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ANIMAL SCIENCE

RESEARCH NOTES

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Effect of Integrated Nutrient Management on Yield and Economics in Groundnut - Wheat Crop Sequence

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(Received : 11-11-2007)

ABSTRACT

The 100 per cent RDF produced significantly higher grain yield (32.48 q ha^{-1}) than 50 per cent RDN (60:60:40 kg NPK ha^{-1}) + 25 per cent N through FYM + Azo + PSB (T_4) and 50 per cent RDN (60:60:40 kg. NPK ha^{-1}) + 25 per cent N through vermicompost + Azo + PSB (T_5). Wheat genotype NIAW-301 produced significantly higher grain yield (31.53 q ha^{-1}) than HD-2189.The pooled dry pod yield of groundnut was non-significant due to fertilizer levels and genotypes. 100 per cent RDF recorded significantly more returns of Rs-32511, which reflected in significantly more in benefit : cost ratio of 2.19 over other treatments.

Key words : Wheat, groundnut, FYM, vermicompost, *Azotobacter*, phosphorus solubilizing bacteria, yield, *kharif*, *rabi*.

Continuous use of inorganic fertilizers hazards the soil health in respect of physical, chemical and biological properties of soil. Therefore, it is necessary to minimize the application of inorganic fertilizers by substituting with organics. Since soil enzyme system associated with organic residue management, incorporation of crop residues in to the soil not only plays an important role in the soil chemical and biological environments, but also affects the rate at which nutrients become available to crop plants as well as other forms of life (Powar and Legg, 1978). Wheat is the major staple food crop in *rabi* season followed by legume crop. Monocropping with wheat has led to depletion of soil fertility. Improvement in soil fertility by crop rotation is possible by inclusion of short duration leguminous crops (Clegg, 1982). It has also been reported that legume in crop rotation benefit the succeeding crop of cereal (Bangar *et al*. 1983 and Singh and Singh, 1990). Hence, more viable and profitable crop sequence is necessary for diversification of existing monocrop towards more balanced cropping system with emphasis on reduction of inorganic fertilizer through organics to maintain the soil fertility.

The present investigation was, therefore, undertaken to study the possibility of reduction or substitution of inorganic nitrogen fertilizer requirement through organic sources and their economics.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* and *rabi* seasons of 2002-03 to 2006-07 at Agricultural Research Station, Niphad on medium black soil under rainfed and irrigated condition. The rainfall received during the experimental period was more than average rainfall (552 mm). The experiment was laid in split plot design with three replications. The treatment consisted of *kharif*-Sole groundnut (Var. JL-24) with recommended dose of fertilizer.

Rabi - A. Main plot (fertilizer levels for

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Table 1. Effect of fertilizer levels and varieties on dry pod and dry creeper yield of groundnut, yield and yield attributes of wheat, wheat grain equivalent and economics of wheat (Pooled data of five years).

Treatments	Groundnut		Wheat							
	Dry pod yield (q ha^{-1})	Dry creeper yield (q ha^{-1})	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	No. of grains ear-$head^{-1}$	Earh-eads m^{-2}	1000 grain wt. (g)	Wheat grain equi-valent (q ha^{-1})	Net returns (Rs.)	B:C ratio
Fertilizer levels :										
T_1 - 100% RDF (120:60:40)	14.47	24.16	32.48	52.77	54	319	40.13	61.42	32511	2.19
T_2 - 75% RDN (90:60:40) + 25% N through FYM	13.88	24.14	31.03	49.42	55	319	39.43	58.79	30742	1.79
T_3 - 75% RDN (90:60:40) + 25% N through vermicompost	14.42	23.62	30.92	48.78	55	313	40.23	59.76	26095	1.25
T_4 - 50% RDN (60:60:40) + 25% N through FYM + Azo + PSB	13.55	23.32	29.20	44.15	53	313	40.63	56.3	27510	1.64
T_5 - 50% RDN (60:60:40) + 25% N through vermicompost+ Azo + PSB	14.21	22.90	29.19	43.58	53	312	41.39	57.61	29835	1.83
S. E. ±	0.53	1.58	0.93	2.49	2.36	8.01	0.71	2.73	1174.62	0.07
C. D. at 5%	NS	NS	2.65	7.11	NS	NS	1.96	NS	3830.06	0.21
Varieties :										
V_1 = NIAW-34	14.36	23.91	31.04	48.59	53	318	41.02	59.76	30661	1.76
V_2 = NIAW-301	14.34	23.53	31.53	47.55	56	323	39.87	60.21	28569	1.82
V_3 = HD-2189	13.62	23.44	29.18	45.85	54	305	40.20	56.42	28787	1.64
S. E. ±	0.76	1.00	0.61	1.59	1.51	6.11	0.46	1.29	1468.86	0.05
C. D. at 5%	NS	NS	1.69	4.40	4.35	16.93	1.27	3.57	NS	0.13
Interaction :										
S. E. ±	1.12	2.25	1.38	3.55	3.38	13.67	1.04	2.89	3284.48	0.11
C. D. at 5%	NS	NS	NS	9.83	NS	NS	2.88	NS	NS	NS

Commodities :	**(Rs. q-1)**		
Farm yard manure	50	K_2O	800
Vermicompost	300	Wheat grain	1000
N	1096	Groundnut dry pod	2000
		P_2O_5	2212

wheat crop) T_1 = 100% RDF (120:60:40 kg. NPK ha^{-1}), T_2 = 75% RDN (90:60:40 kg. NPK

ha^{-1}) + 25% N through FYM, T_3 = (90:60:40 kg. NPK ha^{-1}) + 25% N through vermicompost, T_4 = 50% RDN (60:60:40 kg. NPK ha^{-1}) + 25% N through FYM + *Azotobacter* + PSB and T_5 = 50% RDN (60:60:40 kg. NPK ha^{-1}) + 25% N through vermicompost + *Azotobacter* + PSB

B. Sub-plot (wheat varieties)

V_1 = NIAW-34. V_2 = NIAW-301, V_3 = HD-2189

The experimental site was low in available N (182.2 kg ha^{-1}), medium in P_2O_5 (23.2 kg ha^{-1}) and high in K_2O (672 kg ha^{-1}). Proper plant protections were taken to grow up the crop. The observations on yield were recorded for every year of experiment and data were pooled. Wheat grain equivalent and the economics of different fertilizer levels and varieties were computed on the basis of prevailing market rates of produce and agro-inputs. Groundnut crop was sown in first fortnight of June and wheat crop was sown in first fortnight of November every year. Recommended dose of 25 kg N + 50 kg P_2O_5 ha^{-1} applied to groundnut at the time of sowing. In wheat crop 50 per cent RDN and full dose of P_2O_5 and K_2O were applied at the time of sowing and remaining nitrogen was applied 25 days after sowing. Vermicompost and FYM were applied just before sowing of crop.

RESULTS AND DISCUSSION

Yield : Dry pod yield and dry creeper yield of groundnut were not influenced by different fertilizers levels and varieties in *kharif* season (Table 1). Grain and straw yield of succeeding wheat crop was influenced due to fertilizer levels. Application of 100 per cent RDF recorded significantly more grain and straw yield of wheat over other treatments but remained at par with application of 75 per cent RDN + 25 per cent N through FYM and 75 per cent RDN + 25 per cent N through vermicompost. Similar results were also reported by Basavraj *et al*. (1997) and Jat *et al*. (1998).

Wheat variety NIAW-301 produced significantly higher grain yield over variety HD 2189 but at par with variety NIAW-34. Significantly higher yield of NIAW-301 was mainly due to more number of grains $earhead^{-1}$ and more number of earheads m^{-2} than other varieties, whereas 1000-grain weight of wheat variety NIAW-34 was significantly more than NIAW-301. The variety NIAW-301 recorded significantly more wheat grain equivalent than other two varieties. Wheat grain equivalent was not influenced due to fertilizer levels indicating that all fertilizer treatments were equally effective.

Economics : Owing to higher yield and comparatively less expenditure incurred on inorganic fertilizer, 100 per cent RDF recorded significantly more returns of Rs-32511, which reflected in significantly more in benefit : cost ratio of 2.19 over other treatments. The variety NIAW-301 recorded significantly more B:C ratio of 1.82 as compared to other treatments. The results are confirmatory with the findings of Sivram and Ahlawat (2000).

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Response of Summer Groundnut (*Arachis hypogea* L.) to Varying Levels of Phosphorus and Potassium*

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ABSTRACT

Application of 50 and 75 kg P_2O_5 ha^{-1} to groundnut were at par with each other but significantly increased plant height, spread, number and weight of matured pods $plant^{-1}$, 100 kernel weight, dry pod and haulm yields, protein and oil content and their yields as compared to application of 25 kg P_20_5 ha^{-1}. The dry matter production $plant^{-1}$ and uptake of NPK was significantly increased with each additional level of phosphorus fertilization. The application of 30 and 45 kg K_2O ha^{-1} were found to be at par with each other but significantly increased number of branches $plant^{-1}$, dry matter production $plant^{-1}$, root nodules and their weight $plant^{-1}$ at flowering and pod development stages, protein and oil content in kernel and their yields as compared to application of 15 kg K_2O ha^{-1}. However, application of potassium did not influence yield attributes, dry pod and haulm yields and protein and oil yields. Uptake of N, P and K was significantly increased with the increased levels of potassium fertilization.

Key works : Summer groundnut, growth, nodulation, yield, quality, nutrient uptake.

Fertilization played a vital role in increasing the productivity of crop even after green revolution. Though India occupies unique position in the area and production of oilseeds, judicious fertilizer management plays a pivotal role in influencing the crop yield significantly.

Phosphorus stimulates root formation, growth and increases nitrogen fixation (More *et al*. 2002), mainly it aids in nodule formation and increases the protein and mineral content in groundnut kernel. Potassium is known for its ability to increase yield and improve quality. It is also essential for photosynthesis and pod development in groundnut (Burkhart and Collins, 1941). Thus, there is ample scope for increasing production through use of these nutrient elements. Keeping this in view, an investigation was carried out with an objective to know the effect of phosphorus and

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potassium on plant growth, yield attribute and yield in groundnut.

MATERIALS AND METHODS

A field experiment was conducted during summer season of 2007 at the Post Graduate Institute Research Farm, MPKV, Rahuri. The soil of the experimental field was clayey in texture. The chemical composition indicated that the soil was slightly alkaline in reaction (pH 8.1) with low in available nitrogen (183.76 kg ha^{-1}), medium in available phosphorus (19.92 kg P_2O_5 ha^{-1}) and high in available potassium (398.60 kg K_2O ha^{-1}). The experiment was laid out in a factorial randomized block design with nine treatment combinations along with one control and replicated three times. The gross and net plot sizes were 6.00 m x 4.80 m and 5.60 m x 4.20 m, respectively. Single super phosphate and muriate of potash were the sources of phosphorus and potash, respectively. Full amount of P and K according to treatments was applied at the time of sowing. The uniform application of nitrogen @ 25 kg ha^{-1} as basal dose through urea + 10 t FYM ha^{-1} was applied to groundnut cv. TAG-24. The crop was dibbled on 26th February, 2007 at 30 x 10 cm spacing. Groundnut kernels were treated with PSB and Rhizobium culture. The observations on growth parameters and root nodules were recorded periodically and yield contributing characters and yield at harvest.

The nitrogen content in kernel and haulm was estimated by Microkjeldhal method (A.O.A.C., 2002), phosphorus content by colorimetric method (Jackson, 1973) and potassium content by flame photometer method (Hanway and Heidal, 1967). Protein content was estimated by multiplying nitrogen content by 5.46. The oil content was estimated by Soxhlet Ether Extract method (A.O.A.C., 2002). The uptake of N, P and K was calculated by multiplying yield of kernel and haulm with their respective N, P and K per cent.

RESULTS AND DISCUSSION

Effects of phosphorus : Application of phosphorus at higher levels *viz*., 50 and 75 kg P_2O_5 ha^{-1} were found to be at par with each other (Table 1) but significantly increased plant height and spread as compared to application of phosphorus at 25 kg P_2O_5 ha^{-1}. Further, it was noticed that the number of branches and total dry matter $plant^{-1}$ were significantly increased with the increased levels of phosphorus application up to75 kg P_2O_5 ha^{-1} showing graded response to the phosphorus fertilization. Phosphorus plays important role in growth, development and photosynthesis which might have reflected in higher values for plant height, spread, more number of branches and higher total dry matter production with phosphate fertilization. These results corroborate the findings of More *et al*. (2002).

The mean number of days required for 50 per cent flowering was significantly less under application of 25 kg P_2O_5 ha^{-1} than its higher levels of 50 and 75 kg P_2O_5 ha^{-1}. Phosphate fertilization with 75 kg P_2O_5 ha^{-1} produced more number of root nodules and their weight per plant than 25 and 50 kg P_2O_5 ha^{-1} both at flowering and pod development stages except that it was at par with 50 kg P_2O_5 ha^{-1} for number of nodules per plant at flowering stage.

The increased root growth due to phosphate fertilization and symbiotic nitrogen fixation might have improved root nodulation. Similar results were reported by Kausale *et al*. (2007). The application of 50 and 75 kg P_2O_5 ha^{-1} was at par with each other and significantly increased number of matured pods and their weight $plant^{-1}$, 100 kernel weight and dry pod and haulm yields as compared to 25 kg P_2O_5 ha^{-1} owing to improvement in growth and yield

attributes (Table 2). Similar, results were reported by Bharambe *et al*. (2004). The application of 50 and 75 kg P_2O_5 ha^{-1} were at par with each other and significantly increased oil content and oil and protein yields as compared to 25 kg P_2O_5 ha^{-1} application owing to increase in kernel yield. The protein content of the kernel and NPK uptake, were significantly increased with the increased levels of phosphate fertilization owing to increase in pod and haulm yields and N, P and K content in kernel and haulm. Similar, results were reported by Dutta *et al*. (2004).

Effect of potassium : The plant height and spread were not significantly influenced due to application of different levels of potassium. However, number of branches and total dry matter per plant were significantly increased with increased levels of potassium. Application of 45 kg K_2O ha^{-1} was at par with 30 kg K_2O ha^{-1} and recorded significantly higher values for number of branches and total dry matter $plant^{-1}$ at harvest compared to its lower levels. Potassium is involved in physiological and biochemical functions of plant growth i.e. enzyme activation, water

Table 1. Growth attributes and root nodulation as influenced by different phosphorus and potassium levels.

Treatments	Growth attritutes					Root nodulation			
	Plant height (cm)	Plant spread (cm)	Bran-ches $plant^{-1}$	Total dry matter $plant^{-1}$ (g)	Days to 50% flow-ering	At flowering (42 DAS)		At pod development (70 DAS)	
						Nodules $plant^{-1}$	Wt. of nodules $plant^{-1}$ (mg)	Nodules plant-1	Wt. of nodules $plant^{-1}$ (mg)
Phosphorus leavels (kg ha^{-1}) :									
25	30.60	34.63	8.24	44.36	33.44	39.66	68.07	27.68	38.60
50	33.49	37.47	9.78	47.07	36.11	45.99	76.12	32.04	45.69
75	34.34	38.51	10.40	48.45	37.22	48.11	78.65	34.44	47.80
S. E.±	0.41	0.48	0.15	0.43	0.43	0.86	0.71	0.60	0.49
C. D. at 5%	1.22	1.43	0.46	1.26	1.29	2.55	2.11	1.78	1.46
Potassium levels (kg ha^{-1}) :									
15	32.39	36.08	8.76	45.26	35.11	42.18	72.45	29.61	40.99
30	32.92	37.12	9.62	47.10	35.67	45.06	74.73	32.00	44.77
45	33.11	37.41	10.04	47.52	36.00	46.53	75.66	32.88	46.33
S. E.±	0.41	0.48	0.15	0.43	0.43	0.86	0.71	0.60	0.49
C. D. at 5%	NS	NS	0.46	1.26	NS	2.55	2.11	1.78	1.46
Control vs. other mean :									
Control	23.30	27.60	7.00	36.53	32.33	34.66	61.88	24.33	30.56
Other mean*	32.81	36.87	9.47	46.63	35.59	44.59	74.28	31.50	44.03
S. E.±	0.76	0.87	0.29	0.78	0.79	1.58	1.30	1.09	0.90
C. D. at 5%	1.59	1.84	0.60	1.63	1.66	3.32	2.73	2.29	1.89
Interaction (P x K) :									
S. E.±	0.72	0.83	0.27	0.74	0.75	1.49	1.23	1.04	0.85
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
General mean	31.86	35.94	9.23	45.62	35.23	43.60	73.04	30.78	42.68

* Other mean - cumulative mean of P and K levels.

Table 2. Yield attributes, yield, quality and nutrient uptake as influenced by different levels of phosphorus and potassium.

Treatments	Yield attributes			Yield (q ha^{-1})		Quality				Nutrient uptake (kg ha^{-1})		
	Matured pods plant^{-1}	Wt. of matured pods plant^{-1} (g)	100 Kernel wt. (g)	Dry pod yield	Haulm yield	Oil		Protein		N	P	K
						% in kernel	Yield (q ha^{-1})	% in kernel	Yield (q ha^{-1})			
Phosphorus leavels (kg ha^{-1}) :												
25	14.21	12.25	36.92	25.00	34.55	48.64	8.07	24.20	4.01	129.51	13.65	60.09
50	17.19	14.60	39.90	33.26	41.75	50.42	11.99	25.74	6.12	186.58	24.37	84.65
75	18.34	15.71	40.17	34.73	43.75	51.50	13.18	26.03	6.65	202.21	28.53	92.51
S. E.±	0.41	0.42	0.78	1.40	1.55	0.46	0.47	0.05	0.23	0.75	0.29	0.51
C. D. at 5%	1.23	1.23	2.33	4.16	4.60	1.37	1.40	0.13	0.68	2.23	0.87	1.51
Potassium levels (kg ha^{-1}) :												
15	16.07	13.66	37.59	29.78	38.84	49.06	10.16	25.13	5.22	162.70	19.82	74.22
30	16.78	14.30	40.00	31.18	40.20	50.31	11.27	25.35	5.68	174.84	22.53	79.87
45	16.89	14.59	39.40	32.02	41.00	51.18	11.81	25.48	5.88	180.76	24.20	83.16
S. E.±	0.41	0.42	0.78	1.40	1.55	0.46	0.47	0.05	0.23	0.75	0.29	0.51
C. D. at 5%	NS	NS	NS	NS	NS	1.37	NS	0.13	NS	2.23	0.87	1.51
Control vs. others mean :												
Control	10.20	8.20	33.15	17.81	28.71	47.64	5.29	21.68	2.40	83.11	6.72	40.061
Other mean*	16.58	14.18	39.00	30.99	40.02	50.18	11.08	25.32	5.59	172.77	22.18	79.09
S. E.±	0.75	0.76	1.43	2.56	2.82	0.85	0.86	0.08	0.42	1.37	0.53	0.93
C. D. at 5%	1.59	1.59	3.00	5.38	5.94	1.79	1.81	0.17	0.88	2.89	1.12	1.96
Interaction (P x K) :												
S. E.±	0.62	0.73	1.36	2.43	2.68	0.80	0.81	0.07	0.39	1.30	0.51	0.88
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	3.87	1.51	2.63
General mean	15.94	13.59	38.41	29.68	38.89	49.93	10.50	24.96	5.28	163.80	20.64	75.18

* Others mean - cumulative mean of P and K levels.

Table 3. N, P and K uptake as influenced by interaction between phosphorus and potassium levels.

Treatments	Nutrient uptake (kg ha^{-1})								
Phosphorus levels (kg ha^{-1})	N			P			K		
	Potassium levels (kg ha^{-1})								
	15	30	45	15	30	45	15	30	45
25	118.32	129.21	141.00	11.70	13.77	15.46	54.31	59.84	66.12
50	171.24	192.36	196.14	20.38	25.24	27.49	77.71	87.04	89.21
75	198.54	202.97	205.14	27.59	28.59	29.64	90.64	90.64	94.15
S. E.±		1.30			0.51			0.88	
C. D. at 5%		3.87			1.51			2.63	

balance, protein synthesis, starch synthesis etc. Its application in legumes improves nitrogen fixation capacity of plant. These favorable effects might have resulted in increased dry matter production plant^{-1} at higher potassium levels. The increased values for number of branches and total dry matter production with higher K levels were also reported by Singh (2007).

The potassium applied @ 30 and 45 kg K_2O ha^{-1} were found to be at par with each other and produced more number of root nodules and their weight plant^{-1} than 15 kg K_2O ha^{-1} both at flowering and pod development stages except that weight of root nodules at pod development stage was significantly higher with the application of 45 kg K_2O ha^{-1}. These results are in conformity with the findings reported by Patra *et al*. (1999). The days to 50 per cent flowering, yield contributing characters *viz.*, number of matured pods and their weight plant^{-1}, 100 kernel weight, dry pod and haulm yields and protein and oil yields were not influenced significantly due to potassium fertilization. The application of 30 and 45 kg K_2O ha^{-1} were found to be at par with each other but significantly increased protein and oil content of kernels as compared to application of 15 kg K_2O ha^{-1} which might be due to significant role of potassium in pod development. The uptake of NPK was significantly increased with the increased levels of potassium fertilization owing to increased N, P and K content in kernel and haulm. Hadwani and Gundalia (2005) also reported the similar findings.

The mean values for growth and yield attributes, number and weight of root nodules, pod and haulm yields, protein and oil content and N, P, K uptake, were significantly less under control than other treatment means, which might be due to no supply of P_2O_5 and K_2O through fertilizers and native supply of these nutrients might be inadequate under control.

Effect of interaction : The interaction effects between phosphorus and potassium levels in respect of growth attributes, nodulation, yield attributes, yield and quality parameters were found to be non-significant, however, interaction effect between phosphorus and potassium significantly influenced the nutrient uptake pattern in summer groundnut.

The uptake of NPK was significantly increased with the increased levels of phosphate fertilization at all the levels of potassium (Table 3). Further, it was observed that nitrogen uptake showed graded response to increased levels of potassium at all the levels of phosphorus. Phosphorus and potassium showed graded response with increased levels of potassium at lower level of 25 kg P_2O_5 application and increased with increased levels of potassium application up to 30 kg K_2O ha^{-1} at higher level of phosphorus up to 50 kg P_2O_5 ha^{-1}.

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Effect of Plant Densities and Nutrient Management on Productivity of *Rabi* Sorghum

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ABSTRACT

The grain yield at 1.85 lakh plants ha^{-1} was higher by 19.07 and 9.62 per cent, respectively over 1.11 and 1.48 lakh plants ha^{-1} on pooled basis. The combination of 1.85 lakh plants ha^{-1} with 100:50:50 kg N, P_2O_5 and K_2O ha^{-1} resulted in significantly higher grain yield (54.61 q ha^{-1}) of rabi sorghum under irrigated conditions than other treatment combinations except 1.66 lakh plant ha^{-1} with 100:50:50 kg N, P_2O_5 and K_2O ha^{-1} (52.33 q ha^{-1}) where it was at par. The grain yield increase by application of 100:50:50 kg N, P_2O_5 and K_2O ha^{-1} over 60:30:30 and 80:40:40 kg N, P_2O_5 and K_2O ha^{-1} was 18.27 and 8.0 per cent on pooled mean basis respectively. The significantly maximum gross returns (Rs. 50969 and Rs. 51250 ha^{-1}), net returns (Rs. 35173 and Rs. 34515 ha^{-1}) and B:C ratio (3.22 and 3.05) were realized with planting density of 1.85 lakh plants ha^{-1} and by application of fertilizer @ 100:50:50 kg N, P_2O_5 and K_2O ha^{-1} respectively. The grain and fodder yield advantage by application of bio-fertilizer being 7.55 and 6.95 per cent respectively over the control on pooled basis.

Key words : Plant densities, fertilizer levels, bio-fertilizer, yield, economics, *rabi* sorghum.

Sorghum [*Sorghum bicolor* (L.) Monech] is an important cereal crop in Maharashtra. It is primarily grown for food, feed and forages in dryland ecosystem during *rabi* (post rainy) season over an area of 2.85 million ha with productivity of 500-600 kg ha^{-1}. Variation in annual rainfall and its unpredictability make dry land productive through irrigation (8-10%). Productivity under these more favourable conditions was 2.5 to 3 t ha^{-1} for grain yield and 5 to 6 t ha^{-1} for fodder yield. The productive efficiency of a crop though depends on its genetic potential; its yield could be improved to a predictable magnitude through suitable agronomic practices. The optimum plant density per unit area is an important

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factor needed for realizing higher yield (Balsubramaniyan and Palaniappan, 1991). Secondly, substantial increase in crop production can be obtained by judicious use of fertilizer and bio-fertilizer. Fertilizer use efficiency can be maximized only when plant population is optimum for enhancing the available cultural and solar energy regimes. In order to realize the full potential of 'Phule Yashoda' recently released variety of *rabi* sorghum the present study was undertaken.

MATERIALS AND METHODS

A field experiment was conducted during 2002-03 to 2004-05 on *rabi* sorghum at Rahuri. The soil was deep clay classified as Vertic. Initially it was low in available N (150 kg ha^{-1}), medium in available P (15 kg ha^{-1}) and very high in K (560 kg ha^{-1}), with pH 7.8. The experiment was laid out in split plot design replicated three times. The treatments comprising four plant densities, *viz*., 1.11 (60 x 15 cm), 1.48 (45 x 15 cm), 1.66 (30 x 20 cm), 1.85 (45 x 12 cm) lakh plants ha^{-1} and three fertility levels *viz*., 60:30:30, 80:40:40 and 100:50:50 kg N, P_2O_5 and K_2O ha^{-1} in main plots while two bio-fertilizers *viz*., control and seed inoculation with *Azotobacter* + phosphate solubilizing bacteria in sub-plots. Sorghum variety 'Phule Yashoda' was sown on 23, 28, and 30th September and harvested on 11, 25 and 9th February in 2002-03, 2003-04 and 2004-05, respectively. Gross plot size was 4.8 x 3.6 m. The crop was irrigated at critical growth stages. The rainfall received during crop growth period was 59, 127, 20 mm during first, second and third year, respectively. Entire dose of phosphorus, potassium and half of nitrogen were applied as basal and remaining nitrogen was applied at 30 days after sowing as per the treatments. Economics for each treatment was worked out based on market rate of inputs and outputs.

RESULTS AND DISCUSSION

Effect of plant densities : The results indicated that the differences in grain and fodder yield of 'Phule Yashoda' due to increase in plant density from 1.11 to 1.85 lakh plants ha^{-1} were found significant during all the seasons and when data were pooled over the seasons (Table 1). The significantly higher 1000 seed weight (38.66 g) of sorghum was observed at lower plant density of 1.11 lakh plants ha^{-1} than rest of the treatments. The grain yield of rabi sorghum was significantly higher at higher plant density of 1.85 lakh plants ha^{-1} than grain yield recorded at lower plant densities of 1.11 and 1.48 lakh plants ha^{-1} however, it was at par with 1.66 lakh plants ha^{-1} during all the seasons and pooled mean basis. The grain yield at 1.85 lakh plants ha^{-1} was higher by 19.07 and 9.62 per cent, respectively over 1.11 and 1.48 lakh plants ha^{-1} on pooled basis. The fodder yield increased at 1.85 lakh plants ha^{-1} by the margin of 20.84, 13.28 and 9.27 per

Table 1. Production potential of *rabi* sorghum (pooled mean) as influenced by plant densities and fertilizer levels.

Treatments	1000 seed weight (g)	Grain yield q ha^{-1}	Dry fodder yield ha^{-1}
A. Plant densities (lakh plants ha^{-1}) :			
1.11 (60 x 15 cm)	38.66	42.10	6.14
1.48 (45 x 15 cm)	37.73	45.71	6.55
1.66 (30 x 20 cm)	36.75	47.89	6.79
1.85 (45 x 12 cm)	36.64	50.11	7.42
C. D. at 5%	1.24	2.42	0.20
B. Fertilizer levels (N : P_2O_5 : K_2O kg ha^{-1}) :			
60 : 30 : 30	36.84	42.15	5.91
80 : 40 : 40	37.40	46.56	6.59
100 : 50 : 50	38.10	50.28	7.56
C. D. at 5%	0.71	2.03	0.30
C. Bio-fertilizer :			
Control	37.00	44.50	6.46
Azotobacter + PSB	37.90	47.86	6.91
C. D. at 5%	0.47	0.38	0.14

cent over 1.11, 1.48 and 1.66 lakh plants ha^{-1} respectively. Thorat et al. (1995) also reported that population of 184000 plants ha^{-1} gave maximum grain and fodder yield of sweet sorghum. The maximum gross (Rs. 50969 ha^{-1}) and net returns (Rs. 35173 ha^{-1}) were realized with planting density of 1.85 lakh plants ha^{-1} were significantly higher over rest of plant densities when data were pooled (Table 2). Similar results were also observed during second and third year of experimentation. However, during first year gross and net returns obtained at 1.85 and 1.66 lakh plants ha^{-1} were at par with each other. The higher value of B:C ratio was recorded at planting density of 1.85 lakh plants ha^{-1} (3.22) followed by 1.66 lakh plants ha^{-1} (3.07) on pooled basis.

Effect of fertilizer : The differences in 1000 seed weight, grain and fodder yield of *rabi* sorghum Cv. 'Phule Yashoda' due to different fertilizer levels were found to be significant on pooled basis. The significantly higher 1000 seed weight (38.10 g) of sorghum was at higher level of fertilizer than rest of the treatments under irrigated conditions. The application of fertilizer @ 100:50:50 kg N, P_2O_5, K_2O ha^{-1} gave significantly higher grain and fodder yield of sorghum (Phule Yashoda) than lower level of fertilizer under irrigated conditions. The grain yield increased by application of 100:50:50 kg N, P_2O_5 and K_2O ha^{-1} over 60:30:30 and 80:40:40 kg N, P_2O_5 and K_2O ha^{-1} was 18.27 and 8.0 per cent on pooled mean basis respectively. Similarly, by application of 80:40:40 kg N, P_2O_5 and K_2O ha^{-1} gave 9.52 per cent higher yield over 60:30:30 kg N, P_2O_5 and K_2O ha^{-1}. The significantly higher gross (Rs. 51250 ha^{-1}) and net returns (Rs. 34515 ha^{-1}) were obtained with application of 100:50:50 kg N, P_2O_5 and K_2O ha^{-1} than that obtained in rest of fertilizer

Table 2. Economics of rabi sorghum as influenced by plant densities, fertilizer levels (mean of 3 years).

Treatments	Gross returns Rs. ha^{-1}	Net returns Rs. ha^{-1}	B:C ratio
A. Plant densities (lakh plants ha^{-1}) :			
1.11 (60 x 15 cm)	42637	27712	2.75
1.48 (45 x 15 cm)	45304	29733	2.91
1.66 (30 x 20 cm)	48331	32610	3.07
1.85 (45 x 12 cm)	50969	35173	3.22
C. D. at 5%	2589	2423	-
B. Fertilizer levels (N : P_2O_5 : K_2O kg ha^{-1}) :			
60 : 30 : 30	42064	28018	3.10
80 : 40 : 40	47117	31013	2.92
100 : 50 : 50	51250	34515	3.05
C. D. at 5%	1608	1557	-
C. Bio-fertilizer :			
Control	45089	29567	2.89
Azotobacter + PSB	48532	32797	3.08
C. D. at 5%	1151	1091	-

Table 3. Interaction effect of plant densities and fertilizer levels on grain and fodder yield of sorghum (pooled mean).

Plant densities (lakh plants ha^{-1})	Grain yield (q ha^{-1})			Fodder yield (t ha^{-1})		
	N : P_2O_5 : K_2O kg ha^{-1}			N : P_2O_5 : K_2O kg ha^{-1}		
	60:30:30	80:40:40	100:50:50	60:30:30	80:40:40	100:50:50
1.11 (60 x 15 cm)	3719	43.33	45.78	5.51	6.20	6.71
1.48 (45 x 15 cm)	42.93	45.79	48.42	5.97	6.10	7.13
1.66 (30 x 20 cm)	44.12	47.21	52.33	6.03	6.81	7.54
1.85 (45 x 12 cm)	45.80	49.91	54.16	6.14	7.25	8.86
C. D. at 5%		3.61			0.61	

levels. The increase in net returns by application of fertilizer @ 100:50:50 kg N, P_2O_5 and K_2O ha^{-1} to sorghum over 60:30:30 and 80:40:40 kg N, P_2O_5 and K_2O ha^{-1} were 23.18 and 11.29 per cent respectively. Shinde *et al.* (2001) reported that sorghum variety, Yashoda gave maximum grain and fodder yields and net returns by application of 120 kg N ha^{-1}. The application of higher dose of fertilizer @ 100:50:50 kg N, P_2O_5 and K_2O ha^{-1} recorded more B:C ratio on pooled basis (3.05).

Effect of biofertilizer : Inoculation of biofertilizer (*Azotobacter* + PSB) showed significant effect on 1000 grain weight, grain and fodder yield. The *Azotobacter* + PSB inoculation recorded significantly higher grain and fodder yield over the control. The grain and fodder yield advantage by application of biofertilizer being 7.55 and 6. 96 per cent respectively over the control on pooled basis. A significant increase in grain yield of rabi sorghum due to inoculation of *Azotobacter* was also reported by Deokar and Sawant (2002). The significantly maximum gross (Rs. 48532 ha^{-1}) and net returns (Rs. 32797 ha^{-1}) were realized in seed inoculation treatment of biofertilizer compared to control. Similarly seed treatment with *Azotobacter* and PSB recorded higher B:C ratio (3.08) than the control.

Interaction effect : The interaction effect between plant densities and fertilizer levels on grain and fodder yield of sorghum was found significant on pooled basis (Table 3). Data of pooled analysis showed that the treatment combination of 1.85 lakh plants ha^{-1} with 100:50:50 kg N, P_2O_5 and K_2O ha^{-1} resulted in significantly higher grain yield (54.61 q ha^{-1}) under irrigated conditions than other treatment combinations except 1 .66 lakh plant ha^{-1} with 100:50:50 kg N, P_2O_5 and K_2O ha^{-1} (52.33 q ha-1) where it was at par.

It is concluded that significantly maximum productivity of sorghum cv. 'Phule Yashoda was realized by maintaining either 1.85 lakh plants ha^{-1} (45 oh x 12 cm spacing) or 1.66 lakh plants ha^{-1} (30 x 20 cm spacing) with application of fertilizer @ 100:50:50 kg N, P_2O_5 and K_2O ha^{-1} under irrigated conditions.

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Effect of Application of Humic Acid and FYM on Nutrient Uptake, Yield and Quality of Chilli*

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ABSTRACT

The treatments comprised of foliar sprays of humic acid @ 50, 100 and 200 ppm with and without FYM. Foliar spray of 100 ppm humic acid with and without FYM exhibited significant effects on nutrient uptake, yield and quality parameters. Thus application of foliar spray of 100 ppm humic acid along with soil application of FYM for chilli found better under pot culture.

Key words : Chilli, humic acid, FYM, nutrient uptake, quality and yield.

Now a days there is great demand for organically cultivated vegetables. The organically cultivated vegetables are wholesome valuable and their post harvest losses are less. They are preferred for their flavour, taste, lusture, nutritive value and extended shelf-life. They fetch better price in the market. People are now preferring such vegetables for their safe health. Vegetables produced by the application of organic manures showed good firmness and have longer storage life. The farmers prefer to use FYM as a source of plant nutrients. However, the availability of FYM is inadequate. The application of humic acid showed promises. The prolonged humic acid application had a positive effect on fruit quality, reducing the number of misshapen and rotten fruits and increasing the sugar content (Neri *et al*. 2002). These positive effects on fruit quality are likely due to an indirect positive physiological effect of the humic acid foliar applications on the whole plant and may not relate to any curative action.

The humic substances applied in soil as well as foliar feed to crops improved the quality and yield of crops. However, there is very meager work on application of humic acid as foliar spray in relation to quality and yield of vegetable crops. Therefore, the present investigation was undertaken to study the different levels of humic acid with and without FYM on yield, quality and nutrient uptake by chilli.

MATERIALS AND METHODS

The present investigation was carried out in *kharif* season of 2007-08, under the wire house at division of Soil Science and Agricultural Chemistry, College of Agriculture Pune-5. The chilli crop cv. Phule Jyoti was grown in cemented pots filled with 15 kg 2 mm sieved soil. The well decomposed farm yard manure (FYM) was used for this experiment (Table 1). The recommended plant protection schedule was followed in order to keep crop healthy. FYM @ 20 t ha^{-1} was applied before transplanting of the chilli. The recommended dose of N, P_2O_5 and K_2O i.e. 100:50:50 kg ha^{-1} were applied through urea, single super phosphate and muriate of potash, respectively to all treatments except absolute control. The

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nitrogen was applied in two splits i.e. half at transplanting and half dose 30 days after transplanting. The complete dose of P and K was applied at the time of transplanting.

The humic acid extracted (Table 1) from FYM by following the procedure of Stevenson (1982) was applied as foliar spray 50, 100 and 200 mg L^{-1} at 15, 30 and 45 days after the transplanting of chilli seedlings. The length of fruit, yield, yield parameters and growth parameter observations were recorded. The fresh green chilli fruit weights were recorded at the time of each pickings and summed after all pickings. The fresh green chilli yield per plant was computed. After harvesting the whole plant was dried in oven at 70°C and recorded as dry matter yield. The plant and fruit analysis was carried out after 7 pickings of green chilli fruits for nutrient uptake and ascorbic acid content. The green chilli fruits were analysed for content of ascorbic acid (Vitamin-C). The data was analyzed using FCRD as described by Panse and Sukhatme (1997).

Plant height : The plant height recorded at 30 days after transplanting was higher in foliar spray of 100 ppm humic acid (16.00 cm). This treatment recorded significantly higher plant height over all other treatments except foliar spray of 200 ppm humic acid (15.00 cm). All foliar sprays of humic acid recorded significantly higher plant height over water spray (12.00 cm) and absolute control (11.33 cm). The plant height at 60 and 90 days was significantly higher in 100 ppm humic acid over rest of the foliar sprays of humic acid including absolute control.

The treatment, soil application of FYM recorded significantly higher plant height at 30 days (14.13 cm), 60 days (50.53 cm) and 90 days (61.67 cm) compared with treatment without FYM and absolute control. Interaction of humic acid and FYM application was observed non significant at 30 days but at 60 and 90 days, the interactions were significant in 100 ppm of humic acid with FYM over all other treatments and absolute control.

The increase in height of plant in the treatments of foliar sprays of humic acid might be due to better absorption of nutrients, enhancement of physiological and biochemical process in plant.

Number of branches : The number of branches at 30 days (9.00), 60 days (12.00) and 90 days (15.00) were significantly higher in foliar spray of 100 ppm of humic acid over rest of the treatments of humic acid, water spray and absolute control.

The soil application of FYM recorded significantly higher number of branches at 30 days (7.07), 60 days (10.60) and 90 days (13.67) after transplanting which were significant over treatment without FYM and absolute control.

Table 1. Initial characteristics of FYM.

Properties	**Value**
pH (1:10)	7.65
EC (1:10) (dS m^{-1})	4.1
Moisture content (%)	32.57
Ash (%)	32.43
Total organic carbon (%)	20.30
C/N ratio	21.83
Total N (%)	0.93
Total P (%)	0.83
Total K (%)	0.54
Humic substances (g 100 g^{-1}) :	
Humic acid (HA)	8.2
Fulvic acid (FA)	35.04
E_4/E_6 ratio :	
Humic acid (HA)	3.5
Fulvic acid (FA)	6.4
Iron (mg kg^{-1})	4600
Manganese (mg kg^{-1})	800
Zinc (mg kg^{-1})	200
Copper (mg kg^{-1})	200

Interaction effect of humic acid and FYM application was non significant at 30 days while number of branches at 60 days (13.67) and 90 days (17.33) were significant over other treatments and absolute control except 200 ppm humic acid with FYM which was at par with 100 ppm humic acid with FYM.

Days to 50% flowering : The foliar spray of 100 ppm humic acid required least number of days (44.83) for 50 % flowering which took significantly less period compared with other sprays of humic acid and absolute control (51.67) except 200 ppm humic acid (45.50) which was at par with 100 ppm humic acid.

The application of FYM had no significant effect on 50% flowering. Interaction effect of humic acid spray and FYM application was significant. The foliar spray of 100 ppm humic acid and soil application of FYM (44.33) recorded significantly less period for 50% flowering compared with rest of the combinations.

RESULTS AND DISCUSSION

Fruit length : The fruit length (Table 2) was significantly higher in foliar spray of 100 ppm

Table 2. Influence of foliar spray of humic acid and soil application of FYM on quality and yield of chilli.

Treatments	Fruit length (cm)	Ascorbic acid content (mg 100 g^{-1})	Number of fruits $plant^{-1}$	Yield (g $plant^{-1}$)		
				Green fruit		Stalk
				Fresh	Dry	Dry
A. Humic acid :						
Water spray	7.12	85.78	29.83	57.88	12.25	29.78
50 ppm	7.69	93.07	34.83	66.83	13.93	32.27
100 ppm	8.38	99.47	42.00	84.9	17.84	36.88
200 ppm	8.21	96.87	40.17	82.92	17.30	35.00
S. E.±	0.003	0.19	0.24	0.21	0.04	0.25
C. D. at 5%	0.009	0.57	0.70	0.63	0.12	0.75
B. FYM :						
With FYM	7.93	91.51	34.87	68.37	14.37	34.17
Without FYM	7.36	87.26	31.2	61.79	12.91	28.35
S. E.±	0.002	0.12	0.15	0.13	0.03	0.16
C. D. at 5%	0.005	0.36	0.44	0.4	0.07	0.47
C. Interaction (A+B) :						
0 ppm humic acid with FYM	7.14	84.85	32.33	61.9	13.12	32.73
50 ppm humic acid with FYM	7.80	97.34	36.33	70.98	14.76	35.37
100 ppm humic acid with FYM	9.08	102.91	44.67	89.14	18.99	41.23
200 ppm humic acid with FYM	8.82	100.72	42.67	86.93	18.08	39.13
0 ppm humic acid without FYM	7.10	86.70	27.33	53.86	11.37	26.83
50 ppm humic acid without FYM	7.57	88.80	33.33	62.68	13.10	29.17
100 ppm humic acid without FYM	7.67	96.02	39.33	80.65	16.69	32.53
200 ppm humic acid without FYM	7.60	93.03	37.67	78.9	16.51	30.87
S. E.±	0.004	0.27	0.33	0.3	0.06	0.36
C. D. at 5%	0.012	0.8	0.98	0.89	0.17	1.05
D. Absolute control	6.84	71.75	18.33	32.88	6.87	22.37
Mean	7.65	89.39	33.03	65.08	13.64	31.26

humic acid (8.38 cm) than water spray (7.12 cm) and absolute control (6.84 cm). All foliar sprays of humic acid recorded higher fruit length over absolute control. The soil application of FYM recorded significantly higher fruit length (7.93 cm) as compared to treatment without FYM (7.37 cm) and absolute control (6.84 cm).

The interaction of foliar spray of 100 ppm humic acid and FYM application recorded higher fruit length (9.08 cm) over other interactions, water spray (7.10 cm) and absolute control (6.84 cm). All interactions of foliar spray of humic acid and soil application of FYM recorded significantly higher fruit length than water spray and absolute control.

Ascorbic acid content of fruit : The foliar spray of 100 ppm humic acid observed significantly higher ascorbic acid content (99.47 mg 100 g^{-1}) over other foliar sprays of humic acid, water spray (85.78 mg 100 g^{-1}) and absolute control (71.75 mg 100 g^{-1}). All foliar sprays recorded higher ascorbic acid content than absolute control (Table 2). The significantly higher content of ascorbic acid was recorded with application of FYM (91.51 mg 100 g^{-1}) over no application of FYM (87.26 mg 100 g^{-1}). Similar results were recorded by Chavan *et al*. (1997) and Shashidhara (2000). The combined Application of 100 ppm humic

Table 3. Influence of foliar spray of humic acid and soil application of FYM on uptake of nutrients (mg $plant^{-1}$) by chilli (green) fruits.

Treatments	N	P	K	Fe	Mn	Zn	Cu
A. Humic acid :							
Water spray	206.87	32.34	278.46	4.27	2.21	1.88	0.54
50 ppm	239.85	38.90	317.78	4.91	2.54	2.16	0.57
100 ppm	326.61	53.40	410.55	6.30	3.30	2.82	0.75
200 ppm	311.55	49.99	395.64	6.08	3.19	2.67	0.71
S. E.±	1.15	0.38	0.95	0.05	0.009	0.02	0.02
C. D. at 5%	3.41	1.12	2.80	0.15	0.027	0.05	0.06
B. FYM :							
With FYM	255.78	42.04	329.95	5.09	2.65	2.25	0.59
Without FYM	223.53	34.48	292.67	4.46	2.32	1.97	0.55
S. E.±	0.73	0.24	0.60	0.03	0.006	0.01	0.01
C. D. at 5%	2.15	0.71	1.77	0.1	0.017	0.03	0.04
C. Interaction (A+B) :							
0 ppm humic acid with FYM	223.53	35.88	299.65	4.62	2.39	2.04	0.53
50 ppm humic acid with FYM	257.86	43.30	339.06	5.29	2.72	2.32	0.61
100 ppm humic acid with FYM	353.84	59.50	439.93	6.78	3.56	3.06	0.80
200 ppm humic acid with FYM	330.26	54.84	416.98	6.44	3.39	2.82	0.75
0 ppm humic acid without FYM	190.20	28.79	257.26	3.93	2.03	1.73	0.55
50 ppm humic acid without FYM	121.83	34.49	296.49	4.52	2.35	2.00	0.53
100 ppm humic acid without FYM	299.37	47.29	381.16	5.81	3.05	2.58	0.71
200 ppm humic acid without FYM	292.84	45.13	374.29	5.72	2.99	2.53	0.67
S. E.±	1.63	0.54	1.34	0.07	0.013	0.02	0.03
C. D. at 5%	4.82	1.58	3.96	0.22	0.038	0.07	NS
D. Absolute control	113.42	16.69	154.12	2.33	1.21	1.02	0.27
Mean	197.36	38.26	311.31	4.78	2.49	2.11	0.57

acid spray and soil application of FYM resulted significantly higher content of ascorbic acid (102.91 mg 100 g^{-1}) over other interactions, water spray (86.70 mg 100 g^{-1}) and absolute control (71.75 mg 100 g^{-1}). Humic acid increases the vitamin content of plants. The positive effects on quality of fruits might be due to an indirectly positive physiological effect of foliar applications of humic acid on the whole plant. The resemble results were recorded by Neri *et al.* (2002).

Fruits plant^{-1} : The higher number of fruits per plant (Table 2) was recorded under foliar spray of 100 ppm humic acid (42.00) which was significant over rest of foliar sprays of humic acid and absolute control (18.33).

The soil application of FYM recorded significantly higher number of fruits per plant (34.87) as compared to treatment without FYM (31.20). The combined effect of the foliar spray of humic acid and soil application of FYM on number of fruits per plant was significant. The foliar spray of 100 ppm humic acid and soil application of FYM found significantly superior (44.67) over rest of the combinations and absolute control.

Green fruit yield : The highest fresh green fruit yield (84.90 g plant^{-1}) and dry fruit yield (17.84 g plant^{-1}) were recorded under foliar spray of 100 ppm humic acid which was significantly higher than rest of the treatments and absolute control (32.88 and 6.87 g plant^{-1},

Table 4. Influence of foliar spray of humic acid and soil application of FYM on uptake of nutrients (mg plant^{-1}) by chilli stalks.

Treatments	N	P	K	Fe	Mn	Zn	Cu
A. Humic acid :							
Water spray	427.49	46.27	766.72	12.71	6.33	4.84	1.24
50 ppm	491.63	55.10	832.69	13.99	6.96	5.31	1.37
100 ppm	545.91	65.52	962.69	16.07	8.09	6.09	1.57
200 ppm	513.06	59.93	909.60	15.20	7.61	5.86	1.50
S. E.±	11.19	0.74	6.82	0.11	0.05	0.08	0.01
C. D. at 5%	33.01	2.19	20.12	0.33	0.16	0.25	0.04
B. FYM :							
With FYM	498.98	61.44	880.71	14.77	7.43	5.78	1.45
Without FYM	416.01	39.42	723.82	12.10	5.96	4.39	1.20
S. E.±	7.08	0.47	4.31	0.07	0.03	0.05	0.008
C. D. at 5%	20.88	1.38	12.72	0.21	0.10	0.16	0.025
C. Interaction (A+B) :							
0 ppm humic acid with FYM	475.73	56.77	845.61	14.12	7.04	5.52	1.35
50 ppm humic acid with FYM	517.53	68.40	914.82	15.40	7.76	6.03	1.50
100 ppm humic acid with FYM	615.75	81.10	1081.69	18.05	9.21	7.23	1.76
200 ppm humic acid with FYM	576.50	75.60	1021.81	17.08	8.66	6.78	1.70
0 ppm humic acid without FYM	379.25	35.77	687.83	11.31	5.62	4.16	1.13
50 ppm humic acid without FYM	465.72	41.80	750.56	12.58	6.16	4.58	1.23
100 ppm humic acid without FYM	476.07	49.93	843.70	14.10	6.97	4.94	1.38
200 ppm humic acid without FYM	449.62	44.27	797.39	13.31	6.55	4.95	1.30
S. E.±	15.83	1.05	9.64	0.16	0.08	0.12	0.02
C. D. at 5%	46.69	3.09	28.45	0.46	0.22	0.35	0.06
D. Absolute control	309.41	25.35	539.62	9.20	4.50	3.32	0.95
Mean	545.54	50.43	802.26	13.43	6.70	5.08	1.32

respectively). All foliar sprays of humic acid recorded significantly higher yield of green fruit over absolute control (Table 2).

The soil application of FYM recorded higher fresh yield (68.37 g plant^{-1}) and dry yield (14.37 g plant^{-1}) than treatment without FYM and absolute control. Phosphorus involved in cell division, photosynthesis and metabolism of carbohydrates where potash regulated proper translocation of photosynthates and stimulated enzyme activity which cause greater yield. These results are in accordance with findings of Singh and Kohli (1999), Gowda *et al*. (2002) and Mondal *et al*. (2004).

The interaction of 100 ppm humic acid and FYM application yielded significantly higher fresh (89.14 g plant^{-1}) and dry (18.99 g plant-1) weight of chilli compared with rest of interactions and absolute control.

Stalk yield : The data on stalk yield (Table 2) indicated that the foliar spray of 100 ppm humic acid recorded significantly higher dry matter stalk (36.88 g plant^{-1}) over other foliar spray of humic acid and absolute control (22.37 g plant^{-1}). The soil application of FYM yielded significantly higher dry matter of stalk (34.13 g plant^{-1}) over no application of FYM and absolute control. The combined effect of 100 ppm humic acid and soil application of FYM recorded significantly higher stalk dry matter (41.23 g plant^{-1}) over water spray (26.83 g plant^{-1}) and absolute control (22.37 g plant^{-1}). All other combined application of humic acid and FYM application recorded significantly higher dry matter of stalk over absolute control.

The increase in yield of crop might be due to humic acid which stimulates plant growth by accelerating cell division, increasing the rate of development in the root system and increasing the dry matter. The similar findings were recorded by Senn and Kingman (1973) and Tan and Nopanmornbody (1979). Obreza *et al.* (1989) reported that the proliferation in root growth, resulting in an increased efficiency of the root system, is a likely cause of higher plant yield seen in response to humic acid treatments. Subbaiah *et al*. (1982) reported that the reason for increased yield of chilli is attributed to solubilization effect of plant nutrients by addition of FYM as evidenced by increase in uptake of N, P, K, Ca and Mg.

Uptake of nutrients by chilli fruits : The foliar spray of 100 ppm humic acid recorded (Table 3) significantly higher uptake of N, P, K (326.61, 53.40 and 410.55 mg plant^{-1}, respectively) over water spray (N-206.87, P- 32.34 and K- 278.46 mg plant^{-1}) and absolute control (N-1 13.42, P-16.69, K-154.12 mg plant^{-1}). All foliar sprays were recorded significant results over absolute control.

The significantly higher uptake of N, P, K by chilli fruits were observed in soil application of FYM (255.78, 42.04 and 329.95 mg plant^{-1}, respectively) as compared to treatment without FYM (223.53, 34.78, 292.67 mg plant^{-1}, respectively). Kaminwar and Rajagopal (1993) reported the similar results of higher uptake of nutrients along with FYM application.

The interaction of 100 ppm humic acid spray and FYM application recorded significantly higher uptake of N, P, K by fruits (353.84, 59.50 and 439.93 mg plant^{-1}, respectively) over water sprays (190.20, 28.79 and 257.26 mg plant^{-1}, respectively) and absolute control (N- 113.42, P- 16.69 and K-154.12 mg plant^{-1}). All interactions were recorded significantly higher uptake of nutrients by chilli fruits over absolute control.

The uptake of Fe, Mn, Zn and Cu (Table 3) were found significantly higher in 100 ppm humic acid spray (6.30, 3.30, 2.82 and 0.75 mg plant^{-1}, respectively) over water spray (Fe-4.26, Mn- 2.21, Zn- 1.88 and Cu- 0.54 mg

plant^{-1}) and absolute control (Fe- 2.33, Mn-1.21, Zn -1.02 and Cu -0.27 mg plant^{-1}) while it was recorded at par results with 200 ppm humic acid spray (0.71 mg plant^{-1} Cu).

Soil application of FYM recorded significantly higher uptake of Fe, Mn and Zn (5.09, 2.65 and 2.25 mg plant^{-1}, respectively) by chilli fruit over no application of FYM and uptake of Cu (0.59 mg plant-1) by fruit was at par with the treatment no application of FYM.

The significantly higher uptake of Fe, Mn and Zn by fruit recorded under combination of foliar spray of 100 ppm humic acid and soil applicaton of FYM (6.78, 3.56 and 3.06 mg plant^{-1}, respectively) over water spray with 3.89 mg plant^{-1} Fe, 2.03 mg plant^{-1} Mn and 1.73 mg plant-1 Zn uptake by chilli fruits and absolute control (Table 3). While, the uptake of Cu by chilli fruits had non significant results under combined application of humic acid spray and soil application of FYM.

Uptake of nutrients by chilli stalk : The foliar spray of 100 ppm FYM reported significantly higher uptake of N, P and K by stalk (545.91, 65.52 and 962.69 mg plant^{-1}, respectively) over water spray (N - 427.49, P - 46.27 and K - 766.72 mg plant^{-1}) and absolute control (Table 4). But uptake of N by chilli stalk in treatment, 100 ppm humic acid spray recorded at par results with 200 ppm humic acid spray (513.06 mg plant^{-1}).

The significantly higher N, P and K uptake by chilli stalk were recorded with application of FYM (498.98, 61.44, 880.71 mg plant^{-1} respectively) over treatment without FYM (N-416.01, P- 39.42 and K - 723.82 mg plant-1). The similar results of higher uptake of nutrients with FYM application was also reported by Kaminwar and Rajagopal (1993). The interaction of 100 ppm humic acid and FYM application recorded significantly higher uptake of N, P and K (615.75, 81.01 and 1081.69 mg plant^{-1}, respectively) over water spray (N - 379.25, P - 35.77 and K - 687.83 mg plant^{-1}) and absolute control (N -309.41, P-25.35, K-539.62 mg plant^{-1}). While the uptake of N by stalk in 100 ppm humic acid spray and application of FYM was at par with foliar spray of 200 ppm humic acid and FYM application (576.50 mg plant^{-1}). All interaction recorded significantly higher uptake of N, P and K by stalk over absolute control.

The significantly higher uptake of Fe, Mn, Zn and Cu (Table 4) was recorded in 100 ppm humic acid spray (16.07, 8.09, 6.09 and 1.57 mg plant^{-1}, respectively) over water spray (Fe 12.71, Mn 6.33, Zn 4.84, Cu 1.24 mg plant^{-1}) and absolute control (Fe-9.20, Mn-4.50, Zn-3.32 and Cu-0.95 mg plant^{-1}) while uptake of Zn by stalk (6.09 mg plant^{-1}) in 100 ppm humic acid spray was at par with foliar spray 200 ppm humic acid (5.86 mg plant^{-1}). All foliar spray were recorded significantly higher uptake of Fe, Mn, Zn, Cu by chilli stalk over absolute control.

The soil application of FYM recorded significantly higher uptake of Fe, Mn, Zn and Cu (14.77, 7.43, 5.78 and 1.45 mg plant^{-1}, respectively) over treatment without FYM (12.10 mg plant^{-1} Fe, 5.96 mg plant^{-1} Mn, 4.39 mg plant^{-1} Zn and 1.20 mg plant^{-1} Cu).

The significantly higher uptake of micronutrient by chilli stalk were recorded by 100 ppm humic acid and soil application of FYM (18.05 Fe, 9.21 Mn, 7.23 Zn, 1.76 Cu mg plant^{-1}) over other interaction, water spray (Fe-11.31, Mn-5.62, Zn-4.16 and Cu-1.13 mg plant^{-1}) and absolute control (9.20 Fe, 4.50 Mn, 3.32 Zn, and 0.95 Cu mg plant^{-1}). The uptake of copper by stalk in 100 ppm humic acid spray and FYM application was at par with foliar spray of 200 ppm humic acid and application of FYM. Senn and Kingman (1973) reported that humic acid acts as an organic

catalyst thus increase the availability and uptake of nutrients by plant.

Conclusions : The foliar spray of 100 ppm humic acid registered significantly higher ascorbic acid content over other foliar sprays of humic acid, water spray and absolute control. The fruit length was significantly higher in foliar spray of 100 ppm humic acid than water spray and absolute control. The combined application of 100 ppm humic acid spray and soil application of FYM resulted in significantly higher content of ascorbic acid over other interactions, water spray and absolute control. The similar trend of observations was found in case of number of fruits per plant, green fruit yield, dry fruit yield and uptake of N, P, K, Fe, Mn, Zn and Cu over water spray and absolute control. In general, the application of 100 ppm humic acid either alone or with FYM found beneficial for better nutrient uptake, quality and yield of chilli.

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Growth and Yield of Aerobic Rice (*Oryza sativa* L.) as Influenced by Different Levels of NPK in Cauvery Command Area

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ABSTRACT

An application of 125 kg N ha^{-1} recorded significantly higher plant height (92.21 cm), more number of tillers $hill^{-1}$ (34.97), total dry matter accumulation (161.39 g $hill^{-1}$), grain yield (7.25 t ha^{-1}) and net returns (Rs.26487 ha^{-1}) but these parameters were on par with 100 kg N ha^{-1} at harvest. Among phosphorus levels 62.5 kg P_2O_5 ha^{-1} recorded significantly higher plant height (90.44 cm), more number of tillers $hill^{-1}$ (33.11), total dry matter accumulation (150.51 g $hill^{-1}$), grain yield (7.21 t ha^{-1}) and net returns (Rs. 25836 ha^{-1}) but these parameters were on par with 50 kg P_2O_5 ha^{-1} at harvest. Application of potassium 62.5 kg K_2O ha^{-1} recorded significantly higher plant height (89.51 cm), more number of tillers $hill^{-1}$ (33.01), total dry matter accumulation (151.08 g $hill^{-1}$), grain yield (7.241 ha^{-1}) and net returns (Rs. 26553 ha^{-1}) but these parameters were on par with 50 kg K_2O at harvest. Application of 75 kg N ha^{-1} recorded significantly higher nutrient use efficiency (36.32 kg grain kg^{-1} nutrient), which was on par with 100 kg N ha^{-1} (36.05 kg grain kg^{-1} nutrient). Application of 37.5 kg N ha^{-1} recorded significantly higher nutrient use efficiency (35.59 kg grain kg^{-1} nutrient), which was on par with 50 kg N ha^{-1} (35.24 kg grain kg^{-1} nutrient). Application of 50 kg N ha^{-1} recorded significantly higher nutrient use efficiency (35.95 kg grain kg^{-1} nutrient).

Key words : Aerobic rice, NPK levels, and nutrient use efficiency.

After varietal improvement, fertilizer usage is the principal factor attributed for yield improvement in rice. Adequate supply of essential plant nutrients is essential for getting good yield of rice. Much of the nutrients required by the rice crop come from the soil, but it is insufficient to meet the nutrient requirements for high rice yields. The use of fertilizer is essential to fill the deficit between crop needs for nutrients and the supply of nutrients from the soil. It is reported that the efficiency of N, P and K use is 30-40, 15-20 and 60-70 per cent respectively (Pathak, *et al*. 2002). Further, the NPK ratio of 4:2:1 considered optimum but in reality a wide ratio of 10:2.9:1 prevalent in the country (Tandon, 2001). In ends and for that matter in the entire Asia, fertilizer N mostly urea has received more attention than phosphorus and potassium fertilizer but balanced fertilization is the key to good harvest in aerobic rice. Keeping these things in view, an attempt was made to study the effect of different levels of NPK on growth and yield of aerobic rice under Cauvery command area.

MATERIALS AND METHODS

A field experiment was conducted at Zonal Agricultural Research Station, Visweswariah canal farm, Mandya, Karnataka during *kharif* season of 2004 and 2005. The soil was red sandy loam in texture having pH 6.98, medium in available nitrogen (298 kg ha^{-1}) phosphorus (26.13 kg ha^{-1}) and potassium (149.32 kg ha^{-1}).

The experiment consisted of 3 levels of nitrogen (75,100 and 125 kg N ha^{-1}), phosphorus (37.5, 50 and 62.5 kg P_2O_5 ha^{-1}) and potassium (37.5, 50 and 62.5 kg K_2O

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ha^{-1}) and tested in a factorial randomised design with three replications. The over night soaked seeds of cultures KRH-2 (Kamataka rice hybrid) was dibbled manually at the rate of one seed $hill^{-1}$ with spacing of 25 x 25 cm. Crop was sown on 1st week of August during both the years. Entire phosphorus and potassium was applied at the time of sowing and nitrogen was applied in 3 splits. The crop was irrigated once in 5 days depending upon soil moisture. The cultural practices and plant protection measures were adopted as and when required as per recommended package. Observations on growth parameters and grain yield were recorded at harvest and data were analysed statistically. The economics was worked out with prevailing market prices.

RESULTS AND DISCUSSION

Significantly marked differences were observed in morphological characters. In pooled analysis (Table 1) application of 125 kg N ha^{-1} recorded significantly higher plant height (92.21 cm), number or tillers $hill^{-1}$ (34.97) and total dry matter production (161.39 g $hill^{-1}$) which was on par with 100 kg N ha^{-1} (90.95 cm, 34.5 and 170.66 g $hill^{-1}$ respectively). Similar trend was noticed during the year 2004 and 2005. This might be due to higher dose of nitrogen might have helped in inducing vegetative growth led better interception of photosynthetically active radiation and greater photosynthesis by crop. These results are in conformity with the findings of Sugandhi *et al*. (2003) and Zhao, *et al*. (2005).

In pooled analysis application of 62.5 kg P_2O_5 ha^{-1} recorded significantly higher plant height (90.44 cm), more number of tillers $hill^{-1}$ (32.87) and total dry matter accumulation (150.51 g $hill^{-1}$) which was on par with 50 kg P_2O_5 ha^{-1} (89.16 cm, 32.87 and 151.36 g $hill^{-1}$ respectively). Similar trend was noticed during the year 2004 and 2005. This is due to higher phosphorus levels stimulating better root growth and its proliferation which facilitated better nutrients and water absorption from the large soil profile resulted in increase in plant height, tiller production and leaf area development. This in turn caused effective interceptom of light resulting increased dry matter accumulation. Similar results were also reported by Annadurai and Palaniappan (1934) and Singh *et al*. 1999).

Higher plant height (89.51 cm), more number of tillers $hill^{-1}$ (32.31) and dry matter production (158.42 g $hill^{-1}$) was significantly observed with 62.5 kg K_2O ha^{-1} but these parameters were on par with application of 50 kg K_2O ha^{-1} (88.60 cm, 32.31 and 155.82 g $hill^{-1}$ respectively) at harvest (Table-1). Since potassium is essential for photosynthesis and respiration it might have facilitated better morphological and histological characters. This is in conformity with the findings of Mishra and Singh (1980) and Bohra Doerffling (1993).

In pooled analysis application of 125 kg N ha^{-1} recorded significantly higher grain yield (7.25 t ha^{-1}) and net returns (Rs. 26487 ha^{-1}), which was on par with 100 kg N ha^{-1} (7.20 t ha^{-1} and Rs. 26461 ha^{-1} respectively). Similar trend was noticed during both the year. Increased yield under higher N levels was noticed due to adequate nutrient with more N applied which would have occurred due to increased growth and yield components. Similar results were reported by Jayaprakash and Wahab (1995).

Application of 62.5 kg P_2O_5 ha^{-1} recorded significantly higher grain yield (7.12 t ha^{-1}) and net returns (Rs. 25826 ha^{-1}) which was on par with 50 kg P_2O_5 ha^{-1} (7.07 t ha^{-1} and Rs. 25604 ha^{-1} respectively) in pooled analysis. Higher yields with higher levels of phosphorus due to better root proliferation led good

Table 1. Growth components, yield, nutrient use efficiency and economics of aerobic rice as influenced by different levels of N, P and K (pooled mean).

Treatment	Plant height (cm)	Total drymatter (g hill^{-1})	Number of tillers hill^{-1}	Grain yield (t ha^{-1})	Nutrient use efficiency (kg grain kg^{-1} nutrients)	Net returns (Rs. ha^{-1})
Nitrogen levels (kg ha^{-1}) :						
N_1 - 75	81.12	110.18	24.45	6.39	36.32	21712
N_2 - 100	90.95	159.57	34.54	7.20	36.05	26461
N_3 - 125	92.21	161.39	34.97	7.25	32.24	26487
S. E. m $\pm$	0.54	0.77	0.37	0.02	0.14	120
C. D. (P = 0.05)	1.52	2.28	1.05	0.06	0.38	340
Phosphorus levels (kg ha^{-1}) :						
P_1 - 37.5	83.68	131.06	29.98	6.62	35.59	23231
P_2 - 50.0	89.16	148.42	32.87	7.07	35.24	25604
P_3 - 62.5	90.44	150.51	33.11	7.12	33.79	25826
S. E. m $\pm$	0.54	0.77	0.37	0.02	0.14	120
C. D. (P = 0.05)	1.52	2.28	1.05	0.06	0.38	340
Potassium level (kg ha^{-1}) :						
K_1 - 37.5	86.17	131.84	30.64	6.42	34.42	21842
K_2 - 50.0	88.60	148.87	32.31	7.19	35.95	26266
K_3 - 62.5	78.51	151.08	33.01	7.24	34.26	26553
S. E. m $\pm$	0.54	0.77	0.37	0.02	0.14	120
C. D. (P = 0.05)	1.52	2.28	1.05	0.06	0.38	340
Interaction	NS	*	*	*	*	*
N x P	NS	*	*	*	*	*
N x K	NS	*	NS	*	*	*
P x K	NS	NS	NS	NS	NS	*
N x P x K	NS	*	NS	*	*	*

growth, which finally resulted in increased yield components and yield of rice. Similar results were reported by Singh *et al*. (1999). Higher grain yield (7.24 t ha^{-1}) and net returns (Rs. 26553 ha^{-1}) were noticed with 62.5 kg K_2O ha^{-1} which was on par with 50 kg K_2O ha^{-1} (7.19 t ha^{-1} and Rs. 26266 ha^{-1} respectively) in pooled analysis. The trend was similar during both the years. This might be due to application of potassium increased the growth and yield components resulted in increased grain yield (Bohra and Doerffling, 1993).

The nutrient use efficiency was significantly higher with 75 kg N, 37.5 kg P_2O_5 and 50 kg K_2O ha^{-1} (36.32 kg, 35.59 kg and 35.95 kg grain kg^{-1} NPK respectively) which was on par with 100 kg N, 50 kg P_2O_5 and 37.5 kg K_2O ha^{-1} (36.05 kg, 35.25 kg and 34.42 kg grain kg^{-1} NPK respectively) in pooled analysis (Table-2). The trend was similar during both the study. Similar results were reported by Gunri *et al*. (2004).

The growth parameters, grain yield, nutrient use efficiency and economics were significantly influenced by interaction between all nutrient combinations except between phosphorus and potassium.

Based on two years results it can be inferred that application of 100:50:50 N, P_2O_5 and K_2O kg ha^{-1} was found optimum and economical for aerobic rice in Cauvery

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Effect of Plant Densities and Levels of Nitrogen on Yield of Larkspur*

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ABSTRACT

Number of days required for flowering, spike length, number of florets per spike, duration of flower increased with increasing spacing and nitrogen levels. The optimum yield was obtained with the combination of 30 x 40 cm spacing and 150 kg N ha^{-1}.

Key words : Larkspur, plant density, nitrogen.

Larkspur (*Delphimium consolida* L.) belongs to family Ranunculaceae. The original or wild types from which the named varieties are descended are native of California, Siberia, Syria and India. The plants are tall, early flowering and well branched with deep green, finely divided feathery leaves. The flowers of these plants grow in long spikes. They are cup shaped and may be single or double with colours ranging from creamy white through lilac-pink to dark indigo-blue usually with contrasting "eye" formed by inner sepals. Though it is a commercial flower, very little or

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no research work as regards to standardize cultivation practices has been done.

MATERIALS AND METHODS

The present investigation was carried out at Modibaug garden, Horticulture Section, College of Agriculture, Pune - 411005 during the year 2004-05. The soil contained initially 240, 28, 260 kg N, P_2O_5 and K_2O ha^{-1}, respectively with pH 7.7. The experiment was laid out in a factorial randomized block design with three replications and 12 treatments. The treatments included spacing (cm) - 30 x 20 (S_1), 30 x 30 (S_2), 30 x 40 (S_3); Nitrogen (kg ha^{-1})- 75 (N_1), 100 (N_2), 125 (N_3), 150 (N_4).

The gross and net plot sizes were 2.4 x 2.1 m and 2.1 x 1.8 m respectively and one plant per hill was planted. The experimental area was manured with FYM before planting. Full common dose of 50 kg P_2O_5 and 50 kg K_2O ha^{-1} was applied to all treatments at the time of transplanting. Nitrogen was applied as per the treatments. Half dose of nitrogen was given at the time of transplanting and remaining half nitrogen was applied 30 days after the first dose. All the recommended cultural practices were adopted as and when required.

RESULTS AND DISCUSSION

Spacing : Spacing had a significant effect on growth as regards plant height, number of leaves and leaf area. Different plant densities had significant effect on the height of plant at 30, 60, 90 and 120 days after planting (Table 1). The height of plant was maximum at the closest spacing of 30 x 20 cm and decreased gradually at wider spacing of 30 x 30 cm and 30 x 40 cm. As the plants begin to grow, there is competition for light and nutrients. Hence to have sufficient light, plants tend to grow taller under closer spacing. The results obtained are in agreement with those of Bhati and Chitkara (1987) in African marigold, Khanna *et al*. (1986) in carnation and Birade (1987) in aster.

Table 1. Mean plant growth, number of days required for initiation of flowering stalk, spike length, number of florets per spike and flower duration, on plant as influenced by different spacings and various levels of nitrogen.

Treatment	Plant height at 120 DAP	Plant spread at 120 DAP	Initiation of flowering stalk (days)	Spike length (cm)	Florets $spike^{-1}$	Flower duration on plant (days)
Spacing (cm) :						
S_1 (30 x 20)	124.67	43.08	24.58	20.17	5.67	9.83
S_2 (30 x 30)	121.83	45.75	27.42	23.00	6.50	13.50
S_3 (30 x 40)	115.33	48.58	29.58	26.33	9.25	15.92
S. E.±	0.59	0.35	0.32	0.39	0.23	0.22
C. D. at 5%	1.73	1.03	0.95	1.14	0.68	0.64
Nitrogen (kg ha^{-1}) :						
N_1 (75)	115.67	44.05	25.33	21.67	6.33	11.89
N_2 (100)	119.22	44.94	26.78	22.00	6.56	12.22
N_3 (125)	122.44	46.00	27.44	23.66	7.33	13.67
N_4 (150)	125.11	48.22	29.22	25.33	8.34	14.56
S. E.±	0.68	0.40	0.37	0.45	0.27	0.25
C. D. at 5%	1.99	1.19	1.09	1.31	0.79	0.73
Interaction :						
S. E.±	1.18	0.70	0.65	0.77	0.46	0.43
C. D. at 5%	3.46	NS	NS	NS	NS	NS

The results pertaining to the spread of the plant showed that an increase in planting distance resulted in corresponding increase in spread of plant. The spacing of 30 x 40 cm recorded the maximum spread plant value (48.58 cm). The results were similar to those recorded in calendula by Mili and Sable (2003), and Karavadia and Dhaduk (2002) in chrysanthemum, cv. Local White.

Different plant densities had significant effect on number of leaves. The dense spacing of 30 x 20 cm produced the lowest number of leaves at all the stages of growth. Similar results were obtained by Bijimol and Singh (2001) in gladiolus.

There was increase in leaf area with the increase in plant spacing. It might be due to competition of light and space for growth. The results are similar to the findings in chrysanthemum cv. Chandrama by Barman and Pal (1999).

Spacing significantly influenced the period requried for initiation of flowering stalk (Table 1). The spacing of 30 x 20 cm gave first emergence of flowering stalk followed by the spacing of 30 x 30 cm and 30 x 40 cm. The early flowering may be due to early maturity of the shoots. The results are similar to findings of Singh (1996) in tuberose.

The length of the flower stalk, number of florets spike^{-1} and flower duration on plant were significantly influenced by different spacings (Table 1). The spacing of 30 x 40 cm produced significantly maximum spike length, number of florets spike^{-1} and flower duration. The results are in close conformity with Singh and Bijimol (2002) in gladiolus and Alai (1992) in aster.

Spacing significantly influenced the number of spike plant^{-1} (Table 2). There were more number of spikes plant^{-1} in wider spacing. This might be the result of increased spread and less competition for nutrients. The spacing of 30 x 40 cm gave maximum number of spikes plant^{-1}. Findings in marigold cv. African Yellow by Mohanty *et al*. (1997) tallied with the above results.

The production of spikes per hectare was significantly influenced by the spacing. The highest number of spikes (482.42 thousand) were produced by spacing of 30 x 20 cm. The results are in conformity with those of Mokashi and Nalawadi (1993) in gaillardia, who observed that closer spacing gave maximum flower yield.

Spacing significantly affected the vase life of flowers of larkspur. The results of vase life studies of flower spikes indicated that vase life of flower increased with increase in spacing. The results are similar with the finding of Bijimol and Singh (2001) in gladiolus, that post harvest life of flowers were prolonged, as the

Table 2. Mean number of spikes per plant, number of spikes per hectare and vase life as influenced by different spacings and various levels of nitrogen.

Treatment	Spikes plant^{-1}	Spikes hectare^{-1} (000)	Vase life
Spacing (cm) :			
S_1 (30 x 20)	2.79	482.42	1.92
S_2 (30 x 30)	3.45	399.39	2.42
S_3 (30 x 40)	3.77	353.22	4.58
S. E.±	0.05	0.14	0.15
C. D. at 5%	0.17	0.39	0.44
Nitrogen (kg ha^{-1}) :			
N_1 (75)	2.78	324.02	2.22
N_2 (100)	3.12	405.65	2.78
N_3 (125)	3.56	432.60	3.11
N_4 (150)	3.87	485.09	3.78
S. E.±	0.06	0.16	0.17
C. D. at 5%	0.20	0.46	0.51
Interaction :			
S. E.±	0.11	0.27	0.30
C. D. at 5%	NS	0.79	NS

spacing were increased.

Nitrogen : Nitrogen application had significant effect on growth with respect to plant height (Table 1). The height of plant was increased significantly under the increasing levels of nitrogen at all the growth stages. The maximum height of the plant was recorded with 150 kg N ha^{-1}. The results obtained were in accordance with those of Hassan and Khatlab (1990) in *Delphinium gradiflorum* and Parthiban *et al*. (1992) in tuberose. That increase in nitrogen application increased the spread of the plant. The application of 150 kg N ha^{-1} gave the maximum spread (48.22 cm). The results are similar to those, reported by Anamika and Lavania (1990) in rose. The number of leaves and leaf area increased with increase in nitrogen dose. Leaf production was maximum under nitrogen at the rate of 150 kg N ha^{-1}. The results are in agreement with those of Pandey *et al*. (2000) in gladiolus. Application of nitrogen was found to be beneficial in flowering behaviour and flower characteristic of larkspur (Table 1). Flowering was significantly earlier due to the application of nitrogen at 75 kg ha^{-1} as compared to the higher levels of nitrogen. The results obtained from present investigation are in accordance with that of Singh *et al.* (1990) in chrysanthemum.

The spike length, number of florets $spike^{-1}$ and flower duration on plant were significantly highest with the application of 150 kg ha^{-1} as compared to the other levels (Table 1). These results are in accordance with Gowda *et al*. (1991) in tuberose, Mallick *et al*. (2001) in gladiolus and Kumar *et al*. (2003) in china aster.

Nitrogen had clear and significant effect on yield on number of spikes $plant^{-1}$ (Table 2). Number of spikes $plant^{-1}$ increased gradually with graded levels of nitrogen. Highest dose of nitrogen gave maximum number of spikes $plant^{-1}$. The results in present investigation are in accordance with those reported by Mili and Sable (2003) in calendula, Venugopal and Patil (2000) in ever lasting flower.

The production of spike per hectare was significantly influenced by increase in nitrogen level (Table 2). The nitrogen level of 150 kg N ha^{-1} gave the maximum number of spike per hectare (485.09 thousands) as compared to the other lower nitrogen levels. Similar findings were reported by Rao *et al*. (1992) in Chrysanthemum and Terengpi and Paswan (2003) in Gerbera.

The nitrogen dose of 150 kg N ha^{-1} gave significantly maximum vase life (3.78 days). The results tallied with the findings of Kumar and Misra (2003) in gladiolus and Terengpi and Paswan (2003) in gerbera who reported that with the increase in nitrogen level the vase life of flowers also increased.

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Combining Ability Studies in Bitter gourd (*Momordica charantia* L.)

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ABSTRACT

In studies on combining ability in 8 parental half dialles of bitter gourd the estimated values of SCA were higher than the GCA indicating predominance of dominant gene action for all the characters. The parent Phule Green Gold was observed to be the best general combiner with significant GCA effects for six characters of the eleven studied. The parents *viz*. Co White Long and Delhi Local were found to be the best combiner for yield contributing characters. The combination Phule Green Gold x DVBTG-5 appeared to be the best having significant SCA effects in desired direction for seven yield and yield contributing characters studied. The conbinations, Phule Green Gold x Delhi Local, Phule Green Gold x MC-84, Delhi Local x Co. White Long and MC-84 x Co. White Long also produced significant SCA effects for yield per vine and other yield contributing characters.

Key words : Combining ability, GCA, SCA, bitter gourd.

Bitter gourd (*Momordica charantia* L.) is one of the important vegetable crop grown throughout the country for its high nutritive value and medicinal properties. Wide range of variability in respect of vegetative and fruit character is available in India regarding this crop. However, little attention has been given for genetical improvement in bitter gourd. Bitter gourd, being a monoecious crop is highly cross pollinated crop known to offer good potentialities for increased yield. The present investigation was therefore, undertaken to study the GCA and SCA effects with a view to obtain the suitable combinations for yield and other quality attributes.

MATERIALS AND METHODS

The experiment was carried out at Vegetable Improvement Project, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.) during Summer and *kharif*, 2006. Eight genetically diverse inbreds of bitter gourd *viz*., Phule Green Gold (P_1), Delhi Local (P_2), MC-84 [Preethi] (P_3), DVBTG-5 (P_4), Co-White Long (P_5), DVBTG-7 (P_6), Hirkani (P_7) and NDBT-12 (P_8) were crossed in all possible combinations excluding reciprocals. The 28 F_1 hybrids along with eight parental lines were grown in a randomized block design and replicated thrice. The seeds of F_1 and parents were sown in rows of 1.5 metre apart with a spacing of 1.0 metre between the plants.

The observations were recorded on five plants for eleven economically important traits *viz*., days required to first female flower, node number of first female flower, days to first harvest, length of fruit, diameter of fruit, number of fruits vine^{-1}, average yield vine^{-1}, number of primary branches vine^{-1} and length of vine. Combining ability analysis was carried out by following Griffing (1956) Model-I, Model-II.

RESULTS AND DISCUSSION

Combining ability variances : The

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analysis of variance for combining ability showed significant differences for various characters in respect of general and specific combing ability indicating variation of the parents in their ability to combine with each other (Table. 1).

GCA : The parent Phule Green Gold was observed to be the best general combiner with significant general combining ability effects for six characters (length of main vine, number of primary branches, number of fruits vine^{-1}, average yield vine^{-1}, diameter of fruit and average weight of fruit) of the eleven studied (Table 2). The parents *viz*., Co. White Long and Delhi Local were found to be the best combiners for most of the yield contributing characters.

The parent Co. White Long exhibited significant general combining ability effects for node number to first female flower appeared, fruit length, fruit flesh thickness and average yield vine^{-1}. The parent Delhi Local exhibited significant GCA effects for length of vine and number of fruits per vine. Ranpise *et al*. (2001), Tiwari *et al*. (2001) and Sigh *et al*. (2004) have also provided list of good general combiners for various characters.

SCA : The combination DVBTG-5 x Hirkani recorded highest SCA effects and high

Table 1. Analysis of variance for combining ability.

Characters Source of variants		D.F.	Days required for frist female flower	Node no. of first female flower	Days to first harvest	Len- of to fruit (cm)	Dia- meter of fruit (cm)	Fruit flesh thick- ness (mm)	Av. wt. of fruit (g)	No. of fruits vine^{-1}	Av. yield vine^{-1} (kg)	No. of primary bran- ches vine^{-1}	Length of vine (cm)
GCA	M.S.S.	7	2.31	2.14	1.93	25.38	0.084	0.33	157.76	64.70	1.03	1.54	485.54
	F		2.79*	3.86*	1.78	30.07**	3.35*	6.70**	20.59**	8.07**	24.04**	5.61**	3.55*
SCA	M.S.S.	28	10.93	5.22	11.34	3.73	0.047	0.38	42.09	48.62	0.39	0.94	974.76
	F		13.15**	9.41**	10.41**	4.42**	1.88*	7.70**	5.49**	6.06**	9.18**	3.44**	7.14**
Errors	M.S.S.	70	0.83	0.55	1.08	0.84	0.025	0.05	7.66	8.01	0.04	0.27	136.44

Table 2. Estimation of general combining ability effects of parents in bitter gourd.

Parents	Days required for frist female flower	Nodel no. of first female flower	Days to first harvest	Length of fruit (cm)	Dia- meter of fruit (cm)	Fruit flesh thick- ness (mm)	Av. wt. of fruit (g)	No. of fruits vine^{-1}	Av. yield vine^{-1} (kg)	No. of primary bran- ches vine^{-1}	Length of vine (cm)
P_1	-0.476	0.167	-0.455	1.081**	0.143*	0.016	4.714**	3.747**	0.481**	0.687**	8.750
P_2	0.617	-0.328	0.367	0.136	-0.021	-0.046	-0.751	3.355**	0.141	0.178	6.017
P_3	0.244	0.003	0.530	-1.826	0.074	0.23*	2.084*	-0.757	0.073	-0.253	-8.283
P_4	0.174	-0.251	-0.007	-0.687	-0.091	-0.16	-1.864	0.635	-0.123	-0.197	-3.917
P_5	0.079	-0.781*	0.179	2.912**	-0.100	0.291**	5.005**	0.211	0.277**	0.209	-5.950
P_6	0.436	0.771*	0.127	-1.569	0.002	-0.109	-1.753	0.042	-0.095	0.165	-6.283
P_7	-0.814*	0.128	-0.825	-0.981	0.096	-0.091	-0.248	-2.207*	-0.0169	-0.599**	8.117
P_8	-0.259	0.291	0.082	0.935*	-0.091	-0.276**	-7.187**	-3.756**	-0.585**	-0.198	1.550
S. E.$\pm$	0.407	0.333	0.466	0.410	0.071	0.100	1.237	1.266	0.092	0.234	5.220
C. D. 5%	0.812	0.664	0.930	0.819	0.141	0.200	2.468	2.525	0.185	0.467	10.38
C. D. 1%	1.078	0.882	1.234	1.080	0.188	0.265	3.278	3.354	0.243	0.609	13.83

per se performance (Table 3) for days to first female flower and days to first harvest. These results are in conformity with the results of Khattra *et al*. (2000) and Ranpise *et al*. (2001).

The combination Phule Green Gold x DVBTG-5 recorded significant SCA effect and high *per se* performance (Table 3) for length of fruit, average weight, number of fruits vine^{-1} and average yield vine^{-1}, days to first female flower, node number to first female flowery and fruit flesh thickness. Lawande and Patil (1990) and Tiwari *et al*. (2001) reported similar results. The other hybrid combinations, Phule Green Gold x Delhi Local, Phule Green Gold x MC-84, Delhi Local x Co. White Long and MC-84 x Co. White Long also exhibited significant and desired SCA effects for more than four characters including yield vine^{-1}. The combination Phule Green Gold x Delhi Local

Table 3. Estimates of specific combining ability effects of hybrids in bitter gourd.

Hybrid	Days required for first female flower	Node no. of first female flower	Days to first harvest	Length of fruit (cm)	Diameter of fruit (cm)	Fruit flesh thickness (mm)	Av. wt. of fruit (g)	No. of fruits vine^{-1}	Av. yield vine^{-1} (kg)	No. of primary branches vine^{-1}	Length of vine (cm)
P_1 x P_2	-2.48*	-1.225	-2.37**	1.54	0.22	0.20	3.46	2.12	0.37	1.76**	32.17*
P_1 x P_3	-1.85	-2.18**	-1.17	0.16	0.005	0.028	-2.41	9.01**	0.44*	0.86	35.14**
P_1 x P_4	-2.17*	-1.66*	-1.14	2.65**	-0.07	0.52*	10.22**	11.77**	1.38**	0.015	15.44
P_1 x P_5	0.68	-0.20	0.73	1.08	-0.028	0.026	-2.51	2.14	0.005	-0.078	18.41
P_1 x P_6	1.82	1.60	3.02**	-1.066	-0.19	0.38	6.92**	-0.35	0.33	-1.12*	-29.18**
P_1 x P_7	-3.29**	0.23	-2.14	-2.38*	0.23	0.11	-11.29**	4.70	-0.34	-0.29	-15.92
P_1 x P_8	2.57*	-1.84*	1.95	-0.85	0.16	0.21	4.04	-1.80	0.051	-1.39*	-26.02*
P_2 x P_3	0.46	3.15**	0.65	-1.14	-0.31	-0.21	3.50	-0.92	0.13	-0.029	10.87
P_2 x P_4	2.79**	2.76**	3.02**	0.45	-0.33*	0.69**	0.34	0.73	0.052	0.16	10.874
P_2 x P_5	1.26	1.43	-2.06	0.92	0.25	1.15**	12.17**	2.16	0.85**	0.32	27.54*
P_2 x P_6	-1.86	-1.10	-0.68	-1.03	-0.04	1.11**	-9.02**	9.26**	-0.049	1.37*	11.87
P_2 x P_7	4.89**	-3.54**	4.91**	0.07	0.024	-0.036	-8.33**	0.47	-0.40	-0.85	-9.18
P_2 x P_8	1.14	2.36**	2.87*	2.26*	0.094	0.79**	4.84	4.93	0.53*	0.26	-17.28
P_3 x P_4	2.00*	0.49	1.88	-0.80	0.13	0.09	-4.86	2.99	-0.14	1.035	10.81
P_3 x P_5	1.09	1.62*	1.04	-0.03	-0.17	0.67**	2.06	10.80**	0.82**	0.74	22.84
P_3 x P_6	1.58	-1.27	3.16**	0.70	-0.02	0.41	5.17	6.18*	0.66**	0.01	-1.82
P_3 x P_7	-6.30**	-4.50**	-5.84**	1.85	0.09	-0.098	4..13	0.92	0.24	0.57	42.77**
P_3 x P_8	1.25	-0.33	0.92	-0.46	0.01	0.24	8.61**	2.68	0.56*	-0.01	-10.98
P_4 x P_5	3.31**	1.92*	4.29**	-5.77**	0.10	-0.13	-2.72	-1.10	-0.23	-0.21	-71.18**
P_4 x P_6	0.92	-0.90	1.92	1.01	0.34*	0.10	0.015	-3.45	-0.21	0.17	14.81
P_4 x P_7	-8.40**	-0.36	-9.48**	-2.51*	0.06	0.29	6.40*	-0.28	0.29	0.19	-2.25
P_4 x P_8	-0.51	-0.75	-0.40	1.49	0.35*	0.67**	2.25	-2.53	-0.038	0.82	6.64
P_5 x P_6	-6.37**	-4.73**	-5.70**	2.85**	0.33*	0.18	2.38	4.26	0.37	0.90	7.15
P_5 x P_7	3.90**	2.61**	2.99*	-0.88	0.11	-0.026	-2.93	-2.82	-0.34	-0.58	-16.88
P_5 x P_8	-1.02	-0.89	0.37	1.97	-0.23	-0.10	-4.38	-6.68*	-0.62**	1.91**	59.67**
P_6 x P_7	3.80**	1.49	2.76*	-0.81	-0.11	0.067	-0.97	-6.77**	-0.41	0.27	10.11
P_6 x P_8	-0.71	-1.29	-1.42	-1.90	-0.28	-1.016**	-0.94	-8.41**	-0.47*	-0.93	-54.90**
P_7 x P_8	0.69	0.79	1.47	-0.02	-0.34*	-1.290**	-6.42*	-0.77	-0.30	-0.21	-7.38
S. E.±	0.99	0.81	1.14	1.00	0.17	0.24	3.03	3.10	0.22	0.57	12.57
C.D. at 5%	1.97	1.61	2.26	1.99	0.33	0.47	6.02	6.16	0.43	1.14	25.27

produced significant SCA effects for days to first female flower, days to first harvest, number of primary branches and length of vine. Likewise Phule Green Gold x MC-84 has also produced significant SCA effect for days to first female flower, node number of first female flower, number of fruits vine^{-1}, average yield vine^{-1} and length of vine.

The combination Delhi Local x Co. White Long produced significant SCA effects for fruit flesh thickness, average weight, average yield vine^{-1} and length of vine. The hybrid MC-84 x Co. White Long produced significant effect for fruit flesh thickness, number of fruits vine^{-1} and average yield vine^{-1}. These results are in conformity with the results of Ram *et al.* (1994) and Ranpise *et al*. (2001).

The combinations *viz*., P_1 x P_4, P_1 x P_2, P_1 x P_3, P_2 x P_5 and P_3 x P_5 producing significant and desirable SCA effects for yield vine^{-1}, fruits vine^{-1} and average fruit weight had high *per se* performance. The same was true for the crosses producing significant undesirable SCA effects, indicating the close association between SCA effects and mean performance of these characters.

Considering the overall performance in respect of economic characters, it could be concluded that hybrid P_1 x P_4, P_3 x P_5, P_1 x P_3 and P_1 x P_2 were superior for yield vine^{-1}, number of fruits vine^{-1}, fruit flesh thickness and average fruit weight, while P_1 x P_4 and P_2 x P_5 were superior for average fruit weight and yield vine^{-1}. From above discussion the parents Phule Green Gold, Co. White Long and Delhi Local were best parents, whereas hybrids Phule Green Gold x DVBTG-5, MC-84 x Co. White Long, Phule Green Gold x MC-84, Phule Green Gold x Delhi Local and Delhi Local x Co. White Long were found most promising combinations.

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Studies on Genetic Diversity in Pea (*Pisum sativum* L.)*

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ABSTRACT

Fifty germplasm lines were grouped into 20 clusters. The D^2 statistics showed adequate diversity among the genotypes with D^2 values ranging from 8.83 to 1510.31. Based on D^2 values and cluster mean performance following parents have been selected for hybridization programme in order to obtain better recombinants IC-356172, IC-267142, IC-212393, IC-208368, IC-243334, IC-3 10834, IC-356144, IC-356272, IC-356332, EC-412882, EC-412883, IC-267155 and IC-3 10833. Geographic diversity is not correlated with genotypic diversity.

Key words : Genetic diversity, pea.

Classification of germplasm collection is a prerequisite for distinguishing genetically close and divergent types for various plant breeding programmes. By using advanced biometric techniques, such as multivariate analysis based on Mahalanobis's D^2 statistics, it has now become possible to quantify the degree of divergence amongst biological population and assessing of relative contribution of various desirable attributes of breeding and agronomic value to the total divergence at both intra and inter cluster level. It also helps to identify the suitable genotypes for hybridization programme on the basis of their clustering pattern.

MATERIALS AND METHODS

The 50 germplasms of pea were studied during *rabi* season (October - February) of 2005-06, in a randomized block design with three replications, each entry was represented by single line, spaced at 45 cm between rows and 15 cm within row. Observations were

Table 1. Distribution of 50 genotypes into different clusters.

Cluster number	No. of genotypes included	Genotypes
I	6	EC-398611, IC-208384, IC-268254, IC-332118, IC-356274, IC-356373
II	5	EC-389374, IC-20167, IC-242725, IC-242733, IC-267151
III	5	IC-243334, IC-310834, IC-356144, IC-356272, IC-356332
IV	4	EC-412882, EC-412883, IC-267155, IC-310833
V	4	IC-267182, IC-268275, IC-268276, IC-2996677
VI	3	EC-381897, EC-384890, IC-356378
VII	3	IC-267127, IC-356310, IC-356337
VIII	2	EC-385247, EC-387113
IX	2	EC-398604, IC-267169
X	2	IC-27912, IC-356147
XI	2	EC-341782, IC-208391
XII	2	IC-332113, IC-347185
XIII	2	IC-356268, IC-381861
XIV	2	EC-381866, IC-267161
XV	1	EC-384139
XVI	1	EC-398612
XVII	1	IC-208368
XVIII	1	IC-2123933
XIX	1	IC-267142
XX	1	IC-356172

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recorded on five randomly selected plants from each germplasm line. The observations were recorded on seed yield plant^{-1}, days to flowering and maturity, plant height at harvest, number of branches and pods plant^{-1}, pod length, number of seeds pod^{-1} and weight of 100 seeds. The genetic divergence was assessed using Mahalanobis's (1936) D^2 statistics. The germplasms were grouped according to the method described by Tocher (Rao, 1952).

RESULTS AND DISCUSSION

The D^2 values among 50 germplasm lines ranged between 8.83 to 1510.31. The vast difference in D^2 value indicated good amount of variation for 9 different characters studied among the genotypes. The genotypes EC-

Table 2. Average intra (diagonal) and inter (above diagonal) cluster D^2 values in 20 clusters of 50 genotypes of pea.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1	**51.21**	208.26	164.15	152.24	84.33	135.62	91.07	431.67	237.31	72.59
C2		**38.15**	613.80	364.97	353.49	120.48	401.93	935.86	729.99	81.40
C3			**34.39**	250.89	90.25	431.05	81.32	306.26	97.81	312.44
C4				**43.33**	232.39	129.52	155.26	173.27	215.96	215.99
C5					**45.58**	274.70	91.77	472.21	180.23	143.54
C6						**33.00**	239.03	496.22	417.79	94.71
C7							**26.65**	289.31	130.99	178.04
C8								**10.40**	190.86	639.83
C9									**26.58**	419.83
C10										**45.48**

Table 2. Contd.

	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20
C1	172.83	247.71	137.77	632.23	258.74	271.22	145.15	96.77	401.22	194.22
C2	478.77	729.47	517.11	1215.38	100.05	643.52	114.22	179.19	1016.93	615.01
C3	216.09	94.66	105.43	428.08	664.97	145.19	463.25	254.37	175.24	67.78
C4	85.99	172.03	121.83	297.75	260.76	67.73	254.43	369.14	314.14	239.80
C5	239.05	208.55	143.75	619.45	434.56	320.40	272.59	101.00	349.93	102.25
C6	190.60	449.20	266.85	708.03	65.21	189.60	63.89	255.63	608.24	401.67
C7	128.11	151.48	112.31	475.56	401.41	196.38	261.20	182.87	211.40	80.30
C8	150.24	129.78	181.83	67.01	750.88	42.34	673.51	793.88	147.85	319.23
C9	117.25	123.80	62.27	276.46	684.17	161.11	445.18	432.46	62.17	93.38
C10	287.52	422.57	280.60	870.13	141.86	410.37	94.8	69.24	644.34	312.99
C11	**48.24**	191.91	77.68	306.05	392.40	83.65	255.43	400.67	190.42	222.08
C12		**48.92**	106.43	192.82	686.24	109.85	583.95	455.33	152.67	132.10
C13			**51.67**	296.38	494.73	116.69	314.18	327.20	144.31	142.97
C14				**52.24**	978.36	115.16	936.90	1046.43	221.11	402.58
C15					**0.00**	478.90	96.76	351.29	891.26	573.87
C16						**0.00**	446.56	572.62	184.83	227.81
C17							**0.00**	207.89	648.48	419.85
C18								**0.00**	676.97	299.27
C19									**0.00**	157.55
C20										**0.00**

381866 and IC-242733 recorded maximum D^2 value (1510.31) and genotypes IC-242725 and IC-267151 recorded minimum D^2 value (8.83), suggesting distant and close relationship among these genotypes respectively.

The 50 germplasm lines (Table 1) were grouped into 20 different clusters. Cluster-I was largest with 6 genotypes followed by cluster-II and III with 5 genotypes each; cluster IV and V with 4 genotypes each; cluster VI and VII with 3 genotypes each, cluster VIII, IX, X, XI, XII, XIII and IX with 2 genotypes each and clusters XV, XVI, XVII, XVIII, XIX and XX were monogenotypic.

Looking to the distribution of 50 genotypes into 20 clusters, it was observed that the various indigenous and exotic lines were grouped in the same clusters indicating the fact that, indigenous and exotic lines may have close relationship genetically. These results coincide with those obtained by Chandel and Joshi (1981), Dhobal and Ram (1985), Singh and Tripathi (1985) and Dixit *et al*. (2002).

The maximum intracluster distance (Table 2) was observed for the genotypes falling in cluster XIV (D^2 = 52.24) followed by XIII (D^2 = 51.67) and I (D^2 = 51.21). This implies that the cluster XIV, XIII and I have the genotypes with varied genetic architecture. Genotypes falling between cluster II and XIV exhibited maximum inter cluster distance (D^2 = 1215.38), indicating, genetic make up of genotypes falling in this clusters may be entirely different from one another.

Based on the mean performance of various clusters for 9 different characters, it is observed that genotypes in cluster XIX and XX appears better for number of branches per plant, number of pods per plant, pod length, number of seeds pod^{-1} and seed yield $plant^{-1}$.

Like wise, cluster XVIII for earliness and number of pods $plant^{-1}$, cluster III and V for number of branches $plant^{-1}$ and number of pods $plant^{-1}$; cluster VIII and XVII for pod length and number of seeds pod^{-1} recorded highest mean performance for respective characters.

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Genetic Diversity Studies in Linseed (*Linum usitatissimum* L.)

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ABSTRACT

Higher inter-cluster distance was noticed between cluster VII and cluster XIV and cluster V exhibited more intra-cluster distance. The genotypes in cluster IX showed highest cluster mean values for 1000 seed weight, harvest index and seed yield plant^{-1}. Therefore, crosses can be effected between the genotypes of cluster IX with genotypes of cluster VII and XIV which are distantly related, possess a wide spectrum of variability for different characters. Among the ten characters studied, the most important character contributing to the divergence was days to maturity followed by plant height, capsules plant^{-1}, days to flowering and harvest index.

Key words : Cluster, diversity, linseed.

Diverse germplasm is of vital importance in breeding and improvement of any crop. Genetic improvement in yield and quality is possible only if there exists enough genetic variability which obviously reflects that the phenotype of a individual have a sound base for selection. Apart from it the knowledge of most heritable traits, correlation, direct and indirect effects are also helpful for increasing the yield. The more diverse parent within over all limits of fitness, the greater are the chances of heterotic response in F_1 and throwing up a broad spectrum of variability in segregation (Anand and Murthy, 1968).

MATERIALS AND METHODS

Sixty five genotypes of linseed representing a rich source of diversity were obtained from plant scientist (oilseed), Regional Agricultural Research Station, Raichur of University of Agricultural Sciences, Dharwad during rabi 2005. The experiment was laid out in a randomized block design with three replications. Each experimental plot consisted of five meter long rows and each genotype was sown in a single row leaving 30 cm between the rows. Data on ten characters were recorded from 5 plants per replication and the average was taken for analysis. Observations were recorded on days to flowering, plant height, number of branches plant^{-1}, number of capsules plant^{-1}, number of seeds capsules^{-1}, 1000 seed weight(g), harvest index(%), days to maturity, oil content(%) and seed yield plant^{-1} (g).

The genetic divergence among genotypes was computed by means of Mahalanobi's D^2 technique and genotypes were clustered by means of following Tocher's method as described by Rao (1952). The statistical analysis was carried out using computer software SPAR (Indian Agricultural Research Institute, Delhi) and Indostat (Indostat services, Hyderabad).

RESULTS AND DISCUSSION

The analysis of variance revealed highly significant difference for the characters studied

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among the genotypes. Based on D^2 values 65 genotypes were grouped into fourteen clusters (Table 1) indicating the presence of appreciable amount of diversity among the genotypes. The maximum number of genotypes (29) were grouped into cluster-I, followed by cluster II with eleven genotypes, cluster III with 6 genotypes, cluster V with 5 genotypes and 3 each of genotypes were grouped in cluster VI and cluster VIII. The remaining clusters (IV, VII and from IX to XIV) were all solitary. The intra - cluster D^2 values (Table 2) ranged from 7.077 to 8.444. The average inter cluster distance between the members of cluster V was maximum followed by cluster III, II, VI, I and VIII in the reducing order suggesting that genotypes in cluster V were relatively more diverse than genotypes in the above selected clusters. The maximum amount of heterosis may be expected in cross combination involving the parents belonging to the most divergent cluster. In the present study, the inter cluster D^2 values ranged widely with minimum value of 5.11 and maximum value of 37.32 (Table 2). Cluster VII and XIV were strikingly diverse from rest of the clusters. The divergence between these two clusters was high as evident from their high inter clusters may generate wider variability and is expected to throw high yielding transgressesive segregants in a population improvement programme. The minimum inter cluster D^2 value (5.11) was observed between cluster VII and IV, indicating close genetic relationship between genotypes of these two clusters. Among the ten characters studied, the most important character contributing to the divergence was days to maturity followed by plant height, capsules plant^{-1}, days to flowering and harvest index. While low contribution was from oil content. These observations are also in accordance with earlier workers for days to maturity (Haque *et al*. 1994, Mahto and Singh ,1996 and Mahto and Verma,1998), for plant height and number of capsules per plant (Mahto and Singh, 1996 and Mahto and Verma,1998), for days to flowering and plant height (Asthana and Pandey, 1980), for capsules plant^{-1} and days to flowering (Verma,1996), for plant height (Chandra, 1977), for number of capsules plant^{-1} (Mahto, 1990).The above results imply that, in order to select genetically diverse genotypes for hybridization the material should be screened for important traits like days to maturity, plant height, capsules plant^{-1}, days to flowering, harvest index and oil content.

Table 1. Composition of linseed genotypes in different clusters.

Cluster	No. of genotypes	Name of genotypes
I	29	PKDL-42, RLC-101, LMS-153-03, LMS-153-04, Padmini-1, RLC-93, NL-97, RLC-106, SLS-62, RLC-101,Sweta, JLS-9, PKDL-21, RLC-102, PKDL-41, RLC-99, RLC-88, SLS-63, RLC-81, RLC-89, PKDL-44, NL-165, SLS-66, RLC-94, JLT-118, Padmini, Kiran, PKDL-46, PKDL-47
II	11	LCK-4012, LCK-4036, RLC-96, PCL-2001, NDL-2004-1, R-552, OLC-38, LMS-166-03, Garima, LC-2246, J-23
III	6	SLS-38, SLS-34, SLS-37, NL-155, LMS-92K, T-397
IV	1	LMS-4-27
V	5	SLS-39, LCK-4004, LC-2221, JLT-119, SLS-65
VI	3	RL-24106, RL-24109, Sheela
VII	1	SLS-60
VIII	3	Shubra, Parvati, LCK-4028
IX	1	SLS-64
X	1	Shekar
XI	1	T-397-1
XII	1	RL-2206
XIII	1	RL-2202
XIV	1	LC-54

Analysis of cluster means (Table 3) indicated substantial variation among the fourteen clusters grouped according to D^2 analysis. Based on the range of means it is possible to

Table 2. Average inter-cluster (above diagonal) and intra-cluster (diagonal) D^2 and D values for 14 clusters in linseed.

Cluster number		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	D^2	7.39	13.49	12.73	11.12	11.72	23.05	12.70	17.48	12.77	18.32	12.11	23.64	26.38	27.02
	D	2.72	3.67	3.57	3.34	3.42	4.80	3.56	4.18	3.57	4.28	3.48	4.86	5.14	5.20
II	D^2		7.53	20.68	21.71	15.53	14.10	23.12	11.86	17.61	12.17	21.09	14.22	18.53	18.92
	D		2.74	4.55	4.66	3.94	3.75	4.81	3.44	4.20	3.49	4.59	3.77	4.30	4.35
III	D^2			7.61	10.47	13.11	27.95	13.23	21.22	18.82	25.78	13.85	28.62	28.97	29.33
	D			2.76	3.24	3.62	5.29	3.64	4.61	4.34	5.08	3.63	5.35	5.38	5.42
IV	D^2				0.00	15.27	31.30	5.11	25.01	14.93	26.05	9.10	32.09	34.28	34.99
	D				0.00	3.91	5.59	2.26	5.00	3.86	5.10	3.02	5.66	5.85	5.91
V	D^2					8.44	24.20	15.94	13.93	12.82	17.58	12.78	22.16	22.43	25.44
	D					2.91	4.92	3.99	3.73	3.58	4.19	3.57	4.71	4.74	5.04
VI	D^2						7.49	33.85	15.07	29.09	19.55	31.10	9.58	14.89	11.33
	D						2.74	5.82	3.88	5.39	4.42	5.65	3.10	3.86	3.37
VII	D^2							0.00	26.48	13.75	26.48	7.27	34.09	36.02	34.32
	D							0.00	5.15	3.71	5.15	2.70	5.84	6.00	6.11
VIII	D^2								7.08	19.94	13.59	23.16	10.78	11.38	15.47
	D								2.66	4.47	3.69	4.81	3.28	3.37	3.93
IX	D^2									0.00	15.43	9.92	26.83	29.11	32.69
	D									0.00	3.93	3.15	5.18	5.40	5.72
X	D^2										0.00	22.02	15.89	18.53	22.53
	D										0.00	4.69	3.99	4.31	4.48
XI	D^2											0.00	31.18	32.01	34.36
	D											0.00	5.58	5.66	5.86
XII	D^2												0.00	9.35	12.08
	D												0.00	3.05	3.48
XIII	D^2													0.00	9.37
	D													0.00	3.06
XIV	D^2														0.00
	D														0.00

know the characters influencing divergence. In the present study clusters III, IV, Vll and XI had early flowering genotypes. Whereas, clusters I, II, V, VI, VIII, IX, X, XII, XIII and XIV had late flowering genotypes. The genotypes present in clusters I, II, IV, VIII, IX, X, and XI could be regarded as the source for dwarf types and clusters III, V, VI, VIII, XII, XIII and XIV had tall types. The result indicated the amount of diversity available in the genotypes. The clusters I, II, III, IV, VI, VII and XI included the genotypes with less number of branches plant^{-1} and remaining clusters had more number of branches plant^{-1}. More number of capsules were observed in clusters II, V, VII, VIII, IX, X, XI, XII, XIII and XIV. The clusters I, III, IV and VI had less number of capsules. Number of seeds capsule^{-1} were more in clusters I, II, IV, V, VIII, XI, XII and XIII and medium in cluster I, III, VI, VII, IX, X and XIV these clusters. Thousand seed weight was maximum in clusters V, VIII, X and XII, low in cluster XIV and moderate in clusters I, II, III, IV, VI, VII, XI and XIII. It can be observed that cluster XIV had low harvest index and in other clusters the harvest index was high. The genotypes present in clusters II, IV,

Table 3. Cluster mean values for 10 characters in linseed.

Cluster	Days to flowering	Plant height (cm)	Number of branches plant^{-1}	Number of capsules plant^{-1}	Number of seeds capsule^{-1}	1000 seed weight (g)	Harvest index (%)	Days to maturity	Oil content (%)	Seed yield plant^{-1} (g)
I	36.29	33.21	3.69	20.65	8.26	5.80	30.38	108.15	39.56	1.06
II	44.05	54.57	4.10	22.51	8.40	5.74	30.66	112.70	40.01	1.02
III	31.51	41.54	4.29	19.83	8.10	5.62	29.30	100.27	41.56	0.97
IV	30.00	33.15	3.33	18.53	7.86	5.89	31.33	98.00	41.85	1.00
V	36.37	40.02	4.88	26.82	8.44	6.35	32.93	103.86	39.80	1.31
VI	48.86	41.37	3.51	18.73	7.97	5.64	29.68	121.11	41.00	0.98
VII	30.00	30.92	3.87	21.40	7.80	5.95	31.60	95.67	39.20	1.13
VIII	43.68	42.69	4.75	27.22	8.80	6.60	34.73	113.33	39.74	1.50
IX	35.53	28.73	5.00	29.53	7.60	7.00	36.02	103.00	41.76	1.72
X	43.73	31.60	4.86	32.33	7.33	6.82	33.03	115.00	43.05	1.58
XI	30.00	32.33	3.86	27.40	8.53	5.66	30.66	99.00	40.70	0.94
XII	47.66	42.25	5.33	24.53	8.73	6.80	35.21	122.00	40.46	1.58
XIII	47.00	48.66	5.40	30.33	8.46	5.97	32.30	120.33	40.56	1.23
XIV	50.00	43.43	4.93	24.06	7.46	4.89	26.30	120.33	41.10	0.72

VII and XI could be regarded as the source of earliness and clusters I, II, V, VI. VIII, IX, X, XII, XIII and XIV had late maturing types. Moderate oil content was observed in cluster I, V, VII and VIII. While high oil content was evident in remaining clusters. Seed yield per plant was found to be high in clusters V, VIII, IX, X, XII, XIII and low in I, II, III, IV, VI, XI and XIV clusters. So hybridization between genotypes of divergent clusters will lead to the accumulation of favorable genes in a single variety and also it is suggested to create variability for developing the varieties involving a large number of divergent lines instead of closely related ones (Bergale *et al*. 2001).

In the present investigation it was observed that the genotypes in cluster IX can be chosen for hybridization programme, as it recorded highest cluster mean values for 1000 seed weight, harvest index and seed yield plant^{-1}. However, for earliness genotypes from cluster IX, VII and XI and for seeds capsule^{-1} genotypes from VIII may be included in hybridization programme. The genotype from cluster X was included for breeding programme as it recorded higher mean values for capsules plant^{-1} and oil content. The genotype from solitary cluster XIV which had highest number of days to flowering and plant height can also be considered as parent in crossing programme. It is suggested that the crosses should be effected among the genotypes of above said clusters for improving more than one economic character to develop potential segregants and future selection needs to be made to develop high yielding cultivars of linseed.

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Combining Ability Studies in Chilli (*Capsicum annuum* L.)*

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ABSTRACT

Combining ability analysis of a 6 x 6 half diallel set of crosses in chilli for ten characters revealed predominance of non - additive gene action for all the characters except fruit length. Among the parents, Phule Jyoti and G - 4 were the best general combiners for dry fruit yield plant^{-1}, plant height and plant spread. The parents. Jayanti and Arka Lohit for days to 50 per cent flowering and days to maturity respectively, while parent Phule Suryamukhi for number of secondary branches plant^{-1} were found the best general combiners. The cross Jayanti x G - 4 had highest SCA effects for dry fruit yield plant^{-1} followed by Phule Jyoti x Arka Lohit and Phule Jyoti x Phule Suryamukhi exhibiting importance of both additive and non additive gene effects for genetic improvement.

Key words : Combining ability, diallel, additive and nonadditive, GCA, SCA.

Considerable amount of variability is present in chilli for the traits plant height and number of fruits plant^{-1} (Varalakshmi and Haribabu, 1991), but the productivity is very less. Considering these, six cultivars of chilli were used to study the combining ability for various characters to know the relative proportion of additive and nonadditive genetic variance involved in the inheritance of different traits as well as deciding the appropriate breeding methods for effective exploitation of available genetic variation.

MATERIALS AND METHODS

The experimental material comprised of six parents of chilli *viz*. Phule Jyoti, Jayanti, Arka Lohit, Phule Suryamukhi, G-4 and Surakta and their resulting 15 F_1s in a diallel without reciprocals along with one check, Phule Sai

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were evaluated in a randomized block design with three replications during *kharif*, 2003 at Botany farm, College of Agriculture, Pune.

Each entry was represented by single row of 4.5 m length spaced at 60 cm between row's and 45 cm within plants. Recommended agronomical package of practices were followed before and after transplanting. The fertilizer dose was applied @ of 75:120: 60 kg NPK ha^{-1}. Regular plant protection measures were undertaken to protect the crop and other cultural operations like weeding and hoeing were carried out as per the requirements. The observations were recorded on five randomly selected competitive plants for each genotype per replication for ten traits *viz.*, days to 50 per cent flowering, days to maturity, number of primary branches $plant^{-1}$, number of secondary branches $plant^{-1}$, plant height, plant spread, length of fruits, fruit girth, number of fruits $plant^{-1}$ and dry fruit weight $plant^{-1}$. The statistical analysis for combining ability was done as per method II and model I of Griffing (1956).

RESULTS AND DISCUSSION

The analysis of variance for combining ability (Table 1) revealed that the variances due to general combining ability (GCA) were highly significant for all the characters except fruit length. The variance due to specific combining ability (SCA) were highly significant for all the characters except primary branches $plant^{-1}$ and fruit length. This indicated that both additive and non additive type of gene action were involved in the expression of these characters. The components of variance due to GCA effects were higher than the corresponding components due to SCA effects except plant spread, suggesting predominance of additive type of gene action. These findings were in agreement with Singh and Rai (1986), Jagdeesh (1995) and Patil (1997).

Additive/dominance ratio was less than unity for number of primary branches $plant^{-1}$, plant height, plant spread, number of fruits $plant^{-1}$ and dry fruit weight $plant^{-1}$ indicating preponderance of dominance gene action. Singh and Rai (1986) and Bhagyalaxmi *et al*. (1991) reported the similar results.

The estimates of GCA effects (Table 2) revealed that the parent Phule Jyoti and G-4 was the best general combiners for plant height, fruit girth and dry fruit weight $plant^{-1}$. In addition, parent Jayanti was identified as next

Table 1. Analysis of variance for combining ability and components of variance for different characters in 6 x 6 half diallel of chilli.

Source of variation	GCA	SCA	6^2A	6^2D	h^2 (NS)	A/D
d. f.	05	14	40			
Days to 50% flowering	14.506**	3.655**	2.712	2.584	0.426	1.049
Days to maturity	16.225**	12.529**	0.923	10.568	0.068	8.742
Primary branches $plant^{-1}$	2.635*	0.147	-3.027	0.088	-0.258	-0.314
Secondary branches $plant^{-1}$	6.151**	4.533**	0.404	3.197	0.081	0.126
Plant height (cm)	26.528**	17.592**	2.233	13.870	0.112	0.161
Plant spread (cm)	2.531*	5.158**	-0.656	2.396	-0.145	-3.274
Fruit leangth (cm)	1.170	0.724	0.111	0.478	0.133	0.232
Fruit girth (cm)	8.901**	3.182**	1.429	9.749	0.309	1.146
Fruits $plant^{-1}$	121.025**	80.665**	10.089	34.101	0.111	0.295
Dry fruits weight $plant^{-1}$ (g)	184.912**	200.680**	-3.941	179.134	-0.020	-2.200

*,** denotes significance at 5 and 1 per cent level respectively.

Table 2. Estimates of general combining ability effects for different characters in 6 x 6 half diallel of chilli.

Parents	Days to 50 % flowering	Days to maturity	Primary branches plant^{-1}	Secondary branches plant^{-1}	Plant height (cm)	Plant spread (cm)	Fruit length (cm)	Fruit girth (cm)	Fruits plant^{-1}	Dry fruits weight plant^{-1} (g)
Phule Jyoti (P_1)	0.458	2.000**	0.028	-0.189	1.581*	1.111	0.220	0.103*	-0.674	3.156*
Jayanti (P_2)	-2.000**	-1.375**	0.037	-1.022*	-1.627**	-0.379	0.323*	0.001	3.436	2.755
Arka Lohit (P_3)	-0.875**	-1.042*	-0.003	-0.519	0.518	-0.323	0.104	0.087	2.446	-3.643*
Phule Suryamukhi (P_4)	2.000**	1.542**	-0.097	1.561*	-2.836	-0.319	-0.630**	-0.020	-6.026	-1.204
G-4 (P_5)	0.167	-0.833	-0.030	0.232	1.585*	-0.216	0.284	-0.192**	3.630	5.899*
Surakta (P_6)	0.250	-0.292	0.064	-0.063	0.779	0.034	-0.301	0.020	-2.812	-6.964**
S. E.±	0.333	0.451	0.078	0.373	0.622	0.536	0.160	0.047	2.202	1.498
C. D. at 5%	0.674	0.913	0.157	0.754	1.258	1.084	0.323	0.096	4.450	3.027
C. D. at 1%	0.857	1.161	0.200	0.964	1.602	1.380	0.412	0.121	5.672	3.858

*,** denotes significance at 5 and 1 per cent level respectively.

best general combiner for days to 50 per cent flowering, days to maturity and fruit length. The findings of Jadhav *et al.* (2002) for plant height, Gandhi *et al*. (2001) for fruit girth and Nandadevi *et al*. (2003) were also in agreement with the above results. Likewise parent Arka Lohit and Phule Suryamukhi exhibited highest and significant GCA effect in desirable direction and found best general combiner for days to 50 per cent flowering and for days to maturity, respectively.

The comparison of GCA effects of parents indicated that none of the parents showed significant positive GCA effects for the number of primary branches plant^{-1} and plant spread. However, parent Surakta and Jayanti showed GCA effects in positive direction for number of primary branches plant^{-1}, while parent Phule Jyoti and Surakta recorded positive GCA effect.

In view of present finding, the parents Phule Jyoti, G-4 and Jayanti were the best possible genotypes for exploitation in the genetic improvement programme of chilli.

The estimates of SCA effects (Table 3) revealed that out of 15 crosses studied only six crosses exhibited highly significant and desirable SCA effects for dry fruit weight plant^{-1}. The cross combination Jayanti x G-4 exhibited high significant SCA effects also showed significant *per se* performance for dry fruit weight plant^{-1}, indicating importance of their effects in exploitation of good hybrids for high yields. The other cross combinations *viz*., Phule Jyoti x Arka Lohit, Phule Suryamukhi x G - 4 and Phule Jyoti x Surakta exhibited high significant SCA effect with high *per se* performance for dry fruit weight plant^{-1}. Similar results were recorded by Khadi and Goud (1986) and Burli *et al*. (2001) indicated that high *per se* performance of hybrid was associated with high SCA effects. The crosses Phule Jyoti x Surakta, Jayanti x Phule Suryamukhi and Arka Lohit x G-4 also exhibited high *per se* performance for dry fruit weight plant^{-1} but exhibited low significant SCA effects.

The cross Phule Jyoti x Phule Suryamukhi showed significant SCA effects in desirable direction for days to 50 per cent flowering, days to maturity, plant height, plant spread and fruit length. Similarly the cross Phule Jyoti x Arka Lohit for days to 50 per cent flowering, days to

Table 3. Estimates of specific combining ability effects for different characters in 6 x 6 half diallel of chilli.

Crosses	Days to 50% flowering	Days to maturity	Primary branches plant^{-1}	Secondary branches plant^{-1}	Plant height (cm)	Plant spread (cm)	Fruit length (cm)	Fruit girth (cm)	Fruits plant^{-1} (No.)	Dry fruits weight plant^{-1} (g)
1 x 2	1.113	1.375	0.105	0.448	-5.286**	-3.79**	-1.342**	-0.411**	-1.448	1.010
1 x 3	-2.345**	-2.625*	-0.022	1.465	-0.198	-2.320*	0.331	0.020	12.776*	18.351**
1 x 4	-1.887*	-5.208*	-1.061	-1.635	10.732**	3.786**	1.104**	0.104	4.441	-2.697
1 x 5	-1.720	-0.167	-0.061	-1.873*	2.901*	2.369	-0.516	0.202	9.098	-7.747*
1 x 6	0.836	1.292	0.412	3.632*	-0.892	-2.116	0.235	-0.059	-12.05*	15.173**
2 x 3	-1.220	0.750	-0.297	0.512	0.887	-1.588	-0.462	-0.095	-15.63**	-0.078
2 x 4	0.238	-1.167	0.397*	-2.041	0.798	-0.501	0.202	0.062	0.237	9.343*
2 x 5	-0.262	-3.458**	0.130	0.861	-0.290	1.756	0.238	0.144	10.148*	28.918**
2 x 6	0.988	-1.000	-0.197	1.589	3.930**	0.545	1.525**	0.159	-2.323	-12.916**
3 x 4	-2.220**	-6.833**	-0.230	-2.738**	1.019	0.319	0.448	-0.021	-1.972	-8.926**
3 x 5	0.946	0.208	0.170	-1.342	2.425	-0.865	1.017**	0.021	6.568	8.491*
3 x 6	3.530	2.333*	-0.307	0.752	-1.529	2.857*	-0.788*	0.049	-4.186	-4.855
4 x 5	-0.595	2.292*	0.064	1.587	-7.415**	-2.107	-1.499**	-0.048	-1.057	15.889**
4 x 6	-1.345	-2.917**	0.170	-2.728**	0.392	-1.369	-0.078	0.003	8.552	-1.814
5 x 6	-0.845	-0.875	0.130	-0.372	-1.836	-1.120	0.365	0.398**	-8.064	-7.327*
S. E. ± Sij	0.757	1.024	0.177	0.846	1.412	1.216	0.362	0.108	4.994	3.397
S. E. ± Sii	1.034	1.400	0.242	1.156	1.929	1.661	0.495	0.148	6.823	4.641
C. D. at 5% Sij	1.530*	2.071*	0.358	1.710	2.853	2.458	0.733	0.219	10.093*	6.866
C. D. at 5% Sii-Sij	2.090	2.829*	0.489	2.336	3.898	3.358	1.002	0.300	13.730	9.380
C. D. at 1% Sij	1.950	2.637	0.455	2.179	3.637	3.132	0.932	0.278	12.864	8.750

*,** denotes significance at 5 and 1 per cent level respectively.

maturity, number of fruits plant^{-1} and dry fruit weight plant^{-1}, Phule Jyoti x Surakta for number of primary and secondary branches plant^{-1} and dry fruit weight plant^{-1} showed significant SCA effects in desirable direction. Likewise, the combinations, Phule Jyoti x G-4 for days to 50 per cent flowering and plant height, Jayanti x Phule Suryamukhi for primary branches plant^{-1} and dry fruit weight plant^{-1}, Jayanti x Surakta for plant height and fruit length and Arka Lohit x G-4 for fruit length and dry fruit weight plant^{-1} showed significant SCA effects in desirable direction.

The crosses that producing significant SCA effects involved parents with high x low combiners suggesting predominance of interallelic interaction for respective characters. However, most of the crosses exhibiting significant SCA effects had at least one parent with good GCA. The cross combinations with significant SCA effects involved parents with low x low, high x low or low x average GCA effects indicating the presence of non allelic interactions and also manifested heterosis of higher magnitude. Considering the above condition the best cross combinations were Jayanti x G-4, Phule Jyoti x Arka Lohit and Phule Jyoti x Phule Suryamukhi which can be used for further exploitation.

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Effect of Different Training Systems on Yield and Quality of Bitter gourd cv. Konkan Tara under Konkan Conditions of Maharashtra

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ABSTRACT

The bower system of training was observed to be best for better growth, quality and higher yield of marketable fruits. The response of training systems was highly encouraging. The bower training system was observed to be significantly superior over other training systems, as it has recorded profuse growth, in respect of length of vine, leaves, and branches plant^{-1}, leaf area as well as number of nodes and internodal length with longer and dark green fruits, maximum number of fruits vine^{-1} (30.46) and highest yield of marketable fruits (78.25 q ha^{-1}) as compared with ground system (22.76 q ha^{-1}) and found significantly superior over all other training systems. Increase in the yield due to training systems over ground system was 71.83, 200.65 and 243.80 per cent respectively in bush, kniffin and bower system of training.

Key words : Training, Konkan Tara.

Bitter gourd (*Momordica charantia* L.) is one of the most important cucurbitaceous vegetable crops grown world wide. It is good for diabetic patients because of its medicinal value. The fresh green fruits of bitter gourd are being exported to gulf countries. There is good scope to increase the production of bitter gourd for export purpose. The farmer grows this crop with a support or trailing over the ground.

The importance of providing supports to the vines has been emphasized by the number of

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workers *viz*., Abusaleha and Dutta (1994) and Joshi *et al*. (1994) in bitter gourd, Krishna Prasad and Singh (1987) and Yadav *et al*. (1989) in pointed gourd, Abusaleh and Dutta (1994) in ridge gourd and Rahaman and Hossain (1989) in bottle gourd. The advantages of these supports are attributed to efficient disease and pest management, easy harvesting and improving quality of fruits besides high yield. Therefore, present investigation was undertaken to study the effect of different training systems on growth, yield and quality of bitter gourd under Konkan agro climatic conditions of Maharashtra.

MATERIALS AND METHODS

The experiment was laid out in a randomized block design with five replications during kharif season. The treatments included four different training systems *viz*., ground, kush (dry bamboo sticks along with thorny branches), kniffin and bower system. The seeds were dibbled at 2.5 x 1.0 m spacing in a plot of 5 x 4 m size accommodating ten plants in each plot. The all recommended agro-techniques were followed to get the optimum yield.

Except ground training system, vines were trained on the support. In bush training system, waste dry bamboo sticks along with thorny branches were fixed near the plants and vines were allowed to grow on this without disturbing growth habit. Kniffin and bower were prepared with the help of iron angles (7' x 2") and galvanized iron wire of 10 gauge, and 16 gauge diameter. The jute strings were used for supporting the vines in both kniffin and bower systems. The observations recorded for growth parameters *viz*., length of vine, number of leaves, branches, leaf area, nodes and internodal length; fruit attributes like, weight, length, diameter, shape and colour of fruit and number of seeds per fruit as well as yield contributing characters *viz*., fruits vine^{-1}, yield vine^{-1}, yield of marketable fruits vine^{-1}, yield ha^{-1} and deformed fruits vine^{-1} while, per cent increase in yield over ground system was also calculated. The data were statistically analyzed by method suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

There was significant variation noticed in all growth parameters (Table 1). The significantly maximum average length of vine (593.61 cm) was recorded in bower system as compare with ground system (438.73 cm), while, significantly maximum number of leaves (387.54), number of branches (11.60) and leaf area (498.59dm^2) were recorded by kniffin system followed by bower system and was found significantly superior over all other training systems. But significantly maximum number of nodes (436.66) and highest internodal length (7.54cm) was recorded by bower system and at par with kniffin system. These results are

Table 1. Effect of different training systems on growth parameters of bitter gourd cv. Konkan Tara.

Treatments	Length of vine (cm)	Leaves vine^{-1}	Branches vine^{-1}	Leaf plant^{-1} (dm^2)	Nodes vine^{-1}	Internodal length (cm)
Ground system	438.73	342.06	7.30	335.48	336.18	5.95
Bush system	468.85	368.40	9.88	378.06	366.18	6.55
Kniffin system	531.01	402.34	11.60	498.59	410.92	7.51
Bower system	593.61	387.54	10.20	461.91	436.66	7.54
Mean	508.05	375.08	9.74	418.51	387.48	6.89
S. E.±	4.71	3.25	0.38	21.48	4.59	0.10
C. D. at 5%	14.52	10.03	1.17	66.21	14.14	0.32

Table 2. Fruit characteristics of bitter gourd cv. Konkan Tara as affected by different training systems.

Treatments	Weight of fruit (g)	Length of fruit (cm)	Diameter of fruit (cm)	Shape index	Seeds fruit^{-1}	Fruit colour
Ground system	52.84	10.46	4.54	2.30	9.64	Green
Bush system	64.42	12.39	4.42	2.80	11.28	Green
Kniffin system	69.82	14.43	4.10	3.51	14.30	Dark green
Bower system	77.96	17.31	4.00	4.32	15.58	Dark green
Mean	66.26	13.65	4.26	3.23	12.70	-
S. E.±	1.66	0.32	0.03	0.08	0.52	-
C. D. at 5%	5.12	1.00	0.11	0.25	1.60	-

Table 3. Effect of different training systems on yield attributes of bitter gourd cv. Konkan Tara.

Treatment	Fruits vine^{-1}	Deformed fruits vine^{-1}	Yield vine^{-1} (kg)	Yield of marketable fruits vine^{-1} (kg)	Yield (q ha^{-1})	Increase over ground system (%)
Ground system	12.24	5.94	0.569	0.292	22.76	0.00
Bush system	19.46	4.40	0.978	0.756	39.11	71.83
Kniffin system	25.40	2.44	1.691	1.527	68.43	200.65
Bower system	36.46	1.34	1.956	1.869	78.25	243.80
Mean	21.89	3.53	1.29	1.11	52.14	-
S. E.±	0.16	0.28	0.13	0.08	0.42	-
C. D. at 5%	0.50	0.87	0.03	0.03	1.30	-

agreement with those reported by Joshi *et al*. (1994).

There was great influences of training systems observed in case of fruit characteristics (Table 2). The significantly highest average fruit weight (77.96 g), as well as length of fruit (17.31 cm) with dark green fruits were recorded by bower training system followed by kniffin system and found significantly superior over other training systems and ground system (52.84 g and 10.46 cm respectively). While, significantly highest fruit diameter (4.54 cm) was recorded by ground system as compared with bower and other system (Table 2). The fruits in bower system remain in hanging position, which get proper aeration, sufficient sunlight, definitely helps to increase the length of fruits and ultimately average weight of fruits. These results were similar to those reported by Joshi *et al*. (1994) in bitter gourd and many workers in ridge gourd and bottle gourd.

Different training systems influences on yield as well as yield contributing attributes (Table 3). The bower system recorded significantly highest number of fruits (30.46), average yield vine^{-1} (1.956 kg), marketable fruits (1.869 kg) plant^{-1}, yield ha^{-1} (78.25 q ha^{-1}) and was found significantly superior over other systems with recording lower number (1.34) of deformed fruits. While, considering the yield performance over ground system, bower system recorded 243.80 per cent increase in yield followed by 200.65 per cent increase by kniffin system. The ground system recorded more number of deformed fruits vine^{-1} (5.94) and lower yield of marketable fruits vine^{-1} (0.292 kg). The similar trend of results were also reported by Rahman and Hossain (1989) in bottle gourd. Joshi *et al*. (1994) in bitter gourd and Abusaleha and Dutta

(1994) in ridge gourd

It was concluded from investigation that, the bower training system was found to be significantly superior over all other systems by recording profuse growth, best quality fruits with significantly highest yield with 243.80 per cent increase in yield over ground system followed by kniffin system which recorded 200.65 per cent more yield over ground system and founds significantly superior over all other training systems.

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Correlation and Path Coefficient Analysis in Finger millet (*Eleusine coracana* Gaertn.) under Mango Based Agroforestry System

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ABSTRACT

The study revealed that the grain yield plant^{-1} indicated positive and highly significant correlation with straw yield plant^{-1}, harvest index and weight of grains on main earhead at phenotypic and genotypic level, while number of fingers on main earhead at genotypic level only. Under mango based agroforestry system, path analysis indicated that finger length, harvest index, number of fingers on main earhead and straw yield plant^{-1} had direct positive effect on grain yield at genotypic level. Selection programme based on number of fingers on main earhead and straw yield plant^{-1} will be effective for grain yield improvement in finger millet under mango based agroforestry system.

Key words : Correlation, path coefficient, finger millet, mango trees, agroforestry.

Finger millet is a minor cereal in world food grain production but is an important food crop of the poor marginal farmers, especially the tribal people of India. Finger millet has an excellent food value. It contains carbohydrates,

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proteins, minerals and vitamins in sufficient quantities. It is cultivated over a wide range of agro climatic conditions of India.

Presently in India, the productive resources like land, water are limited but on other hand population of India goes on increasing. For fulfilling the increasing demand of food grains it is now necessary to use limited land resource scientifically and technically and hence under such condition the introduction of finger millet under agroforestry system will be helpful for better utilization of this limited land resource. In the Konkan region there is large area under mango plantation i. e. 1.65 lakh ha. (Shrinivasan, 2005) and is major fruit crop playing important role in economy. Generally mango trees are planted at 10 x 10 m spacing, the area between mango trees remains fallow during early 10-15 years. Under such condition introduction of finger millet under mango based agroforestry system (finger millet + mango trees) will be helpful for better utilization of land resource. Also it is possible to improve socioeconomic conditions of peoples.

Yield is a complex character highly influenced by environmental fluctuations. Hence, direct selection for yield as such does not give expected results. Determination of correlation coefficient of yield components has been helpful to breeders in selecting suitable plant type under mango based agroforestry system. Path coefficient analysis is standardized tool for splitting total correlation into direct and indirect cause of the yield components on yield. Therefore, present study was conducted on correlation and path coefficient analysis in finger millet under mango based agroforestry system.

MATERIALS AND METHODS

The experiment comprised of 19 genotypes of finger millet collected from different parts of

Table 1. Genotypic (rg) and phenotypic (rp) correlation coefficient in 10 characters of finger millet under mango based agroforestry system.

Character		Plant height (cm)	Effective tillers plant^{-1}	Fingers on main earhead	Finger length (cm)	Weight of grains on main earhead (g)	1000 grain weight (g)	Straw yield plant^{-1} (g)	Harvest index (%)	Grain yield plant^{-1} (g)
Days to 50 per cent flowering	rg	0.453	-0.378	0.641**	0.169	0.619**	0.242	0.185	0.561*	0.401
	rp	0.452	-0.253	0.621**	0.170	0.498**	0.145	0.104	0.517*	0.354
Plant height (cm)	rg		-0.012	0.265	0.378	0.539*	-0.154	0.646**	0.313	0.574*
	rp		0.049	0.249	0.376	0.456*	-0.086	0.546*	0.279	0.531*
Effective tillers	rg			-0.066	0.332	0.212	-0.781**	0.268	0.176	0.234
	rp			-0.023	0.260	0.104	-0.391	0.160	0.190	0.203
Fingers on main earhead	rg				0.066	0.769**	0.223	0.462*	0.573*	0.591**
	rp				0.062	0.677**	0.165	0.387	0.548*	0.567*
Finger length (cm)	rg					0.239	-0.554*	0.053	0.096	0.081
	rp					0.208	-0.299	0.041	0.067	0.064
Weight of grains on main earhead (g)	rg						0.128	0.717**	0.817**	0.872**
	rp						0.043	0.701**	0.605**	0.783**
1000 grain weight (g)	rg							0.253	0.056	0.177
	rp							0.152	0.043	0.125
Straw yield plant-1 (g)	rg								0.499**	0.885**
	rp								0.327	0.839**
Harvest index (%)	rg									0.846**
	rp									0.781**

country laid out in a randomized block design with two replications in 25 years old mango trees spaced 10 x 10 m at mango orchard, Department of Horticulture, College of Agriculture, Dapoli, Dist. Ratnagiri (M.S.) during *kharif* 2006 season. The experimental material were planted in four direction i.e. East, West, North and South up to 5 m area by keeping 2 m fallow area from stem base of mango tree. The area under mango tree canopy was 48 sq.m. and 36sq.m. in open canopy for single genotype. The seedlings were transplanted with a spacing of 20 cm between row and 15 cm between plants in row. The twenty plants were selected randomly under mango tree canopy for each genotype in each replication for recording 10 quantitative characters. The gehotypic and phenotypic correlations were worked out through variance and co-variance analysis. Path coefficients were estimated by adapting procedure given by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The study revealed that genotypic correlation coefficients were higher than phenotypic correlation coefficients under mango based agroforestry system (Table 1). Similar result was also reported by Sarviya *et al.* (1983) in open field condition indicating though there is strong association between various characters studied, the phenotypic correlation reduced under the influence of environment. In present study, grain yield per plant had highly significant and positive correlation with weight of grains on main earhead (0.783 and 0.872), straw yield per plant (0.839 and 0.882) and harvest index (0.781 and 0.846) at both on phenotypic and genotypic level under mango tree canopy, while number of fingers on main earhead (0.591) at genotypic level only. Plant height (0.531 and 0.574) showed significant positive correlation with grain yield per plant at both phenotypic and genotypic level while number of finger on main earhead (0.591) at genotypic level only. The characters days to 50 per cent flowering, number of effective tillers per plant, finger length and 1000 grain weight showed positive but nonsignificant correlation with grain yield per plant. Similar results were also reported by Kulkarni (1980) for positive

Table 2. Path coefficient analysis showing direct and indirect effects of ten characters on grain yield in finger millet under mango based agroforestry system.

Characters	Days to 50 per cent flowering	Plant height (cm)	Effective tillers plant^{-1}	Fingers on main earhead	Finger length (cm)	Weight of grains on main earhead (g)	1000 grain weight (g)	Straw yield plant^{-1} (g)	Harvest index (%)	Grain yield plant^{-1} (g)
Days to 50 per cent flowering	-0.137	0.051	0.010	0.050	0.002	-0.030	0.009	0.096	0.352	0.401
Plant height (cm)	0.113	-0.062	0.000	0.020	0.004	-0.026	-0.006	0.335	0.196	0.574*
Effective tillers	-0.025	0.052	-0.005	0.003	-0.001	-0.010	-0.028	0.139	0.111	0.234
Fingers on main earhead	0.077	-0.088	0.002	0.001	0.030	-0.038	0.008	0.239	0.359	0.591**
Finger length (cm)	0.099	-0.023	-0.008	-0.005	0.043	-0.012	-0.020	0.027	0.060	0.081
Weight of grains on main earhead (g)	-0.049	-0.085	0.060	0.002	0.061	-0.005	0.005	0.371	0.512	0.872**
1000 grain weight (g)	0.036	-0.033	0.017	0.005	-0.017	0.0250	-0.006	0.131	0.035	0.177
Straw yield plant^{-1} (g)	0.518	-0.025	0.036	0.000	0.073	-0.007	-0.035	0.009	0.313	0.882**
Harvest index (%)	0.627	-0.077	0.044	0.001	0.035	-0.004	-0.040	0.002	0.258	0.846**

correlation of grain yield per plant with weight of grains on main earhead, Hari Krishna *et al*. (2005) with straw yield per plant and Reddy *et al.* (1994) with harvest index with grain yield finger millet under open field condition.

The association among the days to 50 per cent flowering with number of fingers on main earhead (0.621 and 0.641), weight of grains on main earhead (0.498 and 0.619) and harvest index (0.517 and 0.561) was significantly positive at the both phenotypic and genotypic level. Plant height showed significantly positive association with weight of grains on main earhead (0.456 and 0.539), straw yield per plant (0.546 and 0.646) at both phenotypic and genotypic level. The number of fingers on main earhead showed significant positive association with weight of grain on main earhead (0.769), straw yield per plant (0.462) and harvest index (0.573) at genotypic level. Finger length showed significant negative correlation with 1000 weight (-0.554). Straw yield per plant showed positive correlation with harvest index and grain yield plant^{-1} and harvest index showed positive correlation with grain yield plant^{-1}.

The path coefficient analysis (Table 2) furnishing the cause and effect of different yield components would provide better index for selection rather than correlation coefficients. The result indicated that the characters number of fingers on main earhead (0.001), finger length (0.043), straw yield per plant (0.009) had low direct effect where as harvest index (0.258) had high direct positive effect on grain yield in finger millet. Characters, days to 50 per cent flowering (-0.137), plant height (-0.062), number of effective tillers per plant (-0.005), weight of grains on main earhead (-0,005) and 1000 grain weight (-0.006) had negative direct effect on grain yield per plant. The indirect effect of harvest index and straw yield was also positive and high for most of the characters. The positive direct effect of straw yield per plant on grain yield was also reported by Hari Krishna *et al*. (2005), while Waghaye (2005) reported positive direct effect of plant height and number of effective tillers plant^{-1} on grain yield in finger millet; the same was also reported by Bendale *et al*. (2002) in open field condition.

On the basis of correlation and path analysis for yield, it could be stated that, simultaneous selection on the basis of number of fingers on main earhead, finger length, harvest index and straw yield per plant could be possible for genetic improvement of yield in finger millet under mango based agro forestry system.

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Phule Radha (RDN 99-1) Early Duration, Fine Grained Paddy Variety for Maharashtra

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ABSTRACT

Phule Radha (RDN 99 - 1) is an early duration, semi-dwarf, high yielding short slender, fine quality grain variety. The culture RDN 99-1 has been developed from cross T(N) -1 x Kolamba 540, by pedigree method at ARS, Radhanagari. It gave 33.73 q ha^{-1} grain yield in state coordinated trials, which was 37.23, 19.74 and 22.97 per cent higher over the checks Zinia 63, KJT 4 and Kundalika respectively. Besides having higher grain yield, the culture was found to be superior over the checks for quality characteristics *viz*. hulling percentage, milling percentage, length/breadth ratio, kernel length alter cooking, elongation ratio and amylose content. The variety Phule Radha (RDN 99-1) has been released for commercial cultivation in the state of Maharashtra in the year 2006 and was notified in 2007.

Key words : Rice, Phule Radha, pedigree method.

The productivity of the rice in Maharashtra state is below national average and there is wide scops to improve it. The introduction of high yielding varieties, adoption of improved low cost technology and disease free varieties are the prominent remedies (D'Cruz and Patil, 1966). In the post green revolution period, grain quality has become the major breeding objective, next to yield, in rice improvement programme. Unattractive grain characters and unsatisfactory cooking quality would affect the acceptance and spread of modern varieties. Indian consumers normally prefer dry, flaky (non sticky) rice (Shobha Rani *et al.* 2004). In recent years, consumer's preference and market price in domestic as well as international market are much in favour of quality rice (Dalvi *et al*. 2004). Therefore the efforts were made at Agricultural Research Station, Radhanagari, Dist. Kolhapur (M.S.) to develop high yielding, medium duration, semi-dwarf variety with fine, short slender grain with good cooking quality.

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MATERIALS AND METHODS

T(N) - 1, a coarse, early duration, dwarf, high yielding variety was crossed with Kolamba - 540, a fine grained, midlate, tall variety and the segregating population was evaluated at Agricultural Research Station, Radhanagari during 1994-1997 by following pedigree method. The promising progeny was isolated and studied for its yield and ancillary characteristics in station trial during 1998. The variety RDN 99-1 (Phule Radha) was evaluated in State Coordinated Trial (Quality) in a randomized block design with 3 replications along with the checks during the year 1999 to 2002. At maturity, yield and yield contributing characteristics were recorded. The statistical analysis of yield data of all the trials was done according to Panse and Sukhatme (1985). The variety was evaluated for its reaction to major insect pests and diseases under endemic conditions. The variety was evaluated for its cultural packages in agronomic trial at the station during *kharif* 2003. It was evaluated on farmers' field at fifteen locations in Western

Maharashtra during *kharif* 2003. Simultaneously the grain quality analysis was done at Directorate of Rice Research, Hyderabad for necessary quality attributes and for cooking and consumption at Chhatrapati Shahu Institute for Business Education and Research, Kolhapur (M.S.).

RESULTS AND DISCUSSION

The variety Phule Radha (RDN 99 - 1) is semi-dwarf (90 to 95 cm plant height), early duration (110 to 115 days maturity), non lodging, non shattering in habit and having short slender superfine grain. The variety recorded profuse and synchronous tillering, long panicle (21 cm), more number of spikelets per panicle (139) and low sterility percentage (13.02 %), which were the major yield contributing characters in above variety, resulting higher grain yield than that of the checks KJT 4 and Zinia 63 (Table 1).

Table 1. Salient features of variety Phule Radha (RDN 99-1).

Characters	Particulars
Pedigree	T(N)-1 x K-540
Days to 50 per cent flowering	85-90 days
Days to maturity	110-115 days
Plant height (cm)	90-95
Reaction to lodging	Non lodging
Shattering habit	Non shattering
Kernel length (mm)	5.44
Kernel breadth (mm)	1.80
Length / breadth ratio	3.02
Grain type	Short slender
Length of panicle (cm)	21
Spikelets per panicle	139
Sterility percentage	13.02
Yield potential (q ha^{-1})	35-40
Test weight (g)	14.00
Reaction to major diseases	
i. Bacterial leaf blast	Resistant
ii. Blast	Moderately resistant
iii. Leaf scald	Moderately resistant

The genotype RDN 99-1 was tested with the check RTN 24 in the station trial during *kharif* 1998 at Agricultural Research Station, Radhanagari (Table 2a). In this trial the genotype RDN 99-1 (34.80 q ha^{-1}) recorded higher grain yield (17.61%) over the check RTN 24 (29.59 q ha^{-1}). The grain yield performance of rice variety Phule Radha (RDN 99-1) in State Coordinated Multilocational Trials (Quality) conducted during *kharif* 1999 to 2004 recorded (33.80 q ha^{-1}) 2.49 per cent higher grain yield over the checks Zinia 63 (24.67 q ha^{-1}), 19.82 per cent over KJT 4 (28.28 q ha-1) and 19.01 per cent over Kundalika (27.425 q ha^{-1}). In the agronomic trial conducted at Agricultural Research Station, Radhanagari during *kharif* 2003, the variety Phule Radha (RDN 99-1) has recorded 36.91 and 17.18 per cent higher grain yield than the checks KJT 4 and Zinia 63 respectively. In the adaptive trials conducted on the farmers' field at fifteen locations in Western Maharashtra during *kharif* 2003, the variety Phule Radha has recorded 15.54 per cent higher grain yield than the check KJT 4 (Table 2 b).

Table 2a. Yield of RDN 99-1 in station trial (1998).

Culture	Grain yield (kg ha^{-1})	Per cent increase over check
RDN 99-1	3480	-
RTN 24	2959	17.51
S. E.±	306	-
C. D.±	896	-

The variety Phule Radha (RDN 99-1) was screened for reaction to major rice diseases and insect pests during the year 1999 to 2002 in the state screening nurseries at endemic sites. The variety was found resistant to bacterial leaf blight disease and moderately resistant to blast and scald (Anonymous 2000, 2001). Thus the variety, Phule Radha has been observed to have

Table 2b. Performance of Phule Radha (RDN 99-1) in various trials during the year 1999 to 2003.

Trial	Year	No. of trials	Average yield (q ha^{-1})				Per cent increase over check		
			Phule Radha	KJT 4	Zinia 63	Kund-lika	KJT 4	Zinia 63	Kund-lika
AVT	1999	7	33.30	28.13	23.06	27.72	18.38	41.14	20.13
AVT	2000	7	31.98	24.91	23.98	27.13	28.38	33.36	17.88
AVT	2001	8	33.07	28.94	26.69	-	13.41	22.97	-
AVT	2002	8	36.56	30.70	-	-	19.19	-	-
Mean		30	33.80	28.28	24.67	27.425	19.82	32.49	19.01
Agronomic trial	2003	1	36.02	26.31	30.74	-	36.91	17.18	-
Adaptive trials on farmer's field	2003	15	43.34	37.50	-	-	15.58	-	-

multiple resistance to major diseases (Anonymous, 2004a).

The variety Phule Radha (RDN 99-1) was tested for quality parameters at Directorate of Rice Research, Hyderabad during 2003-04. The performance of the variety Phule Radha for various quality parameters has shown higher hulling percentage, milling percentage, elongation ratio and kernel length after cooking in comparison with check varieties KJT 4 and Zinia 63 (Table 3a). The absence of chalkiness in Phule Radha has a merit in quality aspects where the traders give preference on the translucent slender grain, whereas the intermediate and desirable Amylose content in RDN 99-1 (Phule Radha) has another merit in the quality over the checks KJT 4 and Zinia 63 as the cooked rice is soft, flaky and dry texture (Anonymous, 2004b). The sensory evaluation for consumption qualities of the variety Phule Radha (RDN 99-1) was conducted by preparing seven rice recepies *viz*., plain rice, masala rice, pulav, sweet rice, curd rice, jeera rice and khichadi at Chhatrapati Shahu Institute for Business Education and Research, Kolhapur during 2003-04. The performance of the variety Phule Radha (RDN 99-1) was found to be superior to the checks KJT 4 in consumption quality aspects (Anonymous, 2004c).

Table 3a. Grain quality characteristics of Phule Radha (RDN 99-1), KJT 4 and Zinia 63.

Characteristic	Phule Radha	KJT 4	Zinia 63
Hulling percentage	79.2	77.3	76
Milling percentage	71.1	64.5	64.8
Head rice recovery (%)	45.3	46.0	39.5
Kernel length (mm)	5.44	4.95	5.27
Kernel breadth (mm)	1.80	1.66	1.70
Length / breadth ratio	3.02	2.98	3.10
Kernel length after cooking (mm)	10.6	8.4	9.0
Elongation ratio	1.95	1.70	1.71
Grain chalkiness	Absent	VOC	Absent
Amylose content (%)	24.64	26.43	26.48
Gel consistency (mm)	31	63	75

Table 3b. Sensory evaluation of Phule Radha (RDN 99-1), KJT 4 and Zinia 63.

Characteristic	Phule Radha	KJT 4	Zinia 63
Appearance	Good	Fair	Good
Colour	Very Good	Good	Good
Taste	Very Good	Good	Good
Consistency	Good	Good	Good

Thus the variety Phule Radha (RDN 99-1)

was observed to be superior in yield over the popular varieties KJT 4, Kundlika and Zinia 63, indicating its stable yield performance in varied ecological situations in the state. Besides, the variety Phule Radha (RDN 99-1) was observed to be superior in grain quality and cooking qualities over the popular varieties.

In view of the high yield potential, good milling and cooking qualities and resistance to major diseases, the variety Phule Radha (RDN 99-1) was recommended for release for commercial cultivation in the state of Maharashtra during the year 2004 and released by State Variety Release Committee, Mumbai 2006. The variety Phule Radha has been notified by Ministry of Agriculture, vide Notification S.O. 1178(E), 2007.

The new rice variety, has the potential to meet the requirement of the farmers in the state in respect of yield with superfine quality grain. It can be exploited to increase in rice production and productivity in the state through large scale adoption of the variety.

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Bhogavati (IET 13549) - A New Scented Rice Variety for Maharashtra

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ABSTRACT

Bhogavati (IET 13549) a new scented rice variety, was found superior in grain yield and quality parameters over the popular scented rice varieties *viz*. Indrayani and Pawana. The variety Bhogavati gave 36.85 q ha^{-1} grain yield as compared to the varieties Indrayani and Pawana which gave 35.16 and 32.56 q ha^{-1} in the state co-ordinated trials, respectively. The variety Bhogavati was also observed to be superior in grain quality and cooking qualities over the popular varieties. It is midlate in duration (134-138 days), dwarf (85-90 cm) and have long slender translucent and scented grain. The variety Bhogavati (IET 13549) found to be resistant to leaf and neck blast and moderately resistant to leaf scald and stem borer in state screening programme under endemic conditions. The variety Bhogavati (IET 13549) has been released for commercial cultivation in the state of Maharashtra in the year 2006 and was notified in 2007.

Key words : Rice, Bhogavati, midlate, scented, long slender.

Rice plays pivotal role in Indian economy being the staple food of two third of the population. In Maharashtra it is a second important food grain crop next to Sorghum. The consumer preference has dominant role in localization and adoption of varieties. The quality consideration, food consumption pattern and taste appeal have overwhelming influence on farmers to carefully select and improve the best quality rices that are most preferred. Many states have a collection of native popular scented varieties which are known for their adaptation and cultivation (Singh *et al.* 2000). Besides long grain basmati varieties, which have specific geographical demarcation for their cultivation, numerous indigenous aromatic cultivars are grown in localized pockets distributed in several states of the country (Shobha Rani and Singh, 2003).

In Maharashtra, short-slender, medium slender scented varieties are more popular, especially the varieties like Chinoor, Dubraj are popular in Eastern Vidarbha, while the varieties like Ambemohar 157, Indrayani and Pawana in Western Zone. Most of these local scented types are tall, late maturing, lodging and susceptible to various diseases like bacterial leaf blight, leaf scald and blast. Besides, stickiness and milling problems were observed in Indrayani and Pawana, respectively. Therefore, to overcome these problems the efforts were made at Agricultural Research Station (MPKV), Radhanagari, Dist. Kolhapur to evolve high yielding, good milling and cooking quality rice variety along with resistance to major diseases and insect pests (Anonymous, 2004 a).

MATERIALS AND METHODS

Twenty one Basmati type entries were received from Directorate of Rice Research, Hyderabad for evaluation. These entries were evaluated in station trial for yield and other attributes at Agricultural Research Station, Radhanagari, Dist. Kolhapur and Agricultural Research Station, Vadgaon (Maval), Dist. Pune (M.S.) dunng *kharif* 1994. The culture IET

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Table 1. Average yield performance of rice genotype Bhogavati (IET 13549) in various trials during the year 1994 to 2003.

Trial	Year	No. of trials	Average yield (q ha^{-1})				Per cent increase over check		
			Bhog-avati	Pusa Bas-mati 1	Indra-yani	Paw-ana	Pusa Bas-mati 1	Indra yani	Paw-ana
Station trial	1994	2	38.39	29.02	-	-	32.20	-	-
State co-ordinated trial (Scented)	1995 to 1999	34	36.85	28.37	35.16	32.56	29.89	4.81	13.18
Agronomic trial	2003	1	40.18	-	34.96	35.19	-	14.93	14.18
Adaptive trials on farmers field	2003	17	46.18	-	42.85	37.25	-	7.77	23.97

13549 was tested in State Co-ordinated Multilocational Trial (Scented) at seven locations for five years during 1995 to 1999 in a randomized block design with three replications. The statistical analysis of yield data of all the trials was done according to Panse and Sukhatme (1985). The variety IET 13549 was also evaluated for agronomic performance at this research station during *kharif* 1999 and *kharif* 2003. The variety was evaluated on farmers field at seventeen locations in Western Maharashtra during *kharif* 2003. Simultaneously the grain quality analysis was done at Directorate of Rice Research, Hyderabad for necessary quality attributes and for cooking and consumption at Chhatrapati Shahu Institute for Business Education and Research, Kolhapur (M.S.). The variety was evaluated for its reaction to major insect pests and diseases at endemic sites.

RESULTS AND DISCUSSION

The yield performance of the rice variety Bhogavati (IET 13549) observed in various trials dunng the year 1994 to 2003 is presented in Table 1 . In station trial conducted at two locations during *kharif* 1994, the variety IET 13549 had recorded 32.20 per cent increase in grain yield over the check Pusa Basmati 1. In the state co-ordinated multilocational trial - scented group conducted during *kharif* 1995 to 1999, the variety Bhogavati (36.85 q ha^{-1}) has recorded overall 29.89, 13.18 and 4.81 per cent higher grain yield than the checks Pusa Basmati 1(28.37 q ha^{-1}). Pawana (32.56 q ha^{-1}) and Indrayani (35.16 q ha^{-1}), respectively. In the agronomic trial conducted at this research station during *kharif* 2003, it recorded 14.93 and 14.08 per cent higher grain yield than the checks Indrayani and Pawana, respectively. The variety Bhogavati has shown 23.97 and 7.77 per cent overall increase over the checks Pawana and Indrayani, respectively in the adaptive trials conducted on farmers field during *kharif* 2003.

The variety Bhogavati was tested for quality parameters at Directorate of Rice Research,

Table 2 a. Grain quality characteristics of Bhogavati (IET 13549), Indrayani and Pawana.

Characteristic	Bhog-avati	Indra-yani	Paw-ana
Hulling percentage	77.00	76.70	72.00
Milling percentage	67.50	65.40	65.70
Head rice recovery (%)	43.00	38.50	35.20
Kernel length (mm)	6.90	6.25	6.47
Kernel breadth (mm)	1.94	2.02	2.08
Length / breadth ratio	3.55	3.09	3.11
Kernel length after cooking (mm)	11.40	9.90	10.30
Elongation ratio	1.65	1.58	1.59
Amylose content (%)	26.57	17.77	19.04
Gel consistency (mm)	43.00	75.00	66.00
Aroma	Stong	Medium	Medium

Hyderabad during 2003-04 (Table 2a). It has shown high elongation ratio and kernel length after cooking in comparison with check varieties Indrayani and Pawana. The grains of Bhogavati possesses strong aroma, unlike the varieties Indrayani and Pawana. It has better advantage over the checks Indrayani and Pawana for Amylose content (Anonymous, 2004 b).

The sensory evaluation for consumption qualities of the variety Bhogavati was conducted by preparing eight rice recepies *viz*. plain rice, masala rice, pulav, sweet rice, curd rice, jeera rice, biryani and khichadi at Chhatrapati Shahu Institute for Business Education and Research, Kolhapur during 2003-04. The variety Bhogavati, was found to be superior over the checks Indrayani and Pawana in consumption quality aspects (Anonymous, 2004 c).

The variety Bhogavati was also screened for reaction to major rice diseases and insect pests during the year 1995 to 1999 in the state screening nurseries under endemic conditions. The variety has shown resistance to leaf blast and neck blast diseases and moderately resistance to leaf scald and stem borer pest (Anonymous, 1996, 1997, 1998, 1999, 2000). Thus the variety, observed to have multiple resistance to major insect pests and diseases (Anonymous, 2004 a).

The salient features of the variety Bhogavati recorded at this research station are presented in Table 3. The variety has a mid-late duration (134-138 days), dwarf (85-90 cm), non-lodging plant type having high yield potential (40-45 q ha^{-1}). It has long slender grain type with medium test weight (24 g), long panicle, strong aroma.

Thus the variety Bhogavati was observed to be superior in yield over the popular varieties Indrayani and Pawana, indicating its stable yield performance in varied ecological situations in the state. Besides, the variety Bhogavati was also observed to be superior in grain quality and cooking qualities to the popular varieties.

In view of the high yield potential, good milling and cooking qualities, resistance to major diseases and insect pests, the variety IET 13549 (Bhogavati) was recommended for

Table 2b. Sensory evaluation of Bhogavati (IET 13549), Indrayani and Pawana.

Characteristics	Bhogavati	Indrayani	Pawana
Appearance	Very Good	Good	Good
Colour	Good	Good	Good
Taste	Very Good	Very Good	Good
Flavour	Excellent	Good	Good
Consistency	Very Good	Good	Good

Table 3. Salient features of variety Bhogavati (IET 13549).

Characters	Particulars
Days to 50 per cent flowering	105-110 days
Days to maturity	134-138 days
Plant height (cm)	85-90
Reaction to lodging	Non-lodging
Shattering habit	Non-shattering
Kernel length (mm)	6.90
Kernel breadth (mm)	1.94
Length / breadth ratio	3.55
Grain type	Long slender
Length of panicle (cm)	23
Spikelets per panicle	136
Sterility percentage	12.07
Yield potential (q ha^{-1})	40-45
Test weight (g)	24
Awns percentage	5
Aroma	Strong Scent
Reaction to major diseases	
i. Leaf blast	Resistant
ii. Neck blast	Resistant
iii. Leaf Scald	Moderately resistant
Reaction to major insect pest	
i. Stem borer	Moderately resistant

release for commercial cultivation in the state of Maharashtra during the year 2004 and released by State Variety Release Committee, Mumbai 2006. The variety Bhogavati has been notified by Ministry of Agriculture, vide Notification S.O. 1178 (E), 2007.

The new rice variety will meet the grain yield and quality requirement of the farmers. Similarly it also helps in increasing the rice production and productivity of the state and country through large scale adoption of this variety.

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Effectiveness of Hydrogen Cyanamide (Sangh Bud Break 50% S.L.) in Bud Sprouting of Thompson Seedless Grapes Under Western Maharashtra Conditions

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ABSTRACT

The results revealed that significantly the highest bud break (81.0 %), lowest period for bud sprouting from initiation (3.20 days), the highest length of berry (19.71 mm), T.S.S. (19.83 °Brix) and yield (13.77 kg vine^{-1} i.e. 30.56 MT ha^{-1}) was recorded by application of Hydrogen cyanamide (Sangh Bud Break (SBB) 50% S.L.) @ 3 per cent followed by treatment with SBB @ 2.5 per cent. The bud sprout (78.99 %) with the highest yield (14.88 kg vine^{-1} i.e. 33.03 MT ha^{-1}) was observed due to application of SBB @ 2.0 per cent. Therefore, the Hydrogen cyanamide (SBB 50% S.L.) was found better for the highest and uniform bud sprouting in Thompson Seedless grapes under Western Maharashtra conditions.

Key words : Bud sprouting, hydrogen cyanamide, sangh bud break, Thompson Seedless grape.

In grapes (*Vitis vinifera* L.), pruning is done twice a year, once after the harvesting of crop in April called back pruning, while the later is done in October called fruit pruning. Amongst the various operations, uniform bud sprouting at October pruning is supposed to be basic and very important. Hydrogen cyanamide (H_2CN_2), is a known plant growth chemical, used for increased and uniform bud breaking in grapes in tropical, sub-tropical and temperate areas of the world where grapes are grown (Shulman *et al*. 1983, Williams, 1987, George *et al*. 1988, Reddy and Shikhamani, 1889: Pandey, 1989, Tambe, 2002 and Ramteke *et al*. 2003).

At present, many vineyards are established on rootstocks in Maharashtra. In such vineyards, the uneven cane thickness strikingly observed. This results into reduced and uneven bud break at October pruning. It is, therefore, planed to find out the optimum dose of the H_2CN_2 (Sangh Bud Break (SBB) 50 % S.L.) to achieve early and uniform bud break and also to avoid the misuse of this chemical.

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MATERIALS AND METHODS

An effect of H_2CN_2 (SBB 50 % S.L. and CBB 50 % S.L.) was studied in two parts for bud break, yield and quality of Thompson Seedless grapes. In first part during 2006-07 and 2007-08, the trial of H_2CN_2 (SBB 50 % S.L.) was conducted at the research farm of Maharashtra State Grape Growers' Association, Manjri, Pune on 5 year old Thompson seedless vineyard grafted on Dogridge, planted at 4x2 m apart, trained on extended 'Y trellis and pruned by retaining the two buds of the sub cane of uniform cane thickness (8 to 10 mm) immediately after pruning. H_2CN_2 (SBB) was applied on 2 buds on sub-cane and 2 buds of main cane with a total of 4 apical buds by swabbing. All the canes on the vines were treated uniformly. The experiment was laid out in a randomized block design with seven treatments replicated three times. Pruning was done on 10th October during 2006 and 14th October during 2007 by retaining 8-10 buds (including two buds of sub-canes). Observations

were recorded on per cent bud sprouting, duration of sprouting, days taken for bud sprouting and berry quality parameters such as berry diameter, berry length, Total Soluble Solids (T.S.S.) and yield per vine. In second part during 2008-09, a multi-location trial of various concentrations of H_2CN_2 (SBB 50% S.L.) and Canpex Bud Break (CBB 50% S.L.) was conducted using Thompson seedless on own rooted grape vineyards on grower fields at Takali (Miraj) in Sangli, at Nannaj in Solapur and at the MRDBS research farm, Manjri, Pune. The trial was conducted in a randomized block design with 7 treatments replicated thrice. The pruning was done on 7th, 13th and 26th October, 2008 at Sangli, Pune and Solapur, respectively. H_2CN_2 (SBB and CNB) was applied on 2 buds on sub-cane and 2 buds of main cane with a total of 4 apical buds by swabbing immediately after pruning. All the canes on the vines were treated uniformly. Observations on per cent bud break, days taken for bud break and yield per vine in each treatment were recorded.

RESULTS AND DISCUSSION

Bud sprouting : The data (Table 1) revealed that there were significant differences in per cent bud break due to the application of H_2CN_2 (SBB 50 % S.L.) over untreated control. Significantly highest bud break (81.0%) was observed due to the application of 3 per cent SBB (T_6). However, it was at par with treatments T_4 (1.5% SBB) and T_5 (1.0% SBB). Treatment numbers T_1, T_2 and T_3 were significantly inferior to the above treatments T_6, T_5 and T_4. This observation is in agreement with George *et al*. (1988) who stated the favourable effect of H_2CN_2 on advancing bud break in Muscat Hamburg under the warm subtropical conditions of Queensland.

Duration of bud sprouting : All the treatments were significantly superior over control in respect of duration of bud sprouting. Though the treatment T_6 (3.0% SBB) resulted in significant lowest duration of bud sprouting over the rest of the treatments as well as untreated control, it was on par with T_4 and T_5 treatments. The duration of bud sprouting was reduced to 3.20 days when H_2CN_2 (SBB 50% S.L.) was applied at 3.0 per cent as against 9.28 days in untreated control. Tambe (2002) reported that the application of H_2CN_2 @ 25 ml per litre could hasten the maximum period of bud break (7.50 days).

Days taken from pruning to bud sprouting : The number of days for bud sprouting from pruning differed significantly over untreated control. The number of days

Table 1. Effect of Hydrogen cyanamide (Sangh Bud Break 50% S. L.) on bud breaking in Thompson Seedless grapes (Pooled mean).

Treatment	Conc. used (%)	Bud sprout (%)	Duration of bud sprouting from initiation to comp-letion (days)	Days taken for bud sprout from pruning
T_0 : Untreated	-	31.58^c	9.28^c	16.16^b
T_1 : SBB 50% S. L.	0.5	70.03^b	4.09^b	11.50^a
T_2 : SBB 50% S. L.	1.0	74.33^b	3.84^b	11.16^a
T_3 : SBB 50% S. L.	1.5	75.20^b	3.80^b	10.80^a
T_4 : SBB 50% S. L.	2.0	78.33^a	3.63^a	10.83^a
T_5 : SBB 50% S. L.	2.5	80.08^a	3.51^a	10.33^a
T_6 : SBB 50% S. L.	3.0	81.00^a	3.20^a	10.81^a
S. E.±		(1.80)	(0.20)	(0.56)
C. D. at 5%		(5.41)	(0.61)	(1.69)

Mean for two years. SBB 50% S. L. - Hydrogen cyanamide (Sangh Bud Break 50% S. L.)

Date of pruning	Temperature	
10-10-2006	32.4°C (Max)	12.3°C (Min)
14-10-2007	34.3°C (Max)	15.0°C (Min)

Figures were transformed by Arc sin values (% bud break) and square root transformations (Bud sprouting) for analysis and original values are given in table.

Means within columns lacking common superscript are significantly different at 5% by DMRT.

taken for bud sprouting decreased as the concentration of H_2CN_2 (SBB) increased. Significantly highest days were taken for sprouting in untreated control (16.16 days) as compared to all the treatments of the SBB (10.33 to 11.50 days). These results are in conformity with those reported by Reddy and Shikhamani (1990) who observed that H_2CN_2 @ 3.0 per cent dip treatment was superior over 4.5 per cent H_2CN_2 spray in regard to the number of days from pruning to budbreak.

Quality parameters and yield : The data (Table 2) indicated that there were significant differences in berry size due to application of H_2CN_2 (SBB 50% S.L.) over control. Significantly higher berry size (15.23 mm) was observed due to application of SBB at 0.5 per cent (T_1), but it was at par with T_2 (1.0%), T_3 (1.5%) and T_4 (2.0%) treatments. In respect of berry length and T.S.S., the data showed that there were no significant differences in these berry characters due to the application of H_2CN_2 (SBB 50% S.L.).

The yield was, however, influenced due to the application of H_2CN_2 (SBB 50% S.L.). Though the highest yield was recorded in treatment T_6 (13.77 kg vine^{-1} i.e. 30.56 MT ha^{-1}), it was at par with treatments T_5, T_4 and T_3 (Table 2). Significantly lower yield was recorded in T_2 and T_1. In control yield was significantly lowest (10.09 kg vine^{-1} i.e. 22.39 MT ha^{-1}). These results are in conformity with findings of Reddy and Shikhamani (1990) who reported that the yield increased in treated vines with application of H_2CN_2 over control. Tambe (2002) also recorded higher berry weight (3.45 g), bunch weight (423.25 g) and yield (12.21 kg vine^{-1} i.e. 27.10 MT ha^{-1}) due to application of H_2CN_2 @ 25 ml litre^{-1}. Further, he reported that there was no influence of H_2CN_2 on quality attributes like T.S.S., acidity and TSS/acidity ratio. However, he observed the highest T.S.S. with application of H_2CN_2@ 25 ml per litre (22.02 °Brix).

Table 2. Effect of Hydrogen cyanamide (Sangh Bud Break 50% S. L.) on berry quality parameters and yield of Thompson Seedless grapes (Pooled mean).

Treatment	Conc. used (%)	Berry diameter (mm)	Berry length (mm)	T. S. S. (°Brix)	Yield (kg vine^{-1})
T_0 : Untreated	-	13.42^b	18.00	17.70^b	10.09^b
T_1 : SBB 50% S. L.	0.5	15.33^a	18.92	18.34^a	11.50^b
T_2 : SBB 50% S. L.	1.0	15.23^a	19.10	18.30^a	11.92^b
T_3 : SBB 50% S. L.	1.5	15.20^a	19.34	18.83^a	12.54^a
T_4 : SBB 50% S. L.	2.0	14.83^a	19.54	18.90^a	13.14^a
T_5 : SBB 50% S. L.	2.5	14.17^b	19.75	19.53^a	13.45^a
T_6 : SBB 50% S. L.	3.0	14.16^b	19.71	19.83^a	13.77^a
S. E.±		(0.03)	(0.05)	(0.05)	0.62
C. D. at 5%		(0.10)	(NS)	(NS)	1.90

Mean for two years. SBB 50% S. L. - Hydrogen cyanamide (Sangh Bud Break 50% S. L.)

Date of pruning	Temperature	
10-10-2006	32.4°C (Max)	12.3°C (Min)
14-10-2007	34.3°C (Max)	15.0°C (Min)

Figures were transformed by square root (berry diameter, berry length and T. S. S.) for analysis and original values are given in table.

Mean within columns lacking common superscript are significantly different at 5% by DMRT

Trials at multi-locations : The data (Table 3) indicated that the application of H_2CN_2 (SBB and CBB, 50% S.L.) to canes significantly increased bud sprouting at all the doses as compared to untreated control. Significantly the highest per cent bud sprouting (78.99%) was recorded in treatment T_6 with the application of H_2CN_2 (SBB) @ 2.0 per cent followed by H_2CN_2 (CBB 50% S.L.) @ 2.0 per cent (T_3). The bud sprouting increased with higher concentrations of H_2CN_2 of both SBB and CBB (50% S.L.). The number of days required for bud sprouting from the date of

Table 3. Effect of Hydrogen cyanamide (Canpex Bud Break and Sangh Bud Break 50% S. L.) on bud break, days taken for bud sprouting and yield of Thompson Seedless grapes during 2008-09.

Treatment	Conc. used (%)	Bud sprout (%)				Days taken for bud sprout from pruning				Yield kg vine^{-1}			
		Sangli	Sola-pur	Pune	Pooled mean	Sangli	Sola-pur	Pune	Pooled mean	Sangli	Sola-pur	Pune	Pooled mean
T_0 : Untreated	-	31.33	35.00	28.16	31.50^{d}	12.66	12.33	11.66	12.55^{d}	11.00	12.00	10.00	11.00^{d}
T_1 : CBB 50% S. L.	1.0	68.76	70.16	34.06	67.66^{c}	9.33	9.00	8.66	8.99^{a}	12.33	14.00	12.00	12.77^{c}
T_2 : CBB 50% S. L.	1.5	70.96	79.33	72.66	74.31^{b}	10.66	11.33	9.66	10.55^{b}	13.33	15.00	13.33	13.88^{b}
T_3 : CBB 50% S. L.	2.0	80.63	80.66	75.00	78.76^{a}	10.66	11.66	10.33	10.88^{c}	14.00	14.66	14.00	14.22^{a}
T_4 : SBB 50% S. L.	1.0	65.80	66.00	64.33	65.37^{c}	8.93	9.00	8.00	8.64^{a}	12.66	13.66	11.00	12.44^{c}
T_5 : SBB 50% S. L.	1.5	76.73	76.00	73.40	75.24^{b}	9.66	10.66	9.33	9.88^{b}	14.00	15.33	13.00	14.11^{b}
T_6 : SBB 50% S. L.	2.0	80.66	78.00	78.33	78.99^{a}	10.33	11.00	10.00	10.44^{c}	14.66	15.66	14.33	14.88^{a}
S. E. ±					(0.84)				(0.03)				0.24
C. D. at 5%					(2.53)				(0.09)				0.72

CBB 50% S. L. - Hydrogen cyanamide (Canpex Bud Break 50% S.L.), SBB 50% S. L. - Hydrogen cyanmide (Sangh Bud Break 50% S. L.)

Temperature °C : Sangli : 33.4 (Max), 13.2 (Min) Solapur : 35 (Max), 14 (Min) Pune : 32 (Max), 12 (Min)

Figures were transformed by square root and Arc sin values (% bud break) for analysis and original values are given in table. Mean within columns lacking common superscript are significantly different at 5% by DMRT

pruning ranged between 8.64 to 10.88 days as compared to 12.55 days in control, indicating 2 to 3 days early sprouting of buds in H_2CN_2 treated canes with SBB as well as CBB. The data with respect to yield per vine showed significantly higher yield of 14.88 kg per vine i.e. 33.03 MT ha^{-1} with SBB application at 2.0 per cent (T_6). However, this treatment was on par with CBB (14.22 kg vine^{-1} i.e. 31.56 MT ha^{-1}).

The effectiveness of H_2CN_2 (CBB 50% S.L.) was at par with H_2CN_2 (SBB 50% S.L.) with regards to bud sprouting, duration of bud sprouting and yield kg vine^{-1} in Thompson Seedless under Sangli, Solapur and Pune conditions during 2008-09. The data on yield vine^{-1} indicated significant difference in H_2CN_2 (SBB and CBB) treatments and untreated check.

The results of the trials conducted at MSGGA farm, Manjri, Pune and at the multi-locations in Sangli, Solapur and Pune divisions clearly showed that H_2CN_2 either SBB or CBB (50% S.L.) promoted uniform and increased bud sprouting in Thompson Seedless grapes. These results are in agreement with those reported by Wicks *et al*. (1984), Shikhamani and Manjunath (1992) and Tambe (2002). H_2CN_2 at all the concentrations produced a slightly higher bud break in the vines treated in Solapur than Sangli and Pune. These differences may be attributed to the differences in temperatures in different areas. Similar results were also reported in multi-location trials conducted earlier by Shulman *et al*. (1983), Bracho *et al*. (1984), Frez (1995) and Or, *et al*.

(1999). The interaction between H_2CN_2 concentrations and atmospheric temperatures prevailing during bud break was observed by Shikhamani and Manjunath (1992). It was reported that at temperatures less than 18°C even higher concentration (3.0%) was not effective. Similarly, Nir *et al*. (1986) reported that both low temperatures and H_2CN_2 inhibit catalase activity in grapevine buds. Therefore, it is necessary to prune Thompson Seedless before the night temperature falls below 18°C under tropics to increase bud break with chemicals. However, Tambe (2002) observed that H_2CN_2 with various concentrations had significant influence on bud break at 30.84°C and 20.62°C maximum and minimum temperatures, respectively in Maharashtra.

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Response of Pigeonpea (cv. ICPL-87) to Phosphate Solubilizing Biofertilizers

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ABSTRACT

The inoculation of five phosphate solubilizing isolates recorded significant increase in plant dry matter, N and P uptake and grain yield of pigeonpea. The inoculation effect was maximum in respect of *Aspergillus niger*, and it was followed by *Aspergillus awamori*, *Bacillus* strain-1, *Aspergillus fumigatus* and *Bacillus* strain-2, respectively. The inoculation with fungal inoculant *Aspergillus niger*, recorded the maximum increase in plant dry matter of pigeonpea at flowering and harvesting i.e. 18.25 and 23.47 per cent respectively. Among the bacterial inoculants *Bacillus* strain-1 recorded the maximum increase in plant dry matter at flowering and harvesting i.e. 13.45 and 12.30 per cent, respectively. All the inoculants increased the grain yield from 12.10 to 15.50 g plant^{-1} with the increase in N and P uptake from 23.54 to 60.43 and 14.40 to 30.18 per cent, respectively over uninoculated treatment.

Key words : Phosphate solubilizing biofertilizer, *Fusarium oxysporum* f. sp. *udum*, pigeonpea wilt.

Pulses are an integral part of Indian agriculture and have been traditionally recognized as an indispensable constituent of Indian diet. Amongst the cultivated pulses pigeonpea (*Cajanus cajon* L.) known as arhar or tur or togari or redgram is one of the most widely grown pulse crop in India. According to recent investigation approximately 15-20 per cent of the fertilizer phosphorus is utilized by crop to which it is applied and rest gets fixed in the soil and becomes unavailable to plants (Wani, 1980 and Gaur, 1985). The soil microorganism like bacteria and fungi are known to play an important role in solubilizing phosphate in soil and making it available to plants (Arora and Gaur, 1979). Various bacteria and fungi in rhizosphere help in solubilizing P from phosphate in the soil. With this view, the present investigation was planned to see the response of pigeonpea crop to inoculation with the phosphate solubilizing microorganisms.

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MATERIALS AND METHODS

Using Pikovaskaya's medium, three fungal (*Aspergillus fumigatus*, *Aspergillus niger* and *Aspergillus awamori*) and two bacterial (*Bacilllus* strain-1 and *Bacillus* strain-2) isolates were obtained from pigeonpea rhizosphere. The five isolates were used for field experiment. The experimental work was conducted on the Instructional Farm Area of Post Graduate Institute, M.P.K.V., Rahuri during *kharif* season of 1999-2000. The fertilizers for pigeonpea crop were applied @ 25 kg N and 50 kg P_2O_5 ha^{-1}, nitrogen and phosphorus were applied through urea @ 99 g plot^{-1} and single super phosphate @ 583 g plot^{-1}, respectively.

Observations were recorded at flowering and harvesting on plant dry weight, N and P uptake and grain yield of pigeonpea crop. The N and P content were estimated by following the methods as described by Jackson (1971). The data estimated were subjected to statistical analysis (Panse and Sukhatme, 1967).

RESULTS AND DISCUSSION

Plant dry weight : The results on plant dry weight of pigeonpea (Table 1.) were significant for inoculation with P sources. The results obtained at flowering showed that *Aspergillus niger* recorded maximum plant dry weight i.e. 9.56 kg plot^{-1}, among the bacterial isolates Bacillus strain-1 recorded plant dry weight of 9.17 kg plot^{-1}. However, the uninoculated treatment recorded the least plant dry weight i.e. 8.08 kg plot^{-1}. The results recorded on plant dry weight at harvesting showd that *Aspergillus niger* recorded maximum plant dry weight i.e. 12.28 kg plot^{-1} and among the bacterial isolates *Bacillus* strain-1 recorded plant dry weight of 11.17 kg plot^{-1}. However, the uninoculated treatment recorded the least plant dry weight i.e. 9.95 kg plot^{-1}. The results are in conformity with the workers Rasal *et al*. (1988).

Nitrogen uptake : The results on nitrogen uptake by pigeonpea of flowering and harvesting were significant (Table 2). The inoculation with *Aspergillus niger* recorded significantly maximum N uptake at flowering and harvesting i.e. 329.27 and 308.88 mg plant^{-1}, respectively. Among the bacterial isolates *Bacillus* strain-1 recorded the significant N uptake at flowering and harvesting i.e. 280.78 and 261.35 mg plant^{-1}, respectively. However, control recorded least N uptake as compared to all inoculants at flowering and harvesting i.e. 205.23 and 198.56 mg plant^{-1}, respectively. In general, the N uptake of pigeonpea crop increased from 23.54 to 60.43 and 18.56 to 55.56 per cent at flowering and harvesting, respectively. The increase in nitrogen uptake due to inoculation with different P solubilizing fungi and bacteria has been reported in pea (Srivastava and Ahlawat, 1995).

Phosphorus uptake : The results on phosphorus uptake by pigeonpea at flowering and harvesting were significant. The inoculation with *Aspergillus niger* recorded significantly maximum P uptake at flowering and harvesting i.e. 19.88 and 15.76 mg plant^{-1}, respectively. Among the bacterial isolates *Bacillus* strain$_{-1}$ recorded the maximum P uptake at flowering and harvesting i.e. 18.89 and 14.91 mg

Table 1. Effect of phosphate solubilizing microorganisms on plant dry matter and grain yield of pigeonpea plant.

Inoculants	Plant dry weight				Grain yield	
	g plant^{-1}		kg plot^{-1}		g plant^{-1}	kg plot^{-1}
	Flowering	Harvesting	Flowering	Harvesting		
A. fumigatus	44.93^{e}	54.68^{e}	8.98^{e}	10.93^{d}	12.45^{d}	2.49^{d}
	(11.13)	(9.90)	(11.13)	(9.84)	(32.44)	(32.44)
A. niger	47.81^{a}	61.43^{a}	9.56^{a}	12.28^{a}	15.50^{a}	3.10^{a}
	(18.25)	(23.47)	(18.31)	(23.41)	(64.89)	(64.89)
A. awamori	46.12^{b}	58.56^{b}	9.22^{b}	11.71^{b}	14.10^{b}	2.82^{b}
	(14.07)	(17.70)	(14.10)	(17.68)	(50.00)	(50.00)
Bacillus strain-1	45.87^{b}	55.87^{e}	9.17^{b}	11.17^{e}	13.20^{e}	2.64^{e}
	(13.45)	(12.30)	(13.49)	(12.26)	(40.42)	(40.42)
Bacillus strain-2	43.75^{d}	53.06^{d}	8.75^{d}	10.61^{e}	12.10^{d}	2.42^{d}
	(8.21)	(6.65)	(8.29)	(6.63)	(28.72)	(28.72)
Control	40.43^{e}	49.75^{e}	8.08^{e}	9.95^{f}	9.40^{e}	1.88^{e}
	-	-	-	-	-	-

Note : Figures followed by different latters differ significantly. Figures in parenthesis indicate per cent increase over uninoculated control.

Table 2. Effect of phosphate solubilizing inoculant on nitrogen uptake and phosphorus uptake by pigeonpea plant.

Inoculants	N uptake (mg plant^{-1})		P uptake (mg plant^{-1})	
	Flowering	Harvesting	Flowering	Harvesting
A. fumigatus	265.66^{d}	249.70^{d}	18.25^{e}	14.55^{b}
	(29.44)	(25.75)	(19.51)	(18.48)
A. niger	329.27^{a}	308.88^{a}	19.88^{a}	15.76^{a}
	(60.43)	(55.56)	(30.18)	(28.33)
A. awamori	302.50b	283.67^{b}	19.50^{ab}	15.52^{a}
	(47.39)	(42.86)	(27.70)	(26.38)
Bacillus strain-1	280.78^{e}	261.35^{e}	18.89^{bc}	14.91^{b}
	(36.81)	(31.62)	(23.70)	(21.41)
Bacillus strain-2	253.56^{e}	235.43^{e}	17.47^{d}	13.79^{e}
	(8.21)	(18.56)	(14.40)	(12.29)
Control	205.23^{f}	198.56^{f}	15.27^{e}	12.28^{d}
S. E.±	2.69	1.62	0.23	0.16
C. D. at 5%	8.10	4.88	0.72	0.49

Note : Figures followed by different latters differ significantly. Figures in parenthesis indicate per cent increase over uninoculated control.

plant^{-1}, respectively. However, the control treatment recorded the least P uptake as compared to all inoculants at flowering and harvesting i.e. 15.27 and 12.28 mg plant^{-1}, respectively. In general the P uptake of pigeon pea crop increased from 14.40 to 30.18 and from 12.29 to 28.33 per cent at flowering and harvesting, respectively. Increase in the P uptake due to inoculation with P solubilizing microorganisms has been reported in pigeonpea (Modak *et al.* 1993). The present results are in close conformity with the earlier report (Modak *et al.* 1993 and Srivastava and Ahlawat, 1995).

Grain yield : The results on grain yield of pigeonpea were significant for inoculation with phosphate solubilizing microorganisms. The inoculation with *Aspergillus niger* recorded significantly maximum grain yield of 3.10 kg plot^{-1} and among the bacterial isolates *Bacillus* strain$_{-1}$ the grain yield was of 2.64 kg plot^{-1}. However, control recorded the least compared to all other inoculation i.e. 1.88 kg plot^{-1}. The increase in grain yield due to inoculation with different P solubilizing bacteria and fungi has been reported in pigeonpea (Mohammad, 1984) with which the present results, are in close agreement. The increased yield of pigeonpea could be attributed to the increase in accumulation of dry weight and enhanced nutrient uptake due to inoculation of phosphate solubilizing microorganisms.

The results in general suggest that the use of P solubilizing microorganisms helps in maximization of plant dry matter, N and P uptake and grain yield of pigeonpea crop.

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Response of Chilli (cv. Phule Jyoti) to Phosphate Solubilizing Biofertilizers*

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ABSTRACT

The inoculation of five phosphate solubilizing isolates and BNF culture recorded significant increase in plant dry matter, N and P uptake and yield of chilli. The inoculation effect was maximum in respect of *Aspergillus fumigatus*, followed by *A. niger* isolate-I, BNF culture, *A.niger* isolate-II, *Bacillus* sp. isolate-II and *Bacillus* sp. isolate-Ill, respectively. The inoculation with fungal inoculant *A. fumigatus* recorded the maximum increase in plant dry matter of chilli at flowering and harvesting i.e. 115.53 and 18.01 per cent respectively. Among the bacterial inoculants *Bacillus* isolate-II recorded the maximum increase in plant dry matter at flowering and harvesting i.e. 46.79 and 8.08 per cent respectively. All the inoculants increased the fruit yield of chilli from 5.42 to 20.46 with the increase in N and P uptake from 7.56 to 21.29 and 11.70 to 51.36 per cent, respectively over uninoculated treatment.

Key words : Phosphate solubilizing microorganisms, *Aspergillus fumigatus*, *Bacillus* isolate-II, *Bacillus* sp. isolate-III, *Capsicum annum* L.

Chilli also known as red pepper, hot pepper is the most important spices and solanaceous crop grown for its pungent fruits. According to recent investigation approximately 15-20 per cent of the fertilizer phosphorus is utilized by crop to which it is applied and rest gets fixed in the soil and becomes unavailable to plants (Wani, 1980 and Gaur, 1985). The soil microorganism like bacteria and fungi are known to play an important role in solubilizing phosphate in soil and making it available to plants (Wani *et al*. 1979). Various bacteria and fungi in rhizosphere help in solubilizing P from phosphate in the soil. With this view, the present investigation was planned to see the response of chilli crop to inoculation with the phosphate solubilizing microorganisms.

MATERIALS AND METHODS

Three fungal (*Aspergillus fumigatus*, *A. niger* Isolate-I and *A. niger* isolate-II) and two bacterial (*Bacillus* sp. isolate-II and *Bacillus* sp. isolate-III) isolates were obtained from chilli rhizosphere by using Pikovaskaya's medium. Standard culture of phosphate solubilizing organisms was obtained from Biological Nitrogen Fixation Scheme, Pune. The five isolates and standard culture from BNF were used for field experiment. The experimental work was conducted on the Instructional Farm Area of Post Graduate Institute, M.P.K.V., Rahuri during *kharif* season of 2003. The fertilizers for chilli crop were applied @ 100 kg N, 50 kg P_2O_5 and 50 kg K_2O ha^{-1} through urea, single super phosphate and muriate of potash respectively.

Observations were recorded at flowering and harvesting on plant dry weight, N and P uptake and fruit yield of chilli crop. The N and P content were estimated by following the

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methods as described by Jackson, (1971). The data estimated were subjected to statistical analysis (Panse and Sukhatme, 1967).

RESULTS AND DISCUSSION

Plant dry weight : The results on plant dry weight of chilli in g plant^{-1} and kg plot^{-1} (Table-1) were significant for inoculation with P sources. The results recorded at flowering showed that *Aspergillus fumigatus* recorded maximum plant dry weight i.e. 33.58 g plant^{-1}, among the bacterial isolates *Bacillus* sp. isolate-II recorded plant dry weight of 22.87 g plant^{-1} and standard culture (BNF) recorded plant dry weight of 26.69 g plant^{-1}. However, the uninoculated treatment recorded the least plant dry weight i.e. 15.58 g plant^{-1}. The results recorded on plant dry weight at harvesting shows that *A. fumigatus* recorded maximum plant dry weight i.e. 115.43 g plant^{-1} and among the bacterial isolates *Bacillus* sp. isolate-II recorded 105.71 g plant^{-1}. Standard culture from BNF recorded dry weight 109.32 g plant^{-1}. However, the uninoculated treatment recorded the least plant dry weight (97.81 g plant^{-1}).The results are in conformity with earlier reports recorded in connection with increase in dry weight of soybean due to inoculation with phosphate solubilizing cultures (Rasal *et al.,* 2004).

Table 1. Effect of phosphate solubilizing inoculants on plant dry weight of chilli crop.

Inoculants	Plant dry weight (g plant^{-1})	
	Flowering	Harvesting
Control	15.58^{f}	97.81^{f}
Fungal isolates :		
A. fumigatus	33.58^{a}	115.43^{a}
	(115.53)	(18.01)
A. niger isolate I	30.22^{b}	112.86^{b}
	(93.97)	(15.39)
A. niger isolate II	26.11^{c}	108.92^{c}
	(67.58)	(11.35)
Bacterial isolates :		
Bacillus sp. isolate II	22.87^{d}	105.71^{d}
	(46.79)	(8.08)
Bacillus sp. isolate III	19.91^{e}	101.36^{e}
	(27.79)	(3.62)
BNF culture	26.69^{c}	109.32^{v}
	(71.30)	(11.76)
S. E.±	0.675	0.671
C. D. at 5%	2.005	1.992

Figures followed by different letters differ significantly. Figures in parenthesis indicate per cent increase over control.

Nitrogen uptake : The results on nitrogen uptake by chilli at flowering and harvesting were significant (Table 2). The inoculation with *A. fumigatus* recorded significantly maximum N uptake at flowering and harvesting (10.22 and 87.63 mg plant^{-1}) respectively. Among the bacterial isolates *Bacillus* sp. isolate-II recorded the significant N uptake at flowering and harvesting (101.57 and 78.21 mg plant^{-1} respectively). Standard culture (BNF) recorded the significant N uptake at flowering and harvesting (104.58 and 81.94 mg plant^{-1} respectively). However, control recorded least N uptake as compared to all inoculants at flowering and harvesting (90.87 and 69.08 mg plant^{-1}, respectively). In general the N uptake of chilli crop increased from 7.56 to 21.29 and from 6.67 to 26.85 per cent at flowering and harvesting, respectively over uninoculated control. The increase in nitrogen uptake due to inoculation with different P solubilizing fungi and bacteria has been reported in pea (Srivastava and Ahlawat, 1995).

Phosphorus uptake : The results on phosphorus uptake by chilli at flowering and harvesting were significant (Table 2). The inoculation with *A. fumigatus* recorded significantly maximum P uptake at flowering and harvesting (47. 89 and 34.91 mg plant^{-1}, respectively) Among the bacterial isolates *Bacillus* sp. isolate-II recorded the maximum P uptake at flowering and harvesting (38.18 and

Table 2. Effect of phosphate solubilizing inoculants on nitrogen and phosphorus uptake of chilli crop.

Inoculants	N uptake of plant (mg plant^{-1})		P uptake of plant (mg plant^{-1})	
	Flowering	Harvesting	Flowering	Harvesting
Control	90.87$_e$	69.08$_e$	31.64	17.12
Fungal isolates :				
A. fumigatus	110.22^a	87.63^a	47.89^a	39.91^a
	(21.29)	(26.85)	(51.36)	(103.91)
A. niger isolate I	107.54^b	83.11^b	44.78^b	31.51^b
	(18.34)	(20.30)	(41.53)	(84.05)
A. niger isolate II	103.68^e	80.57^b	41.27^e	27.83^e
	(14.10)	(16.63)	(30.44)	(62.50)
Bacterial isolates :				
Bacillus sp. isolate II	101.57^e	78.21^d	38.18a	25.58^a
	(11.77)	(13.21)	(20.67)	(49.41)
Bacillus sp. isolate III	97.74d	73.69^d	35.34^b	22.64^b
	(7.56)	(6.67)	(11.70)	(32.24)
BNF culture	104.08^e	81.94^b	42.41^e	28.30^e
	(14.53)	(18.16)	(34.04)	(55.08)
S. E.±	0.834	0.764	0.674	0.831
C. D. at 5%	2.478	2.268	2.001	2.469

Figures followed by different letters differ significantly. Figures in parenthesis indicate per cent increase over control.

Table 3. Effect of phosphate solubilizing inoculants on plant dry weight of chilli crop.

Inoculants	Fruit yield tonnes ha^{-1}
Control	5.41e
Fungal isolates :	
A. fumigatus	6.50a (20.37)
A. niger isolate I	6.36a (17.77)
A. niger isolate II	6.01b (11.29)
Bacterial isolates :	
Bacillus sp. isolate II	5.81e (7.59)
Bacillus sp. isolate III	5.65d (4.62)
BNF culture	6.15b (13.88)
S. E.±	0.051
C. D. at 5%	0.151

Figures followed by different letters differ significantly. Figures in parenthesis indicate per cent increase over control.

25.58 mg plant^{-1}, respectively). Standard culture (BNF) recorded 42.41 and 28.30 mg plant^{-1} P uptake at flowering and harvesting respectively. However, the control treatment recorded the least P uptake as compared to all inoculants at flowering and harvesting (31.64 and 17.12 mg plant^{-1}, respectively). In general the P uptake of chilli crop increased from 11.70 to 51.36 and from 32.24 to 103.91 per cent at flowering and harvesting, respectively over control. Increase in the P uptake due to inoculation with P solubilizing microorganisms has been reported in pigeonpea (Modak *et al.,* 1993). The present investigations are in close conformity with the earlier worker.

Fruit yield : The results on fruit yield of chilli were significant for inoculation with phosphate solubilizing microorganisms (Table 3). The inoculation with *A. fumigatus* recorded significantly maximum fruit yield of 6.24 kg plot^{-1} and among the bacterial isolates *Bacillus* sp. isolate-II the fruit yield was of 5.57 kg plot^{-1}. Standard culture (BNF) recorded the fruit yield 5.90 kg plot^{-1}. However, control recorded the least as compared to all other inoculation (5.18 kg plot^{-1}). The increase in yield due to inoculation with different P solubilizing bacteria and fungi has been reported in chilli and bellari (Subbiah, 1994) with which the present results are in close agreement. The increased yield of chilli could be attributed to the increase in accumulation of dry weight and enhanced nutrient uptake due to inoculation of phosphate solubilizing microorganisms.

The results in general suggest, the use of P solubilizing microorganisms for maximum plant dry matter, N and P uptake and fruit yield of chilli crop.

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Management of Sunflower Necrosis Virus Disease

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ABSTRACT

Out of thirteen different treatment combinations, the seed treatment with imidacloprid 70 WS @ 5 g kg^{-1} seed followed by two sprays of imidacloprid 17.8 SL @ 0.0045 per cent at 20 and 30 days after sowing was found to be the most superior. This treatment recorded significantly lowest incidence of necrosis disease (1.31%), minimum thrips count (6.56 thrips $leaves^{-1}$) and highest seed yield (805 kg ha^{-1}) coupled with highest additional returns of Rs.4368/- and incremental benefit:cost ratio of 4.78.

Key words: Sunflower necrosis virus disease, tobacco streak virus, thrips management.

A new virus disease called sunflower necrosis disease (SND) was noticed for the first time in the country during 1997 at Bagepalley of Kolar district and around Bangalore in seed production plots (Singh *et al.* 1997). Subsequently, the disease has been reported in other parts of Karnataka, Arcot district of Tamil Nadu, Kurnool and Ranga Reddy district of Andhra Pradesh and in the districts, Jalna, Aurangabad, Latur and Akola in Maharashtra. Chander Rao *et al*. (2000) reported sunflower necrosis disease incidence varying from 5 to 70 per cent and yield losses ranging from 30-100 per cent on farmers' fields. The disease has become potential threat for sunflower cultivation in the above mentioned states. The sunflower necrosis disease is caused by an ilarvirus related to Tobacco streak virus (Bhat *et al*. 2002). The transmission studies indicated that the virus could be transmitted through sap/mechanical methods from sunflower to

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sunflower and sunflower to cowpea (Chander Rao *et al*. 2000). The disease is transmitted by the insect vector thrips (Anonymous, 2003).

With this background, the present investigation was undertaken on management of thrips transmitting sunflower necrosis virus disease by different management practices such as seed treatment and insecticide spray alone and in combination as well as rouging of affected plants up to flowering.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* season of 2003-04, 2004-05 and 2006-07 at Mulegaon Farm, Zonal Agricultural Research Station, Solapur. A total of thirteen treatments (Table 1) were evaluated in a randomized block design with three replications and a plot size of 2.70 x 4.50 m was maintained.

The seed treatment with imidacloprid 70 WS (*Gaucho*) @ 5 g kg^{-1} seed was given at the time of sowing. The sprays of imidacloprid 17.8 SL (*Confidor*) @ 0.0045 per cent and rouging of necrosis affected plants were done as per the treatment details. The observation on thrips count was taken at 10, 20 and 30 days after sowing. As the thrips population is favoured by temperature around 28-30°C and relative humidity above 80 per cent, the correlation of different weather parameters with thrips count during the years under report was worked out and presented in Fig. 1. The necrosis count was taken at 15, 30 and 45 days after sowing and the per cent disease incidence were calculated by using the formula suggested by Mayee and Datar (1986). The statistical analysis was done by transforming PDI values to the arc-sin (Fisher and Yates, 1963). The data on seed yield was also recorded at harvest. The economics of different treatments was also studied and presented in Table 3.

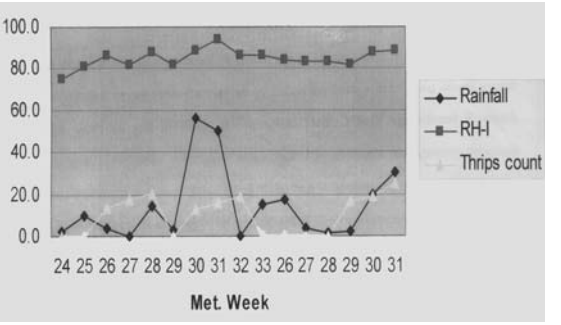

Fig. 1. Correlation of different weather parameters with thrips count

RESULTS AND DISCUSSION

The pooled data for three years in respect of incidence of sunflower necrosis virus disease, thrips count, seed yield and economics as influenced by seed treatment and sprays is presented in Table 1. The results of pooled data for three years revealed that the incidence of necrosis disease, thrips count and seed yield were significantly influenced due to different treatments.

The thrips count was correlated with the weather parameters during the crop growth for all the three years (Fig. 1). The correlation studies indicated that the rainfall, rainy days and relative humidity (RH-I and II) had positive correlation with thrips count whereas the maximum and minimum temperature had negative correlation. Thus, it was observed from three years weather data that the weather condition existing in 10 DAS (average 20.8 mm rainfall coupled with 86% relative humidity), 20 DAS (average 23.2 mm rainfall coupled with 88% relative humidity) and 30 DAS (average 14.9 mm rainfall coupled with 88% relative humidity) was most congenial for maximum thrips population of 14.44, 17.33 and 21.67 thrips $leaf^{-1}$, respectively, resulted in increased incidence of sunflower necrosis virus disease (2.37 to 7.08%) from 15 to 45 days after sowing in the control treatment.

Table 1. Effect of imidacloprid seed treatment and or spray on incidence of sunflower necrosis virus disease, thrips count, seed yield and economics.

Treatments	Disease incidence (%)			Thrips count (Av. of three leaves)			Seed yield (kg ha^{-1})	% increase in yield over control	Addl. yield over control (kg ha^{-1})	Addl. returns over control (Rs. ha^{-1})	Addl. expd. on treatment (Rs. ha^{-1})	IBC ratio
	15 DAS	30 DAS	45 DAS	10 DAS	20 DAS	30 DAS						
T_1	1.03 (5.74)	1.34 (6.49)	2.02 (8.00)	8.11	8.78	10.56	685	14.71	87.79	1848	293	6.31
T_2	1.98 (8.07)	1.98 (8.08)	2.72 (9.46)	9.22	10.11	11.44	641	7.36	43.90	924	310	2.98
T_3	1.22 (6.30)	2.16 (8.43)	2.50 (9.04)	9.0	9.44	10.67	690	15.56	92.82	1953	310	6.30
T_4	0.98 (5.63)	1.49 (6.87)	1.84 (7.67)	9.44	10.11	10.11	710	18.93	112.94	2373	620	3.83
T_5	1.18 (6.28)	1.78 (7.56)	2.19 (8.59)	8.11	10.44	10.56	656	9.89	58.99	1239	603	2.05
T_6	0.96 (5.60)	1.94 (7.98)	3.05 (9.92)	7.67	9.44	9.67	733	22.91	136.72	2877	603	4.77
T7	0.96 (5.56)	0.97 (5.59)	1.31 (6.64)	7.11	8.11	6.56	805	34.87	208.05	4368	913	4.78
T_8	0.98 (5.68)	1.28 (6.27)	1.90 (7.74)	8.78	9.67	11.22	698	17.01	101.51	2142	593	3.61
T_9	0.95 (6.47)	1.91 (7.91)	3.14 (10.17)	10.78	10.78	11.67	669	12.11	72.25	1512	610	2.48
T_{10}	1.30 (6.39)	2.19 (8.38)	2.49 (8.85)	10.0	12.0	12.44	674	13.03	77.73	1638	610	2.69
T_{11}	1.24 (6.42)	1.90 (7.90)	2.54 (8.96)	10.67	11.11	11.89	722	20.92	124.83	2625	920	2.85
T_{12}	2.18 (8.40)	3.23 (10.24)	4.68 (12.30)	12.0	12.44	17.78	626	4.98	29.72	630	300	2.10
T_{13}	2.37 (8.40)	4.22 (11.75)	7.08 (15.12)	14.44	17.33	21.67	597	-	-	-	-	-
S. E.±	0.37	0.34	0.42	0.42	0.42	0.40	23.16	-	-	-	-	-
C. D. at 5%	1.03	0.97	1.19	1.18	1.19	1.12	65.29	-	-	-	-	-
CV %	16.81	12.98	13.43	13.04	11.76	9.96	10.14	-	-	-	-	-

T_1 - S. T. with imidacloprid 70 WS @ 5 g kg^{-1} seed, T_2 - Spray imidacloprid 17.8 SL @ 0.0045% at 10 DAS, T_3 - Spray imidacloprid 17.8 SL @ 0.0045% at 20 DAS, T_4 - Spray imidacloprid 17.8 SL @ 0.0045% at 10 and 30 DAS, T_5 - S. T. with imidacloprid 70 WS + spray imidacloprid 17.8 SL at 20 DAS, T_6 - S. T. with imidacloprid 70 WS + spray imidacloprid 17.8 SL at 30 DAS, T_7 - S. T. with imidacloprid 70 WS + spray imidacloprid 17.8 SL at 20 and 30 DAS, T_8 - S. T. with imidacloprid 70 WS + rouging of affected plants upto flowering, T_9 - Spray imidacloprid 17.8 SL @ 0.0045% at 10 DAS + rouging, T_{10} - Spray imidacloprid 17.8 SL @ 0.0045% at 20 DAS + rouging, T_{11} - Spray imidacloprid 17.8 SL @ 0.0045% at 20 and 30 DAS + rouging, T_{12} - Rouging of affected plant upto flowering, T_{13} - Control (No seed treatment / No spray / No rouging)

Where, S. T. = Seed Treatments, IBC ratio = Incremental Benefit:Cost ratio. Market rates : Sunflower - Rs. 2100/q, Imidacloprid 70 WS (*Gaucha*) - Rs. 39/- per 5 g packet, Imidacloprid 17.8 SL (Confidor) - Rs. 2100/liter, Labour charges - Rs. 100/spray, Rouging charges - Rs. 100/rouging

The significantly lowest incidence of necrosis disease (1.31%) was observed in the treatment, seed treatment with imidacloprid 70 WS @ 5 g kg^{-1} seed followed by two sprays of imidacloprid 17.8 SL @ 0.0045 per cent at 20 and 30 days after sowing over control (7.08%). Similarly, significantly minimum thrips count (6.56 thrips $leaf^{-1}$) and maximum seed yield (805 kg ha^{-1}) was also recorded by the said treatment as compared to other treatments.

The economics of the treatments showed that the treatment, seed treatment with imidacloprid 70 WS @ 5 g kg^{-1} seed followed by two sprays of imidacloprid 17.8 SL @ 0.0045 per cent at 20 and 30 days after sowing recorded 34.87 per cent more seed yield coupled with highest additional returns of Rs.4368/- and IBC ratio of 4.78 over control.

The present investigations are in line with Harvir Singh *et al*. (2000) reported that seed treatment with imidacloprid 70 WS @ 5-7.5 g kg^{-1} of seed was found most effective to protect the crop from insect vector thrips during early stage of the crop. Further, Nagaraju *et al*. (2000) also carried out the field experiment on management of sunflower necrosis tospo virus through judicious use of insecticides and timely rouging of infected plants and reported that seed treatment combined with 3-4 prophylactic sprays of imidacloprid 17.8 SL (Confidor - 0.01%) at 15 days interval starting from 15 day old seedling up to 50 per cent flowering stage of the crop controls the insect vector thrips. Basappa (1999) also reported that the seed treatment with imidacloprid 70 WS @ 5, 7.5 and 10 g kg^{-1} of seed was found most effective with least number of sucking pests and lowest incidence of necrosis disease in *kharif* and *rabi* season. The overall results indicated that for effective and economical management of thrips transmitting sunflower necrosis virus disease, seed treatment with imidacloprid 70 WS @ 5 g kg^{-1} seed followed by two sprays of imidacloprid 17.8 SL @ 0.0045 per cent at 20 and 30 days after sowing under congenial climatic conditions (if rains received/high humidity above 82%) were found beneficial.

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Effect of Microbial Pre-Treatment on Hydrolysis of Fresh and Damaged Sorghum Grains on the Yield of Sugars

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ABSTRACT

In microbiological pre-treatment *Aspergillus niger* NCIM-616 showed maximum release of reducing sugars (62.49 mg g^{-1}), total sugars (88.26 mg g^{-1}) and non-reducing sugars (29.45 mg g^{-1}) followed by *A. awamorii* and *A. oryzae* in fresh sorghum grains. Among bacteria, *Bacillus* spp. recorded the highest reducing and total sugars of 36.60 and 70.37 mg g^{-1}, respectively in fresh sorghum grains. The insect damaged sorghum grains recorded highest reducing (41.4 mg g^{-1}) and total sugars (64.73 mg g^{-1}) as compared to mould infected sorghum grains in *A. niger* NCIM-616. Among the bacteria, *Bacillus* spp. recorded 50.58 mg g^{-1} of total sugars in a period of 48 h and 24.16 mg g^{-1} of reducing sugar after six days of incubation period.

Key words : Sorghum grains, microbial pretreatment, reducing sugars.

The biomass are mainly composed of cellulose, hemicelluloses, lignin, protein, starch etc. and various extraneous matter which are viable source for sugar. The physical and chemical properties of these compounds are dependent on tertiary structure and degrees of polymerization which is inversely related to solubility (Cooking and Brown, 1969).

Starch gelatinisation temperature is influenced by many factors, in particular the length of the various chains in the amylopectin molecule, with gelatinisation temperature increasing with longer chain length (Matsuki *et al*. 2003). The starch is a heterogeneous polysaccharides composed of two high molecular weight components called amylose and amylopectin linked by glycosidic linkages. These polysaccharides on hydrolysis could be broken into simple sugars. It is well established that certain fungi are able to saccharify the substrate through their enzymes, which cleave the complex polymer into simple sugars. The breakdown of starch resulted in the release of fermentable hexose sugar (glucose) and some pentose sugars like xylose, ribose, arabinose etc.

It is estimated by the Food Corporation of India (FCI) that 50 million t. of damaged grains are discarded in FCI godowns annually. A large quantity grains is spoiled every year in India because of unfavourable climatic conditions and inadequate transport and storage facilities. The damaged grains include discoloured, broken, cracked, attacked by fungi, insect damaged, chalky, dirty and grain with bad smell etc. (Suresh *et al*. 1999a). The present study was conducted to know the potentiality of such damaged sorghum grains as an alternate source for ethanol production. Hence, various pretreatment methods were tested for obtaining maximum reducing sugars.

MATERIALS AND METHODS

Four fungal cultures *viz*., *Aspergillus niger* NCIM-616, *Aspergillus awamorii*, *A. oryzae* NCIM-641 and *Pleurotus* ssp. obtained from the AICRP on RES and used for microbiological

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pre-treatment were maintained on potato dextrose agar (PDA) medium (Tuite, 1969). The starch hydrolyzing bacterial cultures *Agrobacterium* spp., *Bacillus* spp. and *Cellulomonas flavigena* were maintained on nutrient agar.

Fresh sorghum grains, insect damaged grains and mould infected sorghum grains were selected from the local market. The particle size was reduced to 2-00 mm and 0.5 mm (sievesize) by using mixer separately. The insect damaged and mould infected grains were selected based on >40 per cent of damage.

The initial starch content (Cleggh 1956) and reducing sugars content (Miller, 1959) were estimated individually.

The samples were weighed seperately and each of 25 g was taken in Erlenmeyer flask of 250 ml capacity seperately and was added at the ratio of 1:3 (substrate : water) and gelatinized at 121°C for 30 min. (Anthony and Heady, 1986). The four fungal strains were grown on PDA for 5 days. Four 10 mm culture slants along with agar bits were inoculated into each flask. The three bacterial strains were inoculated ® 1.5 x 10^7 CFU ml^{-1} and kept for incubation. The substrates were incubated at different periods of 2, 4, 6, & and 10 days at 30°C. The efficiency of the cultures was evaluated in terms of the reducing sugars which was estimated by DNSA method and total sugar estimated by Nelson's modification of Somogyi's method (Nelson, 1944).

RESULTS AND DISCUSSION

Initial starch and reducing sugars content of fresh and damaged sorghum grains were estimated and results are presented in Table 1.

The starch content was differed in fresh sorghum grain (64.68%), insect damaged sorghum grain (41.37%) and mould infected sorghum grain (33.88%). The initial reducing sugars of two particle size of 0.5 and 2.0 mm was estimated before and after heat treatment. The fresh sorghum grains (0.5 mm particle size) showed 2.20 mg g^{-1} reducing sugars before subjecting to heat treatment and 2.0 mm particle size of fresh sorghum grain recorded 1.94 mg g^{-1} reducing sugars which was less as compared to 0.5 mm size. After application of heat treatment, the fresh sorghum grain increased the reducing sugars 2.87 mg g^{-1} (0.5 mm particle size) and 2.28 mg g^{-1} (2.0 mm particle size). Similarly, the insect damaged sorghum grain recorded 0.91 mg g^{-1} reducing sugars (0.5 mm particle size) before heat treatment, the reducing sugars increased (1.76 mg g^{-1}) after heat treatment. The mould infected sorghum grains showed lesser reducing sugars compared to fresh and insect damaged sorghum grains.

Table 1. Initial starch and reducing sugars content of fresh and spoiled sorghum grains.

Sorghum grains	Starch content (%)	Initial reducting sugar (mg g^{-1})			
		Before autoclaving		After autoclaving	
		0.5 mm size	2.0 mm size	0.5 mm size	2.0 mm size
Fresh	64.68	2.20	1.94	2.87	2.28
Insect damaged	41.37	0.91	0.66	1.76	1.09
Mould infected	33.88	0.48	0.36	0.97	0.60

Among the different microbial cultures, *Aspergillus niger* NCIM-616 recorded (Table 2) significantly higher total sugars of 61.38 mg g^{-1} in two days of incubation period as compared to rest of treatments. The next best treatment in releasing total sugars was *Aspergillus owamorii* (59.93 mg g^{-1}) followed by *Aspergillus oryzae* NCIM-641 (45.26 mg g^{-1}). Among the bacterial cultures, *Bacillus*

Table 2. Effect of microbial pretreatment on hydrolysis of heat treated insect damaged sorghum grains (2.0 mm particle size) on the yield of reducing sugars, total sugars and non-reducing sugars (mg g^{-1}).

Starch hydrolyzing culture	Reducing sugar						Total sugar						Non-reducing sugars					
	Incubation (days)																	
	2	**4**	**6**	**8**	**10**	**Mean**	**2**	**4**	**6**	**8**	**10**	**Mean**	**2**	**4**	**6**	**8**	**10**	**Mean**
Cellulomonas flavigena	7.74	9.86	10.06	9.86	9.27	9.36	42.61	41.06	38.05	38.18	37.64	39.51	34.87	31.25	27.99	28.32	28.37	30.15
Agrobacterium spp.	7.85	9.43	9.67	9.54	9.16	9.13	45.91	43.36	42.44	42.15	41.81	43.13	38.06	33.93	32.77	32.61	32.65	34.00
Bacillus spp.	13.67	15.56	16.95	16.62	16.16	15.79	50.76	50.26	48.26	48.09	47.85	49.04	37.09	34.73	31.31	31.47	31.69	33.25
Pleurotus spp.	5.87	6.25	8.03	8.71	8.19	7.41	42.27	41.85	38.93	38.43	38.15	39.93	36.40	35.61	30.95	29.72	29.96	32.52
Aspergillus oryzae NCIM-641	8.86	10.56	11.62	11.82	11.28	10.83	45.26	45.07	44.85	43.15	42.77	44.22	36.45	34.51	33.23	31.33	31.49	33.39
A. awamorii	25.14	26.53	29.35	28.88	28.13	27.61	59.93	58.83	57.21	56.91	56.56	57.89	34.79	32.37	27.86	28.03	28.43	30.28
A. niger NCIM-616	30.16	30.64	31.68	31.26	30.86	30.92	61.38	59.84	58.37	58.15	57.93	59.14	31.22	29.28	26.69	26.89	27.07	28.21
Uninoculated control	1.57	1.59	1.60	1.61	1.63	1.60	18.37	18.34	18.34	18.30	18.29	18.33	16.80	16.75	16.74	16.69	16.66	16.73
Mean	12.61	13.80	14.87	14.79	14.34		45.81	44.83	43.31	42.92	42.62		33.20	31.02	28.44	28.13	28.29	
		SEm±		CD (P = 0.01)			SEm±		CD (P = 0.01)		SEm±	CD (P = 0.01)						
Incubation days (A)		0.006		0.022			0.007		0.025		0.037	0.138						
Starch hydrolyzing culture (B)		0.008		0.028			0.008		0.031		0.047	0.174						
A x B		0.017		0.063			0.019		0.070		0.104	0.390						

Table 3. Effect of microbial pretreatment on hydrolysis of heat treated insect damaged sorghum grains (0.5 mm particle size) on the yield of reducing sugars, total sugars and non-reducing sugars (mg g^{-1}).

Starch hydrolyzing culture	Reducing sugar						Total sugar						Non-reducing sugars					
	Incubation (days)																	
	2	**4**	**6**	**8**	**10**	**Mean**	**2**	**4**	**6**	**8**	**10**	**Mean**	**2**	**4**	**6**	**8**	**10**	**Mean**
Cellulomonas flavigena	13.46	14.67	15.03	14.60	14.26	14.40	45.37	44.66	42.75	42.26	42.04	43.41	31.92	30.06	27.71	27.64	27.86	29.04
Agrobacterium spp.	9.83	11.87	12.15	11.86	11.39	11.42	43.05	41.36	38.76	38.19	37.83	39.84	33.18	29.46	26.65	26.32	26.44	28.41
Bacillus spp.	20.84	23.22	24.16	23.83	23.33	23.08	50.58	48.61	47.90	47.28	46.86	48.25	29.73	25.44	23.72	23.47	23.56	25.18
Pleurotus spp.	5.23	7.73	9.02	10.39	10.15	8.50	42.13	40.36	38.71	37.38	37.14	39.14	36.86	32.61	29.65	27.03	26.93	30.62
Aspergillus oryzae NCIM-641	18.45	20.65	22.28	23.17	22.86	21.48	51.32	50.26	49.66	48.33	48.06	49.52	32.81	29.63	27.43	25.17	24.91	27.99
A. awamorii	36.84	37.34	39.87	39.57	39.25	38.57	65.86	64.55	62.44	62.24	61.93	63.40	29.05	27.25	22.65	22.71	22.76	24.88
A. niger NCIM-616	38.17	39.39	41.42	41.14	40.75	40.17	64.73	62.60	59.36	59.21	58.91	60.96	26.53	23.24	17.93	18.05	18.15	20.78
Uninoculated control	2.29	2.32	2.33	2.33	2.35	2.32	20.57	20.53	20.54	20.51	20.52	20.54	18.29	18.25	18.25	18.17	18.14	18.23
Mean	18.14	19.65	20.78	20.86	20.55		47.95	46.62	45.02	44.43	44.16		29.80	26.99	24.25	23.57	23.60	
		SEm±		CD (P = 0.01)			SEm±		CD (P = 0.01)		SEm±	CD (P = 0.01)						
Incubation days (A)		0.006		0.022			0.007		0.025		0.006	0.024						
Starch hydrolyzing culture (B)		0.007		0.028			0.008		0.031		0.008	0.030						
A x B		0.017		0.062			0.019		0.070		0.018	0.067						

spp. recorded the highest total sugars of 50.76 mg g^{-1}, next best was *Agrobacterium* spp. (45.91 mg g^{-1}) in two days of incubation period. The total sugars decreased significantly with increase in incubation days. All the inoculated treatments showed higher sugars content as compared to uninoculated control (18.37 mg g^{-1}).

Among the different fungal cultures *Aspergillus niger* NCIM-616 gave significantly higher reducing sugars of 31.68 mg g^{-1} in six days of incubation period. The next best treatment in releasing reducing sugars was *Aspergillus awamorii* (29.35 mg g^{-1}) with six days incubation period followed by *Aspergillus oryzae* NCIM-641, (11.82 mg g^{-1}) in eight days of incubation period as compared to control (1.60 mg g^{-1}). Bacterial cultures recorded lesser reducing sugars as compared to fungal cultures. *Bacillus* spp. yielded 16.95 mg g^{-1} of reducing sugars in six days of incubation period, followed, by *Cellulomonas flavigena* (10.06 mg g^{-1}). The fungal and bacterial cultures showed high reducing sugars in six days of incubation except *Aspergillus oryzae* NCIM-641 and *Pleurotus* spp. Which released higher reducing sugars in eight days of incubation period and there after it was decreased in reducing sugars.

The interaction effect between starch hydrolyzing culture and incubation period was significant on non-reducing sugars content of insect damaged sorghum grains (2.0 mm particle size). The *Aspergillus oryzae* NCIM-641 and *Pleurotus* spp. had shown high non-reducing sugars of 36.45 and 36.40 mg g^{-1} in 2 days of incubation period. *Aspergillus niger* NCIM-616 had shown less amount of non-reducing sugars (26.69 mg g^{-1}) as compared to 6 days of incubation period, followed by *A. awamorii* (27.86 mg g^{-1}). Among the bacteria, *Agrobacterium* spp. recorded high non-reducing sugars of (38.06 mg g^{-1}) as compared

Table 4. Effect of microbial pretreatment on hydrolysis of heat treated fresh sorghum grains (0.5 mm particle size) on the yield of reducing sugars, total sugars and non-reducing sugars (mg g^{-1}).

Starch hydrolyzing culture	Reducing sugar						Total sugar						Non-reducing sugars					
	Incubation (days)																	
	2	4	6	8	10	Mean	2	4	6	8	10	Mean	2	4	6	8	10	Mean
Cellulomonas flavigena	22.78	23.91	24.82	24.09	23.70	23.86	63.44	62.27	59.25	59.17	58.62	60.55	40.65	38.36	34.60	34.53	34.94	36.62
Agrobacterium spp.	15.73	16.41	17.27	16.35	15.47	16.25	67.06	65.64	64.85	64.38	64.07	65.20	51.35	49.25	47.64	48.07	48.55	48.97
Bacillus spp.	33.66	35.71	36.60	35.88	35.64	35.50	70.37	69.35	67.55	67.16	66.85	68.25	36.66	33.66	30.62	30.54	31.26	30.55
Pleurotus spp.	18.81	20.23	21.66	22.38	22.25	21.06	58.28	57.86	54.65	53.82	53.27	55.58	39.45	37.64	33.06	31.57	30.93	34.53
Aspergillus oryzae NCIM-641	28.34	30.85	31.38	31.66	31.26	30.70	63.92	61.63	58.45	57.17	56.85	59.60	35.55	30.74	27.16	25.84	25.24	28.91
A. awamorii	50.50	52.44	54.66	53.75	53.25	52.92	82.45	81.55	78.52	78.46	78.27	79.85	31.85	29.07	23.86	24.66	25.05	26.90
A. niger NCIM-616	57.17	61.33	62.49	62.07	61.74	60.96	88.26	86.65	84.72	84.65	84.16	85.69	29.45	24.35	22.34	22.57	22.45	24.23
Uninoculated control	3.51	3.54	3.56	3.57	3.59	3.57	24.38	24.34	24.32	24.29	24.26	24.30	20.91	20.87	20.85	20.83	20.80	20.78
Mean	28.80	30.55	31.56	31.24	30.86		64.77	63.66	61.54	61.13	60.79		35.73	32.99	28.75	29.81	29.89	

	Reducing sugar SEm±	Reducing sugar CD (P = 0.01)	Total sugar SEm±	Total sugar CD (P = 0.01)	Non-reducing sugars SEm±	Non-reducing sugars CD (P = 0.01)
Incubation days (A)	0.095	0.355	0.057	0.214	0.576	2.151
Starch hydrolyzing culture (B)	0.120	0.450	0.073	0.271	0.729	2.721
A x B	0.269	1.005	0.162	0.605	1.630	6.084

to all other treatments in two days of incubation period.

The 0.5 mm particles of all three substrates were also subjected to microbial hydrodyses showed maximum reducing sugars, total sugars and non-reducing sugars as compared to 2.00 mm size. Hence, only 0.5 mm particle size was used in further study as surface area to volume ratio is large for the microorganisms to act upon easily and produce maximum sugars.

The inoculation effect of different microbial cultures in release of total sugars in insect damaged sorghum grains is presented in Table 3. The damaged grains inoculated with *Aspergillus niger* NCIM-616 showed highest total sugar yield (64.73 mg g^{-1}) in two days of incubation, followed by *A. awamorii* (65.86 mg g^{-1}) and *A. oryzae* NCIM-641 (51.32 mg g^{-1}). Among the bacteria, *Bacillus* spp. recorded total sugars of 50.58 mg g^{-1}. The next best treatment in releasing total sugars was *Cellulomonas flavigena* (45.37 mg g^{-1}). The total sugars decreased significantly with increase in incubation period. All the culture treatments showed highest total sugar content as compared to uninoculated control (20.57 mg g^{-1}).

The highest reducing sugars (Table 3) was recorded when insect damaged sorghum grains pre-treated with *A. niger* NCIM-616 (41.42 mg g^{-1}) followed by *A. awamorii* (39.87 mg g^{-1}), *A. oryzae* NCIM-641 (22.28 mg g^{-1}) in six days of incubation period. *Bacillus* spp. bacteria showed highest reducing sugars yield of 24.16 mg g^{-1} as compared to other bacteria and uninoculated control (2.33 mg g^{-1}).

Among the fungal and bacterial cultures, insect damaged sorghum grains inoculated with *Agrobacterium* spp. recorded highest non-reducing sugars (33.18 mg g^{-1}) followed by *Cellulomonas flavigena* (31.92 mg g^{-1}) in two

Table 5. Effect of microbial pretreatment on hydrolysis of heat treated mould infected sorghum grains (0.5 mm particle size) on the yield of reducing sugars, total sugars and non-reducing sugars (mg g^{-1}).

Starch hydrolyzing culture	Reducing sugar						Total sugar						Non-reducing sugars					
	Incubation (days)																	
	2	4	6	8	10	Mean	2	4	6	8	10	Mean	2	4	6	8	10	Mean
Cellulomonas flavigena	7.26	9.45	10.13	9.83	9.39	9.21	42.35	40.62	39.84	39.37	39.26	40.29	35.09	31.17	29.71	29.54	29.87	31.08
Agrobacterium spp.	7.56	8.29	8.35	8.23	8.07	8.10	43.05	40.88	38.93	38.35	38.18	39.88	35.49	32.59	30.58	30.12	30.11	31.78
Bacillus spp.	17.24	18.38	20.25	20.17	19.87	19.18	44.55	43.42	41.94	41.27	40.93	42.42	27.31	25.04	21.69	21.10	21.06	23.24
Pleurotus spp.	6.39	7.86	9.16	9.35	9.19	8.39	38.39	36.54	34.70	33.35	33.09	35.21	32.00	28.68	25.54	24.00	23.90	26.82
Aspergillus oryzae NCIM-641	7.65	9.35	10.13	11.26	11.14	9.91	44.16	41.35	40.42	40.14	39.96	41.21	36.51	32.00	30.29	28.88	28.82	31.30
A. awamorii	30.29	31.91	33.56	33.28	33.05	32.42	52.22	50.46	47.35	47.18	46.83	48.81	21.93	18.55	13.79	13.90	13.78	16.39
A. niger NCIM-616	33.54	34.33	35.85	35.56	35.15	34.89	55.25	53.23	51.41	51.24	50.85	52.40	21.71	18.90	15.56	15.68	15.70	17.51
Uninoculated control	1.77	1.80	1.81	1.83	1.85	1.81	17.76	17.75	17.73	17.70	17.69	17.73	15.99	15.95	15.92	15.87	15.84	15.91
Mean	13.96	15.17	16.15	16.19	15.96		42.22	39.04	39.04	38.57	38.35		28.25	25.36	22.89	22.39	22.39	

	SEm±	CD (P = 0.01)	SEm±	CD (P = 0.01)	SEm±	CD (P = 0.01)
Incubation days (A)	0.006	0.022	0.006	0.021	0.006	0.023
Starch hydrolyzing culture (B)	0.007	0.028	0.007	0.027	0.008	0.029
A x B	0.017	0.062	0.016	0.060	0.017	0.065

days of incubation period. The fungi *Pleurotus* spp. recorded highest non-reducing sugars of 36.86 mg g^{-1} of substrate compared to all other treatments. *A. niger* NCIM-616 recorded the lowest non-reducing sugar yield of 17.93 mg g^{-1} compared to all other treatments in six days of incubation period.

The total sugar content decreased with increase in incubation period upto 10 days (Table 4). The highest total sugar content observed in fresh sorghum grains pre-treated with fungus *Aspergillus niger* NCIM-616 (88.26 mg g^{-1}) in two days of incubation period, followed by *A. awamorii* (82.45 mg g^{-1}) and *A. oryzae* NCIM-641 (63.92 mg g^{-1}). The *Pleurotus* spp. recorded lowest yield of total sugar content (53.27 mg g^{-1}) in ten days of incubation as compared to all Other bacterial and fungal cultures. Two days of incubation period recorded the highest total sugars content.

Among the fungal cultures *A. niger* NCIM-616 showed the maximum reducing sugars yield (62.49 mg g^{-1}) followed by *A. awamorii* (54.66 mg g^{-1}) in six days of incubation (Table 4). The bacteria *Bacillus* spp. recorded the high sugars 36.60 mg g^{-1} followed by *Cellulomonas flavigena* (24.82 g^{-1}), *Agrobacterium* (17.27 mg g^{-1}) in six days of incubation.

The interaction effect between the cultures and incubation period was significant in non-reducing sugar content. *Agrobacterium* spp. recorded highest non-reducing sugar (51.35 mg g^{-1}) as compared to all other treatments in two days of incubation period. The fungi *A. niger* NCIM-616 recorded lowest non-reducing sugars content (22.34 mg g^{-1}) in six days of incubation.

The *Aspergillus niger* NCIM-616 cultures recorded the highest total sugar (55.25 mg g^{-1}) as compared to all other treatments along with control in two days of incubation. The next best treatment was *Aspergillus awamorii* (52.22 mg g^{-1}). Among the bacteria, *Bacillus* spp. recorded highest total sugar (44.55 mg g^{-1}) as compared to other bacteria in two days of incubation. The decline in total sugar contect was noticed with increased incubation.

The mould infected sorghum grains inoculated with *A. niger* NCIM-616 fungi recorded significantly maximum reducing sugar (35.85 mg g^{-1}) compared to rest of the treatments (Table 5) in six days of incubation. The next best treatment in releasing reducing sugar was *A. awamorii* (33.56) in six days of incubation period followed by *A. oryzae* NCIM-641 (11.26 mg g^{-1}) and *Pleurotus* spp. (9.35 mg g^{-1}) in eight days of incubation period. Among the bacteria *Bacillus* spp. recorded the highest reducing sugar (20.25 mg g^{-1}) followed by *Cellulomonas flavigena* (l0.l3 mg g^{-1}) in six days of incubation period.

Among the different fungal cultures mould infected grains inoculated with *A. oryzae* NCIM-641 showed the highest (36.51 mg g^{-1}) non-reducing sugar. The *A. niger* NCIM-616 showed the lowest (2l.71 mg g^{-1}) non-reducing sugars compared to bacterial and fungal cultures. Among the bacteria *Agrobacterium* spp. recorded the highest non-reducing sugar (35.49 mg g^{-1}) in two days of incubation period. The non-reducing sugars decreased significantly with increase in incubation period upto ten days.

Tanaka *et al.* (1986) used *A. awamorii* aerobic amylolytic organism to hydrolyse starch and the organism showed 80 per cent hydrolysis efficiency. Zayed and Meyer (1996) examined *Trichoderma viridae* and *A. niger* for their ability to produce fermentable sugars from lignocellulosic waste and achieved reducing sugar extraction of 27 g from 50 g

wheat straw at 25-30°C within three days.

Marakis and Marakis (1996) obtained water soluble sugars in the aqueous carbon extract consisting of sucrose (77%), fructose (13.9%) and glucose (9%) with total water soluble sugars content of 54.7 per cent on dry weight basis.

The mould infected sorghum grains recorded the least reducing sugars compared to fresh and insect damaged sorghum grains. The reason could be that in mould infected sorghum grains due to many biochemical changes, the sugar might have lost or the possibility of the fungi utilizing sugars for its growth. However, the insect damaged sorghum grains yield considerable amount of reducing sugar which can be more suitable for further conversion ethanol.

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Evaluation of Different Fungicides Against Downy Mildew (*Plasmopara viticola*) of Grapes in Maharashtra

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ABSTRACT

The downy mildew on grape was significantly reduced by systemic fungicides like Metalaxyl 35 WS @ 2.5 g l^{-1} and Fosetyl 80 WP @ 2.0 g l^{-1} which resulted into the higher yields of 15.04 kg and 14.29 kg $vine^{-1}$, respectively.

Key words : Downy mildew, fungicides, grapes.

Downy mildew caused by *Plasmopara viticola* (Berk and Curtis) is a major disease of grapes in all viticulture areas of Maharashtra. In most grape growing districts of the state, it causes severe crop loss each year particularly in wet years to the extent of complete crop loss in some vineyards (Anonymous, 2005-06). Applications of Copper or Mancozeb fungicides are recommended for its control before or after infection (Wicks and Lee, 1982). The objective of this study was to evaluate comparative efficacy of different newer systemic and non systemic fungicides against *P. viticola* after infection.

MATERIALS AND METHODS

The trials were conducted in a randomized block design with three replications on six years old Thompson seedless grape planted at 4 x 2 m apart and grafted on Bangalore Dogridge rootstock at the research farm of Maharashtra Rajya Draksh Bagaitdar Sangh, Manjri, Pune during 2005-06, 2006-07 and 2007-08 fruiting seasons. The systemic fungicides *viz*., Metalaxyl (Methyl N-(methoxyacetyl)-N-(2,6-xylyl)-DL-alaninate), Fosetyl (Aluminium tris-O-ethyl phosphorate) and Dimethomorph (4-(3-(4-clorophenyl)-3-(3,4-dimethoxyphenyl)-l-oxo-2-propeny) morpholine), while non systemic fungicides like Mancozeb (ethylene-1, 2-bisdithiocarbamate polymer), Captan (N-(tricloromethylthio) cyclohex-4 ene-l,2-dicarboximide) and Ziram (Zinc bis(dimethyldithiocarbamate) were tested against the disease. The first spray was given when the climatic conditions were favourable i. e. average temperature and relative humidity around 20 °C and 70 per cent, respectively with rainfall of 50 mm and cloudy overcast during the 5th leaf stage of vine growth. Subsequently, three more sprays were given at 10 days interval. An unsprayed control treatment was routinely included for comparison. The data on the disease severity was recorded 7 days after last spray, adopting ratings in 0-4 scale (Anonymous, 2005-06) *viz*., 0 = No disease infection, 1=25 per cent leaf area infection, 2=50 per cent leaf area infection, 3=75 per cent leaf area infection, 4=Above 75 per cent leaf infection. Per cent disease intensity (PDI) was calculated by using following formula:

$$PDI = \frac{\text{Sum of numerical ratings} \times 100}{\text{No. of leaves observed} \times \text{maximum rating}}$$

1. President and 2. Farm Manager.

RESULTS AND DISCUSSION

The three years pooled data presented in Table 1 showed that all the fungicides were significantly effective in reducing severity of downy mildew on grapes compared to untreated check. Similarly, all the fungicidal treatments showed significant differences within treatments.

Among the systemic fungicides, Metalaxyl 35 WS @ 2.5 g l^{-1} was the most effective and significantly superior to rest of treatments wherein 9.97 PDI was recorded as against 77.17 PDI in untreated control. Metalaxyl was closely followed by the sprays of Fosetyl 80 WP @2.0 g l^{-1} and Dimethomorph 50 WP @ 2.5 g l^{-1} showing 13.30 and 17.42 PDI, respectively, which were at par with each other.

All the non systemic fungicides *viz*., Mancozeb, Captan and Ziram were at par showing 24.50, 25.83 and 29.83 PDIs, respectively and statistically inferior to systemic ones, but superior over control.

As regards the yield per vine, all the fungicidal treatments were significantly superior to untreated control. The maximum yield of 15.04 kg $vine^{-1}$ was recorded in Metalaxyl 35 WS which was followed by Fosetyl 80 WP (14.29 kg $vine^{-1}$) treatment, however, both these treatments were at par. Remaining all fungicidal treatments also resulted into statistical variations in yield over control (8.29 kg $vine^{-1}$).

These results indicated that the application of systemic fungicides significantly reduced the incidence of *P. viticola* on grape leaves. In the tests, Metalaxyl 35 WS provided more protective activity against downy mildew. The efficacy of fungicides obtained in the present study is in agreement with the earlier workers (Wicks and Lee, 1982; Cohen and Coffey, 1986; Wicks *et al*. 1987; Magarey *et al*. 1991; Wicks *et al*. 1999 and Wong and Wilcox, 2001). Efficient use of either of these fungicides will rely on the development of disease forecasting systems that monitor climatic conditions and accurately predict the occurrence of *P. viticola* on grapes. However, in many viticulture areas accurate disease forecasting systems are not yet available and under this situation the only alternative is to apply the fungicide sprays within a few days before the start of an infection period.

Table 1. Bio-efficacy of different fungicides against downy mildew of grapes during 2005 to 2008.

Treatments	PDI on grapes leaves	Fruit yield (kg $vine^{-1}$)
Untreated control	77.17^{d}	8.29^{e}
Metalaxy 35 WS (2.5 g l^{-1})	9.97^{a}	15.04^{a}
Fosetyl 80 WP (2.0 g l^{-1})	13.30^{ab}	14.29^{ab}
Dimethomorph 50 WP (2.5 g l^{-1})	17.42^{b}	13.78^{b}
Mancozeb 75 WP (2.0 g l^{-1})	24.50^{c}	12.38^{c}
Captan 75 WP (2.5 g l^{-1})	25.83^{c}	11.58^{c}
Ziram 80 WP (2.0 g l^{-1})	29.83^{c}	10.33^{d}
S. E.±	1.80	0.40
C. D. at 5%	5.56	1.20

All the figures in table are pooled mean of three replications and years. Means within columns lacking common superscript are significantly differ at 5 per cent.

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Evaluation of Insecticides Against Pink Mealy Bugs and Thrips in Grape Ecosystem in Maharashtra

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ABSTRACT

Two foliar applications of imidacloprid 17.8 SL (0.30 ml l^{-1}) and thiamethoxam 25 WG (0.25 g l^{-1}) reduced the pink mealy bugs and thrips population on grapevines and bunches with significant increase in fruit yield. Moreover, there were no adverse effects on naturally occurring predatory (coccinellid) stages *viz*., grubs and beetles.

Key words: Grapes, insecticides, pink mealy bugs, thrips.

Pink mealy bugs (*Maconellicoccus hirsutus* (Green) and thrips, (*Scirtothrips dorsalis* Hood) are serious pests in grape cultivation in Maharashtra and cause both qualitative and quantitative losses. The infested bunches become unfit for human consumption as well as marketing. Until now, many pesticides have been tested and employed for their management, but these pests found difficult to control. On the contrary, the use of pesticides is discouraged in grape vineyards due to residue problems. In the present study, some safer insecticides have been evaluated against nymphs and adults of mealy bugs and thrips under field conditions and their safety to predatory coccinellid population.

MATERIALS AND METHODS

The experiment was conducted in fruiting season during October to March, 2008 - 2009 on 5-years-old Tas - A - Ganesh grape variety trained to "Y" system at the research farm of Maharashtra State Grape Growers' Association, Manjri, Pune. The trial was laid out in a randomized block design with six treatments replicated four times. The block was pruned on 11th October, 2008. The treatments consisted newer insecticides like imidacloprid 17.8 SL, thiamethoxam 25 WG, botanical azadirachtin 1 per cent compared with carbaryl 50 WP and malathion 50 EC as conventional insecticide checks, besides untreated control. The spray fluid used was 500 l ha^{-1}. The insecticides were sprayed twice at 15 days interval using a high volume sprayer. Treatments were imposed at high population levels of mealy bugs and thrips after October pruning.

Observations on mealy bug colonies on vines and bunches were recorded a day before

1. Research and Development Officer and 2. President

and 3, 7 and 14 days after 1st and 2nd sprays with a sample size of three vines in each treatment. Whereas, population of nymphs and adults of thrips was recorded on shoots of 3 vines just before and 3, 7 and 14 days after 1st and 2nd sprays and fruit damage by thrips was recorded at harvest. Population of grubs and adults of coccinellid predators were also observed on each vine. Grape fruit yield was recorded in March, 2009.

RESULTS AND DISCUSSION

Mealy bugs : The mealy bug colonies in the experimental plot varied from 14.0 to 15.7 before imposing treatments (Table 1). The data revealed that all the treatments were significantly superior over control in reducing mealy bug colonies at three days after first spray. Imidacloprid @ 0.30 ml l^{-1} significantly reduced mealy bug colonies to 5.4 per vine. Thiamethoxam 0.25 g l^{-1} was next best treatment and registered 7.4 mealy bug colonies per vine as against 20.4 colonies per vine in untreated control. At seven days, imidacloprid and thiamethoxam significantly reduced mealy bug colonies to 4.5 and 5.1 per vine respectively, as against carbaryl, malathion and untreated checks. At fourteen days, there was increase in mealy bug colonies in all the treatments which necessitated the second round of treatments. More or less similar trend of efficacy of insecticides against mealy bugs on vines was observed on 3, 7 and 14 days after 2nd spray. Data on mean mealy bug colonies revealed that imidacloprid contributed significant reduction in colonies up to 4.5 per vine with 82.0 per cent over control, followed by thiamethoxam. Azadirachtin 1 per cent was

Table 1. Efficacy of insecticides against grapevine mealy bugs (*M. hirsutus*) during fruiting season.

Treatment	Dose l^{-1}	Pre count, mean mealy bug colonies $vine^{-1}$	Mean mealy bug colonies on days after treatment						Mean mealy bug conlonies $vine^{-1}$	Per cent reduction of mealy bug colonies over control
			1st spray			2nd spray				
			3	7	14	3	7	14		
Imidacloprid 17.8 SL	0.30 ml	14.9	5.4^{a}	4.3^{a}	7.6^{a}	3.5^{a}	3.2^{a}	3.3^{a}	4.5^{a}	82.0
		(9.3)	(5.1^{a})	(3.2^{a})	(4.6^{a})	(3.4^{a})	(1.8^{a})	(2.2^{a})	(2.8^{a})	(84.1)
Thiamethoxam 25 WG	0.25 g	15.0	7.4^{b}	5.1^{a}	8.2^{a}	4.2^{a}	4.1^{a}	4.0^{a}	6.2^{b}	75.2
		(8.9)	(5.9^{b})	(3.8^{a})	(5.3^{a})	(3.6^{a})	(2.2^{a})	(2.4^{a})	(3.3^{a})	(81.1)
Carbaryl 50 WP	2.00 g	15.2	7.8^{b}	7.3^{b}	10.3^{b}	6.4^{b}	4.9^{a}	6.2^{b}	7.2^{c}	71.0
		(9.2)	(6.6^{c})	(4.8^{b})	(6.2^{b})	(5.3^{b})	(3.5^{b})	(4.0^{b})	(5.1^{b})	(71.0)
Malathion 50 EC	2.00 g	15.7	8.5^{c}	8.5^{b}	11.1^{b}	7.3^{c}	5.0^{b}	6.7^{b}	7.8^{d}	69.0
		(9.2)	(6.5^{c})	(5.5^{c})	(7.8^{c})	(6.2^{c})	(4.1^{c})	(4.7^{bc})	(5.9^{c})	(66.5)
Azadirachtin 1%	2.00 ml	15.6	10.1^{d}	10.4^{c}	13.1^{c}	8.4^{d}	5.1^{b}	6.9^{b}	9.0^{e}	64.0
		(9.3)	(7.2^{d})	(6.5^{d})	(7.9^{c})	(6.2^{c})	(4.2^{c})	(5.2^{c})	(6.0^{c})	(65.9)
Untreated control	-	14.0	20.4^{e}	28.1^{d}	25.5^{d}	24.1^{e}	26.0^{c}	26.2^{c}	25.1^{f}	-
		(9.4)	(9.2^{e})	(18.3^{e})	(19.4^{d})	(21.0^{d})	(18.3^{d})	(19.3^{d})	(17.6^{d})	-
S. E.±	-	1.5	0.04	0.05	0.04	0.04	0.05	0.05	0.03	-
		(0.3)	(0.01)	(0.03)	(0.04)	(0.04)	(0.03)	(0.05)	(0.03)	-
C. D. at 5%	-	NS	0.11	0.14	0.11	0.13	0.15	0.14	0.10	-
		(NS)	(0.02)	(0.09)	(0.11)	(0.13)	(˜0.10)	(0.14)	(0.07)	-

Figures in breacket are mealy bug colonies on bunch. Figures were transformed by square root for analysis and original values are given in table. Means within columns lacking common superscript are significantly different at 5%.

Table 2. Efficacy of insecticides against thrips (*Scirtothrips dorsalis* Hood) on grapevine during fruiting season.

Treatment	Dose l^{-1}	Pre count, mean thrips population shoot^{-1} vine^{-1}	Mean thrips population shoot^{-1} vine^{-1} on days after						Mean thrips population shoot^{-1} vine^{-1}	Per cent reduction over control
			1st spray			2nd spray				
			3	7	14	3	7	14		
Imidacloprid 17.8 SL	0.30 ml	13.6	4.1^{b}	2.5^{a}	4.8^{a}	2.8^{a}	1.8^{a}	1.8^{a}	2.7^{a}	81.6
		(26.5)	(20.0)	(12.2)	(19.1)	(11.0)	(6.5)	(8.4)	(12.0)	(67.5)
Thiamethoxam 25 WG	0.25 g	14.1	2.5^{a}	2.2^{a}	4.2^{a}	2.4^{a}	1.5^{a}	1.2^{a}	2.3^{a}	84.5
		(26.8)	(18.7)	(11.7)	(18.0)	(10.5)	(5.2)	(7.9)	(11.4)	(69.0)
Carbaryl 50 WP	2.00 g	13.3	4.8^{c}	4.0^{b}	6.0^{b}	4.2^{b}	3.3^{b}	4.4^{b}	4.4^{b}	70.3
		(24.8)	(21.3)	(14.9)	(20.1)	(14.9)	(8.1)	(13.8)	(15.5)	(57.9)
Malathion 50 EC	2.00 g	13.7	5.9^{d}	4.6^{b}	6.7^{c}	4.5^{b}	3.8^{b}	4.6^{b}	5.0^{b}	66.2
		(25.6)	(22.7)	(16.9)	(21.1)	(15.2)	(10.1)	(18.7)	(17.4)	(52.7)
Azadirachtin 1%	2.00 ml	13.4	6.2^{d}	5.1^{c}	7.8^{d}	5.2^{c}	5.1^{c}	4.9^{b}	5.7^{c}	61.5
		(25.3)	(22.1)	(18.6)	(21.8)	(17.5)	(12.4)	(17.2)	(18.2)	(50.5)
Untreated control	-	14.0	14.3^{e}	15.0^{d}	16.5^{e}	14.4^{d}	14.2^{d}	14.3^{c}	14.8^{d}	-
		(26.1)	(28.7)	(37.6)	(36.2)	(37.2)	(39.7)	(42.2)	(36.8)	-
S. E.±	-	1.2	0.02	0.03	0.02	0.03	0.04	0.03	0.02	-
		(1.7)	(0.09)	(0.20)	(0.18)	(0.27)	(0.37)	(0.36)	(0.19)	-
C. D. at 5%	-	NS	0.07	0.09	0.06	0.08	0.10	0.08	0.07	-
		(NS)	(0.28)	(0.61)	(0.55)	(0.83)	(1.10)	(1.08)	(0.57)	-

Figures in bracket are mean percent fruit damage by thrips / bunch at harvest. Figures were transformed by square root (thrips population) and Arc sin values (grape damage) for analysis and original values are given in table. Means within columns lacking common superscript are significantly different at 5%.

least effective in reducing mealy bug colonies in grape vines.

In order to assess the efficacy of insecticides against mealy bugs on bunch, treatments were imposed after berry formation. Pre-count colonies varied from 8.9 to 9.3 bunch^{-1}. There were significant differences in the efficacy of insecticides tested at 3, 7 and 14 days after treatments. However, at 14 days after first spray, the mealy bug population was increased which necessitated the application of second spray. Similar trend was observed at 3, 7 and 14 days after 2nd spray. Amongst the insecticides, imidacloprid @ 0.30 ml l^{-1} and thiamethoxam @ 0.25 g l^{-1} were superior in reducing colonies of mealy bugs to 2.8 and 3.3 per bunch with, 84.1 and 81.1 per cent reduction over control, respectively. Azadirachtin 1 per cent contributed least effect (Table 1).

Thrips : Thrips population in the plot varied from 13.3 to 14.1 per shoot per vine (Table 2). At 3 days after 1st spray, thiamethoxam @ 0.25 g l^{-1} significantly reduced the population of thrips to 2.5 per shoot per vine followed by imidacloprid @ 0.30 ml l^{-1}. The pest population was minimum and at par in both these treatments at 7 days after sprays. However, it was increased at 14 days after treatments, which indicated that the effect of insecticides in suppressing the pest population persisted up to 14 days. It seems from the data on mean population that imidacloprid @ 0.30 ml l^{-1} and thiamethoxam @ 0.25 g l^{-1} resulted in lowest population (2.3 and 2.7 per shoot per vine) than other

Table 3. Efficacy of insecticides on coccinellid predator population on grapevine and fruit yield.

Treatment	Dose (l^{-1})	Pre count, mean grubs and adults of coccinellid plant^{-1}	Mean grubs and adults of coccinellid plant^{-1} days after treatment						Mean grubs and adults of coccinellid plant^{-1}	Grape fruit yield (kg ha^{-1})
			1st spray			2nd spray				
			3	7	14	3	7	14		
Imidacloprid 17.8 SL	0.30 ml	4.0	5.0	3.2c	4.3	4.0	3.3b	4.0b	4.0	12,076a
Thiamethoxam 25 WG	0.25 g	5.2	5.0	4.8ab	5.5	4.4	3.5b	5.4a	4.3	11,718b
Carbaryl 50 WP	2.00 g	6.5	5.8	4.2b	4.8	4.0	3.4a	4.2b	4.2	10,532c
Malathion 50 EC	2.00 g	5.0	4.5	4.0b	4.5	4.5	3.6b	4.2a	4.4	10,358d
Azadirachtin 1%	2.00 ml	5.9	4.4	4.0b	5.4	4.2	3.2b	5.3a	4.5	9,883e
Untreated control	-	6.0	5.2	6.0a	5.0	5.0	4.8a	5.5a	4.9	7,029t
S. E.±	-	0.9	0.5	0.23	0.6	0.5	0.27	0.23	0.5	0.30
C. D. at 5%	-	(NS)	(NS)	(0.70)	(NS)	NS	(0.82)	(0.68)	(NS)	0.87

Means within columns lacking common superscript are significantly different at 5%. Figures were transformed by square root for analysis and orginal values are given in table.

insecticides with 84.5 and 81.6 per cent reduction in thrips population over control, respectively (Table 2).

The fruit damage due to thrips ranged between 24.8 to 25.8 per cent before imposing treatments (Table 2). It seems from the data on mean per cent fruit damage of 1st and 2nd spray that the damage by thrips varied from 11.4 to 36.8 per cent due to treatments. Significant effect to all insecticide treatments was achieved with reduction in fruit damage by thrips to the extent 50.5 to 69.0 per cent as compared to untreated control (Table 2).

Coccinellid predators and yield : Coccinellid (*Coccinella* spp.) population ranged from 4.0 to 6.0 grubs and beetles per vine before treatments (Table 3). The data revealed that lethal effect to the coccinellid predators was not observed due to all insecticide treatments after 1st and 2nd sprays. Maximum predatory grubs and beetle population was observed in azadirachtin 1 per cent and untreated control vines.

Grape fruit yield was significantly influenced by the insecticidal treatments. Maximum yield recorded in imidacloprid @ 0.30 ml l^{-1} (12,076 kg ha^{-1}), followed by thiamethoxam @ 0.25 g l^{-1} as against 7,029 kg ha^{-1} in untreated control (Table 3).

Bio-efficacy of various pesticides in reducing mealy bugs in grapes has been reported by Elbert and Nauen (2004), Balikai (2005) and Katke and Balikai (2008). Imidacloprid was found to reduce infestation of mealy bugs on table and wine grapes in United States and South Africa (Elbert and Nauen, 2004). Efficacy of thiamethoxam in reducing thrips was recorded in grapes by Nali *et al*. (2004) and Kulkarni and Adsule (2006). It was observed that thiamethoxam at 25 g a.i. ha^{-1} was most effective in reducing thrips and at par with higher dose of 50 g.a.i. ha^{-1}. Bio-efficacy of neem formulation (azadirachtin 1 and 5%) on pests of grapes was reported by Kulkarni *et al*. (2006). A module consisting azadirachtin 1 and 5 per cent formulations along with *Trichoderma harzianum* and *Trichoderma viride* were better alternatives to minimize thrips population as well as pesticide residue in grapes with good natural enemy activity (1-2 grubs and beetles per vine). Sunitha *et al*.

(2008) reported that three neonicotinoids molecules were superior to standard check in reduction of thrips in grape ecosystem which reflected in reduced per cent bunch infestation. The results obtained on efficacy of insecticides, their effect on natural enemy population and yield of grape in the present study are in agreement with those reported by earlier workers.

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Assessment of Training Needs of Personnel in Non-aided and Allied Agricultural Colleges in Western Maharashtra

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ABSTRACT

The maximum number of the personnel had not received any training from SAUs for day to day working. The personnel's expectations in respect of training indicated that, maximum number of them needed refresher training before commencement of each semester. Majority of personnel liked to have training for two days. In respect of physical facilities and technical know-how, a majority of the personnel desired free accommodation, as well as, preferred agricultural university campus for receiving any type of training.

Key words : Assessment, training needs, personnel, agricultural and allied colleges.

The agricultural colleges that have been established by the private organizations on non-grant basis during last five years, are new and the teachers appointed there are not very experienced one. There is need to improve technical and educational skills of the teachers

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in these colleges. It is necessary to know their training needs, so that appropriate training programmes could be organized by the concerned authorities. As such, the present investigation entitled, assessment of training needs of personnel in non-aided and allied agricultural colleges in Western Maharashtra, was conducted.

MATERIALS AND METHODS

The list of all non-aided and allied agricultural colleges affiliated to Mahatma Phule Krishi Vidyapeeth, Rahuri, was obtained for the academic year 2006 - 2007. The list of technical personnel was obtained from the Principal of respective colleges. In all, 80 personnel were randomly selected as respondents.

RESULTS AND DISCUSSION

It is observed from Table 1 that majority (83.75 per cent) of the personnel had Master's degree, while 5.00 per cent were having Bachelor's and 11.00 per cent personnel possessed Doctorate degree. It can be seen that the personnel were well qualified to meet the requirements of their position in the profession. The findings of the present study are not consistent with that of Rao (2001), Abdullah *et al.* (2002), Pawar (2002) and Mali (2004).

Table 1. Distribution of personnel according to their educational qualifications.

Category	Respondents (N = 80)	
	Number	Percentage
Bachelor's degree	4	5.00
Master's degree	67	83.75
Doctorate degree	9	11.25
Total	80	100.00

Table 2. Distribution of personnel according to their position held.

Category	Respondents (N = 80)	
	Number	Percentage
Principal / In charge	21	26.25
Assistant Professor	59	73.75
Total	80	100.00

Table 3. Distribution of personnel according to their professional experience.

Category	Respondents (N = 80)	
	Number	Percentage
Low (Below 2 years)	13	16.25
Medium (2 to 4 years)	56	70.00
High (Above 4 years)	11	13.75
Total	80	100.00

It is revealed from Table 2 that a large number (73.75 per cent) of the personnel were Assistant Professors, while 26.25 per cent were Principals. There is no any post as Associate Professor and Professor at the non-aided agricultural and allied colleges. The findings of the present study are in line with the studies of Rao (2001), Abdullah *et al.* (2002) and Pawar (2002).

It is observed from Table 3 that 70.00 per cent of the respondents had 'medium' professional experience, while 16.25 per cent personnel were found in 'low' category and 13.75 per cent personnel had 'high' professional experience. The findings of the study are consistent with the findings of Pawar (2002), however the results are not consistent with that of Rao (2001).

It is revealed from Table 4 that majority of respondents (85.00 per cent) had not received training of any kind, while 8.75 per cent of the respondents had received short duration training. Further, 6.25 per cent respondents had received up to 2 trainings, 7.50 per cent

Table 4. Distribution of personnel according to the training received by them.

Category	Percentage
Type of training received :	
No training	85.00
Short duration (2 to 4 days)	8.75
Medium duration (15 to 30 days)	6.25
Total	100.00
Number of training received :	
No training	85.00
Upto 2	6.25
3 to 4	7.50
5 and above	1.25
Total	100.00
Organizing institute (Training number = 12) :	
M. P. K. V.	-
SAU in MS	100.00
SAU outside MS	-
ICAR institute	-
Abroad	-
Total	100.00
Type of workshop attended :	
No workshop	91.25
One day	6.25
Two to five days	2.50
More than five days	-
Total	100.00

Table 5. Distribution of the personnel according to their needs and requirements.

Particulars	Percentage
Type of training :	
Orientation	52.50
Refresher	68.75
Foundation	27.50
Place of training :	
University campus	68.75
Central institutes	20.00
Recognized training institutes	7.50
Abroad	3.75
Frequency of training :	
Before commencement of academic year	32.50
Before commencement of each semester	67.50
Duration of training :	
2 days	52.50
5 days	26.25
One week	11.25
15 days	10.00
Physical facilities :	
Free accommodation	97.50
Boarding arrangement	85.00
Transport arrangement	43.75
Library facilities	86.25

respondents had received 3 to 4 trainings and only 1.25 per cent respondents had received 5 and above trainings.

Out of the total 12 trainings received by the respondents, all the trainings were organized by SAUs in Maharashtra. A huge number (91.25 per cent) of the respondents had not attended any workshop. Only few (8.75 per cent) respondents had attended the workshop. Further, 6.25 per cent of the respondents had attended one-day workshop, while 2.50 per cent respondents had attended two to five days workshop.

It is observed from Table 5 that nearly two third (68.75 per cent) of the respondents needed 'refresher' training, while one half of the respondents (52.50 per cent) needed 'orientation' training and few of them (27.50 per cent) needed 'foundation' training.

Majority of the respondents (68.75%) preferred 'University' campus for receiving training, while 20.00 per cent and 7.50 per cent preferred 'central institutes' and 'recognized institutes'. Only 3.75 per cent of them desired to have training 'abroad'. The findings of the study are consistent with the findings of Ahmed *et al.* (2000), Nataraju *et al*. (2000), Waman (2004) and the results are not consistent with Atchuta *et al*. (2003).

Nearly two third (67.50%) of the respondents desired to have training before

commencement of each semester, while one third (32.50%) expressed the need to have training before commencement of academic year.

Majority of the respondents (52.50%) stated that they would like to have training for two days, followed by 26.25 per cent who would like to have training for 5 days, while 11.25 per cent needed training of one week duration and only 10.00 per cent of the respondents needed 15 days training.

With regard to physical facilities, a large number (97.50%) of the respondents desired free accommodation facility either by organizing institute or by their allied colleges, followed by other facilities namely boarding arrangement (85.00%), library facilities (86.25%) and transport facilities (43.75%).

The study concluded that the personnel working in the allied Agricultural Colleges though fulfill the academic qualifications, but the 'in service' or 'short duration' training is required for them to increase the proficiency of their routine work. It is also concluded that the policy makers either at the level of SAUs or management of the colleges, should think seriously for better and quality education to the students.

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Marketing of Selected Vegetables in Junnar Tahsil of Pune District

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ABSTRACT

The findings of the study indicated that the average productivity as well as the per quintal cost of packaging in tomato was more than the other vegetables. The average cost of transportation of vegetables was highest in case of tomato and lowest in case of bhendi in primary market. The per quintal cost of transportation was the lowest in the case of tomato and highest in the case of cabbage in terminal market. The per quintal cost of marketing of selected vegetables was more in terminal markets than in primary markets. Several problems in marketing of vegetables were faced by the vegetable growers such as, lack of cold storage facility, costly packing material, nonreturn of packaging material back to the growers, high commission charges, high transport cost, unauthorized deductions, low prices to the produce etc.

Key words : Marketing, vegetables, cost, problems.

Vegetables are important not only from the diet point of view, but also from the economic point of view of the farmers, as vegetable fetches better prices which becomes a source of income to the cultivators. A farmer with some irrigation facilities can increase his income to a large extent by growing vegetable crops. They should however, be guided about the cost and returns of vegetables cultivation. The present study was therefore an effort in this direction.

MATERIALS AND METHODS

The present study was undertaken in the Junnar tahsil of Pune district, which was purposively selected because of prominent vegetable growing region. After selecting the tahsil, village wise area under vegetables was obtained from the Junnar Panchayat Samiti. Six villages from the tahsil were selected randomly, where vegetables cultivated were on a commercial scale.

A list of vegetable cultivators growing tomato, cabbage, cauliflower and bhendi was prepared from village revenue record and arranged alphabetically. Lastly 20 cultivators from each selected village were selected randomly. Thus, comprised the total sample of 120 vegetable growers.

Survey method was adopted for collecting the data for the year 2005-2006 by personal interview method with the help of a specially designed pre tested schedule from vegetable growers. In view of this, village as primary market and Pune market yard (Gultekadi) as a secondary market were considered for the study.

A sample of 10 commission agents and 10 retailers from Pune market yard, Gultekadi was randomly drawn for securing information on marketing cost.

Marketing cost included transportation charge, packaging, grading and forwarding cost, octroi, commission charges etc. The cost actually paid by the selected sample growers

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was considered and analyzed.

RESULTS AND DISCUSSION

The producers arrange to take their produce after suitable grading and packing through their own means such as cycle, bullock cart or head load to the assembling centres.

It is revealed that, the material used for packaging of tomato was bamboo basket, wooden boxes, corrugated boxes and plastic crates. These packages were also of different capacities and accordingly the cost varied. The highest per quintal cost was required for plastic crates, followed by corrugated boxes, wooden boxes and bamboo baskets. The range of cost varied from Rs. 8.80 to 24.62 per quintal. In case of cabbage and cauliflower, mainly the gunny bags, having capacity of 35 - 40 kg were used. The per quintal cost of packaging was in the range of Rs.10.83 to 13.69. The other important vegetable was bhendi, for which bamboo baskets of capacity 20 to 40 kg were mainly used. The cost of packaging worked out to Rs. 10.32 to 12.72 q^{-1}.

Transport charges are based on distance of market from production centre as well as size and type of packing. In case of primary market, the lowest transport cost was Rs. 12.78 per quintal in case of bhendi, while the highest transport cost was Rs. 15.40 per quintal for tomato. The cost of transportation in terminal market was the lowest in the case of tomato (Rs. 41.62) and the highest in the case of cabbage (Rs. 48.30).

Market intelligence has got special importance in the trade of vegetables. Nearly 70 per cent farmers sought information about prevailing current prices, either directly or from other farmers who had sold their produce a day before. In addition, daily radio broadcast and newspapers were the other sources of market information. This facility was availed by more than 70 per cent farmers. It was further reported that some of the producers (64.18 per

Table 1. Average per quintal cost of marketing of vegetables. (Rs. q^{-1}).

Praticulars	Tomato		Cabbage		Cauliflower		Bhendi	
	P	T	P	T	P	T	P	T
Grading	1.03	1.03	0.78	0.78	0.81	0.81	1.44	1.44
	(1.79)	(0.92)	(1.75)	(0.80)	(1.87)	(0.82)	(2.86)	(1.25)
Packaging	18.61	24.62	10.83	11.32	13.69	13.99	10.32	12.72
	(32.17)	(21.86)	(24.40)	(11.55)	(31.65)	(14.10)	(20.53)	(10.97)
Transportation	15.40	41.62	13.50	48.35	13.35	48.5	12.78	46.00
	(26.63)	(36.94)	(30.42)	(49.30)	(30.86)	(48.62)	(25.44)	(39.75)
Commission charges	21.80	24.15	18.28	22.42	14.40	18.78	24.72	38.25
	(37.69)	(21.44)	(41.28)	(22.86)	(33.30)	(18.92)	(49.18)	(33.05)
Commission of Hundekari	-	18.25	-	12.20	-	14.42	-	14.34
	-	(16.19)	-	(22.86)	-	(14.53)	-	(12.39)
Postage	-	1.00	-	1.00	-	1.00	-	1.00
	-	(0.88)	-	(1.01)	-	(1.00)	-	(0.86)
Weighing charges	1.00	2.00	1.00	2.00	1.00	2.00	1.00	2.00
	(1.72)	(1.77)	(2.25)	(2.03)	(2.32)	(2.01)	(1.99)	(1.73)
Total	57.84	112.67	44.49	98.07	43.25	99.25	50.26	115.75
	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)

(Figures in the parentheses are percentages to total). P = Primary market, T = Terminal market

cent) kept touch with commission agents and traders for knowing day-to-day prices.

The study on marketing cost was undertaken to estimate the per quintal cost of marketing of selected vegetables. Total marketing cost comprises of sum total of costs of all the functions and the other marketing charges. Expenses on packaging, transportation, hamali, weighing charges, commission, market rent, postage etc. were included in marketing cost. The information on these items was collected from the selected sample cultivators and per quintal cost of marketing of vegetables in different markets was worked out.

It is seen from Table 1 that the per quintal cost of marketing of selected vegetables was more in terminal markets than in primary markets. The important items of cost were charges of commission agents, transportation and packaging. In terminal markets, the Hundekari charges and postage expenditure were additional items of cost. The total marketing cost was highest in case of bhendi, followed by tomato and cole crops. Similar results were obtained by Kadam (1999), Naikade (1999), Vaidya (200l), Jadhav (2002), Dumbare (2004) for marketing of vegetables.

It is always expected that marketing system must be efficient to provide necessary environment for greater agricultural production through price incentives to producers on one hand and supply of quality products at fair prices to the consumers, on the other.

At the time of survey, feedback was taken from the sample cultivators to understand the problems in marketing of vegetables and remedial measures for marketing problems. All the sample farmers expressed the problem of lack of cold storage facilities (Table 2) and suggested that facilities if created on co-operative basis would enable them to store their perishable products like fruits and vegetables atleast for some days. All the sample farmers stated that the cost of packing material was very high. Packing materials used for marketing of tomatoes naturally enhance the cost of marketing and thereby adversely affected the net price. All the sample growers pointed out that, wooden boxes, gunny bags, bamboo baskets were not returned back to them for reuse. This certainly enhanced the cost of marketing of vegetables.

Table 2. Problems in marketing of vegetables.

Problems	Per-centage
Lack of cold storage facilites in the producing area	100.00
Packing material is costly	56.67
Packages are not returned back to the growers	100.00
Transportation charges are high	79.17
Malpractices and unauthorized deductions, incorrect weighment etc.	74.16
Commission charges are high	68.33
Absence of open auction method of sale	37.50
Non-receipt of payment in time	40.00
Low prices to the produce	87.50
Absence of co-operative vegetable marketing society in study area	100.00

The transport agencies working in the study area have to make arrangement for collection of produce from various assembling centres. The rates of fuel have also gone up. As a result, the transport charges per unit of package were high. Similar results were obtained by Bhapkar (2002) and Bhor (2003) for marketing of vegetables.

The respondents reported some of the malpractices such as, unauthorized deductions on account of more losses of produce during transport, postage charges and incorrect weighing of produce, incorrect prices, etc. The commission agents working in vegetable

markets in Pune market charge the commission @ 8 per cent on the gross value of produce. These were very high as reported by the respondents. It was noted by the investigator that no open auction method of sale was adopted for vegetables in Pune market. The traders decide the rates of consignment through 'Hatta' method of sale.

The respondents also reported that there were no prompt payments of sale proceeds by the commission agents. The payment of sale proceeds was delayed for a period of even two weeks, as a result, producers were facing financial constraints.

All the sample growers pointed out that there were no co-operative marketing societies in the producing area and therefore, they were not in a position to sell their produce collectively in a distant market, efficiently.

The producers reported that they were not getting remunerative prices as expected. The prices were subjected to fluctuations from time to time, depending upon the forces of demand for and supply of vegetables during season in Pune market. The produce was also perishable and no facilities existed for cold storage to adjust the supply commensurate with demand. Similar results were obtained by Navadkar (2000) and Kolhe (1998) for marketing of vegetables.

It is suggested that, there is a need to establish co-operative marketing societies for vegetables, which could take up the marketing on scientific basis in distant markets like Mumbai for benefit of producers at large.

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Trends in Export of Rice from India

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ABSTRACT

Rice export constitutes a considerable share in the national exports in general, and in agricultural exports in particular. There is a good scope for India to take advantage of the new trade opportunities for sustaining the export of rice. This can be achieved if production is made keeping in view the demand of International markets by increased investment in research and development coupled with realistic policy incentives adopted by the Government. Export of rice from India reached an all time high record and earned foreign exchange to the tune of Rs. 7035.88 crores during 2006-07. There have been year to year fluctuations in both the quantity and value of Basmati, as well as non-Basmati rice exports from India. Though these variations are observed, there is a consistent growth in rice exports over the years. The reasons attributed to these fluctuations mainly include, production and productivity level of both Basmati and non-Basmati rice in India and other export competing countries, Government export policy in order to maintain price stability, and adequate domestic supplies etc.

Key words : Basmati, non-Basmati, export, trends, growth.

The percentage share of agriculture export in total national export was 10.95 per cent whereas the percentage share of rice export in total agricultural export was 12.49 during 2005-06. Thus, rice export contributes nearly 12 per cent of total agriculture export from the country. Rice is also an important cereal food crops in South East Asia. Thailand, Vietnam, Myanmar, China and Japan are the important countries besides India growing rice. Among the exporting countries Thailand, Vietnam, India and Pakistan are the important countries exporting rice in sizeable quantity, Thailand ranks first in the export of rice in the world, followed by India.

Rice contributes 43 per cent of total food grain production and 46 per cent of total cereal production. It continues to play a vital role in the national food grain supply. It is also observed that Gulf region remains the major market for Indian Basmati rice and inside Gulf, Saudi Arabia accounts for the major chunk of Basmati imports from India. Pakistan is the sole competitor for India in the international market for Basmati rice. Daniel Workman (2008), stated that in the leading rice export countries, Chinese rice exports went down by 65 per cent, while Indian grain shipments rose to 41 per cent. In total, Thailand and the U.S. grow 6 per cent of the global rice harvest, yet account for about 45 per cent of worldwide rice exports. Rattaphol Onsanit (2008), stated that the Thailand, the world's biggest rice exporter, pledged to maintain supplies and India vowed to crack down on hoarding, as shortages drove prices to a record and threatened to trigger protests in Asia and Africa.

MATERIALS AND METHODS

The emphasis of this study was on reviewing the progress of export of rice from India.

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Therefore the study is based on the secondary data i.e. published data in the form of various reports published by Directorate of Rice Development and other related agencies engaged in the field of agricultural production and export. The other requisite data were also collected from the various publications and Websites of APEDA and DGCI etc. The data have also been downloaded from the website "dacnet.nic.in".

RESULTS AND DISCUSSION

Percentage share of rice exports in total national export and total agricultural exports during 1996-97 to 2004-05 is given in Table 1. The percentage share of rice export to the nation's total agricultural export was highest during the year 2004-05 (16.9%) than the previous year 2003-04 (11.18%). It was reduced to 12.49 per cent during the next year, 2005-06. Export concessions and ban on exports in order to maintain the domestic supply and stability in food prices were the major reasons for these fluctuations.

Table 1. Rice exports from India vis-à-vis country's total and agricultural exports (1990-91 to 2005-06).

Year	Total national export	Total agril. exports	Agril. exports as % to total export	Rice exports	Rice exports as % to total agril. exports
1990-91	32527	6013	18.49	733	12.19
1991-92	44042	7838	17.80	756	09.64
1992-93	53688	9040	16.84	976	10.80
1993-94	69749	12587	18.05	1287	10.22
1994-95	82673	13223	15.99	1206	09.12
1995-96	106353	20398	19.18	4568	22.39
1996-97	118817	24161	20.33	3172	13.13
1997-98	130101	24832	19.09	3371	13.57
1998-99	139752	25511	18.25	6281	24.62
1999-00	159095	25314	15.91	3126	12.35
2000-01	201356	28657	14.23	2943	10.27
2001-02	209018	29729	14.22	3163	10.64
2002-03	255137	34654	13.58	5831	16.83
2003-04	293367	37266	12.70	4168	11.18
2004-05	356069	39863	11.20	6769	16.98
2005-06	454800	49803	10.95	6221	12.49

(Source : DGCI&S, Ministry of Commerce, GOI.)

The export of Basmati rice from India during 1998-99 to 2000-01 to different continents is given in Table 2. The Gulf region remained the major market for Indian Basmati rice and inside Gulf, Saudi Arabia accounted for the major chunk of Basmati imports from India. Pakistan is the sole competitor for India in the international market for Basmati rice. During 1998-99, 1999-2000 and 2000-01, total quantities of basmati rice exported from India were 5.98, 6.38 and 8.52 lakh MTs. in which the percentage share of Asia was 85.69, 82.124 and 73.38 per cent, respectively. The percentage share of Asia has decreased for basmati rice, during 1998-99, 1999-2000 and 2000-01 but the export to Europe has increased in linear order from 11.41 per cent in 1998-99 to 14.37 per cent in 1999-2000 and 20.46 per cent during 2000-01, respectively. The export to North America has also increased in the same order from 1.39 per cent during 1998-99 to 5.28 per cent during 2000-01. However, the export to other countries remains constant with slight fluctuation from year to year. India's major markets for basmati rice exports have been Saudi Arabia, Australia,- Austria, Belgium, Bahrain, France, Germany, U.K., Denmark, U.S.A., Canada, Belgium, Kuwait, Italy, Oman, Yemen, Netherlands, Jordan, Indonesia etc. In fact, Saudi Arabia traditionally has been the largest market for Indian basmati rice.

Export of non-basmati rice from India during 1997-98 to 1999-2000 to different continents is given in Table 3. The major destinations for India's non-basmati rice exports are Bangladesh, Australia, Bahrain, Ethiopia, Djibouti, France, Germany, U.K., Hong Kong,

Korea, Sri-Lanka, Maldives, Mauritius, Malaysia, Nigeria, Ivory coast, Indonesia, Nepal, Oman, Qatar, Russia, South Africa, Saudi Arabia, Somalia, Singapore, U.A.E. Y.A.R., etc. Competing countries in the international markets for India for the exports of non-basmati rice are Thailand, Vietnam, Burma, China, U.S.A. and Pakistan. Major quantity of non-basmati rice is exported to Asia continent. During 1996-97, 1997-98, 1998-99 and 1999-2000 a total quantity of 9.59, 9.28, 28.75 and 7.08 lakh MTs were exported to Asia continent which were 48.20, 51.66, 65.86 and 56.28 per cent of total export of non-basmati rice from India to Asia, respectively. There was a fluctuation in the export of non-basmati rice from India to Asia during 1996-97 to 1999-2000. After Asia, non-basmati rice is exported from India to Africa continent. During 1996-97, 1997-98, 1998-99 and 1999-2000 a total quantity of non-basmati rice exported from India to Africa were 5.39, 5.59, 10.67 and 3.24 lakh MTs, in which the percentage share of Africa continent was 27.091, 31.14, 24.44 and 25.73 per cent, respectively of total export of non-basmati rice from India. Next to Africa continent, Europe continent has been importing non-basmati rice from India during 1996-97, 1997-98, 1998-99 and 1999-2000. The exports of non-basmati rice from India to other continents are very meager. The exports to Europe continent during the last few years were on an average, more than 1.5 lakh MTs per year, except 1996-97 (38 lakh MTs).

Table 2. Export of basmati rice from India to different continents.

Continents	1998-99		1999-2000		2000-01	
	Metric tonnes	Per cent	Metric tonnes	Per cent	Metric tonnes	Per cent
Asia	5,12,194	85.69	5,24,241	42.12	6,25,024	73.38
Europe	68,216	11.41	91,732	14.37	174,216	20.46
North America	8,338	1.39	18,969	2.97	44,953	5.28
South America	15	-	4	-	42	0.01
Oceana	647	0.11	1,126	0.18	2,835	0.33
Africa	8,346	1.40	2,269	0.35	4,631	0.54
Others	-	-	39	0.01	21	-
Total	5,97,756	100.00	6,38,380	100.00	8,51,722	100.00

(Source : Directorate of Rice Development)

Table 3. Export of non-basmati rice from India to different continents.

Continents	1997-98		1998-99		1999-2000	
	Metric tonnes	Per cent	Metric tonnes	Per cent	Metric tonnes	Per cent
Asia	9,27,757	51.66	28,75,395	65.86	7,07,924	56.28
Europe	1,87,927	10.47	1,61,707	3.70	1,54,028	12.25
Africa	5,59,245	31.14	10,67,079	24.44	3,23,663	25.73
Australia	283	0.02	642	0.01	147	0.01
America	39,512	2.20	2,236	0.05	1,173	0.09
Others	81,019	4.51	2,28,829	5.93	70,855	5.64
Total	17,95,743	100.00	43,65,888	100.00	12,57,790	100.00

(Source : Directorate of Rice Development)

Exports of basmati and non-basmati rice from India over 1991-92 to 2006-07 increased all time high of 47.48 lakh tones, registering more than three fold growth/over the year 2001-02. The export earnings have also been all time high of Rs.7, 035.88 crores. India's export of rice in the year 2006-07 registered a steep growth of 115.96 per cent over the year 2001-02. The export earnings reached a level of Rs. 7035.88 crores as against Rs. 3163.44 crores as on 2001-02, registering an impressive growth by 122.42 per cent (Table 2). Similar observation were also reported by Agarwal *et al.* (2000) and FAO (2007).

Average export price of basmati and non-basmati rice during 1992-93 to 2001 -02 are given in Table 5 revealed that the export price of basmati rice has fluctuated significantly year after year. During 1992-93, average export price of basmati rice was Rs. 2,465 per quintal, which declined continuously year after year up to 1996-97 as compared to 1992-93. Average export price for basmati rice has been worked out to Rs. 2,013 per quintal during 1993-94 and the same has decreased to Rs. 1,957 per quintal during 1994-95. Average export price again increased to Rs. 2,297 per quintal during 1995-96 over previous year price and increasing trend in average export price continued up to 1998-99. During 1996-97, average export price has been worked out to Rs. 2,385 per quintal, which increased to Rs. 2,841 and Rs. 3,140 per quintal during 1997-98 and 1998-99, respectively. However, average export price of basmati rice declined during the following three years as compared to 1998-99. During 1999-2000, average export price was worked to Rs. 2,789 per quintal, which reduced to Rs. 2,543 per quintal during 2000-01 and again increased to Rs. 2,762 per quintal during 2001-02. The reason for fluctuation in average export price of Basmati rice is attributed to different quality and quantity of rice exported to different countries during different years. A particular country may import one year a particular quality/grade of rice and the same country may import another

Table 4. Export of basmati and non-basmati rice from India during 1991-92 to 2006-07.

Year	Basmati rice		Non-basmati rice		Total rice	
	"000" MT	Rs. in crores	"000" MT	Rs. in crores	"000" MT	Rs. in crores
1991-92	266.53	499.18	411.94	256.41	678.47	755.59
1992-93	324.79	800.64	255.62	174.96	580.41	975.60
1993-94	527.23	1,061.26	565.19	225.46	1,092.42	1,286.72
1994-95	442.13	865.32	448.50	340.47	890.63	1,205.79
1995-96	373.31	850.67	4,540.70	3,717.41	4,914.01	4,568.08
1996-97	523.16	1,247.64	1,989.04	1,924.72	2,512.20	3,172.36
1997-98	593.32	1,685.62	1,795.74	1,685.38	2,389.06	3,371.00
1998-99	597.79	1,876.91	4,365.89	4,403.85	4,963.68	6,280.76
1999-00	638.38	1,780.34	1,257.79	1,345.58	1,896.17	3,125.92
2000-01	851.72	2,165.99	682.27	777.26	1,533.99	2,943.25
2001-02	665.84	1,839.08	1,532.35	1,324.36	2,198.19	3,163.44
2002-03	708.79	2,058.47	4,259.08	3,772.77	4,967.87	5,831.24
2003-04	771.49	1,993.06	2,640.57	2,174.94	3,412.06	4,168.00
2004-05	1,162.99	2,823.90	3,615.11	3,945.02	4,778.10	6,768.92
2005-06	1,166.56	3,043.09	2,921.16	3,178.16	4,087.72	6,221.25
2006-07	1,045.71	2,792.80	3,702.19	4,243.08	4,747.90	7,035.88

(Source : Directorate of Rice Development)

quality/grade of rice during next or subsequent years. Thus, different quality and quantity of rice exported to different countries at different export price rate may probably be the reason for fluctuation of average export price of basmati rice. In case of non-basmati rice, almost same trend of fluctuation in average export price is seen as in case of basmati rice. During 1992-93, average export price was worked out to Rs. 684 per quintal for non-basmati rice, which declined to Rs. 399 per quintal during 1993-94. However, it increased to Rs. 759 per quintal during 1994-95 and increasing trend continued up to 2000-0 l. Average export price was worked out to Rs. 819 per quintal during 1995-96, which increased to Rs. 968 per quintal during 1996-97 and slightly decreased to Rs. 939 per quintal during 1997-98 over previous year. During 1998-99, average export price increased to Rs. 1,009 per quintal and continued to increase in linear order to Rs. 1,070 per quintal and Rs. 1,139 per quintal during subsequent two years of 1999-2000 and 2000-01. There was a sharp decline in average export price to Rs. 864 per quintal during 2001-02 over previous five years. The reason for fluctuation in average export price of non- basmati rice could be the same as discussed above in the case of basmati rice. Similar observations were also reported by IRRI (2007) and DRD (2007).

India is facing stiff competition in the international markets from Thailand, Vietnam, U.S.A. and Pakistan. There was a considerable growth in the export of rice from India during the recent past, particularly in the case of non-basmati rice. There are several factors responsible for this growth. In fact, exports depend not only on our ability to sell, but also on the willingness of importers to buy. Sometimes, major markets/importers use to cut down their import due to their internal economic problems or good crop harvest and trade also cut down inventories and people reduce spending. All these measures reduce imports during that particular year. Awareness about basmati rice is spreading among different strata of the society in the country and abroad. Basmati rice is possessing unique grain, cooking, eating and digestive qualities. Hence, majority of people in the country and abroad have developed liking for basmati rice. Because of its superfine quality, basmati rice is most preferred and also meant for high premium value in the national and international markets. Thus, basmati rice is also stated to be 'Pearl' of rice. With the every coming year, domestic as well as international demand for basmati rice is increasing. Maintaining desired aroma in basmati rice along with other quality characteristics may help to boost the export of basmati rice from India.

Non-basmati rice exports have also suffered much due to the competition from exporting countries like Thailand, Vietnam and Pakistan because of their low cost of production. In the recent past, export of non-basmati rice was fluctuating year after year due to various reasons. The export of non-basmati rice was on its peak during 1995-96, it came down during 1998-99 due to many reasons. However, it has nicely picked up further during the years 2001-

Table 5. Average export price of basmati and non-basmati rice during 1992-93 to 2001-02.

Year	Basmati rice (Rs. q^{-1})	Non-basmati rice (Rs. q^{-1})
1992-93	2465	684
1993-94	2103	399
1994-95	1957	759
1995-96	2279	819
1996-97	2385	968
1997-98	2841	939
1998-99	3140	1009
1999-00	2789	1070
2000-01	2543	1139
2001-02	2762	864

(Source : Directorate of Rice Development)

02 to 2005-06. Sometimes, export is also affected if good harvest is there in the importing countries, they reduce their import accordingly. If rice exporters make their sincere efforts with Government supporting export policy, non-basmati rice export is expected to increase in future. Similar observations were also reported by APEDA (2007).

There is year to year fluctuation in the quantity of both basmati and non-basmati rice exported from India during the period of analysis. However, in value terms there is good increase in the value of export earnings from rice in the years 2001-02 onwards. Though there is wide fluctuation in both quantity and value of rice exports, there is a growth in the export over the years. This shows the compound growth rate over 122.00 per cent over the period of analysis. It can thus be concluded that in spite of variations observed, rice export hold promise for India. India must concentrate on export of rice especially basmati rice from the country, since rice export constitutes a considerable share in the national exports. India is likely to be major exporters next to Thailand and its influence on the global rice trade will be significant. Keeping in view the importance of rice in the national export items, concerted efforts are required to be made to further promote the export of rice. There is a good scope for India to take advantage of the new trade opportunities for promoting the export of rice. This can be achieved if production is made as per the requirements of international markets by increasing investment in Research and Development coupled with export friendly trade policies.

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Training Needs of Dairy Farmers

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ABSTRACT

It was observed that clean milk production was perceived as the most important area for training followed by care and management, health care, animal breeding and feeding. Areas of training preferred by dairy farmers were machine milking, silage making, improvement of poor quality roughages, housing, pregnancy diagnosis, first aid measures, weaning method, preparation of balanced ration, deworming. There was positive and significant correlation between training needs and independent variables *viz*., land holding,, number of dairy animals, social participation and animal belief.

Key words : Dairy farmer, training need.

Dairy farmers have less scientific knowledge about dairy husbandry practices like feeding, breeding, management and health. Therefore, it is essential to provide them with relevant information on improved animal husbandry practices through training. The training programme for dairyman should be based on the need and interest of the farmer. Therefore, identification of training needs of dairy farmers is essential. Keeping this in view the present study was conducted with objectives to study personal, socioeconomic, psychological characteristic, training needs and relationship between these characters of dairy farmers.

MATERIALS AND METHODS

Selection of sample : The present study was conducted in Ambajogai Tahsil of Beed district in Marathwada region of Maharashtra state, where dairy animal is one of the major income source for the farmers. The sample consisted of 150 dairy farmers having at least two milch animals each. The respondents were randomly selected from 15 randomly selected villages, with 10 dairy farmers from each village thereby comprising the total 150 respondents. The data were collected personally with the help of structured pre tested interview schedule.

Assessment of training needs : A three point rating scale (most essential 3. essential 2 and least essential 1) was employed to measure the training needs' of dairy farmers in the five main areas of dairy husbandry namely health care, management, breeding, feeding and clean milk production. In order to prioritize the training need areas of animal husbandry, the frequency number of respondents in each area was multiplied by the respective score allotted to least essential (I), essential (2) and most essential (3) and summation was done. Ranking to different areas of improved animal husbandry practices was then given in accordance with the summed score (Gupta and Tripathi 2002) Further the data were analyzed using the appropriate statistical tools *viz*. mean, percentage, standard deviation and correlation coefficient.

RESULTS AND DISCUSSION

Socio-economic status : It is observed

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Table 1. Personal, socioeconomic, psychological, characteristic of dairy farmers (N = 150).

Characteristic	Percentage
Age :	
i. Young	13.33
ii. Middle	53.33
iii. Old age	33.33
Education :	
i. Illiterate	16.66
ii. Primary	28.66
iii. Secondary	26.66
iv. Higher Secondary	17.33
v. College	10.66
Family size :	
i. Small size (upto 5)	33.33
ii. Middle size (upto 6-10)	53.33
iii. Big size (above 11)	13.33
Land holding :	
i. Marginal (upto 1.00 ha)	17.33
ii. Small farmer (1.01 to 2 ha)	16.00
iii. Semi medium (2.01 to 4 ha)	10.00
iv. Medium (4.01 to 10 ha)	46.66
v. Big (above 10.01 ha)	10.00
Number of animals :	
i. Low (upto-3)	17.33
ii. Middle (upto 3-10)	46.66
iii. High (Above 11)	36.00
Annual income :	
i. Upto Rs. 20,000	16.00
ii. Rs. 20,001 to 40,000	18.66
iii. 40,001 to 60,000	25.33
iv. 60,001 to 80,000	22.66
v. 80,001 to 1,00,000	10.00
vi. 1,00,001 and above	7.33
Social participation :	
i. No social participation	10.00
ii. Low social participation (1)	29.33
iii. Medium social participation (2-3)	44.00
iv. High social participation (4 and above)	16.66
Animal belief :	
i. Low (upto 5)	33.33
ii. Medium (upto 10)	40.00
iii. High (above 10)	26.66
Knowledge :	
i. Low knowledge level	20.00
ii. Medium knowledge level	65.33
iii. High knowledge level	14.66

from Table 1 that majority of the respondents were from middle age group (53.33per cent) having education upto primary (28.66 per cent) and secondary level (26.66per cent). Majority of the respondents (53.33 per cent) were having middle size family and were from medium (46.66 per cent) land holding category. About 47 per cent respondents possessed 3-10 milch animals. Forty-eight per cent respondents had medium level (Rs. 40000-80000) of annual income, with medium social participation (44 per cent). Similarly, 40 per cent of the respondents had medium level of belief about animals. The finding also indicate that about two third of the respondents (65.33 per cent) had medium level of knowledge. These findings are in the line with the findings reported by Ingole (1990) and Gaikwad (2003).

Training needs : It can be observed from Table 2 that majority of the respondents (54.66 per cent) had medium level of training needs of dairy husbandry practices. While 26.66 per cent and 18.66 per cent respondents were found in low and high level of training need category. These findings are in the line with

Table 2. Distribution of respondents according to their training needs.

Category	Percentage
Low (Upto 25)	26.66
Medium (25-35)	54.66
High (above 35)	18.66
Total	100

Table 3. Training needs of dairy farmer in major areas of dairy husbandry practices.

Area	Most essential	Essential	Least essential	Total score	Mean score	Rank
Health care	62 (41.33)	64 (42.66)	24 (16.00)	338	2.25	III
Care and management	68 (45.33)	55 (36.66)	27 (18.00)	341	2.27	II
Breeding	52 (34.66)	69 (46.00)	29 (19.33)	323	2.15	IV
Feeding	54 (36.00)	56 (37.33)	40 (26.66)	314	2.09	V
Clean milk production	65 (43.33)	68 (45.33)	17 (11.33)	348	2.32	I

(Figures in the parentheses indicated percentage.)

findings reported by Meena and Fulzele (1997), Gopal and Shankhala (1998) and Gaikwad (2003).

It was observed from Table 3 that out of five areas, clean milk production was perceived as the most important area (mean score 2.32) for training followed by care and management (mean score 2.27), health and care (mean score 2.25), animal breeding (mean score 2.15) and feeding (mean score 2.09).

Clean milk production and care and management were preferred, as training areas due to the fact that majority of the respondents were not knowing the importance of clean milk production and machine milking. The findings of the present study were not in line with the findings of Meena (1994) Omprakash *et al*. (1995) Gupta and Treepathi (2002) and Gangil *et al*. (2005) as they reported health care and breeding as the priority areas for training and in confirmity with the findings of Gupta and Tripathi (2002), Gaikwad (2003).

Health care : The data in Table 4 revealed that first aid measures was the first most important training need (mean score 2.26) in

Table 4. Training needs in health care practices.

Health care practices	Most essential	Essential	Least essential	Total score	Mean score	Rank
Vaccination schedule	62 (41.33)	60 (40.00)	28 (18.66)	334	2.22	III
Knowledge about common diseases	70 (46.66)	40 (26.66)	30 (20.00)	320	2.13	IV
Deworming	72 (48.00)	42 (28.00)	36 (24.00)	336	2.24	II
Information about contagious diseases	50 (33.33)	52 (34.66)	48 (32.00)	302	2.01	V
First aid measures	73 (48.66)	22 (14.66)	55 (36.66)	340	2.26	I
Diagnosis of mastitis and treatment	25 (16.66)	50 (33.33)	75 (50.00)	300	2.00	VI

(Figures in the parentheses indicated percentage.)

Table 5. Training needs in management practices.

Management practices	Most essential	Essential	Least essential	Total score	Mean score	Rank
Care of pregnant cow	42 (28.00)	63 (42.00)	45 (30.00)	297	1.98	IV
Care at calving and care of newly born calf	24 (16.00)	78 (52.00)	48 (32.00)	276	1.84	V
Housing plan for animals	70 (46.66)	52 (34.66)	28 (18.66)	342	2.28	I
Weaning	67 (44.66)	54 (36.00)	29 (19.33)	338	2.25	II
Care and management of lactating animal	42 (28.00)	82 (54.66)	26 (17.33)	316	2.10	III

(Figures in the parentheses indicated percentage.)

Table 6. Training needs in animal breeding practices.

Breeding practices	Most essential	Essential	Least essential	Total score	Mean score	Rank
Knowledge about different breeds	42 (28.00)	84 (56.00)	24 (16.00)	318	2.12	II
Identification of heat symptoms	15 (10.00)	28 (18.66)	107 (71.33)	208	1.38	V
Knowledge about artificial insemination	38 (25.33)	72 (48.00)	40 (26.66)	298	1.98	IV
Pregnancy diagnosis	57 (38.00)	77 (51.33)	16 (10.66)	341	2.27	I
knowledge about sterility and reproductive disorders	52 (34.66)	62 (41.33)	36 (24.00)	316	2.01	III

(Figures in the parentheses indicated percentage.)

health care area. Deworming (mean sore 2.24). vaccination schedule (mean score 2.22) were given next preferences by the respondents. The finding suggested that training about knowledge of common diseases, information about contagious diseases and diagnosis of mastitis and treatment were less preferred sub area for training.It may be due to the fact that most of the veterinary hospitals and veterinary aid centers are away from their villages, so they preferred first aid measures training as first priority. These findings were fairly in accordance with the findings of Gangil *et al.* (2005).

Management practices : Table 5 revealed that most of the respondents opted housing plan (mean score 2.28) and weaning (mean score 2.25) as most priority sub area. Whereas care and management of lactating animal (mean score 2. 10), care of pregnant cow (mean score 1 .98) and care at calving and care of newly born calf (mean score 1.84) were least preferred. These findings are in line with the findings reported by Ingole (1990), Sirsat *et al*. (1994), Nikam and Rajmane (1995) and Sah *et al*. (2001).

Breeding practices : Table 6 showed that pregnancy diagnosis (mean score 2.27) was the first most essential training need while information about breed (mean score 2.12), was found to be the second most preferred training need in animal breeding sub area. This may be due to majority of the dairy farmers have not knowledge about improved breeds. These findings were fairly in accordance with the findings of Kherde *et al*. (1986), Meena and Fulzele (l997), Raju *et al*. (1999) and Gangil *et al*. (2005). Knowledge about artificial insemination (mean score 1.98) and detection of heat (mean score 1.38) were the least preferred. It is because, the most of the respondents well known about the symptom of heat and already-aware of information of artificial insemination due to wide spread activity of veterinary hospital.

Table 7. Training needs about feeding practices.

Feeding practices	Most essential	Essential	Least essential	Total score	Mean score	Rank
Preparation of balanced ration	72 (48.00)	43 (28.66)	35 (23.33)	337	2.24	III
Feeding to different categories of animals	58 (38.66)	52 (34.66)	40 (26.66)	318	2.12	IV
Importance of clean water for drinking	5 (3.33)	20 (13.33)	125 (83.33)	180	1.20	VII
Cultivation of fodder crops	12 (8.00)	20 (13.33)	118 (78.66)	194	1.29	VII
Conservation of fodder crops by silage making	78 (52.00)	62 (41.33)	10 (6.66)	368	2.45	I
Improvement or roughages	62 (4.33)	68 (45.33)	20 (13.33)	342	2.28	II
Importance of mineral maxture and its feedings	40 (26.66)	84 (56.00)	26 (17.33)	314	2.09	V

(Figures in the parentheses indicated percentage.)

Table 8. Training needs in clean milk production.

Milking practices	Mos essential	Essential	Least essential	Total score	Mean score	Rank
Importance of clean milk production	62 (41.33)	58 (38.66)	30 (20.00)	332	2.21	III
Method of hand milking	48 (32.00)	78 (52.00)	24 (16.00)	334	2.22	III
Machine milking	88 (58.66)	46 (30.66)	16 (10.66)	372	2.48	I
Information about storage of milk	35 (23.33)	70 (46.66)	45 (30.00)	270	1.80	IV

(Figures in the parentheses indicated percentage.)

Feeding : It could be seen from the data furnished in Table 7 that conservation of fodder crop by silage making (mean score 2.45) was the first preferred and the most essential need perceived by most of the respondents because majority of them were not aware of silage making. Most of the respondents also preferred training in improvement of roughages (mean score 2.28) and preparation of balanced ration (mean score 2.24). Respondents perceived importance of clean water for drinking and cultivation of fodder crops as least essential sub area for training. Present findings are supported by Gupta (1998), Gangil *et al*. (2005) who also reported that majority of the respondents did not perceive training in clean drinking water.

Clean milk production : Table 8 revealed that the most of respondents preferred training need in machine milking (mean score 2.48). Only about 10 per cent dairy farmer had given machine milking training need as the least essential. The majority of the dairy farmers felt training needs in machine milking because of lack of awareness of machine milking and facing the labours problem. Other preferences in sub area are importance of clean milk production (mean score 2.21) and storage of milk (mean sore 1.80).

Relationship between personal characteristics and training needs of the dairy farmers : Table 9 showed that there was positive and significant correlation between training need and independent variables viz. Land holding, number of dairy animals, social participation and animal belief. While variables like age, education, family size, annual income and knowledge had non-significant relationship with training needs.

Conclusion : The study gives direction in proper organization of training programmes in accordance with the preference by the livestock owners. Area of training need preference were machine milking, silage making, improvement of poor quality roughages, housing, pregnancy diagnosis, first aid measures, weaning method, preparation of balanced ration and deworming. Hence it is necessary to include these topics in the training programmes to bridge the technological gap between existing and recommended livestock production practices.

Table 9. Correlation of personal characteristics with training needs of the respondents.

Independent variables	Correlation coefficient (r Value)
Age	0.052
Education	0.048
Family size	0.138
Land Holding	0.532**
Number of animals	0.210*
Annual income	0.025
Social Participation	0.428**
Animal belief	0.452**
Knowledge	0.087

*,** Significance at 0.05 and 0.01 level of probability respectively.

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Regeneration of Direct Runoff Hydrograph by Gamma Distribution Function Model

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ABSTRACT

Unit hydrograph assumes uniformly distributed storm over the entire area of the watershed hence, a small experimental watershed of 0.12 sq. km was considered for the application of model. Two parameter gamma distribution function model was used to regenerate unit hydrograph ordinates. The peak discharge and time to peak of regenerated unit hydrograph by both methods of base flow separation showed good match. Average unit hydrograph predicted by average values of shape (α) and scale (β) parameters also showed good match with average unit hydrograph of the watershed.

Key words : Direct runoff hydrograph, gamma distribution function, peak flow, hydrograph modeling function

The determination of peak runoff rates and distribution of direct runoff with respect to time from storm rainfall for a watershed are required in the economic appraisal of flood prevention programmes and for the design of hydraulic structures for the watershed and downstream protection.

The hydrograph can be regarded as an integral expression of the physiographic and climatic characteristics that govern the

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relationship between rainfall and runoff of a particular watershed. Sherman (1932) postulated that there is a linear relationship between effective rainfall and direct runoff. Considering the unit hydrograph theory it is possible to model direct runoff hydrograph for ungauged station for known effective rainfall. As hydrograph shape is somewhat skewed, the gamma distribution function attracted the attention of various research workers for modeling unit hydrograph. Edson (1951), Croley (1980), and recently Rana (2001) and Singh (2003) obtained good estimates of shape and scale parameters so that the unit hydrograph can be perfectly modeled. The work reported herein deals with development of gamma distribution function model for Shenda Park watershed, Kolhapur for direct runoff hydrograph.

MATERIALS AND METHODS

At Zonal Agricultural Research Station, Shenda Park, Kolhapur a parshall flume having 30 cm throat width is installed at the outlet of 0.12 sq. km experimental watershed on which a stage level recorder is fitted to monitor stage data. In this present study ten isolated, single peak storm hydrographs from 1992, 1994, 1995 and 1997 were selected. The stage hydrographs were converted to discharge hydrographs using the relationship for parshall flume given by Wasiullah *et al*. (1972).

The base flow was separated by Chow's method (Chow, 1964) to get direct runoff hydrographs. These were divided by effective rainfall to derive the unit hydrographs. The unit hydrographs derived from ten selected storm events were brought to the same duration of 15 min (0.25 h) by means of S-hydrograph technique. The average unit hydrograph of 0.25 hr. duration was plotted by computing mean peak discharge (q_p), mean time to peak (t_p), and mean time base (t_b) and the average hydrograph was drawn by adjusting its shape so that the area under hydrograph equals 1 cm effective rainfall.

Gamma distribution function is positively skewed and can have wide variety of shapes including single peaked positively skewed graph, which perfectly matches the pictorial presentation of unit hydrograph (Hann, 1977). Gamma distribution function model for unit

Table 1. Storm wise values of effective rainfall, observed and regenerated peak discharge, observed and regenerated volume under direct runoff hydrograph for selected ten storms at Shenda Park watershed.

Date of storm	Effective rainfall (cm)	Peak discharge (10^{-3} cumec)		Per cent deviation	Volume under direct runoff hydrograph (cu. m)		Per cent deviation
		Observed	Regenerated		Observed	Regenerated	
October 3-4, 1992	0.204	151.83	152.12	(-) 0.19	245108.88	244158.09	0.39
June 17-18, 1994	0.048	51.65	52.38	(-) 1.41	57798.36	61014.90	(-) 5.60
July 21-22, 1994	0.293	34.93	34.78	0.43	35118.00	36543.96	(-) 4.06
October 4-5, 1994	0.024	23.97	24.10	(-) 0.54	29217.33	29539.04	(-) 1.10
July 19-20, 1995	0.071	53.15	53.04	0.21	84949.74	81295.09	4.30
July 20-21, 1995	0.037	31.26	31.46	(-) 0.64	44812.71	44291.05	1.16
August 3-4, 1995	0.041	40.57	40.12	1.11	49673.43	49844.26	(-) 0.34
October 4-5, 1995	0.252	111.08	110.96	0.11	302288.40	302235.85	0.02
October 19-20, 1995	0.040	36.46	37.52	(-) 2.90	47995.29	49045.27	(-) 2.19
July 4-5, 1997	0.550	150.96	159.80	(-) 5.90	657822.60	592906.14	9.80

Table 2. The effective rainfall, observed and predicted peak discharge, observed and predicted volume under direct runoff hydrograph for storms with same effective rainfall at Shenda Park watershed.

Date of storm	Effective rainfall (cm)	Peak discharge (10^{-3} cumec)		Per cent deviation	Volume under direct runoff hydrograph (cu. m)		Per cent deviation
		Observed	Regenerated		Observed	Regenerated	
July 17-18, 1994	0.048	51.65	38.19	26.06	57798.36	58803.77	(-) 1.74
July 20-21, 1995	0.037	31.26	29.44	5.82	44812.71	45329.49	(-) 1.15
August 3-4, 1995	0.041	40.57	32.93	18.82	49673.43	50709.20	(-) 2.09
October 19-20, 1995	0.040	36.46	31.83	12.67	47995.29	49060.38	(-) 2.22

hydrograph ordinates can be written by introducing a constant suggested by Edson (1951).

A computer programme in C language was written to compute 'α' iteratively using the peak discharge and time to peak for the developed unit hydrograph and the gamma distribution function. Then the scale parameters β was computed using relation $\beta = (\alpha-1)/t_p$.

RESULTS AND DISCUSSION

The values of shape (α) and scale (β) parameters of gamma distribution function were determined for all ten storm events. These parameters were then used to regenerate and predict the direct runoff hydrographs.

Regeneration of direct runoff hydrographs : The performance of the model was tested for all the ten storm events by using α and β values determined from the storms. The observed and computed peaks and runoff volumes were compared in Table 1. It can be revealed that the deviation ranged from (-) 5.90 to 1.11 per cent for peak runoff rate of direct runoff hydrograph in six out of ten cases the computed peak runoff rate was higher than observed peak runoff rate. However, the runoff volume under direct runoff hydrograph showed deviation of (-)5.6 to 9.8 per cent. The deviation is within ± 10 per cent in both the cases, i.e. peak runoff rate as well as direct runoff volume, suggesting good regeneration by the model.

Prediction of direct runoff hydrograph : The average values of α and β were determined with arithmetic average method and these average values were used to predict the direct runoff hydrograph for storms of July 17-18, 1994; July 20-21, 1995; August 3-4, 1995 and October 19-20, 1995. The results are shown in Table 2. These storms occured during monsoon and at the end of monsoon season but with nearly same effective rainfall.

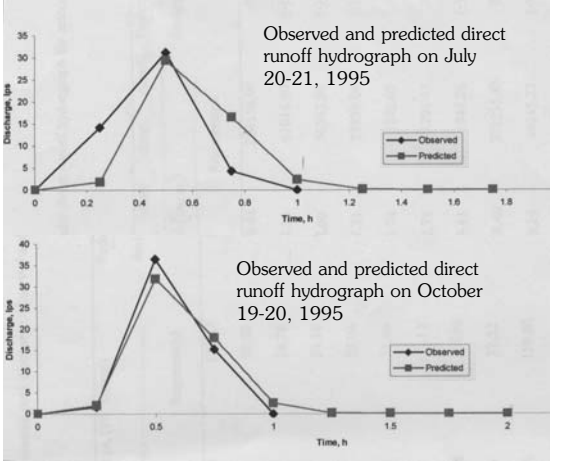

Fig. 1. The observed and predicted direct runoff hydrograph.

The per cent deviation in peak runoff rate was slightly higher and positive suggesting that observed peak runoff rates were higher than predicted peak runoff rates. However, the per cent deviation in runoff volume under direct runoff hydrograph was negative (-1.15) but less. The observed and predicted direct runoff hydrograph for two storms (July 20-21, 1995 and October 19-20, 1995) are depicted in Fig. 1. The figures revealed close agreement between observed and predicted direct runoff hydrographs.

The results of the study lead to conclude that the shape and scale parameters of 2-parameter gamma distribution function can be evaluated using the iterative method suggested. The function can be used to model the unit hydrograph for Shenda Park watershed and the prediction of direct runoff hydrograph with average gamma distribution function model is close to observed.

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Study of Prediction Performance of Gamma Distribution Function Model for Direct Runoff Hydrograph

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ABSTRACT

The regenerated as well as predicted direct runoff hydrograph showed good match with observed direct runoff hydrograph. The statistical indices coefficient of efficiency, integral square error, root mean square error, mean absolute prediction error, mean absolute error, were calculated for average values of α and β. The performance of the model was good. Thus the gamma distribution function model can be utilized for determination of unit hydrograph ordinates and direct runoff hydrograph ordinates from known effective rainfall for ungauged watersheds having similar physiographic and climatic conditions.

Key words : Unit hydrograph, gamma distribution function, direct runoff hydrograph, prediction performance.

Sherman (1932) introduced the concept of unit hydrograph, which can be used to model direct runoff hydrograph for ungauged watershed for known effective rainfall. But it is essential to use those storms, which are uniformly distributed over the entire watershed area for unit hydrograph determination. Gamma distribution function is positively skewed and can have wide variety of shapes including single peaked positively skewed graph, which perfectly matches the pictorial presentation of unit hydrograph (Hann, 1977). Therefore, to evaluate the performance of gamma distribution function model in predicting direct runoff hydrograph this study was undertaken.

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MATERIALS AND METHODS

In this study ten single peaked isolated storm events observed during 1992, 1994, 1995 and 1997 at Zonal Agricultural Research Station, Shenda Perk, Kolhapur were selected. The hydrographs were converted into 0.25 h average limit hydrograph as mentioned by Patil, *et al*. (2010). The shape (α) and scale (β) parameters of gamma distribution function were determined using all ten events and then average values of α and β were determined. Using these average values of α and β and the constant suggested by Edson (1951) the gamma distribution model for determining unit hydrograph ordinates for different time was developed.

The unit hydrograph so developed was used to predict direct runoff hydrograph by considering the effective rainfall during each of the ten storms. Comparison of the observed and predicted DRH was then done considering complete hydrograph using different statistical indices *viz*., as coefficient of efficiency (Nash and Sutcliffe, 1970), Integral square error

Table 1. Statistical indices for all storm events.

Date of storm events	CE	ISE	RMSE	MAPE	MAE
Oct. 3-4, 1992	0.9619	0.1169	0.0100	0.0241	0.0058
June 17-18, 1994	0.4848	0.5693	0.0129	0.1128	0.0072
July 21-22, 1994	-53.6200	6.0566	0.0840	1.1522	0.0450
Oct. 4-5, 1994	0.5158	0.4786	0.0055	0.0031	0.0031
July 19-20, 1995	0.6689	0.3058	0.0102	0.0580	0.0055
July 20-21, 1995	0.9569	0.1216	0.0021	0.0250	0.0012
Aug. 3-4, 1995	0.4734	0.4889	0.0095	0.0955	0.0053
Oct. 4-5, 1995	0.4804	0.2751	0.0330	0.0611	0.0210
Oct. 19-20, 1995	0.6027	0.4031	0.0076	0.0829	0.0044
July 4-5, 1997	0.4848	0.5693	0.0129	0.1128	0.0072

(Diskin *et al*. 1978), mean absolute prediction error (Elwell, 1978), root mean square error (Yu, *et al*. 1994) and mean absolute error (Raghuwanshi and Wallender 2000).

RESULTS AND DISCUSSION

In order to evaluate the prediction performance of the model, statistical indices were calculated, which is a measure of goodness of fit between observed and computed values. The performance of model based on statistical indices were better for average gamma distribution function parameters. The statistical indices for ten selected storms are presented in Table 1.

The coefficient of efficiency values were in acceptable range (>0.6) for four storms. However, the integral square error values ranged from 0.1169 to 6.0566. The ISE value for the storm of July 21-22, 1994 was larger. Except for this value other values were satisfactory.

Root mean square error for all the storms and the averages ranged from 0.0021 to 0.0840. Here also the RMSE value for the storm of July 21-22, 1994 was on higher side. But all these values were quite low suggesting less error in the modelled and observed DRH. The mean absolute prediction error values were better in almost all cases excepting July 21-22, 1994 storm. Based on the values of MAPE it can be said that gamma distribution model performance was better. Since the forecast for all storm events were quite good. Mean absolute error ranged from 0.0012 to 0.0450 indicating better forecasting in almost all cases.

The results of the study lead to conclude that the coefficient of efficiency (CE) which evaluates the model performance was in acceptable range for direct runoff hydrograph predicted using average gamma distribution parameters. However for hydrographs with low peak discharge, like the one of July 21-22, 1994 the perfromance of model is not satisfactory.

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Effect of Different Soil Covers on Infiltration under Simulated Rainfall

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ABSTRACT

The study was conducted under four different soil conditions i.e. bare soil, tilled soil, land covered with madras anjan grass and marvel grass at various rainfall intensities i.e. 6.21, 9.69, 12.75 cm h^{-1}. The relations in the form of Kostiakov's equation were developed for all four soil conditions with the characteristic constants "a" and "b". The cumulative infiltration as percentage of total rainfall for all soil covers were measured. Marvel grass showed maximum cumulative infiltration followed by madras anjan, tilled soil and bare soil. The highest infiltration rates were observed to be 1.5, 1.85 and 1.92 cm h^{-1} for rainfall intensities 6.21, 9.69, and 12.75 cm h^{-1} respectively.

Key words : Soil cover, rainfall simulator, infiltration, Kostiakov's equation.

Rainfall is an important factor in the process of runoff and soil erosion. As the intensity, duration and distribution of rainfall are beyond our control it is not possible to vary these factors quantitatively for the studies on their effect on runoff and soil erosion. Hence to understand the effect of rainfall factors, rainfall simulator can be used. Simulated rainfall has numerous advantages over natural rainfall for many soil erosion studies. For many years, rainfall simulators have been used to accelerate research in soil erosion and runoff from agricultural land. In addition to greater control for field studies, simulated rainfall is readily adoptable to highly controlled laboratory studies. Such studies present the possibility for major advances in understanding of the basic erosion processes.

The rainfall intensity and uniformity coefficient of simulated rainfall increases with an increase in water pressure at the nozzle, while the droplet size decreases with an increase in water pressure (Akhilesh Kumar

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Table 1. Kostiakov's equations for all soil conditions and rainfall intensities.

Soil condition	Rainfall intersities cm hr^{-1}		
	6.21	**9.69**	**12.75**
Bare Soil	$F = 0.5322\ t^{0.6511}$	$F = 0.5169\ t^{0.6949}$	$F = 0.5177\ t^{0.7074}$
	($R^2 = 0.9846$)	($R^2 = 0.9970$)	($R^2 = 0.9982$)
Tilled soil	$F = 0.5155\ t^{0.6931}$	$F = 0.5150\ t^{0.7541}$	$F = 0.5263\ t^{0.7236}$
	($R^2 = 0.9955$)	($R^2 = 0.9895$)	($R^2 = 0.9972$)
Grass cover of madras anjan	$F = 0.5371\ t^{0.6898}$	$F = 0.5644\ t^{0.7856}$	$F = 0.5950\ t^{0.7503}$
	($R^2 = 0.9865$)	($R^2 = 0.9954$)	($R^2 = 0.9931$)
Grass cover of marvel	$F = 0.4996\ t^{0.7920}$	$F = 0.5956\ t^{0.7947}$	$F = 0.5972\ t^{0.7977}$
	($R^2 = 0.9994$)	($R^2 = 0.9997$)	($R^2 = 0.9991$)

1996). Kahlon and Khera (1997) found that high intensities increased raindrop impact on soil surface resulting in greater loss of soil and runoff water. Kukal *et al.* (1999) developed a simple and portable rainfall simulator for small plot studies. It is suitable for small scale field studies of the erosion, infiltration, crusting and runoff processes. Rainfall intensities ranging from 21 to 97 mm hr^{-1} and water pressures raging from 0.32 to 0.60 kg cm^{-2} can be produced with a minimum drop diameter range of 1.1 mm to 2.6 mm.

MATERIALS AND METHODS

A field experiment was conducted on rainfall simulator with sandy loam soil during the year 2005-06 at Dr. A. S. College of Agricultural Engineering, Rahuri. The various components of rainfall simulator are as under.

Size of rainfall simulator (2.18 x 2.65 m), size of soil plot (1.40 x 2.20 m), size of runoff collection tanks (60 x 60 x 60 cm), capacity of water supply tank (1327 lit) and power of motor used for simulating rainfall (0.5 hp).

The different intensities of simulated rainfall (6.21, 9.69 and 12.75 cm hr^{-1}) were achieved by regulating the valve to maintain the pressures of 0.4 , 0.45 and 0.5 kg cm^{-2}. The studies were carried out on four different soil conditions, *viz*., bare soil, tilled soil, soil covered with madras anjan grass, and soil covered with marvel grass under the simulated rainfall for one hour duration. The rainfall amount, drift losses and runoff were measured at 5, 10, 15, 20, 25, 30, 40, 50, and 60 minutes. The observations were taken in single run for each treatment. The average raindrop sizes for different rainfall intensities were determined using Flour Pellet method (Hudson, 1971). These are 2.51, 2.49 and 2.47 mm for 6.21, 9.69 and 12.75 cm hr^{-1} intensity. The basic infiltration rate of experimental soil is 0.58 cm hr^{-1}. The cumulative infiltration was computed as the difference between rainfall and sum of runoff and drift losses.

RESULTS AND DISCUSSION

The relations in the form of Kostiakov's equation (Kostiakov 1932) were developed for all four soil conditions and the characteristic constants "a" and "b" are presented in Table 1 .

Table 2. Cumulative infiltration as percentage of total rainfall for various soil covers.

Rainfall intensity (cm hr^{-1})	Bare soil	Tilled soil	Soil covered with madras anjan grass	Soil covered with marvel grass
6.21	33.84	39.61	37.65	46.87
9.69	25.37	29.47	34.58	36.90
12.75	20.11	21.33	23.83	29.16

The values of coefficient of correlation (R^2) were found maximum in soil covered with marvel grass for all three rainfall intensities. The characteristic constants 'a' and 'b' in Kostiakov's equation for different soil covers suggest that the infiltration rate would be higher in case of marvel grass cover than other covers and bare soil for all the three intensities. Marvel grass showed the highest infiltration rates, *viz*., 1.5, 1.85 and 1.92 cm hr^{-1} for rainfall intensities of 6.21, 9.69, and 12.75 cm hr^{-1} respectively for one hour duration.

The cumulative infiltration as percentage of total rainfall for all soil covers were measured and are presented in Table 2. The cumulative infiltration as percentage of total rainfall was found maximum in case of soil covered with marvel grass to the tune of 46.87, 36.90 and 29.16 per cent for 6.21, 9.69 and 12.75 cm hr-1 rainfall intensities respectively.

It is concluded that the cumulative infiltration as percentage of total rainfall for soil covered with marvel grass was maximum as compared to soil covered with madras anjan grass, tilled soil and bare soil for the simulated rainfall with same intensity. The cumulative infiltration as percentage of total rainfall for soil covered with marvel grass was observed 27.7, 31.24 and 31.0 per cent more than bare soil for rainfall intensities 6.21, 9.69 and 12.75 cm hr^{-1} respectively.

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Non-genetic Factors Affecting Growth, Reproduction and Production Traits of Gir Cow

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ABSTRACT

The milk production of Konkan region is very poor because of the low yielding local breed especially Dangi. A very good herd of Gir cattle is maintained at Mumbai Gorakshak Mandali, Kandivali since 1887. This indicates the good performance of this breed in this region. Results regarding, growth performance of Gir cattle showed lower values of age at puberty and age at first calving in present study. Birth weight, age at puberty, weight at puberty, age at first calving and growth rate up to puberty has not shown any seasonal variation. Quite satisfactory values in case of service period, number of services, calving interval, dry period, breeding has been shown efficiency reproductive and productive. The lactation milk yield (1553.02 l), peak milk yield (8.55 l), days to attain peak yield (69.43 Jays) and standard lactation milk yield (1531.65 l) was higher in summer Other productive parameters did not show any seasonal variation.

Key words : Gir, growth, reproduction, production

The average productivity of an Indian cow is only 978 kg per lactation as against the world average 2038 kg per lactation (Banerjee, 2004). The per capita availability of the milk in the country is 220 g which is still lower than the requirement i.e. 250 g per day (Anonymous, 1998). The milk production of Konkan region is very less because of the local breed especially Dangi. We have three distinct types of cattle breeds *viz*., dairy, draught and duel purpose. The well known dairy breeds are Gir, Sahiwal, Red Sindhi and Deoni. Gir is one of the important dairy breeds originated in South Kathiawad of Gujarat and being reared throughout the country. This breed is fairly good milk producer, hardy, thrives well in wide range of climatic conditions and resistant to many of the infectious diseases. A very good herd of Gir cattle is maintained at Mumbai Gorakshak Mandali, Kandivali since 1887. This indicates the good performance of this breed in this region. A systematic study for its overall performance and likely ways for better management for improving its productivity is warranted. The present study will help in judging the seasonwise adaptability of Gir cattle in high rainfall condition of Konkan region.

MATERIALS AND METHODS

A total of 1090 records pertaining to 226 numbers of Gir cows spread over 26 years period from 1980 to 2005 were compiled from the records maintained at the farm of 'Bombay Gorakshak Mandali', Akurli Road, Kandivali (E) Mumbai. The data on growth, production and reproduction traits available on each cow that had completed its lactation were collected and grouped further according to period, season and parity. Parameters like growth rate up to puberty, reproductive efficiency, breeding efficiency, wet average, daily milk yield, persistency and standard milk yield were calculated by using standard formulae. Reproduction efficiency was estimated by

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formula given by Banerjee, (2004). Breedmg efficiency was estimated by formula given by Tomar (1965). Persistency is the ratio of standard lactation milk yield (300 days yield) to peak yield (observed maximum daily yield). It represents the degree of maintenance of milk production. This method was developed by Rao and Sundaresan (1982). The statistical analysis of the data was done by calculating least squares mean and maximum by using the fixed models given by Harvey (1987). The differences between least squares mean were tested through Duncan's multiple range tests modified by Kramer (1967).

RESULTS AND DISCUSSION

Seasonal performance :

Birth weight : The perusal of Table 1 indicated that the overall mean for birth weight was 23.82 ± 0.20 kg The least squares mean for birth weight were 24.14 ± 0.28, 23.76 ± 0.43 and 23.40 ± 0.37 for winter, summer and rainy season, respectively. Non significant effect of season on birth weight was observed which is suggestive of constant status of herd management over the seasons.

Age at puberty : The overall mean age at puberty was 979.08 ± 12.77 days. The means for age at puberty for winter, summer and rainy seasons were 968.15 ± 20.93, 989.19 ± 21.60 and 986.22 ± 23.06 days, respectively. The age at puberty was statistically non significant. The lowest age at puberty (968.15 ± 20.93) was recorded in winter season. Non significant effect of season on age at first conception in Gir cattle was observed by Bhadoria *et al*. (2002).

Weight at puberty : The overall mean weight at puberty was 288.48 ± 1.44 kg. The least squares mean for weight at puberty ranged from 287.46 ± 2.55 kg to 289.44 ± 2.31 kg. The analysis of variance showed non-significant effect of season on weight at puberty. This indicated that there was no any direct role of season on weight at puberty.

Table 1. Over all least-squares mean and standard error for growth, production and reproduction performance. (N = 1090).

Traits	Least-square mean ± SE
Growth perfromance :	
Birth weight (kg)*	23.82 ± 0.20
Age at puberty (days)*	979.08 ± 12.77
Weight at puberty (kg)*	288.48 ± 1.44
Age at first calving (days)*	1254.29 ± 12.83
Growth rate up to puberty (kg day)*	0.30 ± 0.0034
weight at calving (kg)*	352.63 ± 1.64
Reproductive performance :	
Service period (days)	107.93 ± 0.64
Number of services per conception	1.83 ± 0.03
Calving interval (days)	387.26 ± 0.63
Gestation period (days)	279.86 ± 0.20
Dry period (days)	87.74 ± 0.95
Reproductive efficiency*	40.70 ± 0.11
Bredding efficiency*	89.29 ± 0.40
Production performance :	
Daily milk yield (l)	4.01 ± 0.07
Wet average (l)	5.10 ± 0.03
Peak milk yield (l)	8.32 ± 0.05
Days to attain peak yield	67.45 ± 0.47
Lactation length (days)	299.52 ± 1.04
Lactation milk yield (l)	1523.87 ± 11.01
Persistency index	184.09 ± 0.92
Standard milk yield (l)	1504.96 ± 10.06

*N = 226

Age at first calving : The overall mean age at first calving was 1254.29 ± 12.53 days However, higher values for age at first calving in Gir cattle were reported by Bhadoria *et al*. (2002) as 1719.09 ± 8.11 days. There was no significant difference among seasons for age at first calving. The means for age at first calving were 1244.36 ± 21.03, 1262.08 ± 23.10 and 1261.97 ± 22.17 days in respect to winter, summer and rainy season, respectively. Similar observations were recorded by Bhadoria *et al*. (2002) in Gir cattle.

Growth rate up to puberty : The overall mean growth rate up to puberty was 0.30 ± 0.0034 kg. The analysis of variance observed that there were no any significant differences in growth rate up to puberty between three seasons. The mean growth rate up to puberty was 0.31 ± 0.005, 0.30 ± 0.006 and 0.30 ± 0007 kg per day for winter, summer and rainy season, respectively.

Weight at first calving : The overall mean average weight at calving was 389.89 ± 1.18 kg. The mean for weight at calving were 353.42 ± 2.67, 352.68 ± 2.83 and 351.44 ± 2.96 kg for winter, summer and rainy season, respectively. The analysis of variance showed that there was no significant difference amongst seasons. The highest weight at first calving (353.42 ± 2.67 kg) was recorded in summer season followed by winter (352.68 ± 2.83 kg).

Seasonal reproductive performance :

Service period : The overall mean service period (Table 1 and 2) was 107.93 ± 0.64 days. Similar findings in Gir cows were reported by Pandit *et al*. (1999) as 122.45 ± 2.01 days. The least square mean for service period were 107.42 ± 1.04, 108.01 ± 1.21 and 108.47 ± 1.10 days in winter, summer and rainy season, respectively. The analysis of variance showed that the effect of season of calving was

Table 2. Least-squares mean for birth weight, age at puberty and weight at puberty (N = 1090).

Independent variable	Season			MSS
	Winter	Summer	Rainy	
Growth perfromance :				
Birth weight (kg)#	24.14 ± 0.28	23.76 ± 0.43	23.40 ± 0.37	11.29
Age at puberty (days)#	968.15 ± 20.93	989.19 ± 21.60	986.22 ± 23.06	10658.60
Weight at puberty (kg)#	289.44 ± 2.31	288.03 ± 2.62	287.46 ± 2.55	87.57
Age at first calving (days)#	1244.36 ± 21.03	1262.08 ± 23.10	1261.97 ± 22.17	8675.44
Growth rate up to puberty (kg day)#	0.31 ± 0.005	0.30 ± 0.006	0.30 ± 0.007	0.0024
weight at calving (kg)#	353.42 ± 2.67	352.68 ± 2.83	351.44 ± 2.96	158.69
Reproductive performance :				
Service period (days)	107.42 ± 1.04	108.01 ± 1.21	108.47 ± 1.10	106.18
Number of services per conception	1.80 ± 0.05	1.84 ± 0.05	1.86 ± 0.05	0.43
Calving interval (days)	386.75 ± 1.01	387.53 ± 1.15	387.53 ± 1.15	89.26
Gestation period (days)	279.78 ± 0.27	280.33 ± 0.35	279.50 ± 0.41	54.57
Dry period (days)	89.07 ± 1.49	87.14 ± 1.80	86.69 ± 1.68	612.58
Reproductive efficiency#	40.90a ± 0.17	40.26b ± 0.21	40.81a ± 0.18	8.12*
Bredding efficiency#	89.70 ± 0.62	88.84 ± 0.71	89.08 ± 0.76	15.95
Production performance :				
Daily milk yield (l)	4.04 ± 0.185	4.01 ± 0.056	3.97 ± 0.051	0.55
Wet average (l)	5.02 ± 0.047	5.19 ± 0.065	5.11 ± 0.057	2.64
Peak milk yield (l)	8.27b ± 0.07	8.55a ± 0.09	8.16c ± 0.08	13.32**
Days to attain peak yield	68.73b ± 0.71	69.43b ± 0.88	64.10a ± 0.85	2848.45**
Lactation length (days)	297.68 ± 1.58	300.39 ± 1.98	300.84 ± 1.93	1134.04
Lactation milk yield (l)	1490.64b ± 15.80	1553.02a ± 21.88	1536.14a ± 20.23	392419.72*
Persistency index	184.06b ± 1.42	180.70c ± 1.68	187.19a ± 1.67	3539.86*
Standard milk yield (l)	1477.20b ± 14.50	1531.65a ± 20.21	1513.13a ± 18.28	286114.00*

N = 226 * Significant (P>0.05) ** Significant (P>0.01)

statistically non significant on service period This indicates the uniform reproductive efficiency of Gir cows in all seasons reflecting balanced nutrition and better management of the herd over seasons. The similar findings have been reported by Bhadoria *et al*. (2002) and Barwe *et al*. (2003 a) as in Gir cattle.

Services per conception : The overall mean for number of services per conception was 1.83 ± 0.03. Pandit *et al.* (1999) reported similar findings (2.33 ± 0.8 number of services per conception) in Gir cattle. The mean number of services per conception were 1.80 ± 0.05, 1.84 ± 0.05 and 1.86 ± 05 in winter, summer and rainy season, respectively. The analysis of variance revealed that the number of services per conception was not significantly influenced by the season of calving and was normal in all the seasons with minimum services per conception.

Calving interval : The overall mean calving interval was 387.26 ± 0.63 days. Bhadoria *et al*. (2002) observed similar findings as 439.02 ± 5 98 days calving interval in Gir cattle. The least squares mean for calving interval were 386.75 ± 1.01, 387.53 ± 1.15 and 387.53 ± 1.15 days in winter, summer and rainy season, respectively. The analysis of variance revealed that the mean for calving interval did not differ significantly. This showed the adaptability of Gir cattle to prevailed agroclimatic condition of the region These results are in agreement with Bhadoria *et al*. (2002).

Gestation period : The overall mean for gestation period was 279.86 ± 0.20 days. The mean gestation period were 279.78 ± 0.27, 280.33 ± 0.35 and 279.50 ± 0.41 days for winter, summer and rainy season, respectively. The gestation period was highest (280.33 ± 0,35 days) in summer, followed by winter (279.78 ± 0.27 days) and rainy (279.50 ± 0.41 days) The analysis of variance revealed non significant differences among three seasons for gestation period. The results of present investigation are in consonance with those reported by Kumar (1997) in dairy cattle.

Dry period : The overall mean dry period was 87.74 ± 0.95 days. Similar findings in Gir cattle were.reported by Bhadoria *et al*. (2003) as 137.94 ± 4.04 days. The least squares mean for dry period influenced by season of calving were 89.07 ± 1.49, 87.14 ± 1.80 and 86.69 ± 1,68 days for winter, summer and rainy season, respectively. The analysis of variances revealed that season of calving had non significant effect on dry period. The longer dry period was observed for winter calving while shorter dry period noticed for rainy season. Bhadoria *et al*. (2003) reported non significant effect of season of calving on dry period in Gir cattle.

Reproductive efficiency : The overall mean for reproductive efficiency was 40.70 ± 0 11 per cent. The mean reproductive efficiency was 40.90 ± 0.17, 40.26 ± 0.21 and 40.81 ± 0.18 per cent in winter, summer and rainy season, respectively. The analysis of variances revealed that season of calving had significant ($P < 0.05$) effect on reproductive efficiency. Reproductive efficiency for winter and rainy season calvers was at par with one another. This indicates that the winter and rainy seasons are more suitable seasons for improving reproductive efficiency.

Breeding efficiency : The overall breeding efficiency was 89.29 ± 0.40 per cent. Similar findings in Gir cattle were observed by Bhadoria and Tomar (2000) as 70.88 ± 0.78 per cent. The means for breeding efficiency were 89.70 ± 0.62, 88.84 ± 0.71 and 89.08 ± 0.76 per cent in winter, summer and rainy season, respectively. The analysis of variances revealed that the season of calving had non

significant effect on breeding efficiency. Breeding efficiency in winter season calvers was higher followed by rainy season calvers. This indicates that the winter and rainy seasons were more suitable seasons for improving breeding efficiency. The results of the present study are in confirmatory with the findings reported by Bhadoria *et al*. (2002).

Seasonal production performance :

Milk yield : The overall mean daily milk yield was 4.01 ± 0.07 l per day. This finding was in agreement with Chandratre (1984) as 2.95 ± 1.25 kg per day in Gir cattle. The means for average daily milk yield over seasons were 4.04 ± 0.185 l. 4.01 ± 0.06 l and 3.91 ± 0.051 l for winter, summer and rainy season, respectively. The analysis of variance showed that the effect of season of calving on average daily milk yield was statistically non significant. This showed uniform calving interval and milk yield of cows over seasons. The similar results have been reported by Patil (1997) in dairy catties.

Wet average : The overall mean for wet average was 5.10 ± 0.03 l day^{-1}. These results are in consonant with that of Bangar and Narayankhedkar (1999 b) who has reported, 4.60 kg day^{-1}, in Gir cattle. The seasonal least squares mean with their standard errors for wet averages in winter, summer and rainy season, were 5.02 ± 0.047, 5.19 ± 0.065 and 5.11 ± 0.057 respectively. Analysis of variance showed that season wise wet average did not differ significantly among them, ihis indicates better feeding manageaient in the herd. Similar findings have been reported by Yadav *et al.* (1995).

Peak milk yield : The overall mean peak milk yield was 8.32 ± 0.05 l per day. Similar result has been reported in Gir cattle by Nanavati and Singh (2004) as 10.05 ± 0.10 kg day^{-1}. The analysis of variance showed significant effect of season of calving on peak milk yield. The means of peak milk yield were 8.27 ± 0.07, 8.55 ± 0.09 and 8.16 ± 0.08 l day in winter, summer and rainy season, respectively. The maximum peak milk yield (8.55 ± 0.09 l day) was recorded in summer while minimum (8.16 ± 0.08 l day^{-1}) peak milk yield in rainy season. This reveled that various metabolic changes in mammary tissues were affected by change in climate and nutritional planes. The results of present study are in accordance with the finding of Nanavati and Singh (2004).

Days to attain peak milk yield : The overall mean days to attain peak yield were 67.45 ± 0.47 days. However, less days to attain peak milk yield were reported by Nanavati and Singh (2004) as 43.37 ± 0.84 days, in Gir cattle. The effect of season of calving on days to attain peak milk yield was found to be statistically significant ($P < 0.01$). The cows calved in summer season took significantly more time (69.43 ± 0.88 days) to attain peak milk yield as compared to winter (68.73 ± 0.71 days) and less time (64.10 ± 8.85 days) in rainy season. More number of days to attain peak yield during summer season may be attributed to the environmental conditions because animals were not comfortable due to high temperature and low humidity and spent most of the energy in maintaining homeothermy. Similar results were presented by Kumar (1997) in dairy cattle.

Lactation length : The overall mean lactation length was 299.52 ± 1.04 days. These findings are in agreement with Bhadoria *et al*. (2003) as 292.43 ± 4.35 days in Gir cattle. The least squares mean were 297.65 ± 1.58, 300.39 ± 1.98 and 300.84 ± 1.93 days for winter, summer and rainy season, respectively. Though the effect of season of calving on lactation length was found to be non

significant, the data showed that winter calvers had the shorter lactation length followed by summer and longest in rainy season calvers. Similar results were observed by Bansar and Narayankhedkar (1999 a) in Gir cattle.

Lactation milk yield : The overall mean lactation milk yield was 1523.87 ± 11.01. Similar findings in Gir cattle were reported by Bangar and Naravnkhedkar (1999 a) as 1651.69 ± 247.35 kg. The perusal of analysis of variance showed that season of calving had significant ($P < 0.05$) effect on lactation milk yield. The maximum lactation milk yield (1553 02 ± 21.58 l) was recorded for summer season calvers while, minimum lactation milk yield (1490.64 ± 15.80 l) in winter calvers. There was no difference in lactation milk yield in between summer and rainy season calvers. This may be reflection of higher lactation length in rainy season. The results of present study are in accordance with the finding of Nanavati and Singh (2004) in Gir cattle.

Persistency index : The overall mean persistency index was 184.09 ± 0.92. The analysis of variance revealed that the effect of season of calving on persistency was statistically significant ($P < 0.05$). The mean persistency index of milk yield as affected by season was significantly higher in cows calved in rainy season (187.19 ± 1.67) as compared to the cows calved in winter (184.06 ± 1.42) and lower in summer dreshners (180.70 ± 1.68). The high persistency of milk yield in cows calved in rainy season may be due to suitable climatic condition and ample availability of green fodder. Similar results were obtained by Desai (2000) in dairy cattle.

Standard milk yield : The overall mean standard milk yield was 1504.96 ± 10.06 l. The analysis of variance showed that the effect of season on standard milk yield was significant ($P<0.05$). The summer season recorded highest standard milk yield (1531.65 ± 20.21 l) as compared to rainy season (1513.13 ± 18.25 l) and lowest in winter season (1477.20 ± 14.50 l). However, there was no significant difference in standard milk yield between summer and rainy season. This indicted that the Gir cattle respond to the seasonal variation in case of milk production. This might be due to less difference in minimum and maximum temperature in summer and rainy season with higher humidity as compared to winter.

CONCLUSION

The results regarding overall growth performance of Gir cattle showed lower values of age at puberty and age at first calving. This perhaps may be due to proper management practices, prevailing climatic condition, good fodder base and optimal feeding management in growth period of Gir cattle. Birth weight, age at puberty, weight at puberty, age at first calving and growth rate up to puberty had not shown any seasonal variation. Average weight at calving was higher (394.31 kg) in rainy season; this may be due to availability of green fodder in sufficient amount.

Regarding reproductive performance it showed by and large quite satisfactory values in case of service period, number of services, calving interval, dry period and breeding efficiency. Service period, number of services per conception, calving interval, gestation period, dry period and breeding efficiency had not shown any seasonal variation. Only reproductive efficiency had showed seasonal variation. Reproductive efficiency (40.90%) was more in winter.

In case of productive performance, overall parameters showed quite satisfactory reports. Days to attain peak milk yield had higher value in present study. The lactation milk yield was higher (1553.02 l) in summer Similar trend was

also observed in peak milk yield (8.55 l), days to attain peak yield (69.43 days) Standard lactation milk yields (1531.65 l). Wet average, lactation length and average daily milk yield did not show any seasonal variation.

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Identification of Surti Buffalo on the Basis of Groove and Muzzle Characteristics

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ABSTRACT

Overall 72.88 per cent muzzle prints of Surti Buffalo were grooved and only 27.12 per cent were non-grooved. Among grooved muzzles, incomplete grooves were found on the largest number (96.12 %) of muzzles where as only few (3.88 %) were completely grooved. About 49.19 per cent incomplete grooves were extended to ½, 35.48 per cent to ¼ and 15.33 per cent to ¾ size of the muzzle. Among complete and incomplete grooves of muzzle almost all (99.19 %) grooves were located at the basal part. The muzzle prints also exhibited clove (34.88 %), elliptical (25.58 %), undefined (21.7 %) and arrow (12.4 %) shaped grooves in large numbers, however, diamond, egg and oval shaped grooves were in meager numbers. Only beads (single or clustered beads) were observed and the ridges were totally absent.

Key words : Surti buffalo, muzzle print, muzzle groove, beads, ridges.

The identification methods, *viz.*, tattooing, branding, ear/neck tagging etc. are mostly temporary and having many disadvantages. The perfect identity of each animal is not possible by existing methods. Hence, it is very much needful to invent new methods/ techniques for permanent and perfect identification of dairy animals.

Considering shortcomings of these methods of identification of dairy animals, research workers have tried the method of muzzle printometry with greater degree of accuracy in recent past. Muzzle of animals is formed by 50th day of embryonic life, while, muzzle pattern becomes clearly evident on 58th day and remains characteristic throughout life. As human finger prints, no two bovines have exactly same muzzle print. The research findings put forth by some research workers suggested that muzzle prints of animals, similar to finger prints in human beings, could be used as permanent method of identification (Pandey, 1979). It is proved that muzzle prints are obtained easily, need very short time, economical, not inhumane to animals and remain constant after 2-3 years of age (Pandey, 1979 and Ravikumar, 1994).

MATERIALS AND METHODS

Study on 177 Surti buffaloes were conducted on animals belonging to the government Buffalo Breeding Farm, Hingoli. The muzzle prints were collected by using technique described by Mishra *et al*. (1995) for obtaining quality muzzle prints. The muzzle prints obtained from each animal were examined separately, classified on the basis of grooves and muzzle characteristics and different codes were given (Table 1).

RESULTS AND DISCUSSION

It was observed from Table 1 that 72.88 per cent muzzle prints were grooved and only 27.12 per cent were non-grooved. Among grooved muzzles, incomplete grooves were found on the largest number (96.12 %) of

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muzzles whereas only few (3.88 %) were completely grooved. About 49.19 per cent incomplete grooves were extended to ½, 35.48 per cent to ¼ and 15.33 per cent to ¾ size of the muzzle. Among complete and incomplete grooves of muzzle almost all (99.19 %) grooves were located at the basal part. The muzzle prints also exhibited clove (34.88 %), elliptical (25.58 %), undefined (21.7 %) and arrow (12.4 %) shaped grooves in large numbers. However, diamond, egg and oval shaped grooves were in meager numbers. Only beads i. e. round, oval or irregular structures were observed on the muzzle prints of Surti buffalo and the ridges (elongated, straight or curved structures arranged in specific manner) were totally absent. The beads were found either in single or in clumped form i. e. clustered beads. Pandey (1981), Mishra *et al*. (1997) and Kawthekar *et al*. (2006) also reported the similar findings of muzzle patterns of the buffaloes and stated that these characters can be used for differentiating cattle and buffaloes.

Pandey (1981) reported distinguishing features of cattle and buffalo muzzle prints and concluded that the presence of ridges, distinct tubular spaces and hair pitlessness features in muzzle prints of cattle, while, the presence of hair pits, absence of ridges, non-distinct tubular openings should be considered to be the characteristics of the muzzle prints of buffalo. He suggested that this would help in Vetero-legal cases in identification of animals on the basis of classification of muzzle prints.

Yadav (1991) indicated that muzzle prints varied greatly in their characteristics as well as measurements in spite of breed, sex and age. Hence, the muzzle prints could also be utilized for identification of individual animal. Mishra *et al*. (1997) studied on muzzle prints of Murrah buffalo calves from day 1 to 180 days of age and found that the ridged beads were completely absent. For identification of individual buffalo on the basis of grooves and the muzzle characteristics, different codes were given to complete / incomplete groove, size of groove, location site, shape and also to muzzle characteristics of muzzle as indicated in Table 1. Mishra (1994), Mishra *et al*. (1998), Singh and Patel (2004) and Kawthekar *et al*. (2006) also followed the system of coding of muzzle prints.

Table 1. Classification on the basis of muzzle measurements and muzzle characteristic of Surti buffalo.

Particulars	Code	No. of observations	(%)
On the basis of Grooved/ Non-grooved :			
Non-grooved	0	48	27.12
Grooved	1	129	72.88
Complete	1	5	3.88
Incomplete	2	124	96.12
Size of incomplete groove :			
1/4	2.1	44	35.48
1/2	2.2	61	49.19
3/4	2.3	19	15.33
Location of incomplete groove :			
Basal	2.4	123	99.19
Central	2.5	1	0.81
Upper	2.6	Nil	Nil
Shape of groove :			
Arrow	3.1	16	12.4
Bell	3.2	Nil	Nil
Clove	3.3	45	34.88
Diamond	3.4	1	0.78
Elliptical	3.5	33	25.58
Egg	3.6	3	2.33
Oval	3.7	3	2.33
Undefined	3.8	28	21.7
On the basis of characters :			
Beads only	4	177	100
Ridged beads	5	Nil	Nil
Beads and ridged beads	6	Nil	Nil
Total	-	177	-

For identification of individual buffalo at different age, it is necessary to collect muzzle prints at different ages and maintained an identification chart on the basis of study of muzzle prints of each animal using code

Chart 1. Identification chart of muzzle prints of Surti buffaloes.

Plate no.	Age group (month)	Grooved/ non-grooved	Size of groove	Location groove	Shape of groove	Characteristics
1	31-40	2	2.2	2.4	3.3	4
2	31-40	0	-	-	-	4
3	51-60	2	2.3	2.4	3.8	4
4	71 & Above	2	2.2	2.4	3.5	4

Identification of muzzle prints of Surti buffaloes

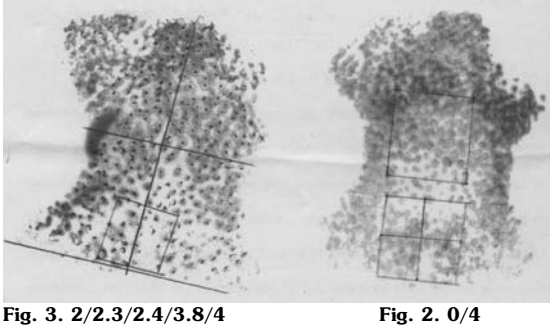

Fig. 3. 2/2.3/2.4/3.8/4 **Fig. 2. 0/4**

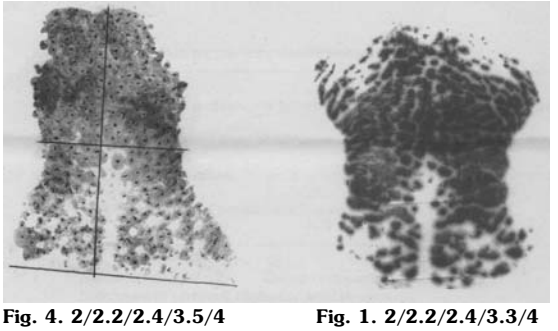

Fig. 4. 2/2.2/2.4/3.5/4 **Fig. 1. 2/2.2/2.4/3.3/4**

numbers (Chart 1 / Fig 1-4). To avoid false results, it is very much important to note that the length of time between muzzle prints taken and the time to utilize the muzzle prints for identification of the animal.

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RESEARCH NOTES

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Genotype x Environment Analysis for Yield of Irrigated Chickpea

There are various methods to assess the stability of genotype in varing environmental conditions. Among them are Eberhart and Russell (1966), Tai (1971), Lin *et al*. (1986) and Laxmi (1998). The yield data generated on seed yield of chickpea (desi) conducted during *rabi* (irrigated) season of 2005-06, through state multi-location trials at eight locations was used in present investigation. Twelve chickpea genotypes *viz*., Phule G-9409-1, Phule G-9758-6-2, Phule G-00110, Phule G-9621-12, BDNG-2001-2-1, BDNG-107, AKG-46-2, Vijay, Vishal, Digvijay, SAKI-9516, and JAKI-9218 were evaluated. The locations were Rahuri, Karad, Dhule, Pandhrpur, Parbhani, Achlapur, Pune, and Badnapur. The experiment was conducted in RBD design with three replications adopting net plot size of 4.0 x 2.4 m with spacing 30 x 10 cm. The recommended package of practices were adopted for raising the crop. The data on seed yield was recorded in various test environments and analyzed as per Laxmi (1998).

The mean seed yield of genotypes over all environments indicated that Digvijay ranked first (2611 kg ha^{-1}) followed by Phule G-9409-1 (2582 kg ha^{-1}) and SAKI-9516 (2549 kg ha^{-1}). It is also revealed that the yield performance of genotypes was not same in all environments due to significant G x E interaction. The average yield performance of genotypes over all environments was at par. So it is difficult to identify the stable and significantly high yielding variety through this multilocation trial. Therefore, it is essential to classify the environments (favourable, average and unfavourable one) and then identify the stable genotype in each environment. The four locations *viz*., Rahuri, Karad, Dhule and

Table 1. Yield performance of *rabi* irrigated chickpea (desi) in different environments.

Genotype	Favourable environment			Average environment			Unfavourable enviornment		
	Yield (kg ha^{-1})	Phenotypic index	Rank	Yield (kg ha^{-1})	Phenotypic index	Rank	Yield (kg ha^{-1})	Phenotypic index	Rank
Phule G-9409-1	3059	263	6	2200	162	4	2073	421	1
Phule G-9758-6-2	2466	-330	9	1645	-393	12	1543	-109	8
Phule G-00110	3087	291	5	2015	-23	7	1560	-92	6
Phule G-9621-12	3100	305	4	2165	127	5	1725	74	4
BDNG-2001-2-1	2005	-791	12	1867	-171	10	1414	-238	12
BDNG-107	2046	-749	11	1666	-372	11	1523	-129	9
AKG-46-2	2330	-466	10	2308	270	3	1553	-99	7
Vijay	2871	75	8	2314	276	2	1469	-182	11
Vishal	2908	113	7	1972	-66	8	1515	-137	10
Digvijay	3372	576	1	2318	280	1	1695	43	5
SAKI-9516	3126	330	3	2092	54	6	1931	280	2
JAKI-9218	3178	383	2	1898	-140	9	1818	167	3
Mean	2796	-	-	2038	-	-	1652	-	-

Pandharpur were found to be the favourable environments for irrigated chickpea, the one locations Parbhani was seen to be average environment while three locations *viz*., Achalpur, Pune and Badnapur were observed as unfavourable environments for irrigated chickpea. Amongst the environments Rahuri ranked first with an average yield of 3111 kg ha^{-1} followed by Dhule with average yield of 2923 kg ha^{-1}.

The genotype Digvijay ranked first in favorable and average conditions with grain yield of 3372 kg ha^{-1} (Table 1) in favorable conditions, which is nearly five and half times more than the state average yield (596 kg ha^{-1}), 1100 kg ha^{-1} more than average yield of over all locations (2272 kg ha^{-1}) and 576 kg ha^{-1} more than favorable environments average yield (2796 kg ha^{-1}). Though the genotype Digvijay ranked first in average condition its yield reduced to 2318 kg ha^{-1} from 3372 kg ha^{-1} in favourable condition. The genotype Vijay ranked second in average environments with grain yield of 2314 kg ha^{-1}, which is nearly four times more than the state average yield. In unfavorable environments, Phule G - 9409-1 ranked first with grain yield of 2073 kg ha^{-1}, followed by SAKI-9516 with grain yield of 1931 kg ha^{-1} which was more than three times higher than state average yield. The performance of chickpea genotype, Phule G-9409-1 was found to be the best in average as well as in unfavorable environments and Digvijay was found to be the best in favourable as well as in average environments.

The average yield of these chickpea genotypes in favourable environments was 2796 kg ha^{-1}, which is more than four and half times of the state average yield. It was reduced to 2038 kg ha^{-1} i.e. by 27.1 per cent in average environment and to 1652 kg ha^{-1} i.e. by 40.9 per cent in unfavorable environment. These results indicated that there is a need to identify the most favourable environment for each crop to obtain maximum yield.

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Direct and Indirect Influence of Component Characters on Yield in Pea (*Pisum sativum* L.)

The yield in pea is complex character and may involve several simply inherited factors whose association with yield can be known through correlation studies. The information derived on correlation and path analysis will help in identifying the desirable component characters for bringing improvement in pod yield. Fifty germplasm lines of pea (*Pisum*

sativum L.) collected from NBPGR, New Delhi were evaluated in a randomized block design with three replications during *rabi* 2005. Out of fifty genotypes, thirteen were exotic germplasms and thirty seven were indigenous. Each entry was represented by two rows of 4.5 m length spaced at 45 x 15 cm apart. Five plants per genotype were used for recording observations in each replication. Observations were recorded on nine different characters along with yield and were subjected to correlation and path coefficient analysis by following Singh and Chaudhary (1977) and Dewey and Lu (1959), respectively.

The character 100 seed weight recorded the highest significant positive correlation with seed yield per plant (0.675) followed by pod length (0.636), number of seeds per pod (0.607), days to maturity (0.483) and days to flowering (0.404). The association between seed yield plant^{-1} and number of pods plant^{-1} and number of branches and plant height was non significant. Hence selection for high seed yield can be done by selecting more number of seeds pod^{-1}, 100-seed weight, pod length, days to maturity and days to flowering. Similar results were obtained by Chaudhary and Singh (1971) for days to 50 per cent flowering and Singh *et al*. (1985) for 100 seed weight, seeds per pod and days to flowering. However, the association between seed yield per plant and plant height at harvest and number of branches per plant was positive and non significant.

Among the correlation between component characters, days to flowering and days to maturity were correlated significantly and negatively with plant height, number of branches per plant, number of pods per plant, whereas, plant height with number of branches and number of pods per plant, number of branches with number of pods per plant and pod length with number of seeds per pod were positively and significantly correlated with each other, indicating, interdependency of these characters. However, the association between number of pods plant^{-1} and pod length, number of seeds pod^{-1} and 100 seeds weight were significantly negative suggesting, the fact that they may not go together. These results coinside with Teotia *et al*. (1983) for pod length with number of seeds per pod and Singh *et al*. (1987) for days to maturity and days to flowering.

The information derived from correlation studies indicates only mutual association among characters whereas, path coefficient analysis provides an effective measure of direct and indirect influence of association and depicts the relative importance of each factor involved in contributing to the final product i.e. seed yield per plant. The character 100 seed weight (0.9495) produced the highest direct effect on seed yield followed by number of seeds per pod (0.4604) and pod length (0.2538). The correlation coefficient between seed yield and 100 seed weight, number of seeds per pod and pod length were significantly positive, indicating, true and perfect association between these characters. Similar results were obtained by Teotia *et al*. (1983), Singh (1985) and Singh *et al*. (1985).

Though number of pods plant^{-1} recorded high direct effect with yield, the correlation coefficient was negative, vice versa days to flowering and days to maturity though produced magnitudinally low direct effect with yield was significantly positive indicating that, they are contributing indirectly through some other characters and reciprocal recurrent selection will serve the purpose to select better recombinants in segregating generations.

Among the indirect contributions, days to flowering and days to maturity through 100-seed weight, plant height and number of branches per plant through number of pods per plant and pod length through number of seeds

per pod contributed to yield indirectly. These results confirm the earlier findings of Teotia *et al.* (1983) and Kumar *et al.* (2003).

From present study, it could be concluded that the characters, 100-seed weight, pod length, number of seeds pod^{-1}, days to maturity and days to flowering are major yield contributing characters and will help in improving seed yield. Therefore, the emphasis should be given on these characters in selection programme to develop desirable genotypes in pea.

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Biochemical Changes in Mungbean due to Infection of Virus (MYMV)

Virus is one of the most important factors causing severe loss in yield and quality in pulses through quick spread in the presence of virus vector. Mungbean is a warm weather pulse crop and suffers greatly from several viral diseases, among which mungbean yellow mosaic virus (MYMV) infecting mungbean has became a major constraint in cultivation and production. The initial symptoms of MYMV on mungbean appear in the form of irregular yellow patches of various sizes, which coalesce to form larger patches of bright yellow colour. Upon MYMV infection biochemical content may be affected e.g. virus induced changes in peroxidase has been reported in tobacco infected with tobacco mosaic virus (Simons and Ross, 1970) and beans infected with southern bean mosaic virus (Farkas and Stahman, 1966). In India, the yield loss per annum due to yellow mosaic diseases in mumgbean, urdbean and soybean combined together was estimated to be 300 million US $ (Varma *et al*., 1992). Looking to the severity of the disease in the mungbean plant present study was undertaken to know about the biochemical changes in total chlorophyll, total soluble sugars, total free amino acids, phenol, enzyme, protein contents and moisture,in MYMV infected and healthy mungbean leaves.

For biochemical estimations healthy leaves from plots covered with net and MYMV infected leaves of mungbean cv. K-851 during 2005-06 were collected and used at the age of 27 days plants from the field. Each test was performed in three replications. Various biochemical parameters were estimated using standard method *viz*., moisture by oven dry method (Mehta and Lodha, 1979), chlorophyll by DMSO (Dimethyl sulphoxide) method (Hiscox and Israelstam, 1979), protein by Lowry *et al.* (1951) method, total free amino acid by ninhydrin (Triketohydrindene hydrate) (Moore and Stein, 1948), total phenol by method of Malik and Singh (1980) and total soluble sugars by phenol-sulphuric acid method described by Dubois *et al*. (1956).

Average data of three observations on various biochemical parameters in the healthy and diseased leaves of mungbean revealed that content was higher in diseased leaf compared to healthy such as moisture, total free amino acids, total phenol, peroxidase specific activity and protein *viz*., 3.06, 125.95, 10.32, 44.55 and 50.27 per cent increase, respectively, whereas, it was lower in case of total chlorophyll and total soluble sugars *viz*., 43.40 and 28.68 per cent decrease, respectively (Table 1). MYMV infection influenced the contents of various biochemical parameters by increase or decrease over healthy. There was increase in moisture (3.06 %), total free amino acids (125.95 %), total phenol (10.32 %), peroxidase specific activity (44.55 %) and protein (50.27 %), while total chlorophyll (43.40 %) and total soluble sugars (28.68 %) decreased. Similar results i.e increase in moisture and amino acids have been reported in yellow vein mosaic of okra and yellow mosaic in greengram by Regupathy and Jayaraj, (1972) and Regupathy *et al*. (1975), respectively phenol, peroxidase activity and protein in mungbean yellow mosaic virus in mungbean and urdbean by Chand and Varma (1980) and Tripathi *et al*. (1975) while decrease in chlorophyll and total soluble sugars content in MYMV infected greengram leaves by Gill *et al*. (2000) and Regupathy *et al*. (1975), respectively.

Table 1. Moisture, total chlorophyll, total soluble sugars, total free amino acids, phenol, enzyme and protein contents in healthy and MYMV infected mungbean leaves.

Biochemical constituents	**Healthy** *	**Diseased** *	**Increase (+) decrease (-) over healthy (%)**
Moisture (%)	77.07	79.43	(+) 3.06
Total chlorophyll (mg g^{-1})	7.954	4.502	(-) 43.40
Total soluble sugars (g $100g^{-1}$ sample)	1.775	1.266	(-) 28.68
Total free amino acids (g $100g^{-1}$ sample)	0.131	0.296	(+) 125.95
Total phenol (g $100g^{-1}$ sample)	0.281	0.31	(+) 10.32
Peroxidase specific activity (Change in OD min^{-1} mg^{-1} protein)	0.101	0.146	(+) 44.55
Protein (mg $100mg^{-1}$ sample)	2.918	4.385	(+) 50.27

* Mean of three observations

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Response of Forage Pearl millet Varieties to Different Nitrogen Levels Under Rainfed Condition

Pearl millet (*Pennisetum glaucum* (L.) Leeke) is one of the most widely adapted forage crops and gaining more popularity in Maharashtra due to its quick growing habit, high quality forage and better palatability. At present, the availability of fodder resources is around 60 per cent of the requirement and area under fodder crops in India is around 8.6 M ha. To meet the fodder shortage for the growing animal population, the fodder growing area should ideally be around 20 M ha by 2020 AD, but this appears to be rather difficult to achieve (Hazra and Tripathi, 1998). Only way is to look for increased productivity per unit area and also through balanced nutrition to fodder crops. Nitrogen is an essential primary nutrient for profuse plant growth and plays a pivotal role in productivity of forage production. Now a days many new improved genotypes of pearl millet are coming up as forage varieties. Therefore, it is necessary to exploit the green forage yield of these varieties under different nitrogen levels. Keeping these in view, the present investigation was undertaken.

The field experiment was conducted at Forage Crops Research Project, MPKV, Rahuri during *kharif* season of 2007-08. The experiment was laid out in a factorial randomized block design with three

replications. Twenty four treatment combinations formulated due to eight varieties and three nitrogen levels (Table 1). The soil of the experimental field was clayey in texture, low in available nitrogen (209 kg ha^{-1}), medium in phosphorus (10.11 kg ha^{-1}) and high in potash (436 kg ha^{-1}). The crop was fertilized with 30 kg each of P_2O_5 and K_2O per hectare. The half quantity of nitrogen was applied at the time of sowing and remaining half quantity was top dressed at 30 days after sowing as per the treatments. The crop was harvested at 50 per cent flowering. There was good and well distributed rainfall during the crop season.

Varieties : The differences in green forage, dry matter and crude protein yield were differed significantly due to varieties (Table 1). The variety BAIF Bajra produced significantly higher green forage yield of 477.82 q ha^{-1} than all other varieties, however, variety Giant Bajra being at par with BAIF Bajra recorded statistically higher dry matter yield of 75.88 q ha^{-1} as compared to all other varieties under study. Whereas, statistically higher crude protein yield of 6.60 q ha^{-1} was registered with variety BAIF Bajra which was at par with Giant Bajra, PHB-2172 and NDFB-2 and significantly superior over remaining varieties. Similar results were reported by Verma and Midha (1989), Verma (1993) and Sharma *et al*. (1999).

Nitrogen levels : Data presented in Table 1 revealed that the application of 100 kg nitrogen per hectare noticed significantly higher green forage yield (400.32 q ha^{-1}), dry matter yield (75.34 q ha^{-1}) and crude protein yield (6.98 q ha^{-1}) than all other levels of nitrogen. Increasing levels of nitrogen from 50 to 75 and 75 to 100 kg ha^{-1} increased the green forage yield by 12.90 and 7.56 per cent, dry matter yield by 35.44 and 15.57 per cent and crude protein yield by 47.10 and 24.87 per cent, respectively. These results are in agreement with those reported by Reddy and Reddy (1991), Subbian (1991), Karle *et al*. (1996) and Sharma *et al*. (1999).

Table 1. Green forage yield, dry matter yield and crude protein yield of pearl millet as influenced by different treatments.

Treatment	Green forage yield (q ha^{-1})	Dry matter yield (q ha^{-1})	Crude protein yield (q ha^{-1})
Varieties :			
Raj Bajra Chari-2	271.89	56.80	5.33
Giant bajra	447.72	75.88	6.17
PHB-2172	300.49	67.45	6.04
JHPM-05-1	377.19	46.44	4.03
NDFB-2	327.80	68.38	5.95
BAIF Bajra	477.82	71.80	6.60
JHPM-05-2	406.82	52.29	4.26
NDFB-9	329.35	64.04	5.25
S. E.±	10.27	2.10	0.25
C. D. at 5%	29.23	5.98	0.71
N levels (kg ha^{-1}) :			
50	329.66	48.13	3.80
75	372.18	65.19	5.59
100	400.32	75.34	6.98
S. E.±	6.29	1.29	0.15
C. D. at 5%	17.90	3.66	0.43

The aforesaid results indicated that for obtaining higher green forage yield of pearl millet, variety BAIF bajra should be grown with application of 100 kg N ha^{-1}.

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Seed Yield of Forage Pearl millet Varieties as Influenced by Nitrogen Levels under Rainfed Condition

Pearl millet is the most important rainy season crop in Maharashtra. It is mostly grown on marginal soils under rainfed conditions. Being a dual purpose and drought hardy crop, it is a major source of food and fodder in dryland tracts as it has high drought tolerance, quick growing habit, high yield potential and better palatability. With the development of high yielding, short duration genotypes, this crop could produce good seed yield with adequate nitrogen fertilization even under rainfed conditions. However, quite less research work has been reported on seed aspects of forage pearl millet. Keeping this in view, the present investigation was undertaken.

A field experiment was conducted at Forage Crops Research Project, MPKV, Rahuri during *kharif* 2007-08. The experiment was laid in a factorial randomized block design with three replications. The treatment comprised of eight pearl millet varieties and three nitrogen levels (Table 1). The soil of the experimental field was clayey in texture, low in available nitrogen (188.35 kg ha^{-1}), medium in phosphorus (16.83 kg ha^{-1}) and high in potassium (431.32 kg ha^{-1}). The full dose of phosphorus and potassium @ 30 kg ha^{-1} each were applied as basal dose. The half quantity of nitrogen was applied at the time of sowing and remaining half quantity was top dressed at 30 days after sowing as per the treatments. There was good and well distributed rainfall during the crop season.

Varieties : The data presented in Table 1 revealed that growth and yield attributes and seed yield were differed significantly due to varieties. The maximum values of growth attributes *viz*., number of tillers per plant, plant height and plant population per metre row length were recorded with variety JHPM-05-2 (Table 1). The significantly higher length of earhead (46.06 cm) was registered with variety BAIF Bajra than all other varieties under study. The same variety also noticed significantly more girth of earhead (9.83 cm) as compared to other varieties except variety Giant Bajra, PHB-2172 and JHPM-05-1, where it was found at par. Whereas, variety PHB-2172 attained statistically higher thousand grain

Table 1. Yield attributes and seed yield of forage pearl millet as influenced by different treatments.

Treatment	Plant population/ meter	Number of tillers/ plant	Plant height (cm)	Length of earhead (cm)	Girth of earhead (cm)	Thousand grain weight (g)	Seed yield (q ha^{-1})
Varieties :							
Giant bajra	6.00	2.80	320.67	35.64	9.69	8.32	28.88
Raj Bajra Chari-2	6.77	4.44	229.67	28.79	6.53	6.71	16.53
BAIF Bajra	5.67	2.78	282.00	46.06	9.83	9.45	31.19
PHB-2172	5.56	3.42	242.22	23.29	9.50	10.73	28.27
JHPM-05-2	6.78	4.46	404.89	27.96	7.86	8.50	14.33
JHPM-05-1	5.89	3.41	345.44	37.89	9.66	8.75	12.85
NDFB-9	5.67	3.48	296.44	32.91	9.10	9.00	14.79
NDFB-2	6.67	4.42	275.33	25.87	9.34	8.31	24.54
S. E.±	0.16	0.09	6.14	0.68	0.15	0.27	0.48
C. D. at 5%	0.45	0.24	17.47	1.93	0.43	0.76	1.50
N levels (kg ha^{-1}) :							
50	5.92	3.53	282.29	29.45	8.39	8.22	19.62
75	6.13	3.65	304.67	32.14	8.90	8.70	21.79
100	6.33	3.78	311.83	35.41	9.53	9.25	22.86
S. E.±	0.10	0.05	3.76	0.42	0.09	0.16	0.29
C. D. at 5%	0.28	0.15	10.70	1.18	0.26	0.46	0.83

weight (10.73 g). Owing to higher yield attributes, the seed yield (31.19 q ha^{-1}) was also at higher magnitude with variety BAIF Bajra. Similar results were reported by Verma and Midha (1989), Verma (1993) and Sharma *et al*. (1999).

Nitrogen levels : The growth and yield attributes and seed yield of rainfed pearl millet were progressively increased with increase in nitrogen levels from 50 to 100 kg ha^{-1}. The application of 100 kg N ha^{-1} being at par with 75 kg N ha^{-1} recorded significantly higher growth attributes *viz.*, number of tillers per plant (3.78), plant height (311.83 cm) and plant population per metre row length (6.33) than 50 kg N ha^{-1}. The same trend also noticed in case of yield attributes. The statistically higher yield attributes *viz*., girth of earhead (9.53 cm), length of earhead (35.41 cm) and thousand grain weight (9.25 g) were attained with 100 kg N ha^{-1} as compared to 50 and 75 kg N ha^{-1}. Significantly higher seed yield of 22.86 q ha^{-1} was obtained with same nitrogen level i.e. 100 kg ha^{-1}. Increasing levels of nitrogen from 50 to 75 and 100 kg N ha^{-1} increased seed yield by 11.06 and 4.91 per cent, respectively. The interaction effects due to varieties and nitrogen levels for growth and yield attributes and seed yield were found to be non significant. These results corroborate the findings of Subbian (1991) and Sharma *et al.* (1999).

The aforesaid results indicated that growing of pearl millet var. BAIF Bajra with application of 100 kg N ha^{-1} showed better proposition for achieving higher seed yield under rainfed condition.

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Effect of Soil Type and Levels of Potassium on Yield of Pigeonpea

Low productivity of pulses has been attributed mainly to imbalance of nutrient supply to the crop. Potassium is the key element required for more than 60 enzymes, plant metabolism, transpiration and nutrient transportation in the plants.

On an average 90 per cent of the total potassium is present as a reserve mineral, 6.3 per cent as a non-exchangeable form, 1.6 per cent as an exchangeable and only 0.2 per cent as a water soluble (Tandon and Sekhon, 1985). With this in view, an attempt was made to study the effect of potassium fertilizer and soil variability on yield and quality of pigeonpea.

A field experiments was carried out on pigeonpea during *kharif* 2002 on Entisol and Inceptisol at Post Graduate Research Farm and on Vertisol at STCRC Project, M.P.K.V., Rahuri. The experimental soils of Entisol, Inceptisol and Vertisol had available 'K', 302.4,

Table 1. Effect of soil type and levels of potassium on grain and straw yield of pigeonpea (q ha^{-1}).

Leavels of potassium (kg K_2O ha_{-1})	**Entisol**		**Inceptisol**		**Vertisol**		**Mean**	
	Grain	**Straw**	**Grain**	**Straw**	**Grain**	**Straw**	**Grain**	**Straw**
0	10	27	10.6	29.5	11.6	33.7	10.7	30.1
10	13.5	38.5	16.2	47.2	16.5	47.3	15.4	44.3
20	14.2	41.2	16.3	47.3	17.3	50.3	16	46.3
30	19.4	56.4	21.6	62.2	21.6	63.3	21.9	60.6
40	17.2	45.5	17.5	50.3	17.7	50.8	17.6	48.9
50	17.4	50.4	17.6	50.5	17.7	50.7	17.6	50.5
Mean	15.3	43.1	16.7	46.9	17.1	49.3	-	-

	Grain		**Straw**	
	S. E.±	C. D. at 5%	S. E.±	C. D. at 5%
Soil	0.043	0.123	0.212	0.602
Level of potassium	0.061	0.174	0.3	0.852
Soil x Level of potassium	0.106	0.301	0.52	1.475

Table 2. Protein, methionine and tryptophan content (%) as influenced by soil and levels of potassium of pigeonpea.

Leavels of potassium (kg K_2O ha^{-1})	Entisol			Inceptisol			Vertisol			Mean		
	Protein	Methionine	Tryptophan	Protein	Methionine	Tryptophan	Protein	Methionine	Tryptophan	Protein	Methionine	Tryptophan
0	20.4	0.88	0.69	20.8	0.89	0.70	21.2	0.92	0.70	20.8	0.90	0.70
10	22.0	0.93	0.70	22.1	0.94	0.71	22.2	0.94	0.71	21.9	0.94	0.71
20	21.6	0.83	0.63	22.2	0.85	0.66	23.2	0.86	0.63	22.3	0.85	0.64
30	22.2	0.86	0.66	22.1	0.87	0.67	23.4	0.87	0.68	22.6	0.87	0.67
40	24.0	0.83	0.62	24.1	0.84	0.64	24.2	0.86	0.68	24.1	0.84	0.62
50	24.0	0.85	0.65	20.0	0.86	0.65	24.2	0.86	0.65	24.1	0.86	0.65
Mean	22.3	0.86	0.66	22.6	0.88	0.67	23.1	0.88	0.66	-	-	-

	Protein		Methionine		Tryptophan	
	S. E.±	C. D. at 5%	S. E.±	C. D. at 5%	S. E.±	C. D. at 5%
Soil	0.058	0.164	0.006	0.018	0.002	0.006
Level of potassium	0.082	0.232	0.01	0.03	0.003	0.009
Soil x Level of potassium	0.142	0.402	0.016	NS	0.005	0.016

291.2 and 357.6 kg ha^{-1}, respectively. The experiment was laid out with 6 treatments replicated 4 times in randomized block design. N (25 kg ha^{-1}) and P_2O_5 (50 kg ha^{-1}) was applied as a basal dose while different doses of K_2O were applied as 0, 10,20,30,40, and 50 kg ha-1 as per the treatments. Pigeonpea (ICPL - 87) was sown at 45 x 10 cm. spacing. Protein content was determined by Microkjeldahl's methods (A.O.A.C., 1975) while methionine (McCarthy and Faille, 1959) and tryptophan (Spice and Chamber, 1949) were analysed colorimetrically. The data were statistically analysed as described by Panse and Sukhatme (1967).

The grain yield of pigeonpea was significantly influenced by soil type and levels of potassium and their interactions(Table 1). The grain yield was highest in Vertisol (17.11 q ha^{-1}) followed by Inceptisol (16.7 q ha^{-1}). The yield differences due to soil type might be associated with the inherent properties of soil as Vertisol having higher depth (in which roots proliferate), higher content of clay (with good supplying power of moisture and nutrients) and microbial activity. Similar results were also reported by Viswanath and Murthy (1986). The grain yield increased with increase in K level upto 30 kg ha^{-1} and decreased at higher level. The reduced yield of pigeonpea at higher level of K might be attributed to nutrient imbalance and confirmed with the results reported by Patel *et al*. (1985).

The straw yield exhibited similar trend as grain yield as highest on Vertisol (49.3 q ha^{-1}) followed by Inceptisol and Entisol. An application of 30 kg K_2O ha^{-1} recorded the highest straw yield than the rest of the potassium levels.

The highest protein content of pigeonpea was observed in Vertisol (23.1%) followed by Inceptisol (22.6%) and Entisol (22. 4%) (Table 2). The protein conteint of pigeonpea increased with increase in level of potassium. The maximum protein content was obtained with application of 40 kg K_2O ha^{-1} and was at par with 50 kg K_2O ha^{-1}. These observations are in accordance with those by Gupta *et al*. (1975). Pigeonpea grown in Inceptisol and Vertisol and

applications of potassium @ 10 kg ha^{-1} recorded significantly higher methionine 0.88 and 0.94 per cent, respectively. However, there was no consistent relationship between the potassium application and methionine content of pigeonpea. The results are in accordance with those of Salunkhe *et al*. (1985).Further growing of pigeonpea in Inceptisol exhibited higher tryptophan cantent (0.67 %) than Vertisol (0.66 %) and Entisol (0.66%). The tryptophan content of pigeonpea was decreased with an increase in potassium level except 10 kg K_2O ha^{-1} (0.71 %). There was no consistent relationship between the rate of potassium application and tryptophan content of pigeonpea. The results are in accordance with those of Shobana *et al.* (1976).

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Assessing the Allelopathic Effects of Weed Species of Northern Iran on Rice Variety - Tarom

Some weeds interfere with crop plants through allelochemicals which inhibit crop growth and other weeds in their vicinity (Qasem and Foy, 2001; Bhowmik and Inderjit, 2003; Romero-Romero *et al*. 2005 and Batish *et al*. 2007). It is generally accepted the most allelochemicals are the small molecular weight compound excreted from plants during the process of secondary metabolism_and produced as byproducts of primary metabolic pathways (Rizvi *et al*. 1992). These compounds vary in chemical composition, concentration

and localization in plant tissues with changes in both biotic and abiotic conditions (Waller, and Einhellig, 1999).

The present research was conducted with objectives to isolate and screen the potential allelopathic phytochemicals from the selected weeds. In this experiment, allelopathic effects of rice weeds *viz*., *Echinochola crusgalli*, *Cyperus difformi*, *Paspalum paspaloides* and *Saggittaria trifolia* of north Iran were evaluated against seeds of Tarom variety aspect leachates bioassay in 2008. For preparing plant leachates bioassay, different parts of every weed which wore including root, stem and leaf were collected from different paddy fields of Mazandaran Province (Iran) after maturity randomly and analysed by procedure of Machado (2007), Moharjan *et al*. (2007) and Sethi (2005).

Table 1. Inhibitory effect of leachates bioassay from different parts of selected weeds on paddy seeds of Tarom variety.

Leachate		**Weed species**			
		Cyperus difformis	***Echinocola crusgalli***	***Paspalum paspaloides***	***Saggittaria trifolia***
Leaf	Sg	1.42 (b)	1.495 (bc)	1.862 (b)	2.580 (ab)
		(-52.09)	(-49.56)	(-37.18)	(-12.95)
	Rg	3.220 (a)	1.335 (d)	1.995 (b)	1.890 (b)
		(-15.55)	(-64.99)	(-47.68)	(-50.43)
	Tsg	4.640 (b)	2.820 (c)	3.857 (c)	4.470 (b)
		(-31.573)	(-58.39)	(-43.09)	(-34.04)
	Germination	83.333	63.3333	83.333	66.666
	percentatge	(-13.792)	(-34.482)	(-13.792)	(-31.034)
Stem	Sg	1.495 (b)	1.170 (c)	1.980 (b)	0.725 (c)
		(-49.56)	(-60.53)	(-33.20)	(-75.54)
	Rg	1.823 (b)	2.150 (c)	1.430 (b)	1.410 (b)
		(-52.19)	(-43.61)	(-62.50)	(-63.02)
	Tsg	3.318 (b)	3.320 (c)	3.410 (c)	2.135 (c)
		(-51.10)	(-51.01)	(-49.68)	(-68.50)
	Germination	73.333	76.666	66.666	56.666
	percentatge	(-24.137)	(-20.689)	(-31.034)	(-41.379)
Root	Sg	1.820 (b)	1.880 (b)	2.535 (ab)	1.52 (bc)
		(-38.60)	(-36.57)	(-14.47)	(-48.72)
	Rg	2.08 (b)	2.965 (b)	3.085 (a)	3.580 (a)
		(-42.45)	(-22.23)	(-19.09)	(-6.11)
	Tsg	3.90 (bc)	4.845 (b)	5.620 (b)	5.100 (b)
		(-42.45)	(-28.51)	(-17.07)	(-24.74)
	Germination	83.333	63.333	86.666	66.666
	percentatge	(-13.792)	(-34.482)	(-10.344)	(-31.034)
Control	Sg	2.964 (a)	2.964 (a)	2.964 (a)	2.964 (a)
	Rg	3.813 (a)	3.813 (a)	3.813 (a)	3.813 (a)
	Tsg	6.777 (a)	6.777 (a)	6.777 (a)	6.777 (a)
	Germination	96.666	96.666	96.666	96.666 (a)
	percentatge				

Data presented are mean of three replicates with different letters refer to significant difference with confidence 95% according to Duncan's multiple - range test. The data in parenthesis indicate % inhibition (-) over control.

Comparison of mean amount of aqueous leachates from different parts of *Cyperus difformis* on paddy seeds of Tarom variety showed in Table 1 indicated that radicle and hypocotyl length were significantly hampered by all types of leachates, except leaf. However, seedling growth of test crop was significantly inhibited by all three types of leachates. Maxmum significant inhibitory effect was caused by stem leachates (51.10 %). Germination of test crop was also decreased by all three types of leachates in which stem leachates had more inhibitory effect as compared with other types of leachates. Results also showed that all three types of leachates from *Echinochloa crusgalli* also had inhibitory effect on both radical and hypocotyl length of test crop. The inhibitory effect of leaf leachates (64.99 %) was more pronounced on radicle length of paddy seedling as compared with other types of leachates. It was also observed that leaf (34.482 %) and root (34.482 %) leachates had more hampered effect on seed germination than stem leachates (20.689 %). Data analysis of *Paspalum paspaloides* showed that stem and leaf leachates of above weed had significant hamper effect on both radicle and hypocotyl length of test crop. In case of seed germination, stem leachates (31.034 %) had more inhibitory effect as compared with leaf (13.792 %) and root (10.344 %).

The radicle and hypocotyl length of test crop was significantly hampered by all three types of leachates from *Sagittaria trifolia*, however root leachates did not show significant inhibitory effect on radicle length of test crop. Seedling growth of test crop was significantly decreased by all three types of leachates. The magnitude of inhibition was in the order: stem > leaf ≥ root > control. In case of seed germination, inhibitory effect of stem (41.379 %) leachates was more pronounced as compared with leaf (31.034 %) and root (31.034 %) leachates.

With the help of HPTLC, three phytoconstituents such as terpenoids, coumarins and phenolic compounds are identified and confirmed from root, stem and leaves of studied weeds. A leaf of *Paspalum paspaloides* (eleven) was containing highest number of coumarins. This study also indicated that the confirmation of terpenoids from root (eight), stem (eight) and which were containing maximum number as compared with other parts of studied weeds. In case of phenolic compounds, root (eight) of *Cyperus difformis* contained highest substances of phenolic compounds.

It is concluded that seedling growth and seed germination of Tarom variety was significantly inhibited by leachates of weed species. There were also differences in allelopathic potential among different parts of weeds. The entire average stem leachates of *Sagittaria trifolia* (68.50 %) were more inhibitory on the test crop. Perhaps stem leachates of above said weed containing more water soluble allelochemicals, which inhibits seedling growth of Tarom variety. These results are in agreement with findings and views of Avchar and Deokule (2007) and Duary (2002).

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Influence of Organic, Inorganic and Biofertilizers on Fruit Yield of Sweet Orange

Sweet-orange is an important fruit crop. India endowed with varied agro climatic conditions where wide range of citrus species can be grown on commercial scale (Shyam Singh *et al*. 1996). Balanced fertilizer application is one of important factor for getting maximum yield and quality fruits. The disproportionate use of fertilizer has widened soil imbalance in terms of NPK ratio. A national assessment of nutrient efficiency reveals the nitrogen deficiency is universal and will continue. In future nearly 49 and 29 per cent of Indian soils well be deficient in phosphorus and potasium respectively (Pandey and Singh 1998). It has now been realized that the use of chemical fertilizers must be integrated through more economic, renewable and environmental friendly organic fertilizers and biofertilizers. Sweet orange responds very well to nutrient management.

An experiment was conducted on eight years old sweet-orange (veriety Nuceller) on Jambheri root stock trees of uniform growth. They were spaced at 6 x 6 meters. An experiment was conducted in Mrig bahar (April - May) in the year 2001 and 2002. The experimental design was factorial randomized block design with ten treatments and was replicated thrice. The plot unit for each treatment consists of one tree. The treatment includes four levels of inorganic fertilizers (25, 50, 75 and 100 % RDF) with 50 kg FYM, with or without *Azospirillum* and PSB 10 g each per tree. Recommended doses of inorganic fertilizer @ 800:400:400 NPK g tree^{-1}.

Well roten FYM was applied to the respective plot as per treatment at beginning. Half does of nitrogen and full doses of phosphorus and pottassium were applied in the form of urea, single super phosphate and

murate of potash in the month of June 2001 and 2002 while remaining half dose of nitrogen was given one and half month after. Biofertilizers such as *Azospirillum* and PSB were given through soil inoculation. The yield in respect of number of fruits / tree was calculated. Average weight of five randomly selected fruits were weighed from each treatment and average weight of fruit (g) was computed.

In the present investigation, significant influence of organic and inorganic fertilizer was observed. The results indicated that the number of fruits / tree and average weight of fruits were significantly increased with the increasing levels of organic and inorganic fertilizers. The average weight of fruits was observed to be increased significantly due to application of RDF (800g:400g:400g + 50 kg FYM). The least number of fruits and lowest weight was observed in trees without fertilizers. This finding is in accordance with Sharma and Azad (1991) who reported that maximum fruit wt. was recorded with increasing levels of fertilizers. In citrus Gawande *et al*. (1998) also reported that application of inorganic fertilizers (NPK) at recommended rate produced highest weight of fruits per trees.

The application of biofertilizers also recorded significant increase in number of fruits and average weight of fruits as compared to the trees without biofertilizers. Number of fruits / tree and average weight of fruits was higher when *Azospirillum* and PSB each @ 10 g were applied. The biofertilizers also acts as growth promoters and supplies more available nutrients to fruit trees.

The interaction effect was also significant. This indicated that when recommended dose of fertilizer was applied along with biofertilizetrs (*Azospirillum* and PSB) resulted in increased number of fruits and average weight of fruit. This may be due to increased nutrient availability from FYM, inorganic fertilizers and biofertilizers which might have increased various endogenous hormonal levels in plant tissue which might be responsible for enhancing flowering, pollen germination and pollen table which might have ultimately increased fruit set.

Table 1. Influence of organic, inorganic and bio-fertilizers on yield of sweet organge.

Treatment symbol	Fruits tree^{-1}	Fruit wt. (g)
F_0	461.33	126.97
F_1	488.42	136.73
F_2	561.50	146.68
F_3	630.92	165.57
F_4	626.67	169.45
Mean	553.76	149.07
S. E ±	3.78	1.106
C. D. at 5%	11.23*	3.28*
B_0	532.80	147.43
B_1	574.73	150.72
Mean	553.76	149.07
S. E ±	2.39	0.70
C. D. at 5%	7.10*	2.07*

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Genotypic Variability in Tissue Cultured Plantlets of Banana Under Greenhouse Condition

The role of hardening of the highly sensitive plantlets under controlled conditions or otherwise results into high mortality of tissue cultured plantlets. Further, the studies pertaining to genotypic variability exhibited by various genotypes under greenhouse conditions are largely lacking. The plantlets obtained *in vitro* of these genotypes were transferred to pots containing soil:sand:FYM (1:1:1) after the period of acclimatization. These plants were then kept for hardening in greenhouse under controlled conditions for three months (Zimmerman 1988). The experiment was laid in CRD. The observations were recorded at weekly interval to assess the genotypic variability under greenhouse conditions. Growth observations on plant height (cm), number of leaves (functional), stem girth (average of top, middle and bottom girth) and leaf area were recorded and average of each character was calculated for five plants. The leaf area of the plantlets was calculated by using the formula given by Bose, (1985).

The genotypes Rasbale and Safed Velchi showed significantly the highest plant height at 12th week (15.36 and 15.20 cm, respectively). The genotype Basrai showed the lowest plant height of 12.43 cm. The genotype Lokhandi showed significantly the highest plant height from 5th week onwards upto 12th week followed by genotype Safed Velchi. Although the difference in average number of leaves per plant varied significantly, it was very marginal. The genotype Basrai showed significantly the highest number of leaves i.e. 7.66 where as genotype Lal Velchi reported the lowest number of leaves i.e. 6.33 in 12th week. However, genotype Basrai has reported significantly the highest number of leaves from 8th week onwards. The genotype Rasbale reported the lowest girth of stem i.e. 2.66 cm where as genotype Grand naine showed significantly the highest i.e. 3.33 cm in 12th week. It showed similar trend in all the weeks exceept 1st and 2nd week whereas genotype Savarbond reported the highest girth of stem. The genotype Basrai reported significantly the highest leaf area (123.41 cm^2) in 12th week and it showed similar trend from 5th week onwards. However, the genotype Safed Velchi showed significantly highest leaf area i.e. 95.03 cm^2 and trend was similar for almost all the weeks except 1st week.

The significantly highest plant height was reported in Safed Velchi which may be attributed to higher dry matter accumulation due to higher number of leaves and girth of stem. The higher number of leaves might be the resultant of earlier establishment of cultures *in vitro*. As against significantly lowest number of leaves in Lal Velchi which can be attributed to slowest establishment of Lal Velchi cultures *in vitro*. The genotype Basrai exhibited significantly the highest leaf area right from 1st to 12th week. This might be due to its genetic make up and highest leaf breadth as against all other genotypes. Galan *et al*. (1992) studied phenological yield parameters for banana plants under greenhouse and reported that plant height and width were greater under greenhouse.

There were marked differences among the days required by the plantlets to reach the stage for field transfer. These differences can be attributed to the response of stage of micropropagated plants taken for acclimatization to different potting media

combinations and the environmental conditions maintained in primary and secondary hardening units (Preece and Sutter 1991). The minimum number of days required by the genotypes *viz*., Basrai, Savarbond (42 days) and Grand Naine, Rasbale,' Shrimanti (49 days). Which may be attributed to earliness due to genetic makeup indicating early completing of life cycle under field condition which however, needs to be investigated under field trial, whereas genotypes Safed Velchi, Lal Velchi and Lokhandi required maximum number of days i.e. 56, 56 and 63 respectively.

The tissue cultured plantiets of genotypes *viz*., Basrai, Safed Velchi, Savarbond and Lokhandi were found to be the most hardy upto 3 months. Distinct genotypic variability was observed among the eight genotypes under investigation in respect of different growth parameters *viz*., plant height in Rasbale and Safed Velchi number of leaves and leaf area in Basrai and Safed Velchi and girth of stem in Basrai. The present studies have also paved the way for studying the genotypic variability by eliminating the role of environment by providing controlled conditions as reported by Nadgowda (2000).

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Effect of Different Varieties and Cuttings on Growth, Quality and Green Yield of Indian Spinach (*Beta vulgaris* var. Bengalensis)

Among the vegetables, the leafy vegetables are of short duration having short storage life and can be taken all the year round. Indian spinach (*Beta vulgaris* var. Bengalensis) is one of the most popular leafy vegetables and commonly known as 'Palak' having higher nutritive value. It may be possible to achieve more plant growth, higher green yield and good leaf quality by using of proper variety and adjusting adequate number of leaf cuttings at proper intervals.

The present experiment was conducted at Department of Horticulture, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri during the *rabi* season of 2002-2003 in a factorial randomized block design with four replications. Two varieties *viz*., 'All Green' and

'Pusa Jyoti' as main plot treatments and four levels of leaf cuttings with an interval of 15 days i. e. C_0 - No cutting, C_1 - one cutting, C_2 - two cuttings and C_3 - three cuttings as sub-plot treatments with plot size of 1.8 x 1.0 m and sowing of seed was done at 30 x 10 cm spacing. The observations were recorded on plant height, No. of leaves plant^{-1}, lenght of petiole, leaf area,Vitamin C and green yield (Table 1). The cultural practices were followed as per the recommendations. The data was analysed by adopting methods suggested by Panse and Sukhatme (1985).

The data on growth as influenced by different varieties and various cuttings levels is presented in Table 1. Analysis of data revealed non-significant variations in most of the attributes over two varieties and four cuttings. The varieties 'Pusa Jyoti' recorded maximum plant height (24.21 cm), number of leaves plant^{-1} (6.98), length of petiole (10.93 cm) and leaf area plant^{-1} (557.08 cm^2) as compared to variety 'All Green'. In general, both the varieties performed well as regards to plant growth. However, the variety 'Pusa Jyoti' seems to have well adopted to the present climatic conditions showing better performance. Similar results were also reported by Choudhari and Rajendra (1980) in palak.

Number of leaves and leaf area were non significant. Significantly maximum plant height (26.63 cm), number of leaves (7.20), length of petiole (12.13 cm) and leaf are plant (600.17 cm^2) were recorded by the treatment C_0 - No cutting than rest of the cutting treatments. In treatments C_1, C_2 and C_3 the cuttings of leaves were taken at 30, 45 and 60 days after sowing which might have suppressed the vegetative growth of plants. Whereas in the treatment C_0 where the leaves were not cut upto 60 days after sowing and vegetative growth continued and ultimately recorded more yield as compared to other treatments. Similar results were also obtained by Parkhee (1978) and Patil (1994) in spinach and Rahman (1987) in fenugreek. The interaction effect between

Table 1. Effect of different varieties and cuttings on the growth, leaf quality and green yield of palak.

Treatments	Height of plant (cm)	Leaves pl^{-1}	Length of petiole (cm)	Leaf area pl^{-1} (cm^2)	Vitamin. C mg 100 g^{-1} (60 DAS)	Moisture % (60 DAS)	Total yield plot^{-1} (kg)	Total yield ha^{-1} (q)
Variety :								
V_1 - All Green	22.01	6.76	9.82	533.71	74.62	86.76	4.95	273.3
V_2 - Pusa Jyoti	24.21	6.98	10.93	557.08	75.36	88.73	4.99	277.1
S. E.±	0.93	0.15	0.49	31.92	1.08	0.88	0.22	122.2
C. D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Cuttings :								
C_0 - No cutting	26.63	7.20	12.13	600.17	75.27	87.55	8.42	467.7
C_1 - One cutting	24.08	6.78	11.16	542.36	74.55	86.94	1.58	87.76
C_2 - Two cutting	19.99	6.65	8.50	519.62	73.50	89.45	5.26	292.1
C_3 - Three cutting	21.73	6.85	9.73	519.42	76.65	87.05	12.77	709.3
S. E.±	1.32	0.21	0.69	45.14	1.53	1.24	0.31	17.22
C. D. at 5%	3.87	N.S.	2.03	N.S.			0.90	49.99
Interaction :								
S. E.±	1.86	0.30	0.97	63.83	2.159	1.76	0.45	24.66
C. D. at 5%	N.S.	0.88	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

N. S. = Non Significant

variety and cuttings was found significant only for number of leaves plant^{-1} while, in other growth characters it was found non-significant. The treatment combination V_1C_0 and V_2C_0 exhibited maximum vegetative growth. The maximum vegetative growth in control (C_0) treatment in both the varieties might be due to effect of no cuttings.

The data in respect of leaf quality parameter like vitamin 'C' content and moisture percentage presented in Table 1, revealed that effect of varieties on vitamin 'C' and moisture content of fresh leaves was non-significant, except at 30 days for moisture percentage. The data revealed that the effect of cuttings on vitamin 'C' and moisture content was non-significant. The interaction effect between variety and cutting was found to be non-significant pertaining to vitamin 'C' and moistur content.

Analysis of data revealed non-significant results regarding the green yield per plot and per ha as influenced by varieties and interaction, whereas significant as influenced by different cuttings. The variety 'Pusa Jyoti' recorded the maximum total green yield plot^{-1} (4.99 kg) and ha^{-1} (277.19 q) with three cuttings. Similar results were also recorded by Parkhee (1978) under Akola and Choudhari and Rajendra (1980) under Delhi conditions.

The results pertaining to the per plot and per ha green yield as influenced by different cuttings were found to be significant. The significantly more green yield plot^{-1} (12.77 kg) and ha^{-1} (709.3 q) was recorded by treatment C_3 (three cuttings) than rest of the treatments except C_0 (no cuttings) which was at par. The treatment C_1 (one cutting) recorded the minimum green yield per plot (1.58 kg) and per ha (87.76 q). In treatment C_3, the green yield was harvested three times i.e. at 30, 45 and 60 days after sowing and therefore, the green yield obtained by this treatment were highest. These results are in close conformity with Saini (1975) in fenugreek and Patil (1994) in Indian spinach. Lal *et al*. (1979) also recorded maximum green yield of 624.34 q ha^{-1} after taking four cuttings in Indian spinach. The interaction effect between variety and cutting was found non-significant in case of green yield plot^{-1} and ha^{-1}.

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Studies on Phosphate Solubilizing Isolates from Chilli Rhizosphere

The present investigation was conducted to isolate phosphate solubilizing microorganisms from the rhizosphere of chilli and to study their physiological aspects. Thirty soil samples were collected from rhizosphere of chilli grown in the Instructional Farm of the Department of Horticulture and Entomology, Mahatma Phule Krishi Vidyapeeth, Rahuri, and from some villages from Pune and Ahmednagar district of Maharashtra State. The phosphate solubilizing microorganisms were isolated by using Pikovaskaya's medium by the dilution and plating method. The microbial colonies showing zones of clearing were transferred on slants of Pikovaskaya's medium. After 4-5 days of incubation, slants were kept in refrigerator and the isolates were used for further studies.

In vitro experiment was conducted to reveal the phosphate solubilizing ability of the isolated microorganisms *viz*., fungal isolates *A. fumigatus*, *A. niger* isolate-I, *A. niger* isolate-II, *Bacillus* sp. isolate- II and *Bacillus* sp. isolate- III. These isolates recovered from chilli rhizosphere were found to produce prominent zones of phosphate solubilization when inoculated on Pikovaskaya's medium containing tricalcium phosphate and proved to possess the ability to solubilize insoluble phosphate. Among these isolates *A. fumigatus* and *Bacillus* sp. isolate III were found to produce prominent zones of phosphate solubilization than rest of the isolates.

The phosphate solubilizing isolates were studied for their growth on different media. Among different media, fungal isolates *A. fumigatus*, *A. niger* isolate I, *A. niger* isolate II recorded good growth on Pikovaskaya's and potato dextrose agar medium. Moderate growth was seen over Czapecks and Yeast extract glucose agar medium. Poor growth was seen over Nutrient Agar medium and less or scanty growth was seen over Jensens and Ashby's medium.

Among these media fungal isolates produced prominent zones of phosphate solubilization on Pikovaskayas medium, while Jensens medium did not show good growth but it showed prominent zone of phosphate solubilization. Among bacterial isolates *Bacillus* sp. isolate-II and *Bacillus* sp. isolate-Ill, showed good growth on Pikovaskaya's, Potato Dextrose Agar and Nutrient Agar medium. Moderate growth was seen over Czapecks and Yeast Extract Glucose Agar medium. Poor growth was seen over Jensens medium and less or scanty growth was seen over Ashby's medium. Zone of P solubilization were produced in Pikovaskaya's medium and Jensen's medium.

The phosphate solubilizing capacity of these isolates was confirmed through colourimetric estimation by using tricalcium phosphate and rock phosphate as a P source in liquid medium. The per cent P solubilization ranged from 30.14 to 71.68 using tricalcium phosphate and from 16.70 to 38.72 using rock phosphate as P source. The pH of the Pikovaskaya's liquid medium using tricalcium phosphate changed from 7.10 to 5.00. Similarly, in case of Pikovaskaya's liquid medium using rock phosphate, pH changed from 7.20 to 4.70 indicating the production of acid by all the isolates. The results further indicated that the isolates under study solubilized the tricalcium phosphate at greater extent and at faster rate as compared to rock phosphate. Tricalcium was easily and effectively solubilized as compared to rock phosphate (Wani *et al*. 1979). Similar results were obtained by Singh and Kapoor,

(1994). The change in pH of the medium due to activities of P solubilizing microorganisms in liquid medium was also reported by Sattar and Gaur (1986) and Yadav and Singh (1991). The present observations of the changes in pH of the liquid medium by P solubilizing microorganisms are, therefore, in conformity with the earlier reports.

The isolates were also studied for their ability to solubilize phosphate *in vitro* at different temperature of incubation, length of incubation and different pH of liquid Pikovaskaya's medium.

The maximum phosphate solubilization by the microorganisms was at incubation temperature 30°C. The minimum solubilization of phosphate was observed at 25°C. In general, results indicated that an optimum temperature for phosphate solubilization was 30°C. The present results are in conformity with the earlier reports which showed that an optimum temperature for maximum P solubilization in liquid medium by *A. awamori, Penicillium digitatum, Pseudomonas striata* and *Bacillus polymyxa* was 30°C to 35°C (Wani *et al*. 1979). Similar results were obtained by Gaind and Gaur, (1991).

The results on effect of incubation period indicated that the maximum solubilization of phosphate by the isolates was at 14 days of incubation. Both bacteria and fungi solubilized maximum phosphate at 14 days of incubation indicating that the optimum incubation period for phosphate solubilization was 14 days. The maximum P solubilization by microorganisms in liquid medium occurred within 14 days of incubation (Wani *et al*. 1979). Similar results were obtained by Singh and Kapoor (1994). Present results are, therefore, in conformity with the earlier reports. The decrease in phosphate solubilizing activity after 14 days could be attributed to the accumulation of acidity as revealed in change of pH of the medium.

The fungal isolates recorded maximum phosphate solubilization at pH 6 while the bacterial isolates solubilized maximum phosphate at pH 8. Fungal isolates *A. fumigatus*, *A. niger* isolate-I, *A. niger* isolate-II solubilized maximum phosphate 47.37, 45.14, 43.17 per cent, respectively at pH 6.00. Among bacterial isolates *Bacillus* sp. isolate-II and *Bacillus* sp. isolate-III were found to solubilize maximum phosphate i.e. 51.40 and 47.90 per cent, respectively at pH 8.00. The overall results indicated that the optimum pH for phosphate solubilization by the fungal and bacterial isolates under study was 6 and 8, respectively. Similar results were obtained by Wani *et al*. (1979).

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Effect of Integrated Weed Management on Yield of Brinjal (*Solanum melongena* L.)

Brinjal being a long durational and irrigated crop , weeds have got favourable conditions for unhealthy competition with the crop. Wide spacing, frequent irrigation, liberal use of manure and fertilizers coupled with congenial weather conditions during crop season promote luxurious growth of weeds and drastic reduction in yield of brinjal. It is therefore, felt necessary to develop cheaper methods of weed control either with the use of herbicides or other combination with mechanical methods. The integrated weed management is gaining wider acceptability. Hence, the present investigation was undertaken during *kharif* season of 2004 to evaluate integrated weed management in brinjal.

The experiment was laid out in a randomized block design with three replications at Agronomy farm, College of Agriculture, Pune. Nine treatments were formulated consisting of different weed control methods (Table 1). The brinjal variety "Phule harit" was planted on ridges at 90 x 90 cm spacing. The gross and net plot sizes were 7.20 x 5.40 m and 5.40 x 3.50 m, respectively. All cultural practices were followed as per the recommendations.

The results revealed that the differences due to different weed control treatments in respect of fruit yield were found to be significant. The highest fruit yield per hectare (33.89 t) was recorded with hand weeding at 20, 40 and 60 days after transplanting (DAT), which was significantly superior to the rest of the treatments except pendimethalin (PE) @ 1.25 kg a.i ha^{-1} + one hand weeding at 40 days after transplanting and fluchloralin (PPI) @ 1 .25 kg a.i. ha^{-1} + one hand weeding at 40 days after

Table 1. The yield of brinjal and benefit cost ratio as influenced by various weed control treatments.

Treatment	Fruit yield (t ha^{-1})	Gross returns (Rs. ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B:C ratio	Dry matter of weeds (g/m^2)
Unweeded control	19.98	58760	30270	28490	1.94	122.20
Three HW at 20, 40 and 60 DAT	33.89	110680	37770	72910	2.93	30.80
Pendimethalin (PE) 1.25 kg ha^{-1}	24.16	80480	34168	46312	2.35	92.40
Pendimethalin (PE) 1.25 kg ha^{-1} + One HW at 40 DAT	31.12	104360	36668	67692	2.84	46.00
Fluchloralin (PPI) 1.25 kg ha^{-1}	23.44	77040	32823	44217	2.34	95.00
Fluchloralin (PPI) 1.25 kg ha^{-1} + One HW at 40 DAT	29.52	99400	35323	64077	2.81	51.00
Glyphosate 1.25 kg ha-1 at 25 DAT	22.18	74520	31385	43135	2.37	96.10
Pendimethalin (PE) 1.25 kg ha^{-1} + glyphosate 1.25 kg ha^{-1} at 40 DAT	27.13	90440	35283	55157	2.56	69.50
Fluchloralin (PPI) 1.25 kg ha^{-1} + glyphosate 1.25 kg ha^{-1} at 40 DAT	26.15	86600	33938	52662	2.55	72.00
S. E.±	0.83	-	-	-	-	0.349
C. D. at 5%	2.48	-	-	-	-	1.046

transplanting . The lowest yield was recorded with unweeded control (19.98 t). The pre planting incorporation of herbicides (PPI) might have inhibited the germination of weed seeds and subsequent hand weeding have checked the further growth of the weeds. These results are in conformity with the findings of Singh and Tripathi (1996) and Reddy *et al*. (2000).

Cost of cultivation was maximum (Rs.37770/- ha^{-1}) with three hand weedings at 20, 40 and 60 DAT. It was followed by pendimethalin (PE) @ 1.25 kg a.i. ha^{-1} + one hand weeding at 40 DAT (Rs.36668/- ha^{-1}). The lowest cost of cultivation was recorded with unweeded control treatment (Rs.30270/- ha^{-1}). The gross monetary returns were maximum (Rs.110680/- ha^{-1}) with three hand weedings at 20, 40 and 60 DAT. It was followed by pendimethalin (PE) @ 1.25 kg a.i. ha^{-1} + one hand weeding at 40 DAT (Rs.104360/- ha^{-1}) and fluchloralin (PPI) @ 1.25 kg a.i. ha^{-1} + one hand weeding at 40 days after transplanting (Rs.64077/- ha^{-1}). The lowest monetary returns (Rs.28490/- ha^{-1}) were obtained from unweeded control treatment. The benefit cost ratio was maximum (2.93) with three hand weedings. It was followed by pendimethalin (PE) @ 1.25 kg a.i ha^{-1} + one hand weeding at 40 DAT and fluchloralin (PPI) @ 1.25 kg a.i ha^{-1} + one hand weeding at 40 days after transplanting. The lowest benefit cost ratio (1.94) was reported by unweeded control. Thus, it could be concluded that application of pendimethalin (PE) @ 1.25 kg a.i. ha^{-1} + one hand weeding at 40 DAT was found effective in controlling weeds and for achieving higher fruit yield as the availability of farm labourers is becoming a serious problem.

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Effect of Weed Management Treatments on Yield and Quality of Soybean (*Glycine max* L. Merrill)

Soybean (*Glycine max* L. Merrill) is one of the important oilseed crop of India. It is of paramount importance in human and animal nutrition, as it is a major source of edible vegetable oil and high quality protein food. It contains about 40 per cent quality protein, 23 per cent carbohydrates and 20 per cent cholesterol free oil.

Soybean is mainly grown in rainy (*kharif*) season facing a serious problem of weed growth. Among the various factors responsible for low productivity of soybean, weed infestation during early stages of crop growth is one of the major factors which results in a loss to the extent of 79 per cent (Reddy *et al*. 1990).

The traditional method of weed control i.e. hand weeding is expensive, tedious and time consuming. Weeding also becomes difficult due to unfavourable weather, wet soil and unavailability of labour. Under such circumstances, use of effective herbicides in suitable dose remains the pertinent choice for controlling the weeds.

Although herbicides give better and timely weed control, high costs prohibit their use by the average cultivators. A judicious combination of chemicals and cultural methods of weed control would not only reduce the expenditure on herbicides but would benefit the crop timely by providing proper aeration and conservation of moisture. A judicious combination of chemical and cultural weed control would certainly prove to be effective for controlling weeds in soybean.

The present investigation was carried out at Agronomy Farm, College of Agriculture, Pune (M.S.) during *kharif*, 2006 in a randomized block design with ten treatments replicated thrice. The treatments comprised of weedy check (T_1), while among the mechanical methods the treatments comprised two hand weedings at 30 and 45 DAS (T_2), two hoeings at 30 and 45 DAS (T_3), one HW at 30 DAS + one hoeing at 45 DAS (T_4). The chemical methods of weed control comprised the treatments fluchloralin (PPI) @ 1 kg a.i. ha^{-1} (T_5), pendimethalin (PE) @ 1 kg a.i. ha^{-1} (T_7) and pursuit (EPOE) @ 100 g a.i. ha^{-1} (T_9). The integrated methods of weed control comprised the treatments fluchloralin (PPI) @ 1 kg a.i. ha^{-1} + one HW at 30 DAS (T_6), pendimethalin (PE) @ 1 kg a.i ha^{-1} + one HW at 30 DAS (T_8) and pursuit (EPOE) @ 100 g a.i ha^{-1} + one HW at 45 DAS (T_{10}). The gross and net plot size

Table 1. Mean number of pods, number of seeds and weight of seeds per plant, hundred seed weight, seed and straw yields as influenced by different treatments in soybean.

Treatment	Pods plant^{-1}	Seeds plant^{-1}	Weight of seeds (g plant^{-1})	100 seed weight (g)	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})	Protein (%)	Oil (%)
Weedy check	29.26	73.60	10.30	14.00	20.44	29.35	37.68	18.44
Two hand weedings (30 and 45 DAS)	59.00	141.60	23.29	16.40	37.23	48.86	42.17	21.74
Two hoeings (30 and 45 DAS)	50.80	119.80	19.16	15.90	30.90	40.09	39.34	19.94
One hand weeding at 30 DAS + one hoeing at 45 DAS	53.93	128.80	20.66	16.00	32.51	42.40	39.91	19.79
Fluchloralin @ 1.0 kg a. i. ha^{-1} (PPI)	41.40	96.60	13.95	14.40	24.23	35.94	38.04	19.95
Fluchloralin @ 1.0 kg a. i. ha-1 (PPI) + one hand weeding at 30 DAS	45.86	107.70	16.37	15.20	28.56	41.20	38.87	20.05
Pendimethalin @ 1.0 kg a. i. ha^{-1} (PE)	44.33	106.40	15.94	14.90	26.47	40.87	39.27	19.00
Pendimethalin @ 1.0 kg a. i. ha^{-1} (PE) + one hand weeding at 30 DAS	48.46	116.30	17.95	15.40	29.17	43.11	40.02	19.74
Pursuit @ 100 a. i. ha^{-1} (EPOE)	47.26	113.40	17.89	15.70	30.00	42.97	40.81	19.87
Pursuit @ 100 a. i. ha^{-1} (EPOE) + one hand weeding at 45 DAS	54.60	131.60	21.45	16.30	32.76	45.47	41.32	20.10
Mean	47.49	113.58	17.69	15.42	29.22	41.02	39.74	19.86
S. E.±	0.66	0.52	0.43	0.16	0.20	0.31	0.89	0.58
C. D. at 5%	1.97	1.56	1.29	0.47	0.59	0.93	2.65	NS

DAS = Days after sowing, PE = Pre emergence, PPI = Pre-planting incorportation, EPOE = Early post emergence, NS = Non significant

was 4.8 x 4.2 m^2 and 4.2 x 3.6 m^2, respectively. The soil of the experimental field was clay in texture, with medium in available nitrogen, medium in available phosphorus and rich in available potassium. The soil was slightly alkaline in reaction with pH of 7.6. The experimental crop was sown by dibbling at 30 x 10 cm^2 spacing on 28th June, 2006. The protein content was determined on the basis of per cent N content in seed.

The mean number of pods plant^{-1}, number of seeds plant^{-1}, weight of seeds plant^{-1}, hundred seed weight and seed and straw yields were significantly affected by different weed control treatments (Table 1). Two hand weedings (30 and 45 DAS) was significantly superior over all the weed control treatments as regards number of pods plant^{-1} (59.00), seeds plant^{-1} (141.60), weight of seeds plant^{-1} (23.29 g) and hundred seed weight (16.40 g) revealing the beneficial effect of weed free environment resulting in no competition between weed and crop plants.

Among the combination of chemical and cultural weed control measures, treatment pursuit @100 g a.i ha^{-1} (EPOE) + one hand weeding at 45 DAS was found to be the best after the treatment T_2 regarding the characters under consideration revealing the efficiency of chemical along with manual weeding in weed control, thereby resulting in better yield and yield parameters. The treatment weedy check , however, was found to indicate the lowest values of the yield and yield components because of severe competition for the natural resources for growth between the crop and weed. These results corroborate the findings of Arya *et al*. (1994).

Fluchloralin@ 1 kg a.i. ha^{-1} (24.23 q ha^{-1}) recorded the lowest seed yield among the chemical weed control treatments which was followed by treatment pendimethalin @ 1 kg a.i ha^{-1} (26.47 q ha^{-1}). These results reveal the comparative inefficiency of the chemical methods of weed control in isolation in reducing the crop weed competition resulting in comparatively lower yields as compared to their use in combination of two hand weedings at 15 and 30 DAS. This results corroborates the results of Porwal *et al*. (1991) and Dubey *et al*. (1996).

The increase in seed yield with integrated methods can be attributed to the fact that the crop was kept free of competition at the early critical stage of growth resulting in the crop using the land and climatic resources more efficiently.These results are in conformation with the earlier findings of Prakash *et al*. (1991), Chandrakar and Urkurkar (1993) and Velu and Sankaran (1996).

Protein and oil content : The data regarding the per cent protein and oil content in soybean seed as influenced by different treatments (Table 1) revealed that two hand weedings at 30 and 45 DAS produced significantly the highest protein (42.17 %) and oil content (21.74 %) in soybean as compared to the other methods of weed control. Similar results were reported by Porwal *et al*. (1991).

Among the herbicide treatments, treatment pursuit @100 g a.i ha^{-1} (EPOE) + one hand weeding at 45 DAS reported the highest protein (41.32 %) and oil (20.10 %) content in soybean. The herbicides in isolation i.e. fluchloralin @1.0 kg a.i. ha^{-1} recorded the lowest protein (38.04%) content among the herbicides treatments which may be due to phytotoxic effect of herbicides on crop plants. These results, however, are contradictory with the results obtained by Chhokar *et al*. (1995).

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Genetic Variability Studies in Blackgram (*Vigna mungo* (L.) Hepper)

Blackgram is herbaceous erect to spreading type, warm season pulse crop widely grown in India. It is one of the rich source of proten (24%) and amino acids. It also contain 1.4 per cent fat and 59.6 per cent carbohydrates. In India productivity of black gram is very low. The knowledge of genetic variability is a prerequisite in a plant breeding programme, since it helps for the choice of best yield attributes either for selection or hybridization. The phenotypic and genotypic coefficient of variation plays an important role in improvement of existing cultivars. High heritability along with high to medium genetic advance provides enough scope for selection, however an opposite of this suggests hybridization as potential method for crop improvement.

Forty genotypes of blackgram were collected from NBPGR, New Delhi and Agricultural Research Station, Badnapur, Marathwada Agriculture University, Parbhani. The experiment was conducted in a randomized block design with three replications. The individual genotype was represented by a single row of 5 m length with spacing of 30 cm between rows and 10 cm between plants. The recommended package of practices of plant productions and protection were followed for successful crop growth. The observations were recorded on randomly selected five plants for thirteen characters of each entry. The data was analysed for GCV, PCV and h^2 as suggested by Burton (1952) and Johnson *et al*. (1955) for genetic advance.

The parameters of genetic variability are summarized in Table 1. In the present investigation, magnitude of PCV was higher than GCV for all 13 characters studied

Table 1. Study of genetic variability for yield in blackgram.

Characters	Range	General mean	Genotypic coifficient of variation	Phenotypic coifficient of variation	Heritability (bs) (%)	Genetic advance	GA as per cent of mean (%)
Days to 50% flowering	39.33-49.67	45.18	5.31	5.62	89.24	4.67	10.33
Days to maturity	77.00-93.67	83.15	4.45	4.74	87.85	7.14	8.59
Plant height (cm)	25.70-41.40	31.26	11.04	11.26	96.26	6.98	22.33
Branches plant^{-1}	2.52-3.56	2.87	7.57	7.67	97.26	0.44	15.37
Pod length	3.84-5.37	4.46	8.57	8.81	94.71	0.76	17.19
Pods plant^{-1}	23.67-55.33	35.25	16.80	17.47	92.48	11.73	33.28
Seeds pod^{-1}	5.53-7.27	6.42	5.47	6.20	77.98	0.63	9.96
Nodules plant^{-1}	22.90-52.87	36.66	19.04	19.32	97.15	14.17	38.67
Clusters plant^{-1}	8.99-18.30	13.06	14.99	16.74	80.19	3.61	27.65
Protein content (%)	18.58-27.12	23.01	8.80	8.82	99.38	4.16	18.07
Harvest index (%)	28.07-46.15	39.62	8.58	9.00	91.03	6.68	16.88
100 seed wt. (g)	3.87-6.13	4.68	13.57	13.81	96.61	1.28	27.49
Grain yield plant^{-1} (g)	6.35-13.74	9.78	21.17	21.78	94.43	4.14	42.38

indicating influence of environment on expression of these characters, suggesting that one should not rely upon phenotypic effect alone.

The GCV and PCV estimates were high for grain yield plant^{-1}, number of pods plant^{-1}, number of cluster plant^{-1}, 100 seed weight and plant height suggesting the presence of variability for these traits. These results confirm the earlier findings of Patil and Narkhede (1987) for plant height and Sharma *et al*. (2000) for plant height, pods plant^{-1}, clusters plant^{-1} and grain yield plant^{-1}. The characters days to maturity days to 50 per cent flowering and number of seeds pod^{-1} exhibited very low GCV and PCV estimates suggesting narrow range of variation. Patil and Deshmukh (1989) and Sharma *et al*. (2000) reported similar finding for number of seeds pod^{-1}. The magnitudinal difference between PCV and GCV estimates were narrow for all the traits except for number of clusters plant^{-1}, number of seeds pod^{-1}, suggesting little influences of environments on these traits.

The heritability (bs) estimates for protein content (99.38%), number of branches plant^{-1}, number of nodules plant^{-1} (97.26%), 100 seed weight (96.61%), plant height (96.26%) and grain yield plant^{-1} (94.43%) were high indicating the major role of genotype and ultimately less environmental influence. Similar results were reported by Patil and Deshmukh (1989), Choulwar *et al*. (1997) for plant height and grain yield plant^{-1}. The lowest per cent of heritability (bs) was observed for number of seeds pod^{-1} (77.98) and number of cluster plant^{-1} (80.19 %). The high heritability estimates of number of nodules plant^{-1} and number of pods plant^{-1} were coupled with high magnitude of expected genetic advance as per cent of mean indicating existence of additive gene action. This suggested the possibility of improving these characters, through direct selection.

The present study revealed that grain yield plant^{-1}, number of nodules plant^{-1} and number of pods plant^{-1} will offer a greater scope for selection from the population as these exhibited greater to moderate genetic advance coupled

with higher heritability estimates.

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Correlation and Contribution of Different Characters Towards Yield in Wal

Yield depends on many component characters and is highly influenced by environmental fluctuations. Hence, the information on the association between yield and its components is a prerequisite for crop improvement, but it doesn't provide an exact picture of the relative importance of direct and indirect influence of each of the component characters towards yield. Path analysis splits correlation coefficients into components of direct and indirect effects and measures the direct and indirect contribution of various independent variables on the dependent variable.

Fifty diverse germplasm accessions of wal collected from NBPGR, New Delhi (30), Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli (8) and Botany farm, College of Agriculture, Pune (12) were evaluated for twelve different yield and yield contributing characters. The field experiment was laid in a randomized block design with three replications, by adopting standard agronomic practices . Each entry was represented by a single row of 6 m length with spacing of 60 cm between rows and 30 cm between plants. Five competitive plants were randomly selected from each treatment in each replication. Genotypic and phenotypic correlation coefficients were worked out by adopting method described by Singh and Chaudhary (1977), while path coefficient analysis was done according to the procedure suggested by Dewey and Lu (1959).

The analysis of variance revealed highly significant differences among the experimental genotypes for all the characters studied except harvest index. Genotypic and phenotypic correlations for 12 characters are presented in Table 1.

The seed yield showed significant and positive association with harvest index, 100-seed weight, number of seeds pod^{-1}, pod length and number of inflorescence plant^{-1}, indicating dependency of yield on these characters. Similar findings were reported by Pandey *et al*. (1980), Kabir and Sen (1989) and Uddin and Newaz (1997). Length of inflorescence showed positive and significant association with number of flowers inflorescence^{-1} and number of pods inflorescence^{-1} confirming the findings of Kamble *et al*. (2000). Likewise, number of pods inflorescence^{-1} showed positive and significant association with length of inflorescence, number of flowers inflorescence^{-1} and harvest index.

The path analysis revealed high magnitude of direct effect accompanied by highly significant correlation in the desired direction for seed yield plant^{-1}, harvest index, 100-seed weight, number of seeds pod^{-1}, length of pod and number of inflorescence plant^{-1} indicating the true and perfect relationship between these characters. This suggested direct selection based on these characters would be helpful in selecting the high yielding genotypes in wal. These results were in agreement with the earlier findings of Kabir and Sen (1989).

Harvest index exhibited highest magnitude of direct effect and also contributed indirectly *via*. 100-seed weight, number of seeds pod^{-1} and number of pods inflorescence^{-1}. Length of pod exhibited negative direct effect but its positive correlation with seed yield was due to presence of higher indirect effect *via*. number of seeds pod^{-1}, harvest index and 100-seed weight which confirmed the findings of Shoran (1982). Days to first flowering exhibited negative direct effect but showed positive association, contributed indirectly *via*. harvest index, number of pods inflorescence^{-1} and pod length. Length of inflorescence exhibited

Table 1. Genotypic and phenotypic correlation of yield and yield contributing characters in wal.

Cha-ract-ers	Days to first flowe-ring (No.)	Primary branches plant^{-1} (No.)	Inflo. plant^{-1} (No.)	Length of inflor. (cm)	Flowers inflor^{-1} (No.)	Pods inflor^{-1} (No.)	Days to maturity	Length of pod (cm)	Seeds pod^{-1} (No.)	100 seed weight (g)	Harvest index (%)	Seed yield plant^{-1} (g)
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	1	0.2122	0.0240	0.1874	-0.0136	-0.3009*	0.9077**	0.1728	0.2827*	0.0530	-0.1085	0.1257
2	0.199	1	0.1218	0.1666	0.2017	-0.0584	0.1705	-0.2080	-0.1870	-0.070	-0.0775	-0.044
3	0.022	0.1146	1	-0.1370	0.0146	-0.0491	0.1356	-0.0300	0.1065	0.0167	0.0492	0.2896*
4	0.186	0.1658	-0.1179	1	0.7861**	0.3926**	0.1399	-0.1730	-0.1270	-0.0310	0.1630	0.594
5	-0.012	0.1939	0.0190	0.7826*	1	0.6245**	-0.0036	-0.2170	-0.1410	-0.0170	0.3481*	0.2362
6	-0.299*	-0.0531	-0.043	0.3879**	0.6158**	1	-0.1913	-0.285*	-0.3086*	-0.1100	0.4098**	0.2514
7	0.901	0.1580	0.1306	0.1383	-0.0043	-0.1877	1	0.2037	0.3128**	0.1293	-0.0598	0.2445
8	0.1724	-0.2003	-0.0299	-0.1721	-0.2147	-0.2824*	0.2015	1	0.7211	0.3808**	0.2338	0.3064*
9	0.279*	-0.1825	0.1004	0.1272	-0.1399	-0.3015*	0.3099*	0.7162**	1	0.3547	0.3442*	0.5017**
10	0.0548	-0.0596	0.0056	-0.0298	-0.0163	-0.1074	0.1272	0.3747**	0.3478	1	0.4826**	0.6300**
11	-0.104	-0.0729	0.0434	0.1588	0.3409*	0.3967**	-0.0588	0.2287	0.3351*	0.4657**	1	0.8440**
12	0.1245	-0.0370	0.2625	0.0573	0.2312	0.2440	0.2404	0.3003*	0.4920**	0.6151**	0.8389**	1

indirect effect through number of seeds pod^{-1} and number of inflorescence plant^{-1}. Number of flowers inflorescence^{-1} showed positive correlation with seed yield which could be explained by its direct effect and indirect effect through harvest index, number of pods inflorescence^{-1}, length of pod and number of inflorescence plant^{-1} positively.

From forgoing discussion, it is revealed that the characters *viz*. harvest index, 100-seed weight, number of seeds pod^{-1}, length of pod and number of inflorescence plant^{-1} had strong association with seed yield and also showed the highest positive direct effects and indirect effects of other component traits, indicating that direct selection for these traits will be effective in enhancing the breeding efficiency for seed yield in wal.

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Response of *Spirulina* to Various Combinations of Media

Spirulina, a spiral, filamentous, blue green alga, is a wholesome food supplement, rich in proteins, vitamins, amino acids, β-carotene, linolenic acid, minerals and other nutrients (Rich, 1931). It is also good source niacin and phosphorus (Tomaselli, 1997). Processed biomass of *Spirulina* is available in various forms such as powder, soup, noodles, candies, vegetable pate, low calarie bread, health drinks and multivitamin tablets. *Spirulina* is claimed as non-toxic, nutritious food supplement with some corrective properties against viral attacks, anemia, cancer, hepatotoxicity, cardiovascular diseases, hyperglycemia, immunodeficiency and inflammatory processes (Venkatraman, 1989). The present paper reports various ways of cost reduction for household level production of *Spirulina* biomass.

A mixture of three species of *Spirulina*, *viz*. *S. maxima*, *S. platensis* and *S. fusiformis*, was obtained from Pyren's Institute,

Babhaleshwar, Dist. Ahmednagar, Maharashtra. Initial culture establishment was done by using Zarrouk's medium in an aquarium of size 36" x 24" x 12". The *Spirulina* cultures were maintained in normal laboratory conditions. The work was done between June 2007 and January 2008.

Attempts have been made to reduce the cost of *Spirulina* biomass production with modifications in Zarrouk's medium as full, three-fourth, one-half and one-fourth strength of Zarrouk's medium.

The optical density of the inoculum was approximately 1, when measured at 560 nm, before inoculating in the media. During all such trials, inoculum and medium ratio was maintained at 1:10. Incubation was done at room temperature, under natural photoperiod. For better aeration, shaking of culture flask was done twice a day. The biomass production was measured in terms of dry matter produced, at an interval of 10 days, for the period of 50 days, after inoculation. From *Spirulina* culture, 20 ml sample was filtered through Whitman filter paper No. 2, for measurement of biomass production. This filter paper along with biomass was oven dried at 40°C for 24 hours and dry weight of biomass was measured. Experiment was carried out in triplicate.

Biomass production was highest in Zarrouk's medium, while it was lowest in MCRC medium. Next to the Zarrouk's medium, the biomass production was highest in CFTRI medium. It was almost equal to Zarrouk's medium after 40 days of incubation. The Zarrouk's medium is the original nutrient medium formulated for *Spirulina* cultivation (Jeejibai, 2006), and all other nutrient medium like CFTRI, MCRC, Rao's medium and University of Rajasthan medium are nutritionally poor as compared to Zarrouk's medium.

The cost of nutrient media per liter was 14,

Table 1. Effect of various nutrient on biomass production in *Spirulina*.

Nutrient medium	Cost of medium (Rs. L)*	Biomass production (g l^{-1}) after days				
		10	20	30	40	50
Zarrouk's medium	14.00	1.92 ± 0.16	3.17 ± 0.26	3.42 ± 0.24	1.62 ± 0.21	0.98 ± 0.25
CFTRI medium	6.00	1.82 ± 0.28	2.19 ± 0.16	2.76 ± 10.29	1.59 ± 0.32	0.74 ± 0.15
Rao's medium	5.90	1.45 ± 0.16	1.82 ± 0.14	2.04 ± 0.24	1.21 ± 0.26	1.02 ± 0.23
MCRC medium	4.75	0.97 ± 0.21	1.08 ± 0.18	0.84 ± 0.25	0.65 + 0.26	0.55 ± 0.06
University of Rajasthan medium	3.80	0.85 ± 0.24	0.67 ± 0.25	0.42 ± 0.19	0.24 ± 0.12	0.16 ± 0.02

* The values given have been calculated by taking costs of laboratory grade chemicals into account.

Table 2. Effect of various strengths of Zurrouk's medium on biomass production in *Spirulina*.

Strength of Zarrouk's medium	Cost of medium (Rs. L)*	Biomass production (g l^{-1}) after days				
		10	20	30	40	50
Full	14.00	1.8 ± 0.27	3.17 ± 0.19	3.42 ± 0.24	1.62 ± 0.26	0.98 ± 0.04
Three-fourth	10.30	1.6 ± 0.18	2.09 ± 0.21	2.23 ± 0.14	1.23 ± 0.21	0.72 ± 0.06
One-half	07.00	1.1 ± 0.14	1.76 ± 0.26	1.96 ± 0.24	0.77 ± 0.17	0.24 ± 0.02
One-fourth	03.50	0.9 ± 0.03	0.88 ± 0.05	0.54 ± 0.08	0.24 ± 0.07	0.18 ± 0.016
Water alone	00.00	0.2 ± 0.11	0.12 ± 0.09	0.086 ± 0.03	0.034 ± 0.012	0

* The values given have been calculated by taking costs of laboratory grade chemicals into account.

8, 5.9, 4.75 and Rs.3.8 in case of Zarrouk's, CFTRI, Rao's, MCRC and University of Rajasthan medium, respectively. Present observations have revealed that due to low cost of production, CFTRI medium is preferable over Zarrouk's medium. The production of biomass proportionately reduced, with reduction in the nutrient strengths of Zarrouk's medium (Table 2). The Zarrouk's medium was diluted by 25, 50 and 75 per cent with the intension of cost reduction. However, dilution resulted into gradual decreased production. *Spirulina* could survive up to 40 days in water and in due course died due to lack of nutrients. Thus, if Zarrouk's medium is to be used, it should be in its full strength only.

The composition of tablets available in market is black pepper 100 mg, Awala powder 100 mg and *Spirulina* powder 400mg per tablet. Same composition has been followed, for the preparation of *Spirulina* tablets, granules, and powder during present study.

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Genetic Variability, Heritability and Correlation in Soybean

Soybean [*Glycine max* (L.) Merill.] is one of the most important agricultural cropin Maharashtra due to its rich source of vegetable oil and protein content. An information on the nature and magnitude of variability, heritability and correlation among different characters is prerequisite in any successful hybridization programme and for selection of parent to produce desirable segregants. In present investigation an attempt was made to assess the genetic parameters and correlation among component characters with yield in soybean at Agricultural Research Station, Gadhinglaj (M.S.) under rainfed condition on vertisols.

The experimental material consisted of sixteen genotypes of soybean which were planted in 5 m length row with spacing of 45 cm between rows and 5 cm between plants in a randomized block design with three

replications during *kharif*-2003. The recommended fertilizer of 50 kg N and 75 kg P_2O_5 ha^{-1} was applied as basal application. The observations were recorded on five randomly selected plants in each plot for seven characters. Genetic components and correlation coefficient were computed with the method suggested by Singh and Choudhary (1977).

The analysis of variance for seven characters showed significant differences among the genotypes indicating thereby considerable amount of variability among them. The values of PCV were higher than GCV indicating the role of environmental variance in the total variance. The PCV and GCV estimates were of high magnitude for number of pods $plant^{-1}$, 100 seed weight and number of branches $plant^{-1}$ than the rest of the characters suggesting the presence of variability for these characters (Table 1). These results confirmed

Table 1. Genetic variability parameters in soybean.

Characters	Mean	Range	GCV	PCV	Herita-bility % (bs)	GA	GA as per cent of mean
Days to 50% flowering	36.98	34.02-44.67	6.37	7.12	80.00	4.34	11.74
Days to maturity	92.79	86.33-101.33	4.54	4.68	93.84	8.40	9.06
Plant height (cm)	51.54	42.40-63.52	8.33	10.30	65.39	7.15	13.88
Branches $plant^{-1}$	5.03	4.0-6.47	10.37	14.36	52.18	0.78	15.34
Pods $plant^{-1}$	42.92	33.67-51.93	11.81	14.44	66.89	8.54	19.89
Hundred seed weight (g)	15.73	13.20-19.10	10.42	14.47	82.56	3.07	19.51
Seed yield $plant^{-1}$ (g)	9.46	8.65-10.06	1.81	8.02	5.11	0.08	0.84

GCV = Genotypic coefficient of variation, PCV = Phenotypic coefficient of variation, GA = Genetic advance, b.s. = Broad sense.

Table 2. Genotypic and phenotypic correlations of different quantitative characters in soybean.

Characters		Days to 50% flow-ering	Days to maturity	Plant height (cm)	Branches $plant^{-1}$	Pods $plant^{-1}$	Hundred seed weight (g)	Seed yield $plant^{-1}$ (g)
Days to 50% flowering	(G)	1.000	0.584**	0.720**	0.756**	0.313	-0.181	0.247
	(P)	1.000	0.504	0.661**	0.412	0.227	-0.083	0.020
Days to maturity	(G)		1.000	0.337	0.220	-0.393	0.144	-0.841**
	(P)		1.000	0.229	0.140	-0.327	0.123	-0.126
Plant height (cm)	(G)			1.000	0.379	0.572**	-0.186	0.642**
	(P)			1.000	0.442	0.385	-0.120	0.002
Branches plant-1	(G)				1.000	0.516**	-0.308	-0.775**
	(P)				1.000	0.419	-0.280	-0.026
Pods plant-1	(G)					1.000	-0.220	0.328
	(P)					1.000	-0.131	0.079
Hundred seed weight (g)	(G)						1.000	-0.262
	(P)						1.000	-0.021
Seed yield plant-1 (g)	(G)							1.000
	(P)							1.000

* and ** are significant at 5 and 1 % respectively. G = Genotypic correlation, P = Phenotpic correlation.

the earlier findings of Harer and Deshmukh (1992). The PCV and GCV indicated the moderate magnitude for plant height, days to 50 per cent flowering and days to maturity, where as the character yield plant^{-1} had very low PCV and GCV estimates indicating the narrow range of variation for these characters and provide very least scope for selection. These results confirm the findings of Pathan (1992) and Bangar *et al*. (2003) for these characters. The magnitudal difference between PCV and GCV was very high for seed yield plant^{-1} which indicates the role of environment in expression of this character. Thorat *et al*. (1999) reported similar findings for pods plant^{-1}.

The heritability (bs) estimates were of high magnitude for all the characters except seed yield plant^{-1}. The character days to maturity exhibited highest heritability (93.84%) followed by 100 seed weight (82.56%) and days to 50 per cent flowering (80.00%). The high heritability indicated that these traits were governed by additive gene action. Harer and Deshmukh (1992) and Bangar *et al*. (2003) reported high heritability for days to maturity, while Thorat *et al*. (1999) reported for plant height. Genetic advance as per cent of mean was high for number of pods plant^{-1} and 100 seed weight. Heritability estimates coupled with high genetic advance as per cent of mean was the most effective tool for selection than heritabilty alone. High heritability along with high genetic advance as per cent mean for 100 seed weight and number of seeds plant^{-1} would be useful for direct selection of these characters in breeding programme.

In the present investigation (Table 2) genotypic correlation were higher than the phenotypic correlation this indicated a strong inherent association between yield and its component traits. The character plant height was positively and significantly correlated with seed yield, while the character days to 50 per cent flowering and number of pods plant^{-1} had a positive but nonsignificant correlation with seed yield, suggesting that the yield is a function of these characters and selection for these character would be effective. Amarnath *et al*. (1990) and Bangar *et al*. (2003) reported similar association except for number of pods plant^{-1}.

The characters days to 50 per cent flowering, days to maturity, plant height, number of pods and number of branches plant^{-1} were positively significant among themselves suggesting the interdependence of these traits with each other. These results were confirmed with findings of Sharma *et al*. (1984) and Bangar *et al*. (2003).

Thus it was revealed from these studies that plant height, number of pods plant^{-1} and days to 50 per cent flowering were more important yield attributing characters in soybean as these were positively correlated with yield. Further it was also showed that they were correlated among each other. Hence for improvement of yield in soybean maximum stress may be given on these characters.

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Evaluation of Insecticidal Applications Against Jassids Infesting Okra

Indiscriminate use of pesticides cause more problems like resurgence, resistance development, residual toxicity etc. Considering the pesticidal hazards, the use of pesticidal formulations based on plant products appears to be promising approach for pest control. Hence, the present investigation was carried out to reduce the number of insecticide sprays by increasing the interval of application of pesticide in okra.

The treatments 1 to 8 were followed at 15 days interval and 9 to 16 at 21 days interval (Table 1). The okra variety Arka Anamika was sown at spacing of 30 x 10 cm in a plot size of 3.5 x 2.5 m^2. Recommended package of practices was followed to raise the crop. The first eight treatments comprising the sprays of Achook (0.5%), ZA-199 (0.5%), NSKE (5%), Cypermethrin (0.01%) and imidacloprid (0.004%) were sprayed alone and in alternation, 4 times at an interval of 15 days. The treatments from nine to sixteen insecticides in alternation with neem formulations were applied 3 times at an interval of 21 days. The observations on jassids were recorded one day before spraying as pre-treatment count. The post treatment counts were taken on 2^{nd}, 5^{th}, 15^{th} and 21^{st} days after each spraying.

The average number of jassids prior to insecticidal treatments ranged from 6.90 to 10.20. The differences among the treatments were non-significant. All the treatments comprising 4 and 3 sprays at 15 and 21 days interval respectively, were found significantly effective in reducing the population of jassids at 2, 5 and 15 days after spraying over untreated control. Two days after spraying, the results revealed that all the treatments were significantly superior over untreated control. The treatment with 4 sprays of imidacloprid (0.004%) was found to be most effective and registered 5.15 jassids $plant^{-1}$ and was on par with rest of the treatments except NSKE (5%) alternated with Cypermethrin 0.01 per cent (4 sprays). The number of jassids ranged from 1.62 to 4.16 $plant^{-1}$ in different treatments as against 19.60 in untreated control in five days after spraying. The treatment comprising four sprays of imidacloprid (0.004%) was most effective (1.62 jassids per plant) followed by Achook (0.5%) alternated with imidacloprid with 4 sprays (2.12 jassids) and 3 sprays of

Table 1. Effect of number and application interval of neem formulations in alternation with synthetic insecticides against jassids infesting okra.

Treatments	Precount	Mean survival jassid population per plant days after spraying		
		2	5	15 and 21
Achook 0.5% alternated with cypermethrin 0.01%	8.30 (2.86)	6.72 (2.59)	3.62 (1.89)	9.95 (3.15)
ZA-199 0.5% alternated with cypermethrin 0.01%	8.70 (2.94)	6.77 (2.60)	2.97 (1.74)	10.40 (3.22)
NSKE 5% alternated with cypermethrin 0.01%	7.60 (2.75)	8.10 (2.84)	3.15 (1.77)	9.97 (3.15)
Achook 0.5% alternated with imidacloprid 0.004%	7.30 (2.70)	5.90 (1.80)	2.12 (1.45)	9.51 (3.09)
ZA-199 0.5% alternated with imidacloprid 0.004%	9.00 (2.99)	6.97 (2.64)	3.15 (1.77)	10.82 (3.29)
NSKE 5% alternated with imidacloprid 0.004%	6.90 (2.61)	6.07 (2.46)	2.90 (1.70)	9.65 (3.10)
Cypermethrin 0.01%	7.20(2.68)	6.45 (2.53)	2.95 (1.71)	10.07 (3.17)
Imidacloprid 0.004%	6.90 (2.61)	5.15 (2.26)	1.62 (1.27)	8.80 (2.96)
Achook 0.5% alternated with cypermethrin 0.01%	7.10 (2.66)	7.26 (2.69)	3.86 (1.93)	12.46 (3.53)
ZA-199 0.5% alternated with cypermethrin 0.01%	7.70 (2.77)	7.56 (2.75)	3.86 (1.95)	12.46 (3.53)
NSKE 5% alternated with cypermethrin 0.01%	8.40 (2.89)	11.92 (3.33)	4.16 (2.01)	13.59 (3.68)
Achook 0.5% alternated with imidacloprid 0.004%	7.60 (2.75)	6.03 (2.45)	2.93 (1.68)	12.46 (3.43)
ZA-199 0.5% alternated with imidacloprid 0.004%	8.10 (2.84)	7.66 (2.76)	3.06 (1.74)	13.73 (3.70)
NSKE 5% alternated with imidacloprid 0.004%	8.20 (2.86)	6.66 (2.58)	3.00 (1.71)	12.53 (3.54)
Cypermethrin 0.01%	7.40 (2.71)	6.50 (2.55)	2.83 (1.68)	12.23 (3.49)
Imidacloprid 0.004%	8.10 (2.84)	5.93 (2.43)	2.13 (1.46)	11.60 (3.40)
Untreated control	10.20 (3.19)	18.85 (4.34)	19.60 (4.42)	21.97 (4.68)
S. E.±	0.13	0.23	0.11	0.06
C. D. at 5%	NS	0.69	0.33	0.17

Figures in parenthesis are means of $\sqrt{X + 0.5}$ transformed values. Treatments 1 to 8 given at 15 days interval and 9 to 16 at 21 days interval.

imidacloprid (2.13 jassids).

Fifteen days after spraying the treatment comprising 4 sprays of imidacloprid (0.004%) was most effective and recorded 8.80 jassids per plant followed by Achook (0.5%) alternated with imidacloprid (9.51 jassids) and NSKE (5%) alternated with imidacloprid (9.65 jassids). It is evident that all the insecticidal treatments were superior in reducing jassid population on okra at 2, 5 and 15 days after application in comparison with untreated control. The treatment with 4 sprays of imidacloprid (0.004%) was most effective against jassids on okra upto 15 days after spraying. It was followed by Achook (0.5%), alternated with imidacloprid (4 sprays) and NSKE (5%) alternated with imidacloprid (4 sprays). Mote *et al*. (1994) and Sreelatha and Divakar (1997) demonstrated the effectiveness of imidacloprid 70 WS as seed dresser on sucking pests of okra. Similarly Mote *et al*. (1995) has also proved the effectiveness of imidacloprid against the pests of cotton.

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Study of Soybean Genotypes for Alternative Uses

Soybean (*Glycine max* L.) is one of the most important legume because of high protein and fat contents and therefore, it is being utilized for increasing the protein contents of many processed foods. Soybean is generally refered as golden bean as well as- wonder bean as source of protein and energy. The protein of soybean is comparable to those of animal protein except for methionine content. Hence, it is appropriate to refer soybean as vegetarian meat. Soybean can be incorporated relatively at higher level to elevate protein energy value of the food products. Sigedar (1999) reported that the optimum acceptable level of soybean mixed in a variety of the selected preparation of snacks was of 10 to 20 per cent.

Irrespective of any age, snacks prepared from soybean are known to be the popular food for consumption and demand is increasing rapidly with an advancement of socio-economic condition.

The present investigation was carried out to study soybean genotypes for alternative uses by judging the acceptability of the selected snacks commonly consumed by the people. The present investigation was undertaken at Department of Agricultural Botany, Marathwada Agricultural University, Parbhani in association with Department of Foods and Nutrition, College of Home Science and College of Food Technology, MAU, Parbhani.

The whole sound soybean of thirteen genotypes under study were cleaned properly to remove dirt, foreign matter, broken grains and soaked in water containing five per cent Sodium bicarbonate and three per cent salt for 2-3 hrs at room temperature. After soaking soybean was sun dried for 10 hrs. The dried soybean roasted at 121°C temperature for 20 minutes, dehulled and ground to fine flour in a grinding mill.

Sensory evaluation was conducted for *sev*, *chapati*, and soyane prepared from 13 soybean genotypes by a panel of 21 trained judges. The various characteristics like taste, flavor, colour, texture and overall acceptability for each of the recipe were assessed using a 5 point hedonic scale, indicating 5 = (excellent), 4 = (very good), 3 = (good), 2 = (fair) and 1 = (poor). Analysis of variance was used to test the difference between the treatments.

The score values for overall acceptability of sev prepared from soy flour of different genotypes ranged from 2.90 to 3.76. The maximum score was obtained by the *sev* prepared from genotype, MAUS 71(3.76) followed by JS 335(3.67), and was significantly more acceptable for taste, colour, flavor and texture. Whereas, the minimum score (2.90) recorded by the *sev* prepared from H1P3 and MAUS 32. The soybean genotypes *viz*. MAUS 2, JS 9305 and MACS 1055 were more or less similar in overall acceptability of recipe.

Chauhan and Tomar (1998) and Sigedar (1999) also reported similar results for acceptability of selected snacks prepared from soybean genotypes.

The score values for overall acceptability of all *chapatti* made from soy flour ranged from 2.90 to 3.62. The significant maximum score (3.62) was obtained by the *chapatti* prepared from soy flour of MAUS 61 followed by JS 335 (3.52). Whereas, the minimum score was observed by the *chapatti* prepared from MAUS 32 and Himso. The genotypes, MAUS 71, MAUS 81 and JS 9305 were ranked more or less similar in this regard. The results revealed that, use of soy flour of MAUS 61 for *chapatti* preparation was most acceptable in respect of colour, flour, taste, texture and overall acceptability. Sinha *et al*. (1993) and Rawat *et al*. (1994) also reported similar finding in this regard.

The significant differences were found in respect of overall acceptability of soyane prepared from different genotypes of soybean. The score values ranged from 2.57 to 3.52. The genotypes, MAUS 81, MAUS 71 and JS 9305 registered significant highest score for overall acceptability. Significant lowest score value (2.57) was indicated by the genotype MACS 1055. The results indicated that, soyane made from the genotypes MAUS 81, MAUS 71, JS 9305 and JS 335 were found more acceptable for organoleptic characteristics like colour, flavour, taste and overall acceptability. Subba Rao and Prasannappa (1989) reported the similar results in this regards. Considering the overall acceptability for different recipes, JS 335 was found superior in respect of colour, taste and flavour.

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Anti-fungal Properties of Plant Extracts Against *Aspergillus flavus* Inciting Groundnut

Aspergillus flavus is a major saprophytic fungus responsible for causing rotting in groundnut kernels under storage and field conditions. About 10-20 per cent kernels under

storage are damaged due to the fungus. Also, seed borne infection of the fungus causes reduction in emergence of seedlings. It not only reduces the yield of the crop but deteriorates the quality as well, ultimately reducing the market potential and delimiting-it's consumption.

Aspergillus flavus is known to produce secondary metabolite called 'aflatoxin' causing ill effects on animal and human health. Since spraying of fungicides is less reliable under storage, studies were carried out to evaluate the efficacy of various plant extracts having anti-fungal properties in inhibiting the mycelial growth, sporulation and spore germination of *Aspergillus flavus* infecting groundnut kernels.

The test fungus was isolated from rotted groundnut kernels and it's pathogenicity and identity was confirmed. Six crude plant extracts of 100 per cent concentration each *viz*., *Bauhnnia purpurea* (Kanchan), *Azadirachla indica* (Neem), *Clerodendron inerme* (Clerodcndron), *Allium cepa* (Onion), *Allium sativum* (Garlic) and *Lantana camera* (Ghaneri) were evaluated *in vitro* by poison food technique. For extraction, plant parts used were-leaves in case of kanchan, neem and clerodendron, bulbs of onion, cloves of garlic and flowers of ghaneri. The effect of crude plant extracts on spore germination of *Aspergillus* flavus was studied by hanging drop technique (Mishra and Dixit, 1976) with some modifications.

From the data presented in Table-1, it is revealed that all the treatments were significantly superior over control in inhibiting the mycelial growth of *Aspergillus flavus* except the treatment of *Bauhunia purpureu* and *Lantanu camera*. The extract of *Allium sativum* was found to be effective with inhibition of 79.22 per cent followed by *Allium cepa* (78.71%), *Azadirachta indica* (74.07%) and *Clerodendron inerme* (72.96%). As regards the sporulation of the fungus, poor sporulation was there in the treatments of *Allium cepa*, *Allium sativum* and *Clerodendron inerme*. Moderate sporulation was noticed with *Lantana camera* and *Bauhunia purpurea*, as compaired to control. The results obtained are in accordance with those reportesd by Agarwal (1978) who obtained effective control of *Aspergillus flavus* and *Curvularia lunata* with bulb extract of *Allium sativum*. The effectiveness of *Azadirachta indica* and *Clerodendron* spp. in inhibiting mycelial growth had been also reported by Parimelazhagan and Francis

Table 1. Effect of plant extracts on mycelial growth, sporulation and spore germination of *Aspergillus flavus*.

Treatment	Colony diameter (mm)	Inhibition of growth (%)	Degree of sporulation	Inhibition of growth (%)
Bauuhnia purpurea	35.26	60.82 (51.24)	++	40.00 (39.23)
Azadirachta indica	23.33	74.07 (59.34)	+	93.00 (73.66)
Clerodendron inerme	24.33	72.96 (58.63)	+	85.00 (67.21)
Allium cepa	19.16	78.11 (62.10)	+	98.00 (81.87)
Allium sativum	18.66	79.26 (62.87)	+	100.00 (90.00)
Lantana camera	33.33	62.96 (52.48)	++	55.00 (47.87)
Control	90.00	0.00	+++	00.00 (00.00)
S. E.±	2.92	1.92		7.10
C. D. at 5%	6.37	4.20		15.48

Note : Figuers in parenthesis are arc sin transformed values. +++ = Abundant sporulation, ++ = Moderate sporulation, + = Poor sporulation. * = Average of three replications, each based on observations of three microscopic fields.

(1999).

Total spore inhibition was obtained with crude plant extract of *Allium sativum*. The other crude plant extracts *viz*., *Allium cepa*, *Azadirachta indica* and *Clerodendron inerme* gave 98, 93 and 85 per cent inhibition of spore germination respectively. The least per cent inhibition was obtained in treatments of *Lantana camera* and *Bauhunia purpurea* (55 and 40 per cent respectively). Similar results were obtained by Datar and Quereshi (1990), wherein, *Allium cepa* was most effective in inhibiting the spore germination of *Curvularia lunata*. Parimelazhagan and Francis (1999) had reported the effectiveness of *Azadirachta indica* and *Clerodendron* spp. in spore germination reduction of major seed borne fungi of African yam.

Thus, crude plant extracts of *Allium sativum* was found most effective in controlling and checking the growth of *Aspergillus flavus* by inhibition of mycelial growth, sporulation and spore germination followed by *Allium cepa*, *Azadirachta indica* and *Clerodendron inerme*.

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March 8, 2009

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