operation shovel 2 resulted in 16.6 per cent higher crescent height than shovel 1 (0.027 m). This value reduced to 6.8 per cent more of shovel's 1 crescent height (0.022 m) when speed increased up to 1.81 m/s. A reverse trend was observed at higher depths of operation where shovel 1 resulted in higher crescent height values of 0.0790 and 0.0675 m as compared to that of shovel 2 (0.068 and 0.060 in) respectively. This may be attributed to the spear shape of shovel 2 which resulted in wider soil spread with lower crescent height and spoil furrow depth as compared to nose shaped shovel 1. Hanna *et al*., (1993) had also reported that wider tools behave in a similar manner.

Effect of tool speed and depth of operation on spoil area : Figure 5 showed that spoil area increased with increase in depth of operation and speed for both the shovels, however shovel 1 gave 2.48 per cent more spoil area than shovel 2 at all speed and depth of operation. For the tools tested it was depth of operation which affected more the spoil area than the speed of operation. The effect on spoil area was more dominant especially when depth of operation increased beyond 0.08 m. At lower and higher depths (0.04 and 0.16 m) with the increase in speed the rate of increase in spoil area was highest (37.89 per cent) for shovel 2 at a given speed of operation. At 0.04 m depth of operation shovel 1 and shovel 2 resulted in non-significant change in spoil area operating at a forward speed of 1.53 m/s and 1.25 m/s respectively. This suggests that the similar spoil areas can be obtained for different tools through specific combinations of speed and depth of operation. At a given depth of operation the rate of increase in spoil area was highest for shovel 1 which was more (235.25 per cent) al lower speed (0.97 m/s) than at higher speed of operation (192.85 per cent). This may be due to the fact that shovel 1 might have to handle less volume of spoil as compared to shovel 2 because of its shape and threw more soil out of trench there by increasing spoil furrow depth which led to higher rate of increased in spoil area.

Effect of tool speed and depth of operation on trench area : Figure 6 showed that trench area increased with increase in depth and decreased with increase in speed of operation for both shovels. The area varied all most at steady rate with increase in depth and

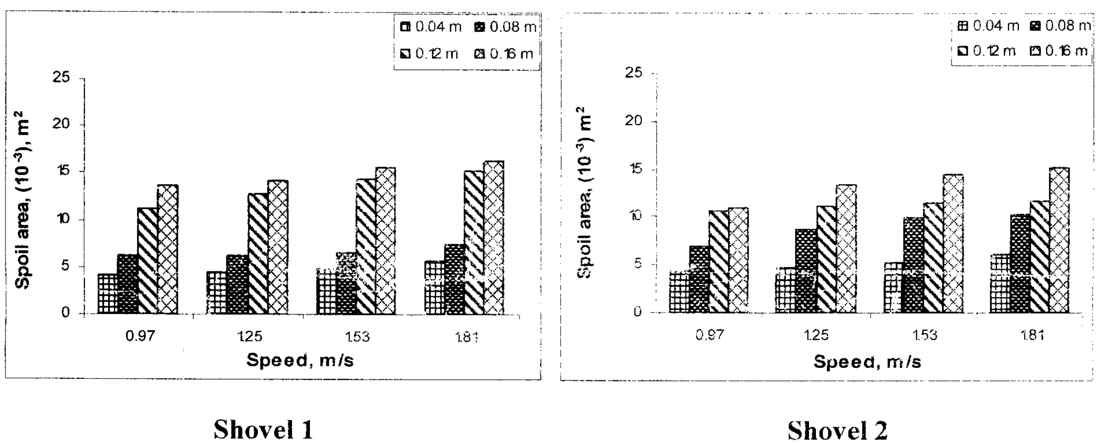


Fig. 5. Effect of speed at different depths on soil area of different shovels.

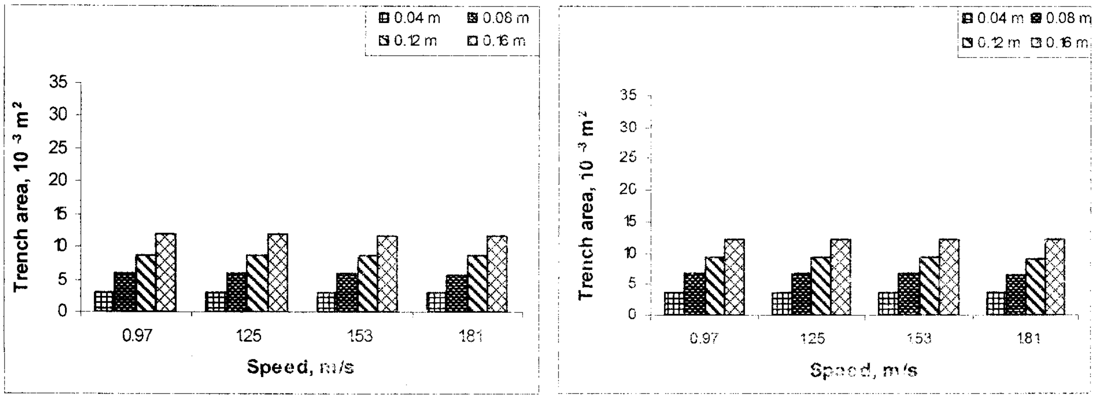


Fig. 6. Effect of speed at different depths on trench area of different shovels.

speed of operation in both shovels. Shovel 2 resulted in more trench area (7.36 per cent) than shovel 1 (0.00737 m2) at all depths and speed of operation. This may be due to the wide cross-section of the shovel 2 that disturbed a larger zone than shovel 1. Similar findings have been reported by Sharifat and Kushwaha (1999) and Mielke *et al.* (2004).

Similar to spoil area, depth of operation was affected more the trench area than the speed of operation. Trench area was not affected significantly with increase in speed from 0.97 to 1.81 m/s at all depths for both the shovels. However it increased at a higher rate for shovel 1 at 0.97 m/s (284.43 per cent) and 1.81 m/s (288.15 per cent) forward speed when depth of operation increased from 0.04 to 0.16 m. This suggests that narrow tools affect trench area at a higher rate than wider tools with increase in depth of operation. Similar findings have been reported by Hanna *et al.* (1993).

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Effect of Sanitary Practices on Quality of Pandharpuri Buffalo Milk on Different Organized Farms

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Abstract

Twelve Pandharpuri buffaloes of same stage of lactation were selected for present investigation. Out of these 6 animals were milked by machine and others were milked by hand milking. The average of SPC and coliform count per ml of unwashed and washed udder milk samples at Pune farm were 261 x 10^3; 36.4 x 10^3 and 38.0 x 10^2; 5.5 x 10^2, respectively. The average SPC and coliform counts of unwashed and washed udder milk samples at Kolhapur farm were 208 x 10^3; 21.3 x 10^3 and 32.4 x 10^2; 3.1 x 10^2 c.f.u. per ml, respectively. Washing of udder has shown decreasing trend of SPC and coliform counts of raw milk. The SPC and coliform counts of raw milk obtained from unwashed udder were significantly (< 0.01) higher than washing of udder. The average SPC of raw milk obtained by hand milking and machine milking at Pune farm were 27.5 x 10^3 and 3.1 x 10^3 c.f.u. per ml while at Kolhapur farm were 21.5 x 10^3 and 2.7 x 10^3 c.f.u. per ml, respectively.

Key words : SPC, coliform milk , Pandharpuri buffalo.

The spoilage of milk because of bacterial action is estimated to be 10 per cent of the total milk production in India (Chakraborti et al. 1986). In terms of quality of milk and productivity of dairy animals. India ranks battom among the major dairy nations. In comparison as against the average bacterial count of raw milk is <105 ml in most of the European countries and USA and in India it ranges from 5 x 10^5 to 10^6 ml. Milking of animals should be done hygienically to preserve its freshness of for longer time. Thus, a need was felt to study the overall effect of milking practices being followed on different organized farms on quality of Pandharpuri buffalo milk.

Materials and Methods

Twelve Pandharpuri buffaloes were selected for present investigation from college of Agriculture Dairy farm, Pune and Kolhapur. The milking management practice specially washing of udder was taken for the study purpose. The treatment unwashed udder was compared of washed of udder with 0.5 per cent KMnO4 solution. The 18 milk samples were collected from washed and unwashed udders aseptically in sterile glass container from each treatment for each farm and analysed immediately. Twelve Pandharpuri buffaloes were selected for present investigation. Out of them 6 were selected at each location for each milking method. During the entire study period all the individuals were kept under similar feeding and managemental conditions. The milking machine employed in this experiment was 'Impulsa' direct to can milking. The milk samples were anlaysed for microbiological quality i.e. standard plate count (SPC) (ISO, 1962) and coliform counts (CC) (ISO. 1986). After recording the data, it was tabulated and statistically analysed by using 't' test as described by Snedecor and Cochran (1967).

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Results and Discussion

Standard plate count (SPC) : It was observed from Table I that, the average SPC in milk samples of Pandharpuri buffalo from unwashed udder and washed udder at Pune Farm were 261 x 10^3 (60 x 10^4 to 40 x 10^4) and 36.4 x 10^3 (7 x 10^3 to 47 x 10^3) c.f.u. per ml, respectively. The average SPC in milk samples of Pandharpuri buffalo from unwashed and washed udder at Kolhapur Farm were 208 x 10^3 (4 x 10^4 to 3 x 10^5) and 21.3 x 10^3 (6 x 10^3 x 35 x 10^3) c.f.u. per ml, respectively. Lavania and Singh (1973) reported that SPC of raw milk from unwashed and washed udder were ranged from 6 x 10^4 to 22 x 10^5 c.f.u. per ml and 11 x 10^3 to 7 x 10^4 c.f.u. per ml, respectively. The present results of SPC of raw milk from unwashed udder were lower than the results of Lavania and Singh (1973). Koshy and Prasad (1993) found that the SPC of raw milk was 17.3 x 10^3 c.f.u. per ml which was lower than the present results of SPC of raw milk of Pandharpuri buffalo at both farms. It was observed that, washing of udder resulted in decreasin of SPC of raw milk.

Coliform count : The average coliform counts of milk sample of Pandharpuri buffalo from unwashed and washed udder at Kolhapur farm were 32.4 x 10^2 (29 x 10^2 to 50 x 10^2) and 31.3 x 10^1 (2 x 10^1 to 80 x 10^1) c.f.u. per ml, respectively. The present results of coliform counts of raw milk from washed udder at both the farms were lower than the results of Rai *et al.* (1990) and Kim(l995). It was observed that the SPC and coliform counts of raw milk samples from unwashed udder were higher (<0.05) than washed udder.

Effect of methods of milking : It was observed that, the SPC of raw milk obtained by hand milking and machine milking at Pune farm ranged from 11 x 10^3 to 69 x 10^3 and 2 x 10^3 to 6 x 10^3 c.f.u. per ml. respectively. The average SPC of raw milk obtained by hand and machine milking at Pune farm were 27.5 x 10^3 and 3.1 x 10^3 c.f.u. per ml. respectively. Lakhani *et al.* (1990) found that average SPC of raw milk obtained by machine hand milking were 26.9 x 10^2 and 21 x 10^3 c.f.u. per ml. respectively, which were lower than the present results. The average SPC of raw milk produced by hand milking and machine milking at Kolhapur farm were 21.5 x 10^3 (6 x 10^3 to 54 x 10^3) and 2.7 x 10^3 (1 x 10^3 to 4 x 10^3) c.f.u. per ml, respectively. It was noticed that the SPC of raw milk was significantly higher in hand milking than machine milking. The results

Table 1. Effect of milking management practices on SPC and coliform count of Pandharpuri buffalo milk on different organized farms.

Farms	Washing of udder	SPC (cfu ml^{-1})			Coliform (cfu ml^{-1})		
		Mean x 10^3	SE ±	t cal	Mean x 10^2	SE ±	t cal
Pune	Unwashed	261	0.950	3.052*	38	1.079	3.226*
	Washed	36.4	1.120		5.5	1.346	
Kolhapur	Unwashed	208	0.80	3.982*	32.4	1.055	3.110*
	Washed	21.3	1.135		3.1	1.330	
Method of milking				CD (5%)			
Pune	Hand	27.5	0.006	0.017	35.9	1.640	5.56*
	Machine	3.1	0.006		3.1	1.162	
Kolhapur	Hand	21.5	0.006	0.017	28.5	1.459	3.299*
	Machine	2.7	0.006		2.1	1.141	

*P<0.05 differs significantly.

of SPC of milk samples are corroborated with findings of Lakhani *et al.* (1990).

It was observed that, the average coliform counts of raw milk obtained by hand milking and machine milking at Pune farm were 35.9 x 10^2 (3 x 10^2 to 51 x 10^2) and 3.1 x 10^2 (5 x 10^1 to 60 x 10^1) c.f.u. per ml, respectively. Lakhani *et al.* (1990) reported that the average coliform counts of raw milk produced by hand milking versus machine milking were 38.4 x 10^2 and 20.8 x 10^1 c.f.u. per ml, respectively which were higher than the present results of hand milking and lower than machine milking of Pune farm. The average coliform counts of raw milk obtained by hand milking and machine milking at Kolhapur farm were 28.5 x 10^2 (3 x 10^2 to 46 x 10^2) and 2.1 x 10^2 (7 x 10^1 to 40 x 10^1) c.f.u. per ml. respectively which were higher than those reported by Lakhani and Jogi (1996). It was analyzed that, coliform counts of raw milk was significantly higher in hand milking than machine milking. The results of coliform counts of raw milk are corroborated with findings of Lakhani *et al.* (1990) and Lakhani and Singh (1998).

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Nutritional Evaluation of Dhaincha (*Sesbania aculeata*) vis-a-vis Lucerne (*Medicago sativa*) in Different Seasons

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Abstract

Dhaincha and lucerne were evaluated for nutrient content and *in vitro* dry matter digestibility in different seasons. The DM content was more in summer while it was less in other seasons. The per cent CP, EE, CF, TA, NFE and *in vitro* dry matter digestibility of dhaincha was more (20.11, 2.85, 16.00, 9.95, 51.16 and 71.69, respectively) in rainy season, while lucerne had more (21.01, 2.32, 24.11, 10.87, 41.69 and 71.88, respectively) in winter season. Carotene (mg 100^{-1} g) was more (33.32) in dhaincha in rainy season than that of lucerne (25.73) in winter. The per cent NDF, ADF, hemicellulosc, cellulose, lignin and silica content of dhaincha was more (45.68, 36.49, 9.19, 20.13, 15.14 and 1.22 respectively) in summer, while in lucerne it was more (47.89, 37.70, 10.19, 20.24, 16.13 and 1.27, respectively) in rainy season. The minerals Ca, P, Mg in dhaincha was more (1.48, 0.33, 0.34, respectively) than that of Cu, Fe, Mn and Zn (23.92, 218.63, 27.77 and 20.42, respectively) in summer season. In lucerne they were 1.49, 0.30, 0.34 and 20.62, 393.72, 39.48 and 16.58, respectively in summer season. The results indicate that the nutritive value of dhaincha was comparable to lucerne and rainy is the best season to grow dhaincha which can be used to feed livestock.

Key words : Lucerne, dhaincha, chemical composition, digestibility.

India has a long history of animal feed shortage especially for small ruminants. Small ruminants are grazing/browsing animals mainly meet their nutrient requirement by feeding on low quality wild grasses and top feeds. During late summer and early monsoon period there is shortage of leguminous fodder and also top feeds viz., leaves of trees, shrubs and bushes. The leftover land after cultivation food crops is either degraded or saline, which does not have any grass cover or is not fit for cultivation, such land can be used for cultivation of some non-conventional fodder. One of them is Dhaincha (*Sesbania aculeata*) which is widely cultivated multipurpose legume. It is highly productive, better leaf quality, easy tillering nature and its ability to grow on a wide range of soils. The full potential of dhaincha as a fodder for livestock in terms of its nutritive value has not been exploited.

1. Associate Professor 2. Assistant Professor.

Materials and Methods

Dhaincha and lucerne were cultivated at Research cum Development: Project on Cattle, M.P.K.V. Rahuri in the month of July 2001 and October 2001 respectively. Dhaincha was harvested at 90 days after sowing as rainy season cut then tillers after another 90 days there after as winter cut and further after 90 days as summer cut. Lucerne was harvested in the month of February 2002 at 3rd cut as winter season, in May 2002 at 6th cut as summer and in August 2002 at 9th cut as rainy season cut. Representative sample of 1 kg was collected of each fodder in their respective season, dried in shed first and then in hot air oven at 100°C overnight for dry matter estimation. Dried samples were ground in laboratory grinding mill using 2 mm sieve for proximate nutrients estimation and 1 mm sieve for cell wall constituents *viz*., neutral detergent fibre (NDF), acid detergent fibre (ADF), hemicellulose, cellulose, lignin and silica estimation. Fodder samples according to season of growth were analysed for proximate principles as per A O A C, (1995) and cell wall constituents as per Goering and VanSoest, (1970). The *in vitro* dry matter digestibility was determined by method of Tilley and Terry (1963). The data were statistically analyzed as per Snedecor and Cochran, (1967).

Results and Discussion

Seasonal effect : The data (Table 1) revealed that season of growth had significant ($P<0.05$) effect on the nutrient composition of both the fodder. The per cent DM content was significantly ($P<0.05$) more in summer in both the fodders while it was on par in other seasons. The per cent crude protein in dhaincha was more in rainy season (20.11), on par in winter (20.05) and less in summer (19.23), while in lucerne it was more (21.01) in winter followed by summer (20.26) and less in rainy (19.71). Ether extract in both the fodders was more in summer and on par in winter and rainy seasons. The per cent crude fibre in dhaincha was more in summer (37.93), followed by winter (16.88) and less in rainy season (16.00), while in lucerne it was more in rainy (25.14) followed by summer (24.57) and less in winter (24.11). The per cent total ash showed nonsignificant effect in dhaincha, while in lucerne it was more in summer (12.12) and on par in rainy and winter seasons. The per cent nitrogen free extract in dhaincha was found to be more in rainy (51.16) and on par in winter and summer, while in lucerne it was found to be more and on par in rainy (41.90) and winter (41.69) and comparatively less in summer (40.02). The carotene content (mg $100g^{-1}$ DM) in dhaincha was more in rainy (33.32) followed by summer (30.63) and less in winter (28.17), while in lucerne it was more and on par in winter (25.73) and summer (25.44) and less in rainy (20.27). The results clearly

Table 1. Proximate composition of dhaincha and lucerne in different seasons. (% on DM basis).

Particular	Fodder	Seasons			SE ±	C. D. (5%)
		Rainy	Winter	Summer		
Dry matter	Dhaincha	21.66^a	21.67^a	23.83^b	0.245	0.735
	Lucerne	22.87^a	22.89^a	23.28^b	0.118	0.354
Crude protein	Dhaincha	20.11^b	20.05^b	19.23^a	0.213	0.639
	Lucerne	19.76^a	21.01^c	20.26^b	0.254	0.762
Ether extract	Dhaincha	2.85^a	2.83^a	3.25^b	0.103	0.323
	Lucerne	2.39^a	2.32^a	3.04^b	0.034	0.108
Crude fibre	Dhaincha	16.00^a	16.88^b	17.93^c	0.150	0.450
	Lucerne	25.24^c	24.11^a	24.57^b	0.273	0.719
Total ash	Dhaincha	9.95	10.04	10.09	0.055	NS
	Lucerne	10.74^a	10.87^a	12.12^b	0.099	0.301
Nitrogen free extract	Dhaincha	51.16^b	50.15^a	49.51^a	0.264	0.832
	Lucerne	41.90^b	41.69^b	40.02^a	0.185	0.583
In vitro DM digestibility	Dhaincha	71.69^c	71.17^b	70.68^a	0.048	0.144
	Lucerne	69.08^a	71.88^c	70.84^b	0.042	0.126
Carotene (mg 100 g^{-1} DM)	Dhaincha	33.32^c	28.17^a	30.63^b	0.280	0.840
	Lucerne	20.27^a	25.73^b	25.44^b	0.323	0.970

NS = Non-significant : Each figure is an average of six observations, Mean values with different superscript in a row differ significantly with each other at 5% level of significance.

indicated that more nutrients in dhaincha were obtained in rainy and summer seasons, while in lucerne it was in winter and summer. This might be due to good growth of dhaincha in rainy season and lucerne in winter season. Sidhuraju *et al.* (1995) and Shahjalal and Topps, (2000) reported more crude protein and nitrogen free extract in dhaincha in rainy season than in

Table 2. Cell wall constituents of dhaincha and lucerne in different seasons.

(% on DM Basis)

Particular	Fodder	Seasons			SE ±	C. D. (5%)
		Rainy	Winter	Summer		
NDF	Dhaincha	44.62	44.96*	45.68d	0.157	0.472
	Lucerne	47.89b	46.59*	46.72*	0.169	0.508
ADF	Dhaincha	35.28*	35.54*	36.49	0.165	0.496
	Lucerne	37.70	36.65*	36.68*	0.171	0.512
Hemicellulose	Dhaincha	9.34	9.42	9.19	0.079	NS
	Lucerne	10.19	9.94	10.04	0.110	NS
Cellulose	Dhaincha	19.92*	19.98*	20.13d	0.041	0.123
	Lucerne	20.24	20.19	20.25	0.093	NS
Lignin	Dhaincha	14.24*	14.51*	15.14	0.141	0.425
	Lucerne	16.13*	15.53*	15.74	0.132	0.398
Silica	Dhaincha	1.12*	1.05*	1.22	0.021	0.086
	Lucerne	1.27	0.93*	1.02*	0.02	0.092

NS = Non-significant : Each figure is an average of six observations, Mean values with different superscript in a row differ significantly with each other at 5% level of significance.

Table 3. Mineral content of dhaincha and lucerne in different seasons.

(on DM basis)

Particular	Fodder	Seasons			SE ±	C. D. (5%)
		Rainy	Winter	Summer		
Calcium (%)	Dhaincha	1.46"	1.35*	1.48d	0.035	0.105
	Lucerne	1.21*	1.42"	1.49"	0.054	0.162
Phosphorus (%)	Dhaincha	0.32*	0.28"	0.33c	0.003	0.009
	Lucerne	0.26*	0.28d	0.30"	0.003	0.010
Magnesium (%)	Dhaincha	0.33*	0.32*	0.34c	0.003	0.009
	Lucerne	0.28	0.33b	0.34c	0.003	0.010
Copper (ppm)	Dhaincha	22.74*	22.83"	23.92"	0.342	1.027
	Lucerne	19.40"	20.33"	20.62"	0.324	0.973
Iron (ppm)	Dhaincha	215.00b	205.00*	218.63"	3.431	10.293
	Lucerne	361.42*	381.17"	393.72"	5.108	15.324
Manganese (ppm)	Dhaincha	26.78"	25.17*	27.77"	0.830	2.490
	Lucerne	32.63"	38.83"	39.48"	1.391	4.172
Zinc (ppm)	Dhaincha	19.10"	18.67"	20.48"	0.223	0.667
	Lucerne	15.52*	16.33"	16.58"	0.193	0.579

NS = Non-significant : Each figure is an average of six observations, Mean values with different superscript in a row differ significantly with each other at 5% level of significance.

winter which agrees with present study. The *in vitro* dry matter digestibility was found to be more (71.69%) in dhaincha in rainy, while in winter season in case of lucerne (71.88%). The more *in vitro* dry matter digestibility in rainy and winter season in dhaincha and lucerne, respectively might be due to less crude fibre and more nitrogen free extract. Guessous *et al*. (1986), Chauhan *et al*. (1987) and Chauhan and Puri (1989) reported more crude protein in summer than in rainy season in lucerne. Binawade (1992) in lucerne reported more crude protein and nitrogen free extract in winter that is in agreement with results reported in the present study.

Cell wall constituents : From the results obtained (Table 2) it indicated that season of growth had a significant ($P<0.05$) influence on cell wall constituents of both the fodder. The per cent fibre fractions in dhaincha *viz*., NDF (45.68), ADF (36.49), cellulose (20.13), lignin (15.14) and silica (1.22) were more in summer, while in lucerne NDF, ADF, lignin and silica were more in rainy and hemicellulose and cellulose showed non-significant differences. The less fibre fractions in dhaincha was due to more vegetative growth of dhaincha in rainy season and lucerne in winter and summer seasons. This might be due to more structural material deposited as the dhaincha crop reaches to maturity early in summer season. Chauhan *et al.* (1987) reported in lucerne low NDF and ADF in summer which increased progressively in rainy that is contradictory to that of dhaincha. Upase (1973) and Binawade (1992) reported more cellulosic material in lucerne in winter season. Lignin and silica were found to be more (15.14 and 1.22 %) in summer season in dhaincha, while they were more (16.13 and 1.27 %) in rainy season in case of lucerne.

Mineral content : Significant ($P<0.05$) differences among seasons (Table 3) were found in mineral content of dhaincha and lucerne. Among the minerals, calcium in dhaincha was found to be more in summer (1.48%) and also in lucerne (1.49%), while less in winter (1.35%) and rainy (1.21%) in dhaincha and lucerne respectively. Phosphorus in dhaincha was found to be more in summer (0.33%) and in lucerne (0.30%), while less in winter (0.28%) and in rainy (0.26%) in dhaincha and lucerne respectively. Magnesium showed similar difference in both the crops as that of calcium and phosphorus. Among the minor minerals (ppm) of dhaincha and lucerne copper (23.92 and 20.62), iron (218 and 393.72), manganese (27.77 and 39.48) and zinc (20.42 and 16,58) were found to be significantly ($P<0.05$) more in summer than in other seasons. Gupta (1976) and Binawade (1992) reported more minerals in summer, while Upase (1973) and Greene *et al.* (1978) reported in lucerne more minerals in winter season.

Conclusion : The results of the present research work indicated that the proximate composition and *in vitro* dry matter digestibility of dhaincha was comparable with lucerne, except dhaincha had more nitrogen free extract and less crude fibre than lucerne. The proximate nutrients in dhaincha were more in rainy season, while in lucerne they were less in rainy season. Hence, dhaincha can be considered as substitute leguminous fodder in place of lucerne in rainy season.

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Organoleptic Qualities of Meat of Broilers Under Fish Meal and Full Fat Soybean (Flake) Diet*

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Abstract

A study was carried out on organoleptic quality of broiler meat when fish meal (FM) was replaced by different levels of full fat soybean (FFSB) in the ration. In terms of colour and appearance the score was 6.63, 6.85, 7.20 and 7.27 in T_0, T_1, T_2 and T_3. The colour and appearance of meat scored the highest in 15 per cent FFSB. It was observed that with an increasing level of inclusion of FFSB increased the score for colour and appearance. Tenderness of meat was not affected significantly by different treatment diets. The average score for juiciness of meat was the highest in 15 per cent FFSB (7.36) and the lowest in FM diet (6.55) differed significantly ($P<0.05$). The higher score for juiciness in 15 and 10 per cent FFSB diets was due to the higher fat content of meat. The average score for meat flavour was highest in 15 per cent FFSB (7.31) and lowest in FM diet (6.60). The flavour of the meat with FFSB diet was significantly superior ($P<0.05$) to fish meal diet. The average score for acceptability of meat was maximum in 10 per cent FFSB (7.60) and minimum in FM diet (6.60). The acceptability of meat was significantly higher ($P<0.01$) in FFSB diets as compared to FM diet.

Key words : FFSB, FM, tenderness, juiciness, flavour, acceptability.

Quality of meat depends on its colour, appearance, tenderness, juiciness and flavour. In the present feeding trials fish meal (FM) is replaced by the different levels of full fat

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soybean (FFSB). While replacing the fish meal by different levels of FFSB how it reflected on the different aspects of meat quality has been studied in this investigation.

Materials and Methods

In this investigation three experimental trials were conducted i.e. in the month of September-October, November-December (2000) and March-April. 2001. During these trials different diets were given to the birds, *viz*., T_0 (Control) received 5 per cent fish meal, T_1, T_2 and T_3 received the diet containing 5, 10 and 15 per cent full fat soybean flake (FFSB), respectively. For studying organoleptic quality 5 birds from each treatment were slaughtered at the age of 6 weeks. The 9 point hedonic scale suggested by Peryam and Pilgrim (1957) was used for organoleptic evaluation of meat samples of broiler. A panel of ten trained and semi-trained persons was formed for the evaluation of meat quality. Due precautions were taken to avoid biasness in judging for particular treatment group. The judges were washing their mouth in between the use of two different samples. The time was kept constant throughout the investigation. Organoleptic tests included the parameters like, colour and appearance, tenderness, juiciness, flavour and general acceptance. For these organoleptic tests plain meat of four different treatment groups was cooked in separate four pressure cookers for 10 minutes with 1 per cent common salt. The judges tested the cooked meat and allotted marks to each point on the basis of 9 points score. Accordingly observations were taken and statistically analyzed.

Results and Discussion

Colour and appearance of meat : The average score (out of 9 points hedonic scale) for the colour and appearance of the meat, was maximum in T_3 (7.27) followed by T_2 (7.20), T_1 (6.85) and to (6.63). The statistical analysis (Table 2) revealed significantly ($P<0.05$) higher score for the birds under T_2 and T_3 diets. However, T_2 and T_3 treatments were statistically at par. The meat of T_1 diet also differed significantly from to in its hedonic score. The colour and appearance of the meat was significantly better in 15 per cent and 10 per cent FFSB diets than 5 per cent FFSB and 5 per cent KM diet. This may be due to higher retention of fats and xanthophyll pigment. In fish meal diet retention of fat was less and during feeding trial the birds suffering from respiratory and diarrhea problems may have affected the colour and appearance of meat. Singh and Panda (1992) reported that the non-dietary factors might reduce the yellow pigmentation of poultry meat and egg when

Table 1. Organoleptic quality of meat of birds under different treatment diets. (n=10).

Parameters	Treatments diets (Scale 0-9)					
	T_0	T_1	T_2	T_3	Mean	SE ±
Colour and appearnace	6.630	6.850	7.200	7.270	6.987	0.198
Tenderness	6.900	7.450	7.300	7.230	7.220	0.233
Juiciness	6.550	6.850	7.340	7.360	7.025	0.208
Flavour	6.600	7.250	7.250	7.310	7.103	0.188
Acceptability	6.600	7.400	7.600	7.300	7.225	0.100

Table 2. Analysis of variance for organoleptic quality of meat of birds fed with different treatment diets.

S.V.	D. F.	MSS				
		Colour and appe-arnce	Tender-ness	Juici-ness	Flav-our	Accept-ability
Replication	9	0.145	0.491	0.808	0.341	0.511
Treatment	3	1.482*	0.539 NS	1.559*	1.130*	1.892**
Error	27	0.375	0.542	0.432	0.355	0.100

NS = Not significant *,** Significant at 0.05 and 0.01 level respectively they suffered from respiratory diseases and coccidia.

Tenderness of meat : The average score for tenderness of meat was highest in T_1 (7.45), followed by T_2 (7.30), T_3 (7.23) and T_0 (6.90). These values indicated more or less similar score for all the treatments under study. The statistical analysis also indicated that the tenderness of meat was not affected significantly by the different treatment diets. According to Singh and Panda (1992) the effect of diet on tenderness of meat was not direct but was mediated through the age at which the bird could be marketed. They further observed that the birds of same age showed similar tenderness of meat and shear values regardless of the composition of the diet fed. In general, the tenderness of meat is a function of the age and class of chickens. Broilers normally did not differ in their tenderness of meat.

Juiciness of meat : The average score for juiciness was maximum in T_3 (7.36) followed by T_2 (7.34), T_1 (6.85) and minimum in T_0 (6.55). The juiciness of meat from the birds provided with 15 and 10 per cent FFSB diet was significantly ($P<0.05$) higher than 5 per cent FFSB and 5 per cent fish meal diet. The 5 per cent FFSB and 5 per cent fish meal diets also differed significantly from each other. Significantly higher juiciness in 15 and 10 per cent FFSB diet may probably be due to the higher fat content. The earlier findings indicated that the fat deposited into intra-muscular and subcutaneous areas improved the juiciness and appearance of meat in poultry birds (Singh and Panda, 1992) holds good in this study.

Flavour of meat : The average score for meat flavour was highest in T_3 (7.3 1) followed by T_2 and T_1 (7.25) and lowest in T0 (6.60). The results indicated that in all the FFSB diets flavour of meat was significantly superior than fish meal diet meat. In all the FFSB diet meat a typical soya flavour was noticed which was highly accepted in organoleptic taste. Generally the meat emit fish flavour when fed with fishmeal or fish oil in the poultry ration (Singh and Panda, 1992). In the present study the diets T_1, T_2 and T_3 were without fish meal and did not emit the fishy flavour, which could be the reason for higher acceptability of the flavour of meat under FFSB diets.

Acceptability of meat : The average score for acceptability of meat was maximum in T_2 (7.60) followed by T_1 (7.40), T_3 (7.30) and T_0 (6.60). Statistical analysis indicated that the acceptability of meat was significantly higher in all FFSB diets as compared to fish meal diet. However, within treatments there was no significant difference observed for the different levels of FFSB diets.

Thus considering the colour and appearance, tenderness, juiciness and flavour the full fat soybean meat was very well acceptable.

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Effect of Different Diets of Full Fat Soybean (Flake) on Meat Composition of Broilers

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Abstract

In the three feeding trials of broilers the meat composition at 6 weeks and 8 weeks age was studied. The meat composition at 6 weeks age indicated that the water content in trial-I, II and III irrespective of feed treatment ranged from 73.23 to 74.70 per cent. The corresponding values at 8 weeks age ranged from 71.70 to 72.75 per cent. There was no significant difference in all the treatments as well as all the trials. However, water content in the meat of birds at advanced age (8 weeks) was comparatively less than 6 weeks age. The protein content of meat at 6 and 8 weeks age ranged from 18.06 to 18.25 per cent and was neither affected by treatment diets nor by different trials. The fat content in meat at 6 and 8 weeks age ranged from 6.03 to 7.33 and 7.83 to 8.90 per cent respectively in all treatments and all the three trials. The fat content of meat was higher in T_3 followed by T_2, T_1 and T_0 in all the trials. The tat content of meal at 8 weeks was significantly higher than 6 weeks meat in all the treatment diets of all the trials. The ash content in the meat at 6 weeks and 8 weeds age amongst the three trials did not show much differences and remained almost similar, however, it was higher at increasing age. Fish meal containing diet (T_0) showed higher ash percentage. The ash content in the meat was in decreasing order with increase in FFSB level in the diet. In T_3 treatment ash content was significantly lower than T_0, T_1 and T_2.

Key words : Diet, meat composition, broilers.

In poultry production protein and energy of the diet are key factors for achieving better growth performance. In broilers, fish meal is mostly used as source of protein. However, with growing demand for the fish meal in the feed market, deceptive practices like spraying of urea and common salt on fish meal during processing are being observed. Moreover, the processing of fish meal in developing country like India are having high contamination which leads to poor growth performance and high mortality in broilers. Therefore, fish meal is replaced by different levels of full fat soybean. Similarly it is necessary to study the effect of replacement of fish meal by different levels of full fat soybean on the composition of broiler meat.

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Materials and Methods

In this investigation three experimental trials were conducted i.e. in the month of September-October, November-December (2000) and March-April. 2001. During these trials different diets were given to the birds, *viz*. T_0 (Control) received 5 per cent fish meal. T_1, T_2 and T_3 received the diet containing 5, 10 and 15 per cent full fat soybean flake (FFSB). respectively.

After attaining 6 and 8 weeks age, 5 birds from each treatment were slaughtered for studying the meat composition. The birds were fasted for 12 hours for complete emptying of crop and intestine. The birds were weighed and sacrificed. The birds were 7 slaughtered by modified Koshers' method (Panda and Mohapatra, 1998). In this method the jugular vein was severed just below the ear taking care not to cut the wind pipe and esophagus. This method is widely used since the birds could be better bled. The meat was analyzed by AOAC (1990) method for determination of water, protein, fat and ash content.

Results and Discussion

Water content in meat : Raw meat composition (Table 1) indicated that the moisture percentage at 6 weeks age was in the range of 73.34 to 74.70, 74.15 to 74.66 and 73.23 to 73.77 in trial-I, II and III, respectively. Water content of meat in T_0 was significantly higher than T_1, T_2 and T_3 indicated that there was significant difference in all the treatments as well as in the three trials. However, in the trial-III water content was less as compared to the first two trials, which might he due to hot climatic conditions prevailing during that trial.

Water content in meat at 8 weeks age (Table 2) ranged from 72.43 to 72.86, 72.50 to 72.95 and 71.70 to 71,95 in trial-I, II and III respectively. The water content in meat of To was significantly higher than T_1, T_2 and T_3 There was significant difference in all the treatments as well as in the three trials. At eight weeks also the water content in meat of third trial was comparatively less than the first two trials. Sahoo and Shingari (1992) reported the moisture percentage of broiler meat ranging from 70.5 to 71.9. They further stated that, in summer and spring season moisture percentage in the meat was comparatively less than winter season.

Protein content in meat : The protein content in the meat of birds in trial-I, II and III at 6 weeks age was almost similar which ranged between 18.06 and 18.25 per cent. The

Table 1. Average chemical composition of meat of broilers under different treatment diets and trials at 6 weeks age.

Treatment	Parameters (per cent)							
	Water		Protein		Fat		Ash	
	6 week	8 week	6 week	8 week	6 week	8 week	6 week	8 week
Trial-I								
T_0	74.70	72.86	18.06	18.12	6.33	8.07	0.84	0.88
T_1	73.83	72.75	18.06	18.12	6.67	8.00	0.82	0.87
T_2	73.67	72.55	18.12	18.18	6.95	8.15	0.82	0.82
T_3	73.34	72.43	18.12	18.18	7.30	8.23	0.77	0.80
Cal. 't' value	5.29	5.45	1.85	1.94	3.14	2.52	2.44	3.01
Trial-II								
T_0	74.66	72.95	18.00	18.12	6.03	7.83	0.85	0.89
T_1	74.30	72.77	18.12	18.15	6.37	7.95	0.83	0.89
T_2	74.27	72.63	18.12	18.15	6.45	8.03	0.83	0.87
T_3	74.15	72.50	18.15	18.18	6.52	8.17	0.80	0.85
Cal. 't' value	5.44	5.18	2.15	1.62	2.57	3.00	2.32	2.15
Trial-III								
T_0	73.77	71.95	18.12	18.18	6.90	8.65	0.83	0.87
T_1	73.70	71.91	18.18	18.15	6.97	8.73	0.83	0.86
T_2	73.58	71.82	18.18	18.25	6.97	8.87	0.82	0.86
T_3	73.23	71.70	18.25	18.25	7.33	8.90	0.76	0.84
Cal. 't' value	6.15	4.17	2.23	1.98	3.02	3.12	2.71	2.24

Each value is an average of 5 observations.

protein percentage of meat was thus not affected by various treatment diets.

Similarly at the age of 8th week, the protein content of meat in all three trials was in the range of 18.12 to 18.25 per cent. The protein percentage of meat at 6 and 8 weeks age remained almost constant. There was no significant difference in all the treatments at 6 and 8 weeks age. Bonami *et al*. (1970) reported that the different levels of fish meal in the diet did not give any difference in the meal composition. Similarly Sahoo and Shingari (1992) also reported that the protein per cent of meat did not change at 6 and 8 weeks age.

Fat content in meat : The fat content in the meat from 6 weeks broiler ranged from 6.33 to 7.30. 6.03 to 6.52 and 6.90 to 7.33 per cent in trial-I, II and III respectively. The fat per cent was significantly higher in T_3 (7.30%) followed by T_2 (6.95%), T_1 (6.67%) and the lowest was in T_0 (6.33%) in the first trial.

In the trial-II, similar trend was observed i.e. T_3 (6.52%) containing significantly higher fat followed by T_2 (6.45%). T_1 (6.37%) and the lowest was in the T_0 (6.03%).

The fat content of meat from trial-III also indicated the similar pattern. The T_3 group contained significantly higher fat (7.33%) in the meat followed by T_2 (6.97%). T_1 (6.97%) and T_0 (6.90%) groups respectively. The higher fat content in T_3 and T_2 may be due to more synergic effect of poly-saturated acid resulting in higher level of full fat soybean diet. Barua *et al.* (1991) reported that the increase in ambient temperature increased carcass fat content. They observed non-significant differences in the carcass fat content of broilers when reared at 27 and 29°C. However, when temperature was higher than 30°C fat content increased in the carcass.

In trial-III fat per cent of meal was comparatively higher because during hot part of the year water losses from the body of bird might be more leading to comparatively less water content of meat and higher fat content. The fat content in meat of 8 weeks broilers in trial-I, II and III ranged from 8.00 to 8.23, 7.83 to 8.17 and 8.65 to 8.90 respectively. The fat content in meat was higher in T_3 followed by T_2, T_1 and T_0 in all the trials. It was observed that the fat content in 8 weeks meat was higher than 6 weeks meat. Barua *et al.* (1991) reported that the fat content in carcass increased with body weight and age the percentage of water, protein and ash decreased with increased fat content. According to Singh and Panda (1992) fat content in carcass was the most variable component and any increase in the fat was accompanied by a parallel decrease in water content and vice-versa.

Ash content in meat : The chemical analysis of meal at 6 weeks age showed that the total ash content in the meat was the highest in T_0 (0.84%) followed by T_1 and T_2 (0.82%) and the lowest was in T_3 (0.77%) in Trial-I. Similar trend was observed in trial-II and III. Student 't' test indicated that in all the trials T_0, T_1 and T_2 were at par, only T_3 was significantly lower in ash content than the rest of treatments.

The results of 8 weeks in trial-I indicated that ash content in meat was significantly higher in T_0 (0.88%) and T_1 (0.87%) than T_2 (0.82%) and T_3 (0.80%). Similar trend was observed in trial-II and III.

The ash content in the meat at 6 weeks age amongst the three trials did not show much differences and remained almost similar. Although the similar trend was observed at 8 weeks, the results indicated that ash content in the meat was higher at this age. Further, it was also observed that amongst the different treatment diets studied the fish meal containing diet (T_0) showed higher ash percentage. The ash content in the meat was in decreasing order with increase in FFSB level in the diet. There was not much difference in the ash content of meat in T_0, T_1 and T_2. Whereas in T_3 diet ash content in the meat was significantly lower than the T_0, T_1 and T_2. It may be due to higher fat content in the diet containing 15 per cent full fat soybean.

The higher level of un-extracted soybean diet intake reduced the calcium and phosphorus retention (Lecson *et al*. 1988). Similarly Mahapatra (1992) observed that the high fat intake in the diet interfered with the absorption of calcium and vitamin-D_3.

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Influence of Non-Genetic Factors on Birth Weight of Osmanabadi Kids

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Abstract

Data on 136 kids born at College of Agriculture, Dhule was collected and analyzed for study. Year of birth, type of birth and sex significantly (P>0.01) influence)on birth weight. The overall mean birth weight of Osinanabadi kids was 2.06 ± 0.028 kg. Highest birth weight 2.27 ± 0.049 kg was noticed in year 2005 while the lowest birth weight of 1.83 ± 0.038 kg was noticed in year 2001. Males were heavier than the females at birth. Single born kids weighed significantly heigher over triplets; however single and twins were at par with each other.

Key words : Osmanabadi kids, birth weight, non genetic factors.

Osmanabadi is the predominant goat breed of Maharashtra and one among recognized goat breeds of India. The breed is characterized by black colour with leggy appearance. The ears are drooping andd in some cases the ears are white in colour with black dots. Osmanabadi goals are very hardy and can walk for a long distance for grazing. Birth weight is the first measurable economic characteristic in life which has great economic value as it has positive relationship with survival and post natal development of kid (Chandra *et al.* 2009). The information on birth weight of Osmanabadi goat reared under Khandesh region of Maharashtra is scanty as it is first time introduced in this region. The main objective of the present study was to investigate environmental influence on growth of the kids borning this region.

Materials and Methods

The data on birth weight of 136 kids produced from the does which were maintained at Agricultural College, Dhule in Khandesh region was collected for the period from 2001 to 2006. In order to analysis of data by least squares method, collected data was classified according to year of birth (P_1 = 2001, P_2 = 2002, P_3 = 2003, P_4 = 2004, P_5 = 2005, P_6 = 2006). season of birth *viz.*, Rainy : S_1 (June-Sept.), Winter : S_2 (Oct.-Jan.) and Summer : S_3 (Feb.-May); type of birth single, (D_1) twin, (D_2) and triple, (D_3) and sex (T_1) male and (T_2) female. The collected data was subjected to Least Squares Techniques (Harvey 1991) analysis to work out influence of years, season, type of birth and sex.

Duncuns multiple Range Test as mentioned by Kramer (1957) was used to make pair wise

Table 1. Least squares analysis of variance of birth weight in Osmanabadi goat.

Source of variation	D.F.	M.S.S.	F ratio
Year of birth	5	0.51584	16.85**
Season of birth	2	0.01301	0.42
Sex	1	0.49079	16.03**
Type of birth	2	0.52934	17.29**
Error	125	0.03062	-

** = P<0.01

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comparism between least squares means with the use of inverse elements and roots means square error.

Results and Discussion

The birth weights of Osmanabadi kids (Table 1) were significantly (P<0.01) affected by all the non-genetic factors under study, except season of birth. The overall birth weight noticed in Osmanabadi was 2.06 ± 0.028 kg. The DMRT revealed that the kids born in year 2005 were significantly heavier (2.27 ± 0.049 kg) over the kids born during rest of the years, except year 2006 where the kids have equally good birth weights (2.21 ± 0.062 kg). The lowest birth weight was noticed in the kids born in year 2001 (1.83 ± 0.038 kg). The results are in agreement with Mia and Bhuniyan (1997) in Barberi, Black Bengal. Anglo-Nubian and their crosses, Karna *et al.* (2001) in Chegu goat, Bobhate *et al.* (2003) in Osmanabadi and its crosses with Sannen, Beetal and Alpine goats. The significant variation in birth weight might be the effect of genetically superior males and the variation in feeding and management regimes adopted during the particular period.

Though the seasonal variation in birth weight was statistically non significant but the kids born in winter weighed heavier (2.08 ± 0.039 kg) than the rainy (2.05 ± 0.037 kg) and Summer season (2.04 ± 0.033 kg). Similar non significant effect of season of birth was also reported by Chandra *et al.* (2009) in Sikkim local kids. This might be due to availability of good quality green fodder during gestation.

The male kids had significantly (P<0.01) higher birth weights (2.12 ± 0.031 kg) than the females (Table 2). This may be due to the effect of male sex hormone which influences growth during prenatal development (Hafez, 1962). The results were corroborated with Das and Roy (1999), Karna *et al.* (2001), Bobhale *et al.* (2003) and Chandra *et al.* (2009).

Table 2. Least squares means and standard error for birth weight of Osmanabadi goat.

Sources	Code	N	Mean	SE ±
Mean :	μ	136	2.06	0.028
Year of birth :	P_1	26	1.83^d	0.038
	P_2	26	1.93^c	0.36
	P_3	25	2.01^{bc}	0.054
	P_4	19	2.09^b	0.048
	P_5	18	2.27^a	0.049
	P_6	10	2.21^{ab}	0.062
Season of birth :	S_1	36	2.05	0.037
	S_2	44	2.08	0.039
	S_3	56	2.04	0.033
Sex :	T_1	73	2.12^b	0.031
	T_2	63	1.99^a	0.34
Type of birth :	D_1	69	2.20^b	0.022
	D_2	61	2.04^b	0.024
	D_3	6	1.93^a	0.76

Means with different superscript in the column differed significantly (P<0.05).

The significantly high birth weight was noticed in D_1 (2.20 ± 0.022 kg) followed by D_2 (2.04 ± 0.024 kg) and the lowest in D_3 (1.93 ± 0.076 kg). The results were supported by Koratkar *et al.* (1998), Neeru *et al.* (2002), Singh (2002). Bobhate *et al.* (2003) and Chandra *et al.* (2009). This variation is obvious because in multiple births the nutrients available from the doe are shared by D_2 and D_3. Another factor might be due to limitation of uterine space for growth of multiple kids during prenatal life.

It can be concluded from present study that, the Osmanabadi goals are aeelimatized in Khandesh region showing significant increase in birth weight with advancement of year and non significant effect of season. The other non genetic factors sex and type of birth showed significant enfluence on birth weight.

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RESEARCH NOTES

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Influence of Sugarcane Verities and Planting Techniques on Yield, Quality and Nutrient Uptake on Saline Sodic Soil

The salinity and sodicity problem is mainly embarrassed in sugarcane growing tract of India and Maharashtra. In Maharashtra major area of salinity and alkalinity (about 60 lakh hectares) fall in sugarcane growing tract. Therefore, it is very necessary to identify such genotypes which are tolerant to salinity and alkalinity in order to get good harvest of sugarcane. The planting method may play an important role to some extent in reducing salinity and alkalinity problems. In view of this the study was undertaken to assess the effect of saline sodic soil along with sugarcane varieties with planting methods on cane, CCS yield, juice quality and nutrient uptake.

The field experiment on preseasonal sugarcane was conducted at Post Graduate Institute Farm, Department Soil Science and Agricultural Chemistry, Mahatma Phule Agricultural University, Rahuri during 2003-04. The experimental soil is grouped under inceptisol with fine montmorillonitic, hyperthermic family of *Vertic Haplustepts.* The soil is having textural class clayey with pH 8.7 and electrical conductivity 4.20 dSm^{-1}. The available nitrogen, phosphorus and potassium were 186.90, 12.50 and 610.40 kg ha^{-1} respectively.

The six treatment combinations with four replications were tried including three sugarcane verities (V_1 - COM 9516, V_2 - CO 86032 and V_3 - CO 8014) as main treatment and two planting methods (S_1 - Set planting and S_2 - Polybag single eye bud planting) as sub treatment in a factorial randomized block design.

The planting material (three eye buded sets and single eye bud polybag seedling) was obtained from Central Sugarcane Research Station, Padegaon and planting was carried out in furrows of 90cm apart. The fertilizer dose of preseasonal was applied as 340:170:170 kg NPK ha^{-1} The nitrogen was applied in four splits as 10 per cent at planting,40 per cent at 6-8 weeks after planting, 10 per cent at 10-12 weeks after planting and 40 per cent at earthing up. The phosphorus and potassium were applied in two splits as 50 per cent at planting and remaining at earthing up. The milliable cane and yield was taken at harvest while the uptake of nitrogen, phosphorus and potassium was assessed by analyzing plant samples at harvest for nutrient concentration and dry matter.

The brix value in the juice sample was estimated by using spindle hydrometer and expressed in terms of brix (C) after making calibration for temperature. The sucrose content was estimated with the help of polarimeter after clarifying the juice using lead acetate. The purity of juice was determined by sucrose and corrected brix.

It could be revealed that the sugarcane variety CO 86032 recorded the highest number of milliable canes (50546) hectare-1, which was on par with COM 9516 (48515) and significantly superior over CO 8014 (37603) (Table 1). However, planting techniques was found to be nonsignificant for milliable cane. The interaction between sugarcane varieties and planting techniques were non- significant for milliable cane hectare^{-1}. Similar observations were also recorded by Singh *et al*., (2003).

The cane and commercial cane sugar yield were statistically significant due to sugarcane varieties and planting techniques whereas, it was non-significant due to interaction effects. The sugarcane genotype CO 86032 under saline sodic soil recorded the higher cane yield (54.73 t ha^{-1}) which was on par with COM 9516 (52.00 t ha^{-1}). The higher cane yield by CO 86032 and COM 9516 was associated with the genetical ability of these two varieties to produce more number of tillers sustained up to milliable cane. These genetically potentials were reflected in an increased per cane weight and per hectare cane yield. Similar observations were also recorded by Singh (2003). Planting of sugarcane in saline sodic soil with set planting technique was recorded significantly higher cane yield (51.35 t ha^{-1}) than polybag planting technique which may be due to in set planting early vigor of seedling was mainly on stored material in sugarcane set, which has required less energy to establish under saline condition. This phenomenon leads to maintain the better establishment and vigor of sugarcane plant in saline sodic soil. Whereas, polybag planting techniques, the seedlings were raised in congenial condition for sugarcane growth. These seedlings were transplanted in totally adverse situation wherein it was raised. Therefore, polybag seedlings had to adjust with saline sodic soil for establishment and thereafter start growing and tillering etc. The difference between set planting and polybag planting techniques for establishment in saline sodic soil can not be narrowed by the sugarcane varieties. Similar observations were also recorded by Barreto and Valdivia (1981) and Singh *et al*. (2003).

Further the cane and commercial cane sugar yield recorded by the sugarcane verities and planting techniques in saline sodic soil were less than average yield. The magnitude of reduction in cane and commercial cane sugar yield were to the tune of 35 to 40 per cent. These results are also corroborated with Bernstein *et al*., (1966).

The corrected brix and sucrose per cent were significantly influenced by the planting techniques. It was higher in set planting (21.83 brix and 19.66 % sucrose) than polybag planting techniques (19.52 brix and 18.42 % sucrose). The sugarcane verities and interaction effects were non-significant for corrected brix and sucrose per cent. The purity per cent of sugarcane juice was found to be significant by sugarcane varieties, planting techniques and their interactions. Whereas, per cent reducing sugar were non-significant due to sugarcane

Table 1. Influence of planting technique and sugarcane varieties on milliable cane, cane and CCS yield under saline sodic soil.

Planting technique	**Milliable cane**			**Cane yield (t ha^{-1})**			**CCS yield (t ha^{-1})**		
Sugarcane varieties	**S_1**	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**	**S_1**	**S_2**	**Mean**
COM 9516	45208	51822	48515	55.51	48.48	52.00	5.92	5.00	5.46
CO 86032	47708	53385	50546	58.01	51.45	54.73	6.39	4.69	5.54
CO8014	42395	32812	37603	40.51	34.73	37.62	4.37	3.66	4.01
Mean	45103	46006		51.35	44.88		5.56	4.45	
	V	S	V x S	S	S	V x S	V	S	V x S
S. E. ±	2089.31	1705.92	2954.74	1.641	2.01	2.84	0.243	0.198	0.343
C. D. at 5%	6295.74	NS	8903.52	4.946	6.05	NS	0.732	0.598	NS

varieties, planting techniques and their interactions. Similar observations were recorded by Sundara and Jalaja (1992) and Prasad *et al*. (1982).

The sugarcane variety COM 9516 (74.63 kg ha^{-1}) and CO 86032 (74.47 kg ha^{-1}) were found at par with each other for their nitrogen uptake and significantly superior over Co 8014 (61.33 kg ha^{-1}). The total nitrogen uptake was higher by sugarcane verities might be due to genetic potential to produce higher biomass. Therefore, the COM 9516 and CO 86032 recorded higher yield than CO 8014. Similar observations were recorded by Kadam *et al*. (1991). Total phosphorus uptake of sugarcane did not influenced by sugarcane varieties, planting techniques and their interactions. Whereas, total potassium uptake in sugarcane was influenced significantly by sugarcane varieties, planting techniques and their interactions. The higher uptake of potassium was reported in CO 86032 (127.60 kg ha^{-1}) than COM 9516 (108.81 kg ha^{-1}) and CO 8014 (101.25 kg ha^{-1}). The set planting was found beneficial for total potassium uptake (122.0 kg ha^{-1}) than polybag planting technique (103.16 kg ha^{-1}).

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Studies on Prevalance of Sub Clinical Mastitis in Private Buffalo Farms Around Pune City in Maharashtra

Major losses in dairying occur due to sub-clinical mastitis (SCM). If not treated earlier, sub clinical mastitis leads to clinical stage which may damage the teats permanently, ceasing the milk production. It is essential to draw the attention of the dairymen to this aspect and make them aware of the symptoms of sub-clinical mastitis, easy and practicable methods of .diagnosis, factors affecting-incidence-of sub-clinical-mastitis and the curative and preventive measures to be taken to over come the problem of sub-clinical mastitis.

Out of 200,11 private buffalo dairy farms, were selected on random basis and were grouped into three types on the basis of number of animals 25 (6 farms), 25-50 (3 farms) and 50 and above buffaloes (2 farms). The total no. of buffaloes studied were 225 consisting of 160 murrah, 50 Jaffarabadi and 6 Mehasana. Clinical Mastitis Test (CMT) was used for detection of sub-clinical mastitis cases, in these buffalo farms. The test was performed bv modified method of Pandit and Mehta(1969). The data so collected were classified, tabulated and statistically analysed by using standard methods as explained by Snedecor and Cochran (1967).

Out of 225 buffaloes tested at 11 private buffalo farms showed with incidence of 39.56 per cent. The incidence increased with advancing the lactation of animals, these findings were in close agreement with those of Chakraborty and Hazarika (1978) and Bajpai *et al*. (1997). It indicated that higher percentage of incidence was found in late lactation and advanced age. Lower incidence (Table 1) of SCM was found in all the individual of 1st lactation buffaloes. While the highest incidence was found in the fore left quarter of buffaloes in 7th lactation, It was also observed in pairs of quarters of udder of buffalo that the incidence was lower in hind and left pairs of quarters of buffaloes in 1st lactation and the highest incidence was seen in fore and left pairs of quarter of buffaloes in 7th lactation.

Incidence of sub clinical mastitis was significantly ($P < 0.05$) higher in late stage of lactation (56.92%). However, Mitra *et al.* (1995) and Premchand *et al.* (1995) reported higher incidence in early stage of lactation. Higher incidence noticed in later stage of lactation in this study might be due to involution of udder tissues making them susceptible for infection by number of microbes causing sub-clinical mastitis.

Out of total 892 quarters tested, 158 quarters were found affected with sub-clinical mastitis showing incidence of 17.71 per cent. The percentage of incidence in respect of single, double, triple quarters and all quarters was 22.33, 9.78, 4.44 and 4.00, respectively. However, the differences were not significant. Higher incidence of SCM in hind and left side quarter of udder was revealed. This may be due to more stress on the teats caused by hand milking and calf suckling from left side of animals (Bhagat *et al.* 1992). The incidence was lowest (7.23%) in right hind quarters.

Prevalence of SCM recorded were 22.22, 35.71, 39.29, 33.33, 53.84, 44.44 and 66.66 per cent in 1st , 2nd, 3rd, 4th, 5th, 6th lactations respectively. The highest incidence was noticed in 7th lactation and the lowest in 1st lactation. The percentage of incidence in full hand and knuckling method were 38.37 and 43.34, respectively.

Table 1. Proportionate (%) quarter difference in prevalence of sub clinical mastitis with the parity of buffalo.

Parity	No of animals	Individual quarters				Paried quarters			
		Hind left	Hind right	Fore right	Fore left	Hind pair	Fore pair	Right pair	Left pair
1st	9	-	11.11	11.11	11.11	11.11	22.22	22.22	11.11
2nd	28	25.00	14.28	17.85	14.28	39.28	32.13	32.13	39.28
3rd	56	21.42	12.50	14.28	16.07	33.92	30.35	26.78	37.49
4th	72	16.66	20.83	19.44	12.50	37.49	31.94	40.27	29.16
5th	39	18.05	17.94	15.38	17.95	35.99	33.33	33.32	36.00
6th	18	10.25	10.25	02.56	10.25	20.50	12.81	12.81	20.50
7th	3	-	-	33.33	66.66	-	100.00	33.33	66.66

The incidences of sub-clinical mastitis in respect to test day milk yield were 70.58, 42.10 and 30.85 per cent in 0-5, 5-10 and 11 to 15-liters of milk-yield group, respectively showing significant increase in the milk production with increase in rate of incidence of sub-clinical mastitis. An incidence was higher in small farms as compared to the large farms. Large farms followed better management practices.

The incidence of SCM was 39.16 per cent in Murrah, 36.00 per cent in Jaffarabadi and 66.67 percent in Mehasana.

The study revealed that the overall prevalence of sub clinical mastitis (SCM) among buffaloes was 39.56 per cent. The quarter basis incidence of SCM was 22.33, 9.78, 4.44 and 4.00 per cent on single, double, triple quarters and all quarter's basis, respectively. Percentage of prevalence of SCM was 22.22, 35.71, 39.29, 33.33, 53.84, 44.44 and 66.66 in 1st, 2nd, 3rd, 4th, 5th, 6th and 7th parturition respectively. The incidence was higher (51.28%) in small farms than large farms (34.58%).

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Effect of Integrated Nutrient Management and Row Spacings on Growth and Yield of Composite Maize (*Zea mays* L.)

Particularly, high yielding varieties of maize gives good response to nitrogen, phosphorus and potassium application when these nutrients are applied in judicious quantity with appropriate forms and time. Fertilizer use continued to play a key role in augmenting higher crop productivity, while the continuous use of high amounts of chemical fertilizers only had deleterious effect leading to decline in crop productivity due to limitation of one or more of micronutrients. Use of organic sources of nutrients in combination with inorganic fertilizer has generated a still higher importance in crop production (Anil Kumar *et al.* 2005). In order to obtain higher yield per unit area, plant geometry has unique importance in crop production. In view of these considerations, the present study was undertaken to investigate the effect of integrated nutrient management and row spacings on growth and yield of composite maize (*Zea mays* L.).

The field experiment was conducted during *kharif*, 2005-06 on deep vertisol soil at Post Graduate Institute Research Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri. The soil of the experimental field was clayey in texture. Experimental field had 0.48 per cent organic carbon, 165.4 kg ha^{-1} available N, 18.4 kg ha^{-1} available P and 356.62 kg ha^{-1} available K with pH of 8.1. The experiment was laid out in factorial randomized block design with three replications. A composite MPQ 13 (Karveer) was used as test variety. There were nine treatment combinations comprising three fertility levels *viz.*, 60:30:30(50% RDF), 120:60:40 (100% RDF), 180:90:60(150% RDF) N, P_2O_5, K_2O kg ha^{-1}. Where 1/4 N was applied through FYM (contairiing 0.%54 N, 0.34% P and 0.76% K) 3/4 N was applied through urea and three row spacings *viz.*, 45,60,75 cm and plant to plant spacing was 20 cm adopted.

The FYM was applied just before dibbling and basal dose of Ilalf N and full of P_2O_5 and K_2O were applied at the time of dibbling. The remaining half nitrogen was given one month after dibbling as a top dressing.

Growth of maize plants (Table 1) in terms of plant height and dry matter production per plant varied significantly due to various fertility levels. Application of 150 per cent RDF produced tallest plant (216.80 cm) and more dry matter per plant (247.10 g) but it was statistically at par with that of lOO per cent RDF (210.78 cm and 245.46 g, respectively). Both those fertility levels were significantly superior to the 50 per cent RDF (174.03 cm

Table 1. Effect of integrated nutrient management and row spacings on growth, yield attributes and yield of maize.

Treatment	Plant height (cm)	Dry matter $plant^{-1}$ (g)	Length of cob (cm)	Number of grains cob^{-1}	1000 grain weight (g)	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})
Fertility levels :							
50% RDF (60:30:20)	174.03	232.33	16.00	379.27	283.84	39.38	60.63
100% RDF	210.78	245.46	19.13	438.84	298.36	47.29	74.94
150% RDF	216.80	247.10	19.26	444.91	301.07	48.00	76.39
S. Em ±	2.87	2.97	0.21	3.04	1.93	0.72	1.14
C. D. at 5%	8.60	8.90	0.62	9.10	5.78	2.17	3.41
Row spacing (cm) :							
45	191.60	236.95	16.81	408.89	287.98	42.17	73.00
60	202.22	242.19	18.23	422.56	294.73	45.10	71.04
75	207.43	245.75	19.34	431.58	300.56	47.40	67.91
S. Em ±	2.87	2.97	0.21	3.04	1.93	0.72	1.14
C. D. at 5%	8.60	NS	0.62	9.10	5.78	2.17	3.41
Interaction :							
S. Em ±	4.97	5.14	0.36	5.26	3.34	1.25	1.97
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS
Mean	200.54	241.63	18.13	421.00	294.22	44.89	70.95

and 232.33 g, respectively). Adequate supply of nutrients might have helped the maize plants to increase their growth, which in turn put forth more photosynthetic surface and thus contributing to more dry matter. Similar findings were also reported by Grewal *et al.* (1982) and Shanti and Sharma (1997).

The plant height was significantly increased with increase in row spacings from 45 to 75 cm, while the dry matter production was non significant at all the row spacings. Interaction effects were non-significant between fertilizer levels and row spacings.

The application of 100 per cent RDF, in which 1/4 N was applied through FYM and 3/4 N through urea influenced values of yield contributing characters viz., length of cob, number of grains per cob, 1000 grain weight and yield of maize grain and stover as compared to 50 per cent RDF. Further increase in fertilizer level to 150 per cent RDF did not increase values of all these yield contributing characters and maize grain and stover yields significantly as compared to 100 per cent RDF. The increase in yield contributing characters with RDF might be attributed to rationally supply of nutrients for sufficient dry matter production. Similar results were also reported by Shanti and Sharma(1997), Anil Kumar *et al.* (2005) and Karki *et al.* (2005). The increase in maize grain and stover yields with higher fertilizer level might be attributed due to increase in growth attributes like plant height, dry matter production and yield components like length of cob, number of grains and 1000 grain weight indicating importance of adequate nutrient supply of maize.

The values of yield contributing characters viz., length of cob, number of grains cob^{-1}, 1000 grain weight and maize grain yield were significantly increased with increase in row spacings of maize from 45 to 75 cm. Owing to availability of more space under wider row spacing which might have harvested natural resources like solar radiation, soil moisture and plant nutrients efficiently. Similar results were also reported by Thakur *et al.* (1997), Sen *et al.* (1999) and Huseyin *et al.* (2003). However, stover yield under wider row spacing of 75 cm was significantly lower than narrower row spacing of 45 cm because of lower plant population under wider row spacing. The interaction effect between fertility levels and row spacing were found to non-significant in respect of yield and yield contributing characters.

The results of the investigation suggest that there was no significant difference between 100 and 150 per cent fertility levels. It would be advisable to fertilize the maize with 100 per cent RDF (120:60:40 NPK kg ha^{-1}) where 1/4 N be applied through FYM and remaining N through inorganic fertilizer. The adoption of wider row spacings of 60 and 75 cm significantly increased all the growth and yield contributing characters as compared to narrow spacing of 45 cm resulting the significant increase in grain yields particularly under wider row spacing of 75 cm.

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Soil Fertility Status of Alphonso Mango Orchards from Devgad Tahashil - A Case Study

Mango (*Magifera Indica* L.) var. Alphonso is grown on 1.80 lakh ha as a cash crop in Konkan region and the economy of Konkan farmers is directly related to mango production. Devgad hapus is famous for its taste, aroma and keeping quality which is preferred not only in the state, but all over the world. In view of the above it was decided to study the nutrient status of the orchards from Devgad tahashil.

Soil samples were collected from orchards of Devgad Tahshil, (Grid distance of 3-4 km) grown in lateritic soil. Soil samples were collected from fertilizer application zone up to 45cm depth from the surface. Farmers from Devgad tahasil are generally using recommended dose of inorganic fertilizers, micronutrients and organic manures every year. Age of orchards under the study were 20 to 30 years. The collected soil samples were analysed for pH, EC, OC, exchangeable Ca, Mg, available N, P_2O_5 and K_2O, DTPA extractable Fe, Mn, Zn and Cu. The data emerged out of research presented Table 1 indicated that pH of the soil was varied from 4.67 to 6.57 with the mean value of 5.65, indicating slightly acidic nature of the soil. The soil salinity ranged from 0.18 to 0.80 dSm^{-1} with the average value of 0.37dSm-1 indicating low salinity. The mean organic carbon content was observed to be 6.57 g kg^{-1} with the lowest value of 4.91 g kg-1 and the highest value was 7.91 g kg^{-1}, indicating very high organic carbon content. It may be because farmers are using organic manures every year alongwith chemical fertilizers and micronutrient fertilizers. Generally, lateritic soil contains about 0.79 to 2.46 g kg^{-1} organic carbon with mean value 1.82 g kg^{-1} (Patil and Meisheri, 2002).

Further it was observed that the available nitrogen varied from 693.06 to 1019.20 kg ha^{-1} with the mean value of 816.50 kg ha^{-1}. Continuous application of fertilizers and manures resulted in the build up the nitrogen status of the soil. Therefore, the mean value was observed as 746.63 kg ha^{-1} which is considered to be very high. Lateritic soil of Konkan contains 371.51 kg ha^{-1} available nitrogen (Shinde 2006). However, the mean P_2O_5 content in the soil was 17.83 kg ha^{-1} which is rated as low. Even with continuous application of Phoshatic fertilizers and organic manures there was no sign of phosphorus build up in the soil. This was attributed to very high (90.95%) P fixing capacity of the lateratic soil in the presence of iron and aluminum oxide. Lateritic soils of Konkan contains 16.97 kg ha^{-1} P_2O_5 (Patil *et al.*, 1983). On the other hand, available potassium content in the soil ranged from 537.60 to 2083.20 kg ha^{-1} with the mean value 1493.67 kg ha^{-1} which is considered to be very high. This build up of potassium in the soil was due to continuous application of potassic fertilizers and organic manures.

In respect of secondary nutrients, exchangeable Ca^{++} vary from 5.13 to 32.81 cmol. (P^+) kg^{-1} soil with the mean value of 16.11 cmol. (P^+) kg^{-1}. However, exchangeable Mg^{++} ranged from 2.74 to 11.73 cmol. (P^+) kg^{-1} soil with the average value of 7.37 cmol. (P^+) kg^{-1} soil. Shinde (2006) reported 2.23 and 1.20 cmol. (P^+) kg^{-1} soil of Ca^{++} and Mg^{++} respectively, in the lateritic soil of Dapoli. Most of the samples indicated higher values of the secondary nutrients.

DTPA extractable micro nutrients indicated higher values than the critical limits in the tested soil samples. Iron ranged from 25.88 to 86.38 mg kg^{-1} with 49.33 mg kg^{-1} mean value. However, Mn vary from 10.68 to 123.48 mg kg^{-1} with the mean value of 47.45 mg kg^{-1}. Average value of Zn and Cu was 6.87 and 9.42 mg kg^{-1} respectively and their values were ranged between 2.70 to 16.78 and 3.25 to 22.60 mg kg^{-1}, respectively. Mean value of Fe, Mn, Zn and Cu were 44.54, 42.5, 1.03 and 3.32 and their values were ranged between 14.98-111.95, 6.06-6, 8.60, 0.29-2.28 and 1.49-9.32 respectively, reported in lateritic soils of Konkan by Patil and Meisheri (2004).

From the present investigation it is concluded that the soils were acidic in reaction with no harmful effect of salinity, high in available nitrogen, very high in organic carbon and available potassium. The available micronutrients such as Fe, Mn, Zn and Cu were also higher than the critical limits. The enrichment in the soil fertility is observed in the soils of mango orchards from Devgad tahashil due to continuous application of fertilizers and

Table 1. Soil analysis from Devgad tahashil for fertility parameters.

Orch-ard No.	pH	EC dSm^{-1}	O. C. $g\ kg^{-1}$	Exchangeable nutrients cmol. (P+) kg^{-1}		Available major nutrients (kg ha^{-1})			DTPA extractable micronutrients (mg kg^{-1})			
				Ca^{++}	Mg^{++}	N	P_2O_5	K_2O	Fe	Mn	Zn	Cu
1	5.15	0.20	4.91	11.36	2.74	705.60	11.76	537.60	64.68	28.82	5.72	8.10
2	5.70	0.33	6.71	18.69	6.41	846.72	7.06	806.4	32.12	41.58	3.43	6.92
3	5.26	0.18	5.49	10.63	5.31	834.18	17.25	1310.40	71.06	12.68	3.88	9.02
4	6.01	0.43	7.91	18.33	10.99	1003.52	2.35	1579.20	36.96	35.07	2.70	3.25
5	5.95	0.48	6.39	13.01	11.73	693.06	5.49	2083.20	25.88	123.48	2.99	9.02
6	5.81	0.26	7.06	18.88	8.79	790.27	16.46	940.80	44.46	58.90	6.26	5.44
7	6.57	0.80	7.44	32.81	6.59	715.01	18.81	1444.80	46.04	104.50	16.78	22.60
8	6.0	0.55	7.25	18.69	8.98	1019.20	27.44	1948.80	44.88	10.68	8.64	8.68
9	5.67	0.30	6.35	17.59	7.69	918.85	21.16	1310.40	86.38	12.78	9.96	10.30
10	4.67	0.38	6.66	5.13	4.58	809.09	37.03	1310.40	34.50	21.80	2.70	4.44
11	5.36	0.16	6.20	12.09	7.33	624.07	31.36	1579.20	55.72	71.74	12.58	15.88
Mean	5.18	0.37	6.03	14.77	6.76	746.63	16.35	1237.50	45.23	43.51	6.31	8.64

manures to mango orchards by the farmers. High amount of organic carbon, nitrogen, potassium and micronutrients might be the reason of the quality fruits with higher yields of Devgad farmers.

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Training Impact on Knowledge Attitude and Participation About Mushroom Technology Among Rural Women

Self employment is a major tool of empowering women. There is need to propogate economically viable small scale industries for women. Mushrooms command a high price in the market today. Without using any fertilized land, growing mushrooms at home level has indeed become a lucrative business.

In this task, a vast army of women with sound orientation and training programmes are essential, as training is advocated as essential method of communication (Aski, *et al.* 1996). Keeping this in view the present study has been conducted.

The study was conducted through purposive randomly selected villages in Kolhapur district. Seventy seven rural women who were beneficiaries of krishi vighyan kendra (KVK), integrated child development scheme (ICDS) and self help group (SHG) and nearby villages *viz*., Bambavade, Kodoli, Peth-wadgaon, Uchgaon, Talsande and Warana in Kolhapur district were evaluated regarding the knowledge of mushroom cultivation technology before training programme. By keeping in the view of productive age i.e. 21 to 40 years the self interested 70 rural women had given training about mushroom cultivation technology. The content of training programme was lectures of eminent persons, demonstrations, visit to the mushroom centres, slide show, counseling and guidance for 30 days. The data was collected through self structured questionnaire by using 'one group before-after research design' by Kerlinger (1983). The data was analyzed statistically by using 'Z' value (Gomez and Gomez, 1980).

Data presented in Table 1 reveals the knowledge of rural women about mushroom cultivation technology. Before training programme, 48.1, 37.6 and 14.3 per cent of rural women were totally ignorant, completely aware and partially aware respectively regarding the knowledge of nutritive values in mushroom. After training, their knowledge about nutritive values in mushroom were significantly increased in perfection with 74.3 per cent. The high level knowledge had considerably increased and low level knowledge of mushroom had been drastically reduced due to training. Such type of result was also reported by Shrivastava and Lakhera (2003) in their study.

Most of the rural women (42.8 per cent)

Table 1. Knowledge of rural women about mushroom cultivation technology.

Particulars	Before training (N=77)			After training (N=70)			Z' values
	a	b	c	a	b	c	
Nutritive value	29 (37.6)	11 (14.3)	37 (48.1)	52 (74.3)	13 (18.6)	05 (7.1)	a Vs. a_1 (5.29)** b Vs. b_1 (0.21) NS c Vs. c_1 (5.11)**
Acceptability as a food	19 (24.7)	25 (32.5)	33 (42.8)	40 (57.2)	21 (30.0)	09 (12.8)	a Vs. a_1 (4.09)** b Vs. b_1 (0.11) NS c Vs. c_1 (3.88)**
Preparation of byproducts	20 (26.0)	16 (20.8)	41 (53.2)	48 (68.6)	15 (21.4)	07 (10.0)	a Vs. a_1 (4.11)** b Vs. b_1 (0.09) NS c Vs. c_1 (4.20)**
Medicinal value	9 (11.7)	19 (24.7)	49 (63.6)	53 (75.7)	14 (20.0)	3 (4.3)	a Vs. a_1 (6.70)** b Vs. b_1 (0.18) NS c Vs. c_1 (6.25)**
Toxicity	17 (22.1)	25 (32.5)	35 (45.4)	44 (62.8)	16 (22.9)	10 (14.3)	a Vs. a_1 (4.05)** b Vs. b_1 (1.19) NS c Vs. c_1 (4.08)**
Variety of spawn	14 (18.2)	20 (26.0)	43 (55.8)	62 (88.5)	06 (8.6)	2 (2.9)	a Vs. a_1 (7.22)** b Vs. b_1 (2.11)NS c Vs. c_1 (5.10)**
Substrate preparation	9 (11.7)	12 (15.6)	56 (72.7)	54 (77.2)	11 (15.2)	5 (7.1)	a Vs. a_1 (7.05)** b Vs. b_1 (0.03) NS c Vs. c_1 (6.68)**
Spawing	7 (9.1)	16 (21.8)	54 (70.1)	52 (74.3)	13 (18.6)	5 (7.1)	a Vs. a_1 (6.42)** b Vs. b_1 (0.08) NS c Vs. c_1 (6.31)**
Harvesting and marketing	10 (13.0)	15 (19.5)	52 (67.5)	50 (71.5)	15 (21.5)	5 (7.1)	a Vs. a_1 (5.99)** b Vs. b_1 (0.04) NS c Vs. c_1 (5.38)**
Yield and economy	6 (7.8)	10 (13.0)	61 (79.2)	60 (85.8)	5 (7.1)	5 (7.1)	a Vs. a_1 (7.77)** b Vs. b_1 (1.29) NS c Vs. c_1 (7.11) NS
Preservation methods	8 (10.4)	16 (21.8)	53 (68.8)	60 (85.8)	6 (8.6)	4 (5.6)	a Vs. a_1 (7.19)** b Vs. b_1 (2.11)* c Vs. c_1 (5.81)**
Funding scheme	6 (7.8)	20 (26.0)	51 (66.2)	65 (92.9)	5 (7.1)	-	a Vs. a_1 (8.39)** b Vs. b_1 (2.16) NS

a, a_1 = Aware perfectly. b, b_1 = Aware partially. c, c_1 = Ignorant. * - Significant at 5% level. ** - Significant at 1% level, NS - Non significant were found to be not accepting the mushroom as a food. A significant change was observed after training. Majority of the women (57.2 per cent) accepted mushroom as a food for the consumption purpose.

Preparation of byproduct from mushroom was not known by many of the rural women (53.2 per cent). After the training a drastic change was noticed among these women. Majority of rural women (68.6 per cent) gained the knowledge about different mushroom recipes.

Mushroom has a medicinal value. However, 63.6 per cent women were ignorant about medicinal value of mushroom. After training programme 75.7 per cent women agreed about the medicinal value of mushroom. The knowledge about toxic varieties and toxicity of mushroom were also not observed upto the optimum level among these rural women before training. It was found increased upto 62.8 per cent after the training programme.

Only 18.2 per cent women perfectly aware about the availability and edible variety of spawn. This knowledge was gained by 88.5 per cent after training. The preparation of the substrate for the cultivation of mushroom were known perfectly by only 1 1.7 per cent, partially aware by 15.6 and totally ignorant by 72.7 per cent women before training. This knowledge was perfectly increased with 77.2 per cent of rural women after the demonstration in training programme. The information about spawing of mushroom was not known by 70.1 per cent women. This was updated with perfection by 74.3 per cent after the training.

Harvesting and marketing is also one of the important criteria in the mushroom cultivation, which was not noticed in 67.5 per cent women before training. However, it was found to be gained by 71.5 per cent women after the training. Among the 79.2 per cent rural women ignorant was recorded about the yield and economy regarding mushroom. It was changed into 85.6 per cent after their visits at mushroom cultivating centres under this training programme. Among the rural women 68.8 per cent had not correct idea about the exact procedure of the mushroom preservation. After the visit to cultivation centres and demonstration, 85.8 per cent of women developed a confidence about the methods of mushroom preservation.

For the cultivation of mushroom some funding schemes are needed at primary level in the village areas. In this regards, 66.2 per cent women were unable to describes the funding schemes for mushroom cultivation. Only 7.8 per cent women had an idea about the bank loan facilities for mushroom cultivation. The knowledge regarding funding schemes, name of the banks, procedure etc. was significantly increased (92.9 per cent) after the training programme. The perfectly positive attitude before training was increased from 38 to 66 per cent after the training programme.

The participatory approach of rural women regarding training of mushroom technology was changed after the training programme (Table 2). It was noted that, 54.3 and 22.8 per cent women changed their approach as earning and innovative activity respectively. Whereas 17.2 per cent women approach were reflected

Table 2. Participatory approach of rural women regarding training in mushroom technology (percentage).

Participatory approach	Before training (N=77)	After training (N=70)	Z' values
Innovative activity	24.6	22.8	(0.06) NS
Leisure time activity	41.6	17.2	(3.81)**
Earning activity	20.8	54.3	(3.59)**
Developmental activity	13.0	5.7	(1.02) NS

** - Significant at 1% level. NS - Non significant.

as leisure time activity. Only 5.7 per cent women reported as a developmental activity.

It might be inferred from the investigation of the present study that, skill-oriented training programmes had a positive impact regarding update the knowledge, positive change in attitude and perfect approach about the adoption of technology regarding mushroom cultivation among the rural women. Again more training are necessary to transfer the technology for the rural development.

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Effect of Various Methods of Weed Control and Planting Layouts on Weed Intensity, Weed Control Efficiency, Weed Index and Yield of Groundnut

Groundnut is an unique and important oilseed crop in India. It ranks first on area and production but low in productivity due to various factors. Among these, weed problem is one of the most important factor.

A field experiment was carried out during 2004 to evaluate weed intensity, weed control efficiency and weed Index at harvest of the crop groundnut. The soil of the experimental plot was sandy loam in texture with pH 7.8, available nitrogen 209.89 kg ha^{-1}, phosphorus 21.46 kg ha^{-1} potassium 312.97 kg ha^{-1} and organic carbon 0.51 per cent. The experiment was conducted in a factorial Random Block Design with three replications and consisted of two planting layouts and six weed control methods. The major weeds infesting the Indian groundnut crop were *Cyprus rotundas* L., *cynodon dactylon* L., *Commelina bengalensis* L., *Parthenium hysterophrous* L., *Tridex procumbent* L., *Euphoriba geniculata* L.

The planting layout, raised bed significantly reduced the weed intensity, higher per cent of weed control efficiency and lower weed Index. Also all the weed control treatments significantly reduced the weed intensity and biomass compared to the unweeded check (Table 1) This might be due to the rapid growth of groundnut, as indicated by more plant height and branches per plant which did not allow the weeds grow vigorously due to smothering. In the beginning slight injury symptoms were observed on the crop due to application of oxyfluorfen. Among the weed control method, weed free check was found most useful in reducing the weed intensity, showed higher per

Table 1. Weed intensity (m^2), weed control efficiency (%), weed index and yield of groundnut as influenced by different weed control methods and planting layouts.

Treatment	Weed intensity (m^2)	Weed control efficiency (%)	Weed index	Yield (q ha^{-1})		
				Dry pod	Haulm	Kernel
Layout :						
L_1 : Flat bed	13.54	94.29	-	11.39	11.86	6.78
L_2 : Raised bed	13.19	95.75	4.95	12.08	12.78	7.15
S. E. ±	0.11	-	-	0.21	0.09	0.10
C. D. at 5%	0.34	-	-	0.64	0.28	0.31
Weed control methods :						
W_1 : Unweeded control	66.03	-	24.78	9.70	11.44	5.87
W_2 : Weed free check	1.28	98.06	6.02	12.41	12.57	6.76
W_3 : Oxyfluorfen (PE) @ 0.300 kg a.i. ha^{-1}	4.99	92.44	8.18	11.79	12.02	6.30
W_4 : Oxyfluorfen (PE) @ 0.300 kg a.i. ha^{-1} plus hand weeding	1.96	97.03	5.09	12.29	12.48	6.72
W_5 : Pendimethalin (PE) @ 1.00 kg a.i. ha^{-1}	4.85	92.65	7.56	11.87	12.09	6.41
W_6 : Pedimethalin (PE) @ 75 % 1 kg a.i. ha^{-1} plus hand weeding	1.89	97.13	-	12.95	13.19	7.19
S. E. ±	1.05	-	-	0.21	0.20	0.14
C. D. at 5%	3.08	-	-	0.64	0.61	0.44
Interactoin (L x W) :						
S. E. ±	0.09	-	-	0.58	0.28	0.17
C. D. at 5%	NS	-	-	NS	NS	NS
Mean	13.51	95.46	10.33	10.36	3.77	6.53

Sig. - Significant. N.S. - Non significant.

cent of weed control efficiency and lower weed Index, while other treatments were found at par. Among the herbicides pre emergence application of pendimethalin @75 per cent of 1.00 kg a.i. ha^{-1} plus hand weeding was found significantly superior over others in reduction of weed intensity, lower weed Index and higher per cent of weed control efficiency. Due to effective weed control by herbicides and cultural operations in integration more nutrients were available to crop, better vegetative growth and ultimately resulted in better development of higher pod yield in the corresponding treatments. These results were in conformity with the results of Biradar (1978), Patel *et al.* (1996) and Bhagat (1997).

The dry pod, haulm and kernel yield were influenced significantly by planting layouts. Raised bed recorded higher dry pod, haulm and kernal yield over flat bed. Pre mergence application of pendimethalin @ 75 pe cent of 1.00 kg a.i. ha^{-1} plus one hand weeding was significantly superior over other treatments. The yield obtained by raised bed was maximum than flat bed might be due to less weed intensity, porous nature of bed, more development of pods, more availability of moisture, nutrients and other parameters. Similar observation was recorded in case of pre emergence application of pendimethalin @ 75 per cent of 1.0.0 kg a.i ha^{-1} with one hand weeding (40 days after sowing).

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Effect of Different Water Soluble Phosphatic Fertilizers on Growth and Yield of Sugarcane

Sugarcane takes 12-18 months for maturity and requires heavy doses of NPK fertilizers. Fertilizers are the basic important input to get the potential yield from improved varieties. Out of the above plant nutrients, phosphorus is one of the major nutrient require in huge amount for best development of sugarcane and sugar quality. It is the key nutrient that stimulates rooting and tillering in sugarcane.

Sugarcane being a long duration crop, application of rock phosphate was found to be beneficial (Nasir *et al*., 1997). The studies on water soluble phosphatic fertilizer (single super phosphate) with the combination of rock phosphate and jhabua rock phosphate were found beneficial in sugarcane (Malthi and Balsundaram 2001). However, inadequate information is available on effect of different water soluble phosphatic fertilizers in sugarcane for Rahuri area of M.S. With these considerations, the present investigation has been planned to study the effect of different water soluble phosphatic fertilizers on growth and yield of pre-seasonal sugarcane cv. CO 86032.

An experiment was conducted at the Water

Table 1. Growth attributing characters of sugarcane at harvest as influenced by the various treatments.

Treatments	Milliable cane height (cm)	Inter-nodes plant^{-1}	Length of internode (cm)	Dry matter plant^{-1}	Milliable cane (000 ha^{-1})	Cane yield (t ha^{-1})	Green top yield (t ha^{-1})	CCS (t ha^{-1})
T_1 100% WSP	265.83	33.60	17.28	421.25	96.09	128.95	20.81	13.38
T_2 30% WSP	273.38	24.70	17.58	432.25	99.54	137.21	22.40	15.02
T_3 50% WSP	271.00	24.50	17.45	429.00	98.75	135.50	21.97	14.75
T_4 60% WSP	266.98	24.40	17.28	423.25	96.13	129.93	21.21	13.83
T_5 Absolute control	239.25	21.13	14.58	344.25	87.32	101.73	16.69	10.10
S. E. ±	4.53	0.42	0.44	3.81	2.42	3.02	0.74	0.63
C. D. at 5%	13.95	1.28	1.35	11.73	7.46	9.31	2.28	NS
Mean	263.69	23.67	16.83	410.00	95.57	126.66	20.61	13.42

Management Project. Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra) during 2003-04. The experiment was laid out in randomized block design with four replications. Five treatments i.e. 30, 50, 60 and 100 per cent water soluble phosphatic fertilizers along with absolute control were considered under study. The soil of experimental field was clayey in texture, low in available nitrogen, moderate in available phosphorus and high in available potassium content. The reaction of the soil was slightly alkaline.

The data (Table 1) indicated that the growth attributing characters of sugarcane did not respond to various sources of phosphorus. However, they are significantly better than absolute control. Maximum growth attributing characters were recorded under treatment 30 per cent WSP through NPK grade 15:15:15 fertilizers. Lowest growth attributing characters were recorded in the control. These findings are in conformity with the results of Desai *et al.* (1988) and Jaybal *et al*. (1992).

The number of millable canes and cane as well as green top yields of sugarcane were significantly improved due to application of different water soluble phosphorus than control. However, they were found to be statistically non significant. Similar trend was recorded in case of commercial cane sugar as that of cane yield under study. These result are in agreement with the results of Desai *et al*. (1988), Patel *et al.* (1991) and Sundra and Natrajan (1997).

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Chemical Induction of Male Sterility in Rice(*Oryza sativa L.*)

In conventional methods used in the improvement of self-pollinated crops, genetic recombination is restricted since populations rapidly approach homozygosity under selfing. Genetic male sterility has permitted breeders easy access to the repeated hybridization and selection cycles in several self-pollinated crops. The problems in the use of genetic male sterility relate to its maintenance, perpetuation and transfer. The transfer of male sterility may be accompanied by undesirable traits through linkage and pleiotrophy. To over come several potent gametocides at different formulations were tried since last many years, keeping in view that the chemicals must have least effect on female organ (Kaul. 1988). Significant progress has been achieved in China on the use of gametocides in rice (Wang *et al.* 1991). The present study was conducted to study the effect of two gametocides on inducting pollen sterility and its effective concentration.

The experiment was conducted at the Research Farm of Agril. Botany Department, College of Agriculture, Dapoli, Dist. Ratnagiri during the *kharif* 2007, using two gametocides *viz*., Ethrel and Gibberllic acid on Ratnagiri-24 (V_1) and Palghar-1 (V_2) cultivars of rice.

The experiment was laid in factorial randomized block design with three replications. The chemicals *viz*., ethrel and gibberllic acid were used at three concentrations i.e. ethrel at 1000, 2000 and 3000 ppm, and Gibberllic acid at 400, 800 and 1200 ppm. The gametocides were applied as foliar sprays at booting stage. Twelve plants were treated in each treatment. The spikelets which were about to bloom were collected randomly and stored in 70 per cent alcohol. In the laboratory, the anthers in each spikelet were crushed in the presence of 2 per cent acetocarmine stain and observed under microscope. The pollen grains, which stained pinkish, were considered as fertile and those, which did not take the stain were classified as sterile.

The mean observation on pollen sterility is presented in Table 1. There were significant differences on the induction of pollen sterility amongst the different treatments at all three sprays as well as between varieties except in two sprays. The maximum pollen sterility was observed in the treatment ethrel at 3000 ppm (51.28 %) in variety Palghar-1, which was much higher than the control There was increase in pollen sterility with increase in concentration of the chemicals. Ethrel induced higher pollen sterility at all the three concentrations than gibberllic acid.

The analysis showed that the maximum

Table 1. Effect of different concentrations of Gametocides on pollen sterility in rice.

Treatments	Pollen sterility (%)		
	V_1 Ratnagiri-24	V_2 Palghar-1	Means
T_1 Control	8.42	11.95	10.19
T_2 Ethrel - 1000 ppm	37.01	43.10	40.05
T_3 Ethrel - 2000 ppm	44.02	44.87	44.45
T_4 Ethrel - 3000 ppm	47.19	51.28	49.24
T_5 GA_3 - 400 ppm	28.91	29.37	29.14
T_6 GA_3 - 800 ppm	32.24	34.03	33.13
T_7 GA_3 - 1200 ppm	35.29	37.03	36.16
Mean	33.29	35.94	
	Var.	Treat.	V x T
S. Em ±	0.541	1.011	1.430
C. D. at 5%	0.571	2.940	

pollen sterility in V_1 observed at T_4 (47.19%) followed by T_3 (44.02%) and T_2 (37.01%) as compared to T_1 (8.42%), while in V_2 maximum pollen sterility obtained at T_4 (51.28%) followed by (44.87%) T_2 (43.10%) as compared to T_1 (11.95%).

In the variety Palghar-1, ethrel at 3000 ppm induced maximum pollen sterility (51.28%) as against the minimum (1 1.95%) in the control. Ethrel caused deformation of anthers with low or absent, pollen grain production, which became severe with increasing concentrations. The similar trend of increase in the pollen sterility with increase in concentration of both the gametocides was observed in Ratnagiri-24 and Palghar-1, This is in agreement with the findings of Bose and Sharma (1972) and Aswathanarayana and Mahadevappa (1992), who reported that the pollen sterility increased with increase in concentration of GA_3. However, Prabha and Thangaraj (2005) reported significantly higher percentage of male sterility in TGMS lines at 8000 ppm. Ethrel, at all the three concentrations tried, induced pollen sterility higher than that in the other treatments. This agrees with the findings of Guimaraes *et al.* (1981), who reported that the pollen sterility was maximum when was treated at 4000 ppm ethrel.

The gametocides were applied at booting stage, because booting stage accounting for a higher pollen sterility which has been also confirmed earlier by Parmar *et al.* (1979) and Aswathanarayana and Mahadevappa (1992). However, the induced pollen sterility was relatively less in Ratnagiri-24 (47.19%) at ethrel-3000 ppm.The higher pollen sterility at booting stage may be due to the fact that this stage coincides with the spikelet differentiation stage and reduction division stage leading to degeneration of pollen mother cells and resulting in higher pollen sterility. In hybrid rice breeding where almost complete male sterility is required, ethrel at higher concentration appeared to be more suitable.

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Standardizing the Frequency of Application of the Gametocides to Induce Pollen Sterility in Rice (*Oryza sativa* L.)

Breeders must adopt innovative breeding approaches to push production towards the projected yield levels. Two-line hybrid is alternative to male sterile-maintainer-restorers based three line hybrid breeding. Since the pioneering work on the gametocidal property of maleic hydrazide in gladiolus and corn (Moore,1950), a wide range of chemicals has been screened and many to selectively induce male sterility in crop plants. Though instances of use of some of them in crops other than rice are several, none proved to be strictly selective, totally sterilizing and non phytotoxic (Perez *et al*. 1973). Based on the primary report on the effect of ethrel and GA_3 on rice (Aswathanarayana and Mahadevappa, 1992), the present study was undertaken to evaluate and standardize the frequency of application, and its effective concentration and use in commercial hybrid rice seed production.

The field experiment was conducted at the Research Farm of Agril. Botany Department, College of Agriculture, Dapoli, Dist. Ratnagiri during *kharif* 2007, using two gametocides viz. Ethel and Gibberllic acid on Ratnagiri-24 and Palghar-1 cultivars of rice.

The experiment was laid out in factorial randomized block design with three replications. The chemicals viz., Ethrel and Gibberellic acid were used at three concentrations i.e. ethrel at 1000, 2000 and 3000 ppm and gibberellic acid at 400, 800 and 1200 ppm. The gametocides were applied as foliar sprays at booting stage. Total three foliar sprays were given at four days internal. Twelve plants were treated in each treatment. The spikelets which were about to bloom were collected randomly and stored in 70 per cent alcohol. In the laboratory, the anthers in each spikelet were crushed in 23 per cent acetocarmine stain and observed under microscope. The pollen grains with pinkish stain were considered as fertile and those which did not take the stain were classified as sterile.

There were significant differences between

Table 1. Effect of frequency of different concentrations of gametocides on pollen sterility (%) in rice.

Treatments	Pollen sterility at one spray			Pollen sterility at two spray			Pollen sterility at three sprays		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1 Control	8.42	11.96	10.09	8.42	11.96	10.19	8.42	11.96	10.19
T_2 Ethrel - 1000 ppm	32.77	34.58	33.67	37.17	33.33	35.25	37.01	43.10	40.05
T_3 Ethrel - 2000 ppm	32.53	34.15	33.64	39.73	39.38	39.55	44.02	44.87	44.45
T_4 Ethrel - 3000 ppm	37.70	41.67	39.69	44.69	42.79	43.74	47.19	51.28	49.24
T_5 GA_3 - 400 ppm	23.77	26.06	24.92	25.18	22.86	24.02	28.91	29.37	29.14
T_6 GA_3 - 800 ppm	26.96	27.15	27.06	29.43	31.05	30.24	32.24	34.03	33.13
T_7 GA_3 - 1200 ppm	28.33	32.05	30.19	31.27	34.66	32.96	35.29	37.03	36.16
Mean	27.21	29.66		30.84	30.85		33.29	35.94	
	Variety	Treat.	V x T	Var.	Treat.	V x T	Var.	Treat.	V x T
S. Em $\pm$	0.67	1.26	1.78	0.65	1.22	1.72	0.54	1.01	1.43
C. D. at 5%	1.96	3.66	NS	NS	3.53	NS	1.57	2.94	NS

two varieties (except two sprays), among the various treatments at all three sprays. However, treatment variety interactions were non significant at all three sprays. Between the two varieties, Palghar-1 recorded higher pollen sterility (51.28%) as compared to Ratnagiri-24 (47.19%) at third spray. The treatment Ethrel-3000 ppm applied thrice resulted in higher pollen sterility (51.28%) closely followed by Ethrel-2000 ppm applied thrice (44.87%) and Ethrel 1000 ppm applied thrice (43.10%). The interaction between treatments and varieties revealed that Ethrel 3000ppm applied thrice recorded the highest pollen sterility (49.24%) as compared to control.

The treatment GA_3 1200ppm applied thrice also induced a high pollen sterility (37,03%) closely followed by GA_3 800 ppm applied thrice (34.03%) in Palghar1 where as Ratnagiri 24 (35.29%) at GA_3 1200 ppm.

The study revealed that with increase in frequency of application of the gametocides, an increase in pollen sterility was also noticed with respect to both the gametocides. This was true for both the varieties studied *viz*., Ratnagiri-24 and Palghar-1. This finding confirm with the previous research studies by Bose and Sharma (1972), Perez *et al.* (1973)) and Parmar *et al.* (1979). A high degree of pollen sterility (71.00%) by applying ethrel-8000 ppm thrice has also been reported in the earlier work conducted by Aswathanarayana and Mahadevappa (1992).

The differences in the degree of pollen sterility between the two varieties could be attributed to the differences in the bio-chemical composition of the two varieties as the gametocides are known to act on the sulfhydryl compounds presented in the anthers (Shao and Hu, 1986). The higher pollen sterility at booting stage may be due to the fact that this stage coincides with the spikelet differentiation stage and reduction division stage leading to degeneration of pollen mother cell and resulting in higher pollen sterility. In hybrid rice breeding where almost complete male sterility is required, ethrel at higher concentration appeared to be more suitable.

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Effect of *Kharif* Legumes and Soybean on Growth and Yield of *Rabi* Sorghum under Rainfed Condition with Different Fertilizer Levels

Sorghum (*Sorghum bicolor* (L.) Moench) is one of the most important food grain crops grown in India under rainfed conditions. Due to the uncertainty of monsoon particularly in August - September, the productivity of *rabi* sorghum (Post rainy season) is always less than that of kharif season. The double cropping of rainy season legumes followed by post rainy season sorghum is more profitable than single cropping. Hence double cropping was recommended in Maharashtra, particularly in Marathwada region in the areas of assured and moderately high rainfall area zone (Anonymous, 1988). To study the performance and economic returns of soybean as preceding crop under double cropping in comparison to traditional legumes such as green gram (*Vigna radiata*) and black gram (*Vigna mungo*) under rainfed condition, the present study was carried out.

The experiment was conducted in a factional randomized block design (FRBD) with three replication on deep vertisol during 2002-03 to 2004-05 at Sorghum Research Station, MAU, Parbhani (MS). The treatments comprised of four rainy season legumes *viz*., 1. Green gram (BM 4), 2. Black Gram (TAU-1), 3. Early type Soybean (MAUS 47) and 4. Mid late Soybean (JS 335) grown under recommended practices as preceding legumes (kharif). The succeeding post rainy season (rabi) sorghum was grown with three fertilizer management practices i.e. 1. Control or no fertilizer, 2. 50 per cent recommended dose of fertilizers (20:10:0 kg NPK ha^{-1}) and 3. 100 per cent RDF (40:20:0 kg NPK ha^{-1}). The rainy season legumes were sown on onset of monsoon (on 20^{th} June 2002, 26^{th} June 2003 and 29^{th} June 2004) and *rabi* sorghum on 1^{st} October 2002, 6^{th} October 2003 and 11^{th} October 2004. The gross and net plot sizes were 3.6 x 6.0 m^2 and 2.7 x 5.0 m^2 respectively. The data on the grain yield of *kharif* legumes, grain and fodder yield of rabi sorghum was recorded.

***Kharif* legumes :** On the basis of three years average (Table 1) soybean JS 335 gave highest grain yield (1945 kg ha^{-1}) followed by MAUS 47 (1775 kg ha^{-1}) and black gram (1542 kg ha^{-1}). Green gram yielded lowest grain yield (1354 kg ha^{-1}).

***Rabi* sorghum :** During all three years, the grain yield of *rabi* sorghum after *kharif* legumes was influenced significantly. Hegade and Patil (1981) also found similar results. On the basis of pooled analysis for three years data, *rabi* sorghum produced maximum grain yield after preceding black gram and which was significantly superior over soybean JS 335 and at par with other preceding *kharif* legumes. *Rabi* sorghum after preceding green gram and black gram gave significantly higher fodder yield compared to the preceding soybean in the studies carried out by Mahadkar and Saraf, 1988 also. The next best treatment was soybean MAUS 47, and lowest yield was due to soybean JS 335.

Fertility levels : The 100 per cent RDF (40:20:0 kg NPK ha^{-1}) was found to be highest in recording grain yield (1629 kg ha-1) which was significantly superior to 50 per cent RDF (20: 10: 0 kg NPK ha^{-1}) (Rao and Rao, 1980) and control (0 kg NPK ha^{-1}) treatment (Aglave and Lomte, 1998). Later two treatments being at par with each other (Pawar and Khuspe, 1980).

Sorghum Grain Equivalent Yield (SGEY) :

Sorghum crop : The preceding kharif legumes, green gram and black gram gave at par yield but both were found significantly superior than soybean variety MAUS 47 and JS 335. However, MAUS 47 was significantly superior to JS 335. The fertility levels of 100 per cent RDF was significantly superior to 50 per cent RDF and 0 level, the later two being at par with each other.

Legume - *rabi* sorghum : The SGEY from legume - *rabi* sorghum sequence cropping was non significant. Each higher fertilizer level was significantly superior to its lower level in giving SGEY. The interaction of legume x fertilizer revealed that green gram, black gram and soybean MAUS 47 with 100 per cent RDF produced maximum yield.

Monetary returns : Net monetary returns obtained from all preceding legumes were comparable. Every higher fertility level was significantly superior to lower level in giving net monetary returns. The interaction effect of legume x fertilizer on net monetary returns indicated that the black gram and green gram was at par and significantly superior to all the remaining treatment combinations.

The present study indicated that growing of sorghum during *rabi* season after green gram, black gram and early soybean (MAUS 47) found remunerative. However, mid late

Table 1. Grain and fodder yield (kg ha^{-1}), monetary return (Rs. ha^{-1}) and ancillary data of *rabi* sorghum as influenced by various treatments in sequence cropping.

Treatments	*Kharif* legume Grian yield (kg ha^{-1})	*Rabi* sorghum		SGEY from sorg-hum	SGEY from seq-uence	NMR (Rs. ha^{-1})	B : C ratio	Ancillary data			
		Grain yield (kg ha^{-1})	Fodder yield (kg ha^{-1})					Plant height (cm)	50 % flow-ering	Grain yield (g pl^{-1})	1000 seed weight (g)
Preceding legumes (L) :											
Green gram (BM4)	1354	1607	7126	2982	6166	24080	1:1.50	164	78	31.0	32.0
Black gram (TAU-1)	1542	1718	7122	2946	5936	22587	1:1.41	172	77	29.9	32.5
Early soybean (MAUS 47)	1775	1548	6117	2637	6264	22421	1:1.22	155	81	31.4	32.8
Mid late soybean (JS 335)	1945	1059	5067	2024	6001	20887	1:1.14	142	85	29.2	32.4
S. E. ±		111	222	70	97	643	-	-	-	-	-
C. D. at 5%		308	626	198	NS	1814	-	-	-	-	-
Fertilizer level of *rabi* sorghum :											
Control (0 kg NPK ha^{-1})		1362	5646	2424	5707	19947	1:1.48	156	82	28.9	32.4
50 per cent RDF (20:10:0 kg NPK ha^{-1})		1451	6192	2540	6070	22308	1:1.66	159	80	33.7	32.8
100 per cent RDF (40:20:0 kg NPK ha^{-1})		1629	7232	2976	6498	25227	1:1.87	160	80	34.0	32.9
S. E. ±		44	111	60	84	557	-	-	-	-	-
C. D. at 5%		141	311	171	238	1571	-	-	-	-	-
Interaction : Legume x Fertilizer level :											
S. E. ±		101	377	121	169	1114	-	-	-	-	-
C. D. at 5%		NS	NS	343	477	3143	-	-	-	-	-
CV %		19	10.4	-	-	-	-	-	-	-	-
G. M.		1485	6358	2647	6091	22494	-	158	80	31.0	32.7

soybean (JS 335) has reduced yield of succeeding *rabi* sorghum compared to early soybean. In above sequence cropping RDF (40:20:0 kg NPK ha^{-1}) should be applied to rainfed *rabi* sorghum on vertisol under assured rainfall areas.

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Effect of Water Stress on Growth, Yield and Economics of Summer Groundnut

Groundnut (*Arachis hypogaea* L.) is most important oil seed as well as cash crop of India and particularly of Maharashtra. India accounts 40 per cent of area and 30 per cent worlds out put of groundnut. During 2005-06 the crop occupied an area of 6.74 million ha. with its annual production 7.99 million ton and average productivity of 1187 kg ha^{-1}. Maharashtra is one of the leading state of groundnut production ranked 5th in area (0.43 million ha) and production (0.41 million ton) during 2005-06 with its productivity of 958 kg ha^{-1} (Anonymous, 2006). The low yield of groundnut in Maharashtra is mainly due to the fact that about 90 per cent of crop is cultivated during kharif season under rainfed condition. Vagaries of monsoon drastically affect yield of crop due to uneven and long dry spells during crop growth period that mostly affect at phenophages of groundnut. Besides that improper irrigation layout, imbalance fertilizer, local seeds are responsible for less yield in groundnut. However, in summer it has less scope to cultivate due to inadequate irrigation water availability. Moisture stress at various critical growth stages of groundnut reduces number of pods by greater extent than stress at pod formation stage (Venkateshwar Rao *et al*. 1986). The information is limited about effect of water stress at different phenophages on growth and reproductive efficiency of the crop (Golakiya and Patel, 1992).

In recent year some useful techniques like use of organic mulch, plastic mulch have been evolved to minimize water losses through these

Table 1. Growth and yield contributing characters of summer groundnut as influenced by different treatments.

Treatment	Plant height (cm)	Plant spread (cm)	Functional leavels $plant^{-1}$	Leaf area $plant^{-1}$ (dm^2)	Dry matter $plant^{-1}$ (g)	Dry pod yield (q ha^{-1})	Haulm yield (q ha^{-1})	Dry karnel yield (q ha^{-1})
M_1	28.63	23.09	69.86	16.43	13.38	23.56	38.89	16.49
M_2	29.76	23.81	70.43	17.58	15.17	25.81	42.20	18.40
M_3	30.82	23.89	71.77	18.10	15.76	27.10	44.72	19.46
M_4	30.06	24.33	71.29	16.61	13.74	24.38	40.17	17.60
M_5	31.84	24.21	72.29	19.48	16.72	26.41	43.57	18.99
M_6	37.77	25.23	72.59	21.17	17.77	28.96	47.41	20.83
M_7	28.10	24.35	68.25	15.69	12.20	22.94	38.04	16.74
SE $\pm$	0.57	0.42	0.94	0.54	0.30	0.41	0.73	0.31
C. D. at 5%	1.70	1.26	2.80	1.61	1.05	1.13	2.18	0.97
G. M.	30.10	24.24	70.99	17.87	14.87	25.59	42.14	18.61

M_1 = Sugarcane trash mulch with stress at flowering stage, M_2 = Sugarcane trash mulch with stress at pegging stage, M_3 = Sugarcane trash mulch with stress at pod development stage, M_4 = White polythene mulch with stress at flowering stage, M_5 = White polythene mulch with stress at pegging stage, M_6 = White polythene mulch with stress at pod development stage and M_7 = Control.

operations. Organic mulch is available easily on farm for conserving soil moisture, avoid soil erosion and helpes in increasing microbial activity in soil. With the above considerations this study on the effect of water stress on growth and yield of groundnut was under taken.

The field experiment was conducted during summer 2006 at PG farm of Mahatama Phule Krishi Vidyapeeth, Rahuri. The soils of the site was sandy loam (pH 8.2), low in available nitrogen (220.5 kg ha^{-1}), moderately high in phosphorous (23.6 kg ha^{-1}) and very high in potassium (326.31 kg ha^{-1}). Well decomposed FYM applied before sowing @10 ton ha^{-1} and fertilized with 25 kg N ha^{-1} and 50 kg P_2O_5 ha^{-1}. Experiment was laid out in a randomized block design with four replications and seven treatments comprising of application of sugarcane trash and white polythene mulch and stress given at different growth stages of groundnut compared with control treatment where no mulch, no stress was considered.

The data respect of growth characters as influenced by the different treatments are presented in Table 1. The mean values of growth contributing characters *viz*., plant height, plant spread, number of functional leaves $plant^{-1}$, leaf area $plant^{-1}$ and dry matter $plant^{-1}$ were 30.10 cm, 24.24 cm, 70.99, 17.87 dm2 and 14.87 g respectively.

Table 2. Oil content and economics of groundnut as influenced by different treatments.

Treat-ment	Oil cont-ent (%)	Oil yield (q ha^{-1})	Gross monetary returns (Rs. ha^{-1})	Net monetary returns (Rs. ha^{-1})	B:C ratio
M_1	46.52	7.85	49058	25469	2.08
M_2	46.85	8.60	53735	30146	2.28
M_3	47.31	9.22	57686	34097	2.44
M_4	46.65	8.15	50764	24473	1.93
M_5	47.22	8.87	55043	28752	2.09
M_6	47.79	9.89	60296	34005	2.29
M_7	47.71	7.78	47777	25821	2.17
SE $\pm$	0.15	0.15	838	838	0.03
C. D. at 5%	0.46	0.45	2489	2488	0.10
G. M.	47.12	8.63	53480	28966	2.18

The treatment of white polythene mulch

with stress at pod development stage recorded the maximum plant height (37.77 cm), plant spread (25.23 cm), number of functional leaves plant^{-1} (72.59), leaf area plant^{-1} (21.17 dm^{-2}) and dry matter plant^{-1} (17.77 g). Increase in number of leaves plant^{-1} and leaf area (dm^{2}) enhances photosynthetic activity and therby increases dry matter plant^{-1}. This results are inconformity with Chavan (1997). Leaflet size was significantly and negatively correlated with drought stress condition as reported by Venkateshwar Rao *et al*. (1986), who observed that stress at flowering decreased dry matter production.

Maximum dry pod yield (28.96 q ha^{-1}), haulm yield (47.41 q ha^{-1}), dry kernel (20.83 q ha^{-1}) was recorded in the treatment of white polythene mulch stress at pod development stage. The results are in conformity with Golakiya and Patel (1992) and Venkateshwar Rao *et al.* (1986).

Highest oil content (Table 2) was recorded in treatment of white polythene mulch with stress at pod development stage (47.79%) and was significantly superior over rest of the treatments. However, it was at par with sugarcane trash mulch with stress at pod development stage (47.31%). Data revealed that the treatment of white polythene mulch with stress at pod development stage recorded maximum oil yield (9.89 q ha^{-1}) and was significantly superior over rest of the treatments. Similar results were also reported by Sham Sundar (1999) and Shaikh *et al*. (2004).

Maximum gross monetrary returns were obtained in white polythene mulch with stress at pod development stage (Rs. 60296 ha^{-1}) and it was followed by sugarcane trash mulch with stress at pod development stage (Rs. 57686 ha^{-1}). Smilar results were reported by Chitodkar (2000) and Raskar and Bhoi, (2003).

Highest net monetary returns and maximum B:C ratio obtained with sugarcane trash mulch with stress at pod development stage (Rs. 34097 ha^{-1} and 2.44) due to less cost of sugarcane trash. It is observed that, yield and yield contributing characters are favorably influenced due to white polythene mulch.

The differences in mean moisture content (Table 3) was statistically significant. The moisture per cent was significantly higher in polythene mulch than sugarcane trash mulch and control. Sometimes moisture per cent got reduced due to stress to particular growth stage of crop but at 105 DAS, and 120 DAS, there was no reduction in moisture, because frequent

Table 3. Soil moisture status (%) at 15 days interval as influenced by different treatments.

Treatments	Days after sowing							
	15	30	45	60	75	90	105	120
M_1	37.76	29.30	25.56	34.05	37.59	34.10	32.32	32.68
M_2	37.35	33.56	37.20	28.61	38.72	34.00	31.82	31.19
M_3	36.79	32.77	36.73	34.60	28.69	24.27	31.87	32.36
M_4	38.42	30.95	27.04	36.40	38.09	35.71	32.73	35.10
M_5	37.60	35.52	38.08	29.89	38.92	36.14	32.50	34.21
M_6	39.25	34.86	37.89	36.49	30.97	25.29	32.21	33.01
M_7	34.39	27.02	32.10	25.94	35.87	30.71	28.17	27.90
SE ±	0.44	0.46	0.34	0.34	0.35	0.41	0.36	0.40
C. D. at 5%	1.30	1.39	1.03	1.02	1.06	1.24	1.07	1.20
G. M.	37.36	32.01	33.51	32.28	35.54	31.64	31.68	32.50

rainfall received during the last days of crop growth period which might have affecfed the stressed condition. Mulches improved soil moisture by reducing evaporation, runoff, suppressing weed growth, increased germination and early crop growth due to increase in soil temperature. Higher moisture conservation can be achieved by using transparent plastic mulch as reported by Pawar *et al*. (2008).

From the above it could be concluded that flowering and pegging stages of groundnut were sensitive to moisture stress and caused maximum yield reduction, while polythene mulch played important role in conserving moisture and reducing weed growth ultimately enhanced the yields.

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Manufacture of Ice creame by Incorporation of Ginger (*Zingiber officinale* L.) Juice

Ice cream is highly delicious and nutritionally rich frozen product Different fruit flavours have been added to enhance product acceptability. According to me Ayurvedic medicinal system, ginger is considered to be carminative, stimulant and given in dyspepsia and flatulent colic. Medical properties of ginger are well documented (Buchman, 1980 and Kaur and Kapoor, 2002). There are tendency of some people to refrain from consuming ice-cream for fear of catching cold. Ginger ice-cream, however may be acceptable to mem. In the present study, attempts were made to study, the possibility of preparmg tee cream by incorporation of gnger juice as a flavouring agent.

Fresh buffalo milk was procured fiom the Dairy Unit of the College of Agriculture, Dapoti, for the manufacture of ice cream. Ice cream was prepared as per procedure suggested by De (2001) with slight modifications. The standard ice cream mix was formulated to contain 10 per cent fat, 11 per cent SNF, 15 per cent sugar, and 0.4 per cent gelatin as a stabilizer. Aging period was maintained at 10°C for 12 hrs. The ginger juice was prepared and analysed in me laboratory. Ginger juce contained 13.68 per cent total solids, 1.12 per cent fat, 2.18 per cent protein and 0.203 per cent acidity. Ginger juice was added after ageing as a flavouring agent as per different treatments. The aged ice cream mix with added ginger juice was subjected to freezing in ice cream pot. After hardening, the ice cream from different treatments was served to a panel often judges for sensory evaluation.

The treatments were plain ice cream as a control (T_0), ginger juice @ 1.5, 3.0, 4.5, and 6.0 per cent of mix as T_1, T_2, T_3, and T_4 respectively. The fat content of ice cream was estimated using Standard Gerber method as per IS:1224 (part I, 1977). The protein was determined as per method suggested by Chaudhari (1959). Total solids and tiratable acidity was determined according to IS:2802 (1964). The percentage over-run of ice cream was determined in terms of volume as per method described by Arbuckle (1986). The melting time of ice cream was noted in minutes at room temperature. The sensory attributes of

Table 1. Physico-chemical and sensory quality of ginger ice cream.

Per cent ginger juice	Chemical quality (per cent)				Physical characterstics		Sensory characteristics			
	Total solids	Fat	Protein	Titra-table acidity	Melting time (min)	Over run (%)	General appea-rance	Body and texture	Flavor	Overall accept-ability
Control	37.07	10.58	4.005	0.189	58.53	51.42	7.69	7.20	6.96	7.28
1.5	37.04	10.48	3.93	0.190	63.83	49.36	7.60	7.58	7.56	7.58
3.0	36.98	10.41	3.82	0.207	67.16	46.12	8.14	8.05	8.22	8.13
4.5	36.98	10.22	3.71	0.216	69.16	42.61	7.89	7.88	7.89	7.88
6.0	36.92	10.09	3.63	0.225	71.00	39.79	7.52	7.51	7.17	7.39
S. E. $\pm$	0.07	0.06	0.02	0.001	0.41	0.18	0.03	0.02	0.03	0.02
C. D. at 5%	0.29	0.22	0.09	0.005	1.66	0.72	0.014	0.09	0.13	0.07

the products such as general appearance, body and texture and flavour were studied by house panel often judges using nine point hedonic scale as per IS:6273 (part II, 1971).

From the results in Table 1, it is revealed that the variation in total solids content of ice cream was significant, due to different levels of ginger juice. The total solids content decreased with the increase ia level of ginger juice due to dilution effect of ginger juice in ice cream which was found to exercise significant influence on its total solids content. Ginger juice had significantly affected Ihe fat content of ice cream. It was observed that addition of ginger juice decreased the fat content of ice cream.

The preparation of ice cream incorporated with ginger juice had significant effect on its protein content. An increase in Ihe level of ginger juice decreased the protein content of ice cream. The protein content in treatment T_0 (control) was 4.00 per cent. This is in range of 4.00 to 4.60 per cent required for good quality ice cream (Webb *et al*., 1974 and Atbuckte, 1986). The protein content in treatment T_1 to T_4 was 3.93, 3.82, 3.71, and 3.63 per cent, respectively. The decreasing trend of protern in ice cream may be due to low protein content of ginger juice (2.18 per cent).

Titratable acidity of ice cream was increased with an increase in the level of gmger juice due to higher acidity of ghger juice (0.203 per cent). As per ISI specification (IS:2802, 1964) the ice cream should have mmimum acidity of 0.25 per cent, which was within the ISI limits (De, 2001).

Mettdown is an important property of an ice cream affecting its sensory quality. It is important from at least two view points eye appeal and mouth feel (Flack, 1988). Deviation in the melting property from ideal condition can make the ice cream defective. The melting time of ice cream samples containing ginger juice increased progressively, with increasing level of ginger juice. In general, the viscosity increased resistance to melting (Arbuckie, 1986). Slow melting generally, indicated over stabilization and such condition can be corrected by reducing the amount of starch and/or emulsifiers. Ginger containing hydrocolloids (starch) which might be responsible for the increased viscosity hence the mettdown time.

The variation in overrun of ice cream incorporated with different levels of ginger juice was statistically significant. The over run of ice cream decreased with me increase in level of ginger juice.

Ice-cream with 3 per cent level of ginger juice had most appealing general appearance, flavour, body and texture. Incorporation of ginger juice in ice cream significantly improved its flavour acceptability. But increase in me ginger juice level had pronounced effect on its general appearance.

From overall acceptability score, the most acceptable quality ice cream can be prepared by using 3 per cent ginger juice. Such flavouring did not appreciably affect the composition of ice cream. There was some reduction in over run in ice cream containing ginger, but the ginger juice had a positive effect on flavour acceptability and resistant to melting. Ice cream mix with ginger juice has several therapeutic benefits. Thus, it may be concluded that, best quality of ice cream could successfully be prepared by using 3 per cent level of ginger juice.

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Influence of AM on Growth and Yield of Groundnut (*Arachis hypogaea* L.)

Groundnut (*Arachis hypogaea* L.) the important oil seed crop of India. It is a well known fact that AM improves growth of plants by providing higher absorptive surface as compared with root hairs and thus helps in the absorption of relatively immobile ions in soil such as phosphorus, copper and zinc (Bowen *et al.*, 1974; Bagyaraj, 1992). The role of AM fungi in plant nutrition especially phosphorus is well known (Peterson *et al.*, 1984). Several field and laboratory experiment have demonstrated that AM colonization improves the growth and nutritive value of host plant (Mosse, 1973), which have been shown to increase the ability to absorb more nutrients than plants lacking AM (Daft and Nicolson, 1969). There are few reports on association of AM with groundnut in unsterile soil for nutrition of microelement in seeds (Caris *et al.* 1998; Charritha Devi and Reddy, 2004). Therefore, detailed studies were conducted on the AM association and its application in increasing the growth and nutrient uptake in groundnut in unsterile soil (Mosse *et al.*, 1969),

A field experiment was conducted using groundnut variety G. G. -2, at Dev-daithan, Tahasil Shrigonda, Dist. Ahamednagar, during *kharif* season of 2008. Soil of the experimental plot was lateritic, clay loam in texture, slightly alkaline in reaction (pH 7.5). Water table was below 7 m and the field capacity and permanent wilting point were 30.0 and 18.3

Table 1. Effect of *G. mossae* and *G. fasciculatum* on growth of *Arachis hypogaea*.

Treatment	Fodder plant^{-1} (g)	Pod plant^{-1} (g)	Seed plant^{-1} (g)	Husk plant^{-1} (g)
Contol	32	5.9	3.7	2.2
GM + GF	37.4 (16.87)	9.1 (54.23)	5.3 (43.24)	3.8 (72.72)
C D (p = 0.05)	34.34	20.37	10.18	10.18

C = Control, GM = *G. mossae*, GF = *G. fasciculatum*.
Note : Figures in parenthesis are per cent increase over control.

per cent, respectively.

Glomus fasciculatum was isolated from rhizosphere soil of *Memecylon umbellatum* and *G. mosseae* was isolated from rhizosphere soil of *Eugenia jambolana* (Gerdemann and Nicolson, 1963). These cultures were maintained on maize roots using a mixture of soil:sand:FYM (1:1:1). The rhizosphere soil containing 80-100 chlamydospores/50g and root segments of maize colonized by particular AM fungus were used as mycorrhizal inoculum.

The trial was laid in split-split plot design with three replicates. The plot size was 3.0 x 2.10 m^2 and net plot size was 2.80 x 1.5 m^2. The sowing was done by dibbling on 25^{th} July, 2008 with 30 x 10 cm spacing. Ten randomly selected plants from each plot were tagged and considered as observation plants. The observations were recorded at harvest stage. The observations such as fresh wt, dry wt of fodder, pod, seed, husk and yield, spore count, pH, %AM colonization, root length, shoot length and quantity of macro and micronutrients from seeds. The root samples of each treatment were collected, processed and stained with cotton blue (Philips and Hayman 1970). Per cent root colonization was calculated as per Giovanetti and Mosse (1980). Potassium was estimated by flame photometer. The micro elements from seeds were estimated by using Atomic Absorption Spectro Photometer (AASPM). The data was statistically analyzed as per the standard method (Panse and Sukhatme, 1985).

Table 2. Effect of *G. mossae* and *G. fasciculatum*, on growth and yield of *Arachis hypogaea*.

Treat-ment	Root length (cm)	Shoot length (cm)	Spore count	pH	% AM colon	Yield q ha^{-1}
Contol	10.83	41.45	360	7.5	60	19
GM + GF	11.97 (10.52)	57.9 (39.68)	509 (41.38)	7.5	100 (66.66)	26 (36.84)
C D (p=0.05)	7.21	104.8	949.6		254.9	44.53

The Table 1 indicates increase in fresh wt 168.4 g $plant^{-1}$ (21.15% more over control) and dry wt 37.4 g $plant^{-1}$ (16.87% more over control). The pod dry wt 9.1 g $plant^{-1}$ (54.23% more over control), seed dry wt 5.3 g $plant^{-1}$ (43.24% more over control), husk dry wt 3.8 g $plant^{-1}$ (72.72% more over control).

The results on yield were significant, plants inoculated with the AM showed 26 q ha^{-1} increase yield (36.84% more over control). The AM treated plants also showed significant increase in root length 11.97 cm (10.52% more over control) and shoot length 57.9 cm (39.68% more over control). The increase in yield is directly proportional to increase in spore count and percentage of root colonization in AM inoculated plants (Table 2) indicated AM helped in uptake of nutrients from soil (Hattingh *et al*. 1973).

It is evident from Table 3 that concentration of nutrient content in groundnut seeds was higher in AM treated plants (N 2.12; P 0.16 %; Ca 0.11 ppm; Mg 0.11 ppm, and Mn 44

Table 3. Effect of *G.mossae* and *G. fasciculatum*, on macro and micronutrient of *Arachis hypogea*.

Treatment	Total N (%)	Total P_2O_5 (%)	Total K_2O (%)	Total Ca (ppm)	Total Mg (ppm)	Total Cu (ppm)	Total Fe (ppm)	Total Mn (ppm)
Contol	1.69	0.10	1.36	0.099	0.10	20	traces	13
GM + GF	2.12 (25.44)	0.16 (60.00)	1.48 (8.22)	0.11 (11.11)	0.11 (10.00)	13 -	76 -	44 (238.4)
C D (p = 0.05)	2.7	0.36	0.72	0.06	0.06	-	-	197.5

ppm). Similar observation wre reported by Bowen *et al*. (1974) for AM inoculated plants which showed more amounts of minerals like Ca, K, Cu, Mn, Mg and Zn than un inoculated plants. This indicated that the AM played an active role in mineral absorption in plants.

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Estimation of Broad Sense and Narrow Sense Heritability in Single and Double Cross F_4 and F_5 Progenies of Bhendi [*Abelmoschus esculentus* (L.)]

Bhendi [*Abelmoschus esculentus* (L.) Moench] also known as ladies finger is an important vegetable crop cultivated throughout the world and is a native of tropical Africa. All forms of plant improvement activities through breeding contemplate an eventual boost in genetic potential for yield. Since, yield is polygenically controlled and highly influenced by environment, selection based on yield alone is not effective. The breeder hence develops into proposition of selecting for high yield indirectly through yield associated and highly heritable characters after eliminating environmental components of phenotypic variance. An attempt to improve a character by selection would be futile unless a major portion of variation is heritable which depends entirely on the magnitude of genetic variability in the source progeny. Intergeneration correlation coefficients give an idea about the effectiveness of single plant selection and to some extent on nature of gene action. If the correlation coefficient is high, it would mean high heritable portion and probably the additive component. Lush (1945) defined heritability in broad and narrow sense and emphasized that characters are subjected to different amount of non heritable variation. The broad sense heritability includes genotypic variance and phenotypic variance, but genotype variance includes both dominance and additive variance, so it is not a reliable index for practicing selections. While narrow sense heritability includes additive variance and phenotypic variance, so additive variance is a reliable index of the total genotypic variance, and selections will be effective for carry forwarding the lines or genotypes to next generation. Hence a study was conducted to deduce intergeneration correlation and estimation of narrow sense heritability in single and double cross F_4 and F_5 progenies of bhendi. The experimental material in the present study consisted of F_4 and F_5 populations of four single crosses (BH-10, BH-11, BH-13 and BH-14) and three double crosses (BH-15, BH-16 and BH-16) along with popular checks. The experiment was laid out in RBD with three replications during summer 2008 (F_4) and *kharif* 2008 (F_5) at Agricultural Research Station, Hanumanamatti, University of Agricultural Sciences, Dharwad. Each progeny line was sown at a spacing of 60 x 30 cm with a row length of 5 m having eight progeny lines in each single cross and 10 progeny lines in each double cross in both the generations. The observations were recorded from five competitive plants from each row (totally 40 plants in each single cross and 50 plants in each double cross) on twelve quantitative characters. Heritability in broad sense were calculated as per Hanson *et al.* (1956) Correlation was worked out according to the formula given by Weber and Moorthy (1952). Inter generation correlation coefficient for all the twelve quantitative characters between F_4 and F_5 generations were calculated as per Weber and Moorthy (1952) by taking the same character in both the generations. Narrow sense heritability was calculated as per Cahaner and Hillet (1980) based on parent offspring regression method.

Table 1. Comparison between broad sense and narrow sense heritability.

Characters	**Single cross**		**Double cross**	
	Broad sense	**Narrow sense**	**Broad sense**	**Narrow sense**
Days to first flowering	82	27	74	13
Days to 50% flowering	82	11	82	28
Plant height (cm)	90	09	83	05
Branches plant^{-1}	79	12	92	08
Internodal length (cm)	83	34	89	36
Fruit weight (g)	70	13	81	14
Fruit length (cm)	77	09	83	16
Fruit diameter (cm)	67	18	83	15
Seeds fruit^{-1}	88	33	85	42
100 seed weight (g)	88	47	86	31
Fruits plant^{-1}	88	09	73	08
Fruit yield plant^{-1} (g)	87	08	75	05

In the present study (Table 1), high heritability and significant correlation were observed for days to first flowering, internodal length, number of seeds per fruit and 100 seed weight in both single and double cross progenies. Indicating these traits are mostly governed by additive gene action and suitability

Table 2. Intergeneration correlation coefficients between F_4 and F_5 generation for twelve quantitative characters.

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
SCH	0.366*	-0.110	0.254	0.301	0.413**	0.314	0.126	0.255	0.367*	0.479*	0.153	0.134
DCH	0.411**	0.369*	0.312	0.214	0.452**	0.233	0.236	0.311	0.405*	0.365*	0.114	0.151

* - Significant @ 5%, ** - Significant @ 1%

Table 3. Heritability (Narrow sense) estimates for twelve quantitative characters in single and double cross progenies.

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
SCH	27	11	09	12	34	13	9	18	33	47	09	08
DCH	21	28	05	08	36	14	16	15	42	31	08	05

X_1 - Days to first flowring
X_2 - Days to 50% flowering
X_3 - Plant height (cm)
X_4 - Branches per plant
X_5 - Internodal length (cm)
X_6 - Fruit weight (g)
X_7 - Fruit length (cm)
X_8 - Fruit diameter (cm)
X_9 - Seeds per fruit
X_{10} - 100 seed weight (g)
X_{11} - Fruits per plant
X_{12} - Fruit yield per plant (g)
Low h^2 = 5-10%, Medium h^2 = 10-30%, High h^2 = 30-60%

of these traits for selection on individual plant basis in the advanced generations of segregating progenies. These findings were supported by Kulkarni *et al*. (1976) and Reddy *et al.* (1985).

The Plant height, number of branches plant^{-1}, fruit weight, number of fruits plant^{-1} and fruit yield plant^{-1} were recorded low values of correlation coefficient and heritability indicated non correspondence of two generation values for these characters and which could be attributed to preponderance of non additive variation. If additive variance will be present for a trait, then selection for such traits will be effective. Which would further helps in developing inbreeds or varieties. If dominance variance is present, then it is going to reduce and gradually disappear in future generations. For such traits one need to go for heterosis breeding to develop hybrids. These reports are in accordance with Kulkarni *et al.* (1976) in okra.

The high narrow sense heritability was observed for days to first flowering, days to 50 per cent flowering; internodal length, number of seeds per fruit and 100 seed weight indicate these characters were governed by additive variance. So selection will be effective for such traits based on phenotypic observations.

Low to moderate narrow sense heritability was observed for number of branches plant^{-1}, fruit weight, fruit length and number of fruits plant^{-1}. This indicated both dominance and additive variance (epistasis) for these traits. So, selection based on phenotypic observations may not be effective. Under such situation, the progeny test will be required to confirm the worth of genotypes.

High broad sense heritability (Table 2) was observed for all the characters in single and double cross progenies (except fruit yield per plant in single cross), indicating high magnitude of genetic variability for the characters and environmental influence was low on the character expression.

The high narrow sense heritability (Table 3) was observed for days to 50 per cent flowering, internodal length, number of seeds fruit-1 and

100 seed weight, Low to moderate narrow sense heritability was observed for most of the traits, which contribute to the fruit yield i.e., number of branches plant^{-1}, fruit weight, fruit length and number of fruits plant^{-1}. So based on these results, the narrow sense heritability was low compared to broad sense heritability for all the characters.

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Effect of Feeding of Dhaincha (*Sesbania aculeata*) Fodder on Performance of Growing Kids

There are some fodders, which are conventionally not considered for livestock feeding but may be utilized efficiently. *Seshania aculeata* (Dhaincha) the crop cultivated for reclamation of saline soil. It is a multipurpose shrub, easy tillering and can be used. as a source of fodder for livestock. Though, *Sesbania aculeala* grows throughout the year and can supply high proteinous green feed. The full potential of dhaincha as forage for livestock has not been exploited.

Twenty-four weaned Osmanabadi kids (3 months of age with mean body weight 8.28± 0.15 kg) were selected and were randomly divided into four equal groups. All the kids were vaccinated against Enterotoxaemia and were also dewormed. Feeding trial of 3 months duration was conducted by providing required DM, DCP and TDN as per NRC, 1981. 0ne third of the required nutrients were given through prepared concentrates and 2/3rd were given through respective green fodder. The group To was fed with green lucerne and prepared concentrate. Dhaincha fodder at flowering was incorporated in the dietary groups of T_1, T_2 and T_3 to replace 50, 75 and 100 per cent of green lucerne keeping concentrate part same for all the groups. The experiment was continued for 3 months. Metabolism trial was conducted for a period of 7 days at the end of the feeding trial. Daily faecal output of individual kid was preserved in the airtight containers in 40 per cent H_2S0_4 for N-estimation. The daily feed and fodder offered and left over were recorded and representative samples were collected for its dry matter content. The samples of feed, fodder residues and faeces were estimated for proximate principles as per method of AOAC, (1995). The data were statistically analysed as per Snedecor and Cochran, (1967).

It was observed that the CP content of

dhaincha was comparable to lucerne while EE was more in dhaincha than lucerne. The CF content was more in lucerne than dhaincha indicating more structural components in lucerne. Dhaincha had more NFE which is an indication of more soluble carbohydrates than lucerne. The ash content was more in lucerne than dhaincha. Sahu et al. (1988) reported less CP (18.70%), more EE(4.9%) and CF (35.4%), less NFE (31.9%) in dhaincha than obtained in the present study. Sidhuraju *et al*. (1995) reported about 20 per cent CP in dhaincha. Shahjalal and Topps (2000), reported more than 20 per cent CP, 2.8 per cent EE, 1 8 per cent CF and 48 per cent NFE in dhaincha fodder, the results of which are almost similar to that obtained in the present study. Hossain (2001), reported more than 20 per cent of CP in *Sesbania* fodder. Parnerkar et al. (1988) reported more CP (22%). TA (16.0%) and EE (4.36%), less CF (21.3%) and NFE (36.1%) in lucerne than obtained in the present study. Arora, (1988) reported CP, EE, C'F, NFE and TA in lucerne to be 19.40, 1.71, 29.61, 34.68 and 14.10 per cent, respectively which widely varies than values obtained in the present study.

The daily DMI showed significant ($P<0.05$) difference within treatment groups. With addition of dhaincha there was increase in DMI (day-1) of kids than sole feeding of lucerne. However, DMI didn't show any significant difference with increasing level of dhaincha in kids beyond 50 per cent. Significant ($P<0.05$) difference was also found when DMI was expressed as g kg^{-1} W°75 in dhaincha feeding, than lucerne feeding. The observed DMI was less than reported 3.32 per cent by Sahu *et al*. (1988) and 3.47 per cent by Khan (1985) by feeding dhaincha to goats. Shahjalal and Topps (2000) reported 2.55 to 2.89 kg DMI 100^{-1} kg body weight in dhaincha fed goats, which agrees with the present study.

The digestibility of DM and CP was found to be significantly ($P<0.05$) more in dhaincha fed groups than sole lucerne feeding, while fibre digestibility was more in sole lucerne feeding. The NFE digestibility was significantly ($P<0.05$) more in sole dhaincha feeding than lucerne feeding. The daily intake of DCP and TDN was found to be more in T_1 (67.78 and 277 g respectively) and T_2 groups (67.25 and 276 g respectively), which might be due to combination effect, while low in T_0 (61 .08 and 256 g respectively) and T_3 (62.38 and 257 g respectively). There was no significant difference in body weight change. Significant difference ($P<0.05$) was found in respect to efficiency of utilization of DM, DCP and TDN in T_1 and T_2 treatments groups, which might be due to combination effect of different fodders fed. Sahu *et al.* (1988) and Shahjalal and Topps, (2000) reported 63.12 and 62.42 per cent digestibility of protein in dhaincha. Bonsi *et al*. (1994) reported 70.81 per cent CP digestibility in *Sesbania* fodders. Khan (1985), and Shahjalal and Topps, (2000) reported 17.44 and 14.71 per cent feed efficiency respectively in dhaincha fed goats. Sahu *et al*. (1988) reported DM intake in dhaincha fed goats to be 3.30 per cent.

It is concluded that growing kids can be maintained through feeding dhaincha fodder replacing 75 per cent of conventional lucerne fodder in the diet of growing kids. The feeding of dhaincha may be advocated as partial replacement of traditional fodders; particularly during months when cultivated fodders are in short supply.

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Effect of Well Water Quality on Soil Characteristics in Haveli Tahasil of Pune District

The present investigation was undertaken to generate the data based on water quality parameters during 2003-2004. The fifty one well water samples were collected from working wells located in Haveli tahasil of Pune district, situated at an elevation of 558.53 meter above mean sea level. The district lies between 10°54' and 19°24' North latitude and 73°19' and 75°10' East longitude. Those water samples were collected in three intervals at before summer, after monsoon and during winter. To study the effect of irrigation water on various chemical properties of soil, the samples were collected from the land under continuous irrigation for a long period. The soil samples of adjecent field never received irrigation water in part were also collected. The standard method of analysis as described by U.S.D.A. Handbook (1954), Piper (1966), Richards (1968), Jackson (1973) and Page *et al*. (1982) have been employed throughout the investigation. For pH, EC, carbonate and bicarbonate estimation of water samples. Sodium Absorption Ratio (SAR) was determined by United State Salinity Laboratory (USSL) staff (1954) SAR Residuals (Ca+ Mg2)1/2 sodium carbonate (RSC) was calculated by following formula given by Eaten (1950). Kelley's ratio was calculated by ratio proposed by Kelly *et al.* (1940).

Table 1. Seasonwise pH of well water.

Parameter	July 2003	November 2003	April 2004
Minimum	7.42	7.39	7.36
Maximum	8.63	8.64	8.39
Average	8.07	8.03	7.89
S. D.	0.33	0.32	0.24
C. V. (%)	5.04	4.95	3.75

Analysis of well water : The season wise data on pH of irrigation water from Haveli tahasil indicated that in the first season i.e., in the month July 2003 the samples had pH range of 7.42 to 8.63, in the November 2003, it ranges from 7.39 to 8.64. Thus maximum pH of well water samples of Haveli tahasil was 8.64 during 2003 and minimum 7.36 in the month of April 2004. From these data it can be revealed that pH was increased upto November and started decreasing further upto April month. It may be due to increase in electrical conductivity. These results are in accordance with Sanjay Kumar *et al.* (1990) and Patil *et al*. (1996).

The irrigation water from all well (Table 2) was above salinity classes (0.25 dSm^{-1}) of water. The periodical assessment of irrigation water indicate that in the month of July 2003, EC values ranged from 0.38 to 4.51 dSm^{-1} in November 0.77 to 4.74 dSm^{-1} and in the month of April 2004, it was 0.79 to 4.78 dSm^{-1}. From this observation, it reveal that EC was increased substantially from monsoon (July) to summer season (April). The increase in EC may be attributed to the increase in the salt content in the well water sample. Similar results were reported by Patil *et al*. (1996).

The SAR values (Table 3) were observed in the range of 1.76 to 12.42 with an average of 7.49 $(mmol.\ L^{-1})^{1/2}$. The wide deviation in SAR values were observed in all season. However, the highest SAR values (12.42) was observed in the month of April 2004 and lowest (1.76) in the month of November 2003. Similar observation were previously reported by Patil *et al.* (1996) and Sarsambi (2000).

The RSC values lies between the range of -8.37 to 1.39 meL^{-1}. Further it was noticed that 94.11 per cent well water samples were suitable for irrigation and 5.88 per cent samples were marginal. The highest RSC values (1.39 meL^{-1}) was in the month of April 2004. The similar RSC values were also reported by different workers (Patil *et al*. 1996 and Sarsambi 2003).

Kelley's ratio of these well water samples

Table 2. Electrical conductivity (dSm^{-1}) of well water samples of Haveli tahsil of Pune district.

Parameter	Values	Salinity classes (EC in dSm^{-1})		
		Medium (0.25-0.75)	High (0.75-2.25)	Very high (>2.25)
No. of samples	51	2 (3.92)*	15 (29.41)	34 (66.67)
Minimum	0.38	0.38	0.77	2.80
Maximum	4.78	0.63	2.16	4.78
Average	2.82	0.51	1.47	3.79
S. D.	1.29	0.27	0.32	1.13
C. V. (%)	45.68	40.72	21.94	32.54

*Figures in parenthesis indicate percentage distribution of samples.

Table 3. Derived parameters from irrigation water samples of Haveli tahsil of Pune district.

Parameters	SAR $(mmol.\ L^{-1})^{1/2}$	RSC meL^{-1}	Kelley's ratio
Minimum	1.76	-8.37	0.69
Maximum	12.42	1.39	2.33
Average	7.49	-4.74	1.63
S. D.	2.68	2.58	0.32
C. V. (%)	35.86	54.44	19.77

Table 4. Chemical properties of irrigated and unirrigated soil from Haveli Tahasil.

Parameters	pH		EC (dSm^{-1})	
	Irri-gated	Unirri gated	Irri-gated	Unirri-gated
Minimum	7.70	7.60	0.73	0.89
Maximum	8.65	8.39	4.27	4.37
Average	8.23	8.15	2.34	2.39
S. D.	0.20	0.19	1.10	1.08
C. V. (%)	2.44	2.28	47.18	45.28

ranged from 0.69 to 2.33 with an average value of 1.63. Kelley *et al*. (1940) observed that the application of comparatively dilute saline water contain Na^+ and Ca^{++} in the ratio of 2:1 had no deteremental effect on soil.

Chemical properties of soil : The pH of irrigated soil (Table 4) ranged from 7.70 to 8.65 with an average value of 8.23, while in unirrigated soil it ranged from 7.60 to 8.39 with an average value of 8.15. The highest pH (7.2) of irrigated soil was observed during summer (April 2004) and lowest (8.65) was observed during winter (November 2003).

The EC values of irrigated soils ranged between 0.73 to 4.27 dSm^{-1} with an average value of 2.34 while for unirrigated soil it ranged from 0.89 to 4.37 dSm^{-1} with an average value of 2.39 dSm^{-1}. The higher EC value in unirrigated soils might be due to more amount of salt present in upper layer of soils as a results of continuous moisture extraction and evaporation while these were low in irrigated soil might be due to leaching of salts from upper to lower level with irrigation water. Qureshi *et al*. (1996) and Sarsambi (2000) were also observed the same trend.

Exchangable calcium of irrigated soil was observed in the range of 20.61 to 20.62 (cmol (P^+) kg^{-1}) with average value of 20.64 (cmol (P^+) kg^{-1}). While in unirrigated soils, it was observed in the range of 24.73 to 24.87 (cmol (P^+) kg^{-1}) with an average value of 24.75 (cmol (P^+) kg^{-1}). In respect of exchangeable Mg++ in irrigated soil, it was recorded in the range of 8.68 to 8.75 (cmol (P^+) kg^{-1}).

In general the concentration of exchangeable Ca^{++} and Mg^{++} was low in irrigated soil as compared to that unirrigated soils. It might be due to leaching of cations with irrigation from surface soil to sub surface soil. In general Ca^{++} was predominant (20.61 cmol (p^+) kg^{-1}) cation followed by Mg^{++} [8.71 cmol (p^+) kg^{-1})] while Na^+ [1.55 cmol (p^+) kg^{-1})] and K^+ concentration was negligible.

It is concluded that the concentration of cations and anions of irrigation water was lowered during monsoon season upto winter and then increased upto summer season. The EC of unirrigated soils is higher than irrigated soil. Ca^{++} was predominant followed by Mg^{++}, Na^+ and K^+ in both irrigated and unirrigated soils. Under correlation studies in both irrigated and unirrigated soil the EC and boron content of water showed significant positive correlation with each cations.

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Effect of Spacings and Fertilizer Levels on Yield Attributes, Seed Cotton Yield and Economics of Bt Cotton

Hybrid Bt cotton is an exhaustive crop and needs heavy fertilization to get the targeted yield. Further, nutrient recommendation varies with crop response, soil condition, genotypes and climatic conditions. Area under transgenic cotton is increasing year by year and new cotton hybrids are entering in market. With this background in view, a field experiment was conducted to study the effect of different plant densities and fertilizer levels on Bt cotton hybrid Bunny Bt at Cotton Research Scheme, Marathwada Agricultural University, Parbhani during *kharif* 2008-09.

The soil of the experimental field was clayey in texture. The experiment was laid out in split plot design including six spacings *viz*., S_1 - 120 x 90 cm, S_2 - 90 x 90 cm, S_3 - 90 x 60 cm, S_4 - 120 x 60 x 30 cm (paired row), S_5 - 180 x 30 cm and S_6 - 150 x 45 cm in main plot whereas, sub plot comprised five fertilizer levels *viz*., F_1 - 100:50:50, F_2 - 125:62.5:62.5, F_3 - 150:75:75, F_4 - 175:87.5:87.5 and F_5 - 200:100:100 NPK kg ha^{-1}. Sowing was done on 24th June 2008. Fertilizers were applied as per the treatments in three splits i.e. 20 per cent N and 50 per cent P and K at sowing while 40 per cent N and 50 per cent P and K were applied 30 days after sowing and remaining 40 per cent N was applied 60 days after sowing.

Perusal of data in Table 1 revealed that no significant effect was observed in respect of plant height due to different plant densities. As regards to yield attributes, significantly more yield per plant as well as number of bolls per plant were recorded at wider spacing of S_1 i.e. 120 x 90 cm than all the remaining spacings. It also recorded highest boll weight but it was at par with remaining spacings. This might be due to the fact that the better aeration and adequate interception of light and lesser competition of nutrients at wider spacing, than sowing at closer spacing, which in turn resulted in synthesis of higher photosynthates and thereby helped to produce higher seed cotton yield per plant under the wider spacing. These results are in conformity with those reported by Nehra *et al.* (2004). Among the different spacings maximum seed cotton yield (3046 kg ha^{-1}) was recorded at 180 x 30 cm but it was at par with S_3 i.e. 90 x 60 cm spacing (2774 kg ha^{-1}) which was further at par with S_6 i.e. 150 x 45 cm spacing (2671 kg ha^{-1}). The gross and net monetary returns also varied significantly due to different spacings and the trend was similar to that of seed cotton yield. Regarding benefit cost

Table 1. Effect of spacings and fertilizer levels on yield attributes, seed cotton yield and economics.

Treatments	Plant height (cm)	No. of bolls plant^{-1}	Yield plant^{-1} (g)	Boll weight (g)	Seed cotton yield (kg ha^{-1})	GMR (Rs. ha^{-1})	NMR (Rs. ha^{-1})	B:C ratio
Main plot : Spacing (cm) :								
S_1 - 120 x 90	118	54	220	4.07	2041	55974	33202	2.45
S_2 - 90 x 90	115	45	177	4.02	2190	60077	36081	2.50
S_3 - 90 x 60	118	39	150	3.82	2774	76088	49096	2.81
S_4 - 120 x 60 x 30	127	16	60	3.62	2209	60741	30316	1.99
S_5 - 180 x 30	134	42	164	3.80	3046	83543	55848	3.01
S_6 - 150 x 45	123	46	185	3.88	2671	73271	45473	2.63
S. E. $\pm$	3.56	2.07	815	0.09	118.61	3257	2940	
C. D. at 5%	10.39	6.03	23.77	NS	345.66	9493	8567	
Sub plot : Fertilizer levels (NPK kg ha^{-1}) :								
F_1 - 100:50:50	120	36	139	3.81	2190	60071	36227	2.51
F_2 - 125:62.5:62.5	129	37	147	3.83	2299	63055	37924	2.50
F_3 - 150:75:75	123	40	156	3.85	2451	67233	40715	2.53
F_4 - 175:87.5:87.5	120	44	174	3.88	2686	73780	45703	2.62
F_5 - 200:100:100	121	46	181	3.92	2817	77268	47778	2.62
S. E. $\pm$	2.14	1.06	4.33	0.10	60.81	1665	1515	
C. D. at 5%	6.23	3.10	12.64	0.30	177.25	4854	4414	
S x F Interaction								
S. E. $\pm$	5.24	2.61	10.62	0.25	148.97	4070	3710	
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS

ratio the spacing 180 x 30 cm recorded highest value (3.01). These results are in conformity with those reported by Reddy and Gopinath (2008).

The higher fertilizer levels of 200:100:100 NPK kg ha-1 and 175:87.5:87.5 NPK kg ha^{-1} recorded significantly more number of bolls per plant and yield per plant over remaining lower levels of fertilizer application. The favourable effect of higher NPK dose on yield attributes was also noted by Halemani *et al.* (2004). However, there were no significant differences in plant height and boll weight due to different fertilizer levels. The seed cotton yield of both of these higher fertilizer levels were also found significantly superior over remaining lower levels of fertilizer application. Yadav *et al.* (1990) also recorded increase in seed cotton yield with increasing nitrogen fertilization.

Regarding gross and net monetary returns, application of 200:100:100 NPK kg ha^{-1} and 175:87.5:87.5 NPK kg ha^{-1} recorded significantly more gross and net monetary returns over remaining fertilizer levels. Both of these higher fertilizer levels also recorded highest benefit cost ratio. The lowest gross and net monetary returns were recorded with application of 100:50:50 NPK kg ha^{-1}.

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Effect of Maleic Hydrazide, Cycocel and SADH (Alar) on Growth and Flower Quality in Marigold (*Tagetes erecta*)

In India marigold (*Tagetes* sp.) is one of the most common commercially grown loose flower crop. Though marigold has become one of the most popular flower in India; its yield, productivity and quality is poor, which needs to be improved by adopting various techniques viz., shoot pinching and use of plant growth regulators. Technological advances pertaining to plant growth regulators have been progressing fast since last three quarters of the century. To catch the Dashera and Diwali flower markets when flower prices are high, delayed flowering is essential. This is possible through two ways first through use of plant growth retardants and the other way is the delayed transplanting. However, delayed transplanting has the disadvantages of higher mortality of seedlings. In view of the above, to enhance the marigold productivity in Western Maharashtra and regulate supply of quality marigold flowers so as to assure good prices, transplanting in the last week of June and delayed flowering by plant growth retardants was tried.

An experiment was laid out in randomized block design with three replications and eleven treatments at College of Agriculture, Pune during *kharif*, 2007 with the objective to study the effect of plant growth retardants on growth and flowering in African marigold, to find out the optimum concentration of plant growth retardants for better yield and quality of African marigold. The gross plot size selected was 3.6 x 2.4 m (48 plants plot^{-1}) with net plot size of 2.4 x 1.8 m (24 plants plot^{-1}). The recommended package of practices for raising marigold was adopted. Three plant growth retardants viz., Maleic hydrazide (MH), cycocel and SADH (alar) were used as a foliar spray after 35 and 50 days of transplanting. MH and cycocel were applied at 500, 750 and 1000 ppm concentrations while SADH at 1000, 1500 and 2000 ppm concentrations compared with treatments pinching and non-pinching. In treatment pinching of growing points, It was done 20 days after transplanting. The observations viz., girth and height of stem, number of primary branches, duration of the crop, flowering pattern and flowering characters were recorded. Harvesting was done at full bloom stage. The data were recorded on horticultural performance.

Among the growth retardants SADH and maleic hydrazide had a significant retarding effect as compared to cycocel and both control treatments. The treatment effect of SADH 2000 ppm exhibited maximum retardation of plant height (99.6 cm), however, the maximum plant height was recorded in control treatments. Similar results were recorded by Gowda and Jayanthi (1991), Singh and Rathore (1992), Yadav (1997) and Khandelwal *et al*. (2003) in African marigold.

Significantly highest plant spread was recorded under the treatment cycocel 500 ppm (32.09 x 36.67 cm), however, it was minimum with the treatment control without pinching.

All the plant growth retardants used in the study at all concentrations were found superior than control treatments for the production of primary branches plant^{-1}. Similar results with plant growth retardants were recorded by Gowda and Jayanthi (1991), Singh and Rathore (1992) in marigold and by Joshi and Reddy (2006) in china aster.

All growth retardant treatments recorded the significant results over control for stem diameter. The maximum stem diameter (3.09 cm) was recorded with SADH 2000 ppm, however, it was minimum in treatment control without pinching (1.85 cm). The similar results were obtained by Khandelwal (2003) in marigold.

The treatment SADH 2000 ppm recorded the maximum days for 50 per cent flowering (82 days) and the treatment MH 500 ppm recorded the least days (73) for 50 per cent flowering from transplanting. The results are in close agreement with that of Khandelwal *et al*. (2003) in marigold.

All the treatments of plant growth retardants and pinching signifacntly influenced the number of flowers produced per plant. Significantly maximum number of flowers plant^{-1} was recorded in treatment SADH 2000 ppm (36.57) and the minimum (21.85) was recorded in treatment control without pinching. The results obtained in present study are in conformation with findings of Gowda and Jayanthi (1991), Singh and Rathore (1992), Yadav (1997), Khandelwal *et al*. (2003) in

Table 1. Performance of marigold as affected by plant growth retardant treatments.

Treatment	Plant height (cm)	Days required for 50% flowering	Number of flower plant-1	Flower diameter (cm)	Yield plant^{-1} (g)	Yield ha^{-1} (t)
T_1	101.2	73	28.02	4.46	171.85	9.55
T_2	100.8	73	28.04	4.68	176.63	9.81
T_3	100.1	74	28.77	4.73	189.42	10.52
T_4	103.8	77	27.99	5.05	187.56	10.42
T_5	103.4	80	31.03	5.33	199.6	11.09
T_6	102.9	80	32.59	4.88	206.94	11.50
T_7	100.5	80	32.85	4.75	218.42	12.13
T_8	99.9	81	32.66	5.73	223.73	12.43
T_9	99.6	82	36.57	4.76	232.21	12.90
T_{10}	111.3	80	21.85	4.68	141.21	7.85
T_{11}	107.2	76	30.43	4.23	179.54	9.97
S. E. $\pm$	0.12	0.07	0.05	0.02	6.00	0.33
C. D. at 5%	0.35	0.2	0.04	0.05	17.72	0.99

marigold and Joshi and Reddy (2006) in china aster.

The plant growth retardants used recorded significant effect on flower diameter. The treatment SADH 1500 ppm recorded the significantly maximum flower diameter which was superior over rest of the treatments. The results recorded were on similar line as recorded by Gowda and Jayanthi (1991) in marigold.

The maximum weight of 20 flowers was recorded in treatment SADH 1500 ppm (138 g) which was superior over rest of the treatments except cycocel 500 ppm and SADH 1000 ppm which were on par. Khandelwal *et al*. (2003) recorded increase in flower weight in marigold with cycocel.

Maximum yield of flowers was obtained with treatment SADH 2000 ppm which was statistically at par with treatments SADH 1500 and 1000 ppm. The minimum yield was recorded with treatment control without pinching. The results obtained for this character found in agreement with Singh and Rathore (1992) and Khandelwal *et al.* (2003) in marigold.

Most of the growth retardant treatments had reduced the number of seeds per flower over control without pinching. The maximum number of seeds per flower (255) was recorded under treatment SADH 1000 ppm.

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Tractor Use Pattern and Purchase Trends in Beed District

Most of the farmers are ignorant of the use and benefit of the improved implements. This is mainly because of the lack of sufficient extension work and low investing capacity of the farmer to buy tractor and related farm equiments. Mechanization in India can be done in three different ways (Michael and Ojha, 2005) by introducing the improved agricultural implements on small size land holdings to be operated by bullocks or small tractor drawn implements or machines on medium size land holdings and using large size tractors and mahines on remaining land holdings.

This study is mainly stressed to measure the purchase trend and use pattern in Beed district of Maharashtra in the year 2007.

A random sample of 100 tractor owners from all eleven talukas of Beed district was selected for study. An interview questionnarie was designed to obtain information from respondents regarding their personal, social and economical characteristics which includes items like land holding, living conditions, source and extent of income, farm power, social participation and source of irrigation etc. Similarly information regarding tractor i.e. company name, HP, use pattern, purchase trends, problems and also different tractor drawn implements like M.B. plough, disc plough and cultivator etc. was also collected. The data was collected through personal interview of tractor owners.

The information collected through interviews was transferred from the questionnaire to the primary and secondary tables. The data was processed and tabulated by using simple frequencies. The percentage was worked out whenever needed. The parameter mean was used for categorization and interpretation of the data.

Level of education : The classification of tractor owners according to level of education indicated that the tractor owners, who had high school education, had more precise technical knowledge than the rest of tractor owners. They were interested to learn advantage of tractor drawn implements. The illiterates and those who had primary education were ignorant about adoption of agricultural technology and tractor drawn implements.

Source of irrigation : The main sources of irrigation in Beed district were observed to be open well and bore. It was observed that, most of tractor owners had open well as source of irrigation i.e. 83 per cent and minor tractor owners had bore well as source of irrigation (17%).

Annual income and attitude of tractor owners towards tractor drawn implements : The attitude of tractor owners towards tractor drawn implements influenced by their level of education and annual income directly. Also, it was observed that most of the tractor owners were under high income group with good standard of living (Singh and Patil 1988).

It was observed that, most of the tractor owners (97%) had favorable attitude towards tractor drawn implements and unfavorable attitude towards tractor drawn implements was about 13 per cent.

Distribution of tractors according to different tractor manufacturers : Distribution refers to the number of tractors of different manufacturers found in Beed district. Data revealed that mostly sold tractors (44%) in the Beed District were of Mahindra and Mahindra company. Now a day's trend towards TAPE tractors purchasing (19%) was increasing.

Also, share of market sale of other tractors were found to be, 9 per cent of John Deere, and Sonalika, 8 per cent of Swaraj, 6 per cent of Bajaj Tempo, 3 per cent of New Holland (ford) and 2 per cent of Escort (Farm Track) tractor respectively.

Distribution of tractors according to horse power (hp) range : Mostly preferred range of tractors considering the hp by the farmers were 35-45 hp. Also trend of purchasing below 45 and above 60 hp is not so satisfactory; it may be due to lack of technical/educational knowledge. In the market sale, 17 per cent tractors were of 50 HP, 14 per cent of 55 HP, 5 per cent 60 HP and 2 per cent 40HP.

Factors which affects choice of tractors : It was observed that, old customers were mostly influenced by the Brand name (35%). Remaining of the total i.e. 20, 5, 5, 3 and 5 per cent were affected/influenced by the fuel efficiency, availability of spare parts, coverage of tractors, after sale service and warranty respectively.

Financial factors which influences buying of tractors : Mostly deciding factors from the financial point of view were observed to be price (40%) and loan facility (35%). Of the remaining i.e 12, 8 and 5 per cent were influenced due to buy back scheme, discount and personal selling respectively.

From the survey it was concluded that the tractor owners grouped into a high income group and their level of education was good as reported by Bawajir and Nandupurkar (1985). The main source of irrigation was open well and these have favorable attitude towards improved implements such as M.B. Plough and cultivators etc. as reported by Yadav (2004). A buying of tractor was mostly influenced by price and loan facility, and they preferred to buy a tractor in winter and summer season. The choice of tractor was mostly affected by brand name, fuel efficiency and kind of work to be taken from tractor. An old customers and mechanics were mostly influenced due to buy a particular brand of tractor. Similar results were also reported by Reddy (1996), Singh and Patel (1988) and Singh *et al*. (1991).

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Effect of Row Spacings and Planting Patterns on Pigeonpea Yield

Pigeonpea is cultivated in the semi-arid areas of tropics and sub-tropics. Farmers grow it in various production systems as a mix crop, inter crop or a perennial crop using long established traditional practices. In Maharashtra there is not much increase in yield of pigeonpea and stagnated over a period of time substantial fluctuations inspite of availability of number of disease resistant varieties. It seems that the yield of these varieties has not been fully released and stabilized. Keeping in view these points the studies were undertaken to assess the effect of row spacing and planting pattern on pigeonpea varieties BSMR-736 and BSMR-853.

An experiment was conducted at Agricultural College Farm, Marathwada Agricultural University, Parbhani during *kharif*, 2001. The soil of the experimental plot was clayey in the texture, low in nitrogen (160 kg ha^{-1}), medium in phosphorous (9 kg ha^{-1}), rich in potash (370 kg ha^{-1}) and slightly alkaline in reaction. The experiment consisted of 12 tretment combinations involving three rows spacing (R_1 - 60 cm, R_2 - 90 cm and R_3 - 120 cm), two planting patterns (P_1 - Normal planting and P_2 - Paired row planting) and two varieties (BSMR-736 and BSMR-853). Recommended dose of fertilizer @ 25kg N, 50kg P_2O_5 per hectare was applied through suphala (20:20:0) and single super phosphate basal dose. The experiment was laid out in split plot design and replicated thrice. The gross plot size was 7.2 x 5.4 m. The experimental crop was sown on 21st July, 2001 as per the treatments by dibbling at 20 cm plant to plant distance.

There was increase (Table 1) in number of pods $plants^{-1}$, weight of pods $plant^{-1}$, grain weight $plant^{-1}$ and 1000 seed weight with increase in the row spacing from 60 to 120 cm. The row spacing of 120 cm was found significantly superior over 60 and 90 cm in

Table 1. Mean yield atributes in pigeonpea as influenced by various treatments.

Treatments	No. of pods	Weight of pods (g $plant^{-1}$)	Grain weight (g $plant^{-1}$)	1000 seed weight (g)
Row spacing (cm) :				
R_1 - 60	153.6	62.19	41.07	110.30
R_2 - 90	179.0	71.82	49.11	111.16
R_3 - 120	193.6	77.93	52.43	112.40
S. E. ±	3.92	1.49	1.15	0.21
C. D. at 5%	12.36	4.70	3.62	0.65
Planting pattern :				
P_1 - Normal	176.05	70.70	48.06	111.13
P_2 - Paired	174.83	70.23	47.03	114.14
S. E. ±	3.20	1.22	0.94	0.17
C. D. at 5%	NS	NS	NS	NS
Varieties :				
V_1 - BSMR-736	173.11	69.58	46.58	106.65
V_2 - BSMR-853	177.77	71.35	48.51	115.92
S. E. ±	4.10	1.56	1.36	0.21
C. D. at 5%	NS	NS	NS	0.65
Interactions :				
R x P				
S. E. ±	5.55	2.11	1.62	0.29
C. D. at 5%	NS	NS	NS	NS
P x V				
S. E. ±	5.80	2.20	1.92	0.30
C. D. at 5%	NS	NS	NS	NS
R x V				
S. E. ±	7.10	2.70	2.36	0.36
C. D. at 5%	NS	NS	NS	NS
R x P x V				
S. E. ±	10.04	3.81	3.33	0.51
C. D. at 5%	NS	NS	NS	NS
G. M.	175.44	70.47	47.55	111.30

recording the number of pods (Table-1). Similarly, 90 cm spacing was significantly superior over 60 cm row spacing. This might be due to more space and nutrients available to individual plant at wider spacing compared to narrow spacing. Similar effects due to increase in a row spacing were noted by Dubey and Upadhyaya (1991).

Planting pattern did not affect the number of pods as well as weight of pods plant^{-1}. Among the varieties BSMR-853 produced significantly more number of pods and pod weight plan^{-1}. The weight of grain plant^{-1} increased significantly with every increase rows spacing from 60 to 120 cm. Planting pattern did not differ significantly with each other in respect of grain weight plant^{-1}. The test weight of pigeonpea was increased with increase in spacing. It means that plant obtained more nutrients at low plant density thereby reflecting in comparatively bolder grain size than lower spacing. Variety BSMR-853 recorded more test weight than BSMR-736.

Table 2. Pod, grain, stalk, bhusa, biological yields (q ha^{-1}) and harvest index as influenced by various treatments.

Treatments	Pod	Grain	Stalk	Bhusa	Biological	Harvest index (%)
Row spacing (cm) :						
R_1 - 60	27.12	17.54	31.97	9.62	75.89	23.26
R_2 - 90	29.92	18.82	34.98	9.86	78.24	24.13
R_3 - 120	24.18	15.15	28.30	7.94	67.70	22.32
S. E. ±	0.36	0.70	0.95	0.29	1.99	0.90
C. D. at 5%	2.63	2.20	3.00	0.90	6.30	NS
Planting pattern :						
P_1 - Normal	26.90	17.26	31.30	9.24	74.19	23.15
P_2 - Paired	27.50	17.14	32.20	9.03	73.70	23.32
S. E. ±	0.68	0.57	0.79	0.23	1.63	0.74
C. D. at 5%	NS	NS	NS	NS	NS	NS
Varieties :						
V_1 - BSMR-736	25.28	16.16	29.42	9.01	71.72	22.39
V_2 - BSMR-853	28.80	18.25	34.08	9.26	76.12	24.07
S. E. ±	0.89	0.47	1.02	0.21	1.82	1.07
C. D. at 5%	2.75	1.46	3.16	NS	NS	NS
Interactions :						
R x P						
S. E. ±	1.18	0.99	1.35	0.40	2.82	1.28
C. D. at 5%	NS	NS	NS	NS	NS	NS
P x V						
S. E. ±	1.26	0.67	1.45	0.30	2.57	1.51
C. D. at 5%	NS	NS	NS	NS	NS	NS
R x V						
S. E. ±	1.54	0.82	1.77	0.37	3.15	1.85
C. D. at 5%	NS	NS	NS	NS	NS	NS
R x P x V						
S. E. ±	2.18	1.16	2.51	0.52	4.45	2.61
C. D. at 5%	NS	NS	NS	NS	NS	NS
G. M.	27.07	17.20	31.75	9.14	73.95	23.24

The pod, grain, stock, bhusa and biological yields ha^{-1} (Table 2) were influenced substantially by inter row spacing and variety tested. However, the planting pattern did not influence these characters. The higher grain, pod, stalk, bhusa and biological yields ha^{-1} were obtained at 90 cm row spacing which were remarkably more than wider spacing of 120 cm and also better than narrower spacing of 60 cm. (Table-2). The harvest index was not influenced significantly either by row spacings, planting patterns, varieties or there interactions.

Yield is the function of growth yield attributes. In this experimentation, most of the growth and yield attributes observed to be lower under closer spacing but yield ha^{-1} was higher than wider spacing. The low yield per plant under closer spacing may be due to less availability of space under dense plant population suppressing individual plant growth. However, results in yield hectare^{-1} from closer spacing was higher due to more number of plants unit^{-1} area not on the compensated bases low yield plant^{-1} but yielded more on area bases under high plant density pressure. Similar effects of row spacing on grain yield were observed by Dubey and Upadhyaya (1991), Mohite *et al.* (1993) and Velaythum *et al.* (2000).

Variety BSMR-853 produced higher grain yield per hectare compared to variety BSMR-736, The varietal differences in grain yield might be due to genetical efficiency of the variety to convert biological yield into economic yield. Similar results were obtained by Zote *et al.* (2000).

From the above discussion, it could be concluded that growing of pigeonpea variety BSMR-853 at 90 cm spacing is beneficial for obtaining higher yield.

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February 28, 2010

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