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RESEARCH NOTES

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Simultaneous Transformation of N and Mn in a Limed and Unlimed Soil

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(Received : 01-06-2009)

ABSTRACT

Irrespective of liming treatments, all forms of inorganic and organic N as well as Mn decreased with increase in the period of incubation. Irrespective of treatments, comparatively higher amount of available N was decreased in unlimed over the corresponding limed soil during incubation. However, a completely reverse trend of results was observed for available Mn. Results further showed that the higher amount of decrease in total hydrolysable organic N in limed soil is corroborated with the decrease in amino acid N which is the main contributor to the N-mineralization process. This trend of results was observed in all the treatments. In general, irrespective of treatments, non-hydrolysable organic and hydrolysable $NH4^{+}$– N fractions which are other major forms susceptible to mineralization showed an opposite trend of results. Combined application of inorganic N and Mn slowed down the process of mineralization of both total hydrolysable and non-hydrolysable organic N which is reflected by their constituent forms under study. This trend of results was observed in both the unlimed and limed soil.

Key words : N, Mn, transformation, liming.

Nitrogen is one of the major nutrients required by plant for growth and metabolic activity, mostly taken up from the soil. The organic forms of N, particularly hydrolysable form, is slowly mineralized and is transformed to mineral form (Salam *et al*. 1990). Although, single transformation processes has been extensively studied but still there are many points to be illucidated before the N transformation in totality is fully understood. Mineralization of N from soil varies due to various factors (Pal *et al*. 1987a; Saha, 1999; Chakraborty *et al*. 2005 and Chakraborty *et al*. 2005). Mn is taken up by plants as Mn^{2+}. The most important Mn fraction in soils are Mn^{2+} and the manganese oxides in which Mn is present in trivalent (Mn^{3+}) or tetravalent (Mn^{4+}) form. Divalent Mn is adsorbed on the soil colloidal materials and is also most important form of Mn which is readily available to plants.

Liming soils of acidic reaction has been reported to increase the production of mineral N and decrease the amount of soil organic matter (Saha and Mukhopadhyay, 1985b). When acid soils are limed, a portion of soil organic matter becomes more susceptible to mineralization but after this portion has been decomposed, mineralization reaction reaches its original level (Salam *et al*. 1990). Singh and Randhwa (1969), found negative significant relationship between exchangeable Mn and $CaCO_3$ in calcareous soil. Das (2003), reported application of N-fertilizer to the soil enhances the uptake of Mn in plant. Combined application of N and Mn fertilizer increased exchangeable and easily reducible Mn in both limed and unlimed soil (Ghosh and Saha, 2006). Keeping above information in view an investigation was carried out to study simultaneous transformation of different forms of inorganic and organic N and available Mn in

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a limed and the corresponding unlimed soil treated with or without inorganic nitrogen or manganese fertilizer.

MATERIALS AND METHODS

The soil sample (0-15 cm depth) used for the present investigation was a composite sample of cultivated field under university farm at Jhargram in the district of West Midnapur, West Bengal, India. This soil was termed 'unlimed soil' in the text.

Preparation of limed soil - Liming material, equivalent to lime requirement, was added to the soil uniformly and allowed to react with soil mass for three months period with repeated wetting and drying. The soil so prepared was termed 'limed soil'. Before use both the unlimed and limed soils were air dried, ground by a wooden mortar and passed through 0.1 mm sieve.

Experimental set up - Each 25 g of the unlimed and limed soils were taken separately in 100 ml beaker for the incubation study. Altogether four sets of both the soils were maintained for four treatments. The 1st set was maintained as control without addition of any inorganic N and Mn fertilizer. In the 2nd set of soils, inorganic N was added as treatment material at 150 mg kg^{-1} N in the form of $(NH_4)_2SO_4$. In the 3rd set, Mn was added as treatment material at 25 mg kg^{-1} as $MnCl_2$. The 4th set of soils was maintained where both inorganic N and Mn were added at 150 mg kg^{-1} and 25 mg kg^{-1} in the form of $(NH_4)_2SO_4$ and $MnCl_2$, respectively. Respective soil samples were then moistened to 60 per cent of the moisture holding capacity (MHC) by addition of distilled water. After moistening, the soils were allowed to maintain at room temperature (30±2°C) for a period of 90 days. Five separate sets were maintained for laboratory analysis on 0, 15, 45, 60 and 90th

Table 1. Relevant physical and chemical characteristics of the unlimed and limed soils used for the investigation.

Character	Unlimed soil	Limed soil	Methods used
pH (soil : water : 1:2.5)	5.3	6.85	Glass electrode pH meter, Black (1965)
EC (dsm^{-1})	0.18	0.26	Electrical conductivity bridge, Black (1965)
Mechanical analysis			
Sand (%)	62.1	62.1	Hydrometer method (Bouyoucus, 1962)
Silt (%)	15.7	15.7	
Clay (%)	22.2	22.2	
Oxidisable organic carbon (%)	0.22	0.20	Walkley and Black method (Jackson, 1967)
A. Total N (mg kg^{-1})	1199.55	1141.53	Stevenson (1998)
B. Available N (mg kg^{-1})	134.33	134.98	Bremner and Keeney, (1966)
C. Organic forms of N (mg kg^{-1})			Stevenson (1998)
i. Total hydrolysable organic N	688.54	652.64	
ii. Total nonhydrolysable organic N	376.67	353.90	
iii. Hydrolysable NH4-N	222.96	217.56	
iv. Amino acid	329.46	327.30	
CEC [C mol (P+) kg^{-1}]	10.9	11.5	
Moisture holding capacity (%)	42.04	43.68	Keen-Rack Zowski method (Piper, 1950)
Available Mn (mg kg^{-1})	37.78	36.45	
Nomenclature	Plinth	Plinth	USDA
according to USDA system of soil classification	Ustalf	Ustalf	

day of incubation. Soil samples were identically collected for analysis of different fractions of organic N and Mn. Loss of moisture due to evaporation was replenished by the addition of distilled water on every alternate day by difference in weight.

The treatments included in the incubation study for both the unlimed and limed soils were T_1 = Soil, T_2 = Soil + N at 150 mg kg^{-1}, T_3 = Soil + Mn at 25 mg kg^{-1} and T_4 = Soil + N at 150 mg kg^{-1} + Mn at 25 mg kg^{-1}. All the treatments were replicated thrice.

2 M Kcl solution was employed for extraction of exchangeable NH_4^+ and soluble NO_3– which are together termed as available N and were estimated according to the method of Bremner and Keeney (1966). Among the different fractions of organic N, total hydrolysable organic N, hydrolysable NH_4^+ and amino acid-N were determined by the method of Stevenson 1998. The difference between Total N (excluding exchangeable NH_4^+ and soluble NO_3–) and total hydrolysable organic N was reported in the text as total non-hydrolysable organic N.

Table 2. Changes in the amount (mg kg^{-1}) of available N due to liming and N and Mn application.

Treatment	Liming	Incubation period (days)					Mean
		0	15	45	60	90	
Soil	unlimed	134.33	120.96	118.02	93.82	76.42	108.67
	limed	134.98	117.92	114.40	98.43	77.40	
Soil + N	unlimed	200.08	168.40	150.74	129.79	119.47	153.60
	limed	199.94	165.94	149.36	132.20	120.06	
Soil + Mn	unlimed	131.84	120.31	107.79	98.94	87.84	110.56
	limed	133.33	118.31	110.91	103.66	93.04	
Soil + N + Mn	unlimed	194.68	160.66	120.72	108.64	96.20	136.36
	limed	192.86	155.47	122.72	109.85	101.81	
Statistical calculation		**Incubation**	**Treatment**	**Liming**			
SeM (±)		0.78	0.70	0.49			
LSD (P = 0.05)		2.25	2.01	NS			

Table 3. Changes in the amount of hydrolysable NH_4 (mg kg^{-1}) due to liming and N and Mn application.

Treatment	Liming	Incubation period (days)					Mean
		0	15	45	60	90	
Soil	unlimed	222	216	215	212	209	213
	limed	217	210	209	208	207	
Soil + N	unlimed	241	232	228	227	221	227
	limed	235	226	224	221	216	
Soil + Mn	unlimed	219	217	213	209	208	212
	limed	217	211	208	207	207	
Soil + N + Mn	unlimed	242	231	229	227	224	229
	limed	235	228	227	225	223	
Statistical calculation		**Incubation**	**Treatment**	**Liming**			
SeM (±)		1.13	1.01	0.71			
LSD (P = 0.05)		3.25	2.90	2.04			

RESULTS AND DISCUSSION

Irrespective of treatments, available N decreased with increase in the period of incubation in both the unlimed and limed soil (Table 2). Comparatively, higher amount of available N was accumulated in limed over the unlimed soils, particularly at the later stage of incubation. This is due to higher order of microbial activity in limed than the unlimed soils (Ghosh *et al*. 1989). Data further revealed that 75-85 per cent of the added N was recovered on first day of the incubation. In absence of added inorganic N, application of Mn increased available N in both the unlimed and limed soils at the later period of experiment. However, irrespective of liming and stages of incubation, a completely reverse trend of results was observed in presence of added inorganic N showing a net loss of available N in soils. Present results are in agreement with earlier works (Lie *et al*. 1991).

Like available N, irrespective of liming and treatments, hydrolysable- NH_4^+ and amino acid-N which are the major forms of organic fractions are susceptible to mineralization, decreased with increase in the period of

Table 4. Changes in the amount (mg kg^{-1}) of amino acid N due to liming and N and Mn application.

Treatment	Liming	Incubation period (days)					Mean
		0	15	45	60	90	
Soil	unlimed	329	316	301	296	293	296
	limed	327	316	298	295	290	
Soil + N	unlimed	349	339	330	325	293	333
	limed	348	338	330	322	320	
Soil + Mn	unlimed	327	316	301	297	325	305
	limed	232	314	298	294	291	
Soil + N + Mn	unlimed	349	340	329	325	321	330
	limed	348	335	325	317	315	
Statistical calculation		**Incubation**	**Treatment**	**Liming**			
SeM (±)		5.48	4.90	3.46			
LSD (P = 0.05)		15.78	14.11	NS			

Table 5. Changes in the amount (mg kg^{-1}) of total hydrolysable organic N due to liming and N and Mn application.

Treatment	Liming	Incubation period (days)					Mean
		0	15	45	60	90	
Soil	unlimed	688	673	668	648	637	640
	limed	652	610	622	612	586	
Soil + N	unlimed	791	773	761	751	742	744
	limed	750	739	732	715	690	
Soil + Mn	unlimed	690	673	669	647	639	644
	limed	646	642	632	613	591	
Soil + N + Mn	unlimed	703	683	682	672	666	639
	limed	653	644	643	632	612	
Statistical calculation		**Incubation**	**Treatment**	**Liming**			
SeM (±)		11.61	10.38	7.34			
LSD (P = 0.05)		33.43	29.89	21.13			

Table 6. Changes in the amount (mg kg^{-1}) of total non-hydrolysable organic N due to liming and N and Mn application.

Treatment	Liming	Incubation period (days)					Mean
		0	15	45	60	90	
Soil	unlimed	376	260	257	239	210	265
	limed	353	256	255	236	209	
Soil + N	unlimed	365	394	386	364	302	346
	limed	355	355	341	333	260	
Soil + Mn	unlimed	378	270	265	249	229	273
	limed	353	269	254	246	219	
Soil + N + Mn	unlimed	390	271	260	250	249	275
	limed	344	261	251	240	230	
Statistical calculation		**Incubation**	**Treatment**	**Liming**			
SeM (±)		0.55	0.49	0.34			
LSD (P = 0.05)		1.58	1.41	0.97			

Table 7. Changes in the amount of available Mn (mg kg^{-1}) due to liming and N and Mn application.

Treatment	Liming	Incubation period (days)					Mean
		0	15	45	60	90	
Soil	unlimed	37	33	29	28	23	27
	limed	36	25	22	19	16	
Soil + N	unlimed	37	39	38	37	37	35
	limed	37	36	32	29	26	
Soil + Mn	unlimed	61	54	50	42	36	48
	limed	60	52	47	40	31	
Soil + N + Mn	unlimed	62	69	66	65	63	63
	limed	63	65	63	61	58	
Statistical calculation		**Incubation**	**Treatment**	**Liming**			
SeM (±)		0.067	0.063	0.043			
LSD (P = 0.05)		0.21	0.19	0.13			

investigation (Table 3 and 4). Results further showed that irrespective of treatments and stage of incubation both the hydrolysable-NH_4^+ and amino acid-N decreased in limed than the unlimed soils. Liming creates a favorable environment for microbial activity which caused higher order of mineralization of different forms of organic-N (Table 2) leading to higher amount of accumulation of available N in limed soil (Ghosh *et al*. 1989). Although, addition of N did not influence the transformation of hydrolysable- NH_4^+ but amino acid-N significantly decreased in unlimed situation.

Addition of Mn alone, or in presence of inorganic-N did not affect significantly transformation of both the hydrolysable- NH_4^+ and amino acid fractions of organic-N. Results in Table 5, revealed that irrespective of treatments, total hydrolysable organic-N decreased with increase in the period of incubation. Again, comparatively, higher amount of decrease in total hydrolysable organic-N was recorded in limed over the unlimed soil. It is interesting to note that the

effect of liming on decrease in total hydrolysable organic-N was prominent in both the untreated and treated soil. However, presence of Mn alone or in combination with N did not influenced significantly the transformation of total hydrolysable organic-N in both the limed and unlimed soil. The explanation furnished earlier with respect to effect of liming on decrease in different fractions of organic-N is equally applicable here as well.

Results in Table 6, revealed that irrespective of treatments and stages of incubation, the amount of total non- hydrolysable organic-N decreased with increase in the period of investigation. Presence of inorganic-N accentuates the decrease in total non-hydrolysable organic-N particularly in limed soil. However, addition of N, in presence of Mn did not show any significant change between unlimed and limed situations. Irrespective of treatments, the amount of available Mn decreased with increase in time (Table 7). Comparatively higher amount of decrease in available-N was registered in limed over the unlimed soil. This trend of results was observed in all the treatments under investigation. Critical analysis of the data revealed that higher order of decrease in available Mn was recorded in Mn treated soil. This trend of result was observed for both the unlimed and limed situation. Combined application of inorganic N and Mn did not show any significant change in available form of Mn over the incubation period. The decrease in available Mn in limed soil due to formation of carbonate of Mn (Saha *et al*. 1999).

Liming an acid soil increased available form of N whereas, total hydrolysable and non hydrolysable organic N and as well as available Mn decreased with time. The constituent hydrolysable-NH_4^+ and amino acid forms of organic-N were also found to decrease in limed soil. Combined application of inorganic N and Mn did not influence the transformation of different forms of N in soil.

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Effect of Integrated Nitrogen Management and Irrigation Regimes on Productivity of Mustard (*Brassica juncea* L.)*

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ABSTRACT

The growth and yield attributes *viz*., plant height, plant spread, number of primary and secondary branches, dry matter, number of siliquae and length of siliquae plant^{-1} number of seeds siliquae^{-1}, seed weight plant^{-1}, 1000 seed weight and seed yield (12.43 q ha^{-1}) were increased significantly by integrated application of 75 per cent RDN through urea + 25 per cent N through FYM than rest of treatments. Application of 4 irrigations to *rabi* season mustard at 100 mm CPE recorded significantly higher growth and yield parameters as well as yield of mustard (12.60 q ha^{-1}), where as the highest yield was obtained with combined application of 75 per cent RDN + 25 per cent N through FYM and irrigation at 100 mm CPE.

Key words : Integrated nitrogen management, irrigations regimes, yield, economics and moisture studies.

Indian mustard [*Brassica juncea* (L.) Czernj. and Cosson] is the second most important oilseed crop in India, ranking next to groundnut. Existing levels of mustard productivity (800 kg ha^{-1}) in the state is lower than national (1057 kg ha^{-1}). Several biotic and abiotic stresses lead to low productivity. The productivity of crop is low as it is normally grown on marginal lands with limited irrigation. Thus, only option left is to increase the productivity by better management of limited and costly inputs *viz*., irrigation and fertilizer.

Combined use of organic and inorganic sources of nitrogen increases the production and profitability of field crops and helps in maintaining the fertility status of the soil. Depression in seed yield varied from 22.1 to 36.6 per cent when irrigation was withheld at seedling and flowering stage. The scheduling of irrigation to mustard as per cumulative pan evaporation will be useful to see the response of crop to productivity. Keeping this in view the present experiment was conducted.

* Part of M. Sc. (Agri.) thesis submitted by first author to MPKV, Rahuri.

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MATERIALS AND METHODS

An experiment was conducted in a split plot design with three replications during *rabi* season 2007-08 at Agriculture College, Pune. The soil was clay with pH 7.6, organic carbon 0.42 per cent, bulk density 1.21 g cm^{-3}, the field capacity 36.07 per cent, permanent wilting point 18.45 per cent, available N, P and K content in soil was 143, 16.5 and 416 kg ha^{-1} respectively. The treatments comprised of four integrated nitrogen combinations *viz*., 100 per cent RDN through urea, 75 per cent RDN through urea + 25 per cent N through FYM, 50 per cent RDN through urea + 50 per cent N through FYM and 25 per cent RDN through urea + 75 per cent N through FYM and five irrigation schedules *viz*., irrigation scheduled at 60, 80, 100 and 120 mm CPE and at critical growth stages (Branching, flowering and siliquae formation). The sowing of mustard variety Varuna was done on 12th November, 2007 at 45 x 15 cm spacing with common post sowing irrigation and harvested on 28th February, 2008. The recommended dose 50 : 75 kg N : P_2O_5 ha^{-1} and irrigation were applied to mustard as per treatments.

RESULTS AND DISCUSSION

Integrated nitrogen management : Growth parameters (Table 1) were significantly influenced by different INM treatments. The treatment comprising 75 per cent RDN through urea + 25 per cent N through FYM recorded significantly the highest plant height (160.15 cm), plant spread (81.76 cm), number of primary(8.24) and secondary branches (12.36) and dry matter (47.40 g) $plant^{-1}$ than rest of the treatments however primary and secondary branches $plant^{-1}$ were at par with application of 50 per cent RDN + 25 per cent N (FYM), respectively. Similarly the yield parameters (Table 2) *viz*., number of siliquae $plant^{-1}$ (238), length of siliquae, (5.45cm) number of seeds $siliquae^{-1}$ (12.05), weight of seeds $plant^{-1}$ (8.65 g) and 1000 seed weight (5.03 g) were significantly increased due to application of 75 per cent RDN through urea + 25 per cent N through FYM as compared to

Table 1. Growth parameters of mustard as influenced by integrated nitrogen management and irrigation regimes.

Treatments	Plant height (cm)	Plant spread (cm)	Primary branches $plant^{-1}$	Secondary branches plant-1	Dry matter $plant^{-1}$ (g)
Integrated nitrogen management :					
100% RDN	148.12	74.12	7.47	11.01	41.08
75% RDN + 25% N (FYM)	160.15	81.76	8.24	12.36	47.40
50% RDN + 50% N (FYM)	157.49	79.76	8.08	11.84	45.99
25% RDN + 75% N (FYM)	134.73	67.83	7.07	10.11	36.53
S. E. ±	0.42	0.18	0.16	0.32	0.22
C. D. at 5%	1.46	0.62	0.55	1.10	0.74
Irrigation regimes (mm CPE) :					
60	149.34	75.27	7.30	10.63	42.11
80	149.41	75.41	7.48	11.18	42.63
100	151.53	76.27	8.18	11.77	43.27
120	149.70	76.17	7.60	11.45	42.74
At critical growth stages	150.61	76.22	8.00	11.62	43.02
S. E. ±	0.54	0.23	0.15	0.08	0.25
C. D. at 5%	1.55	0.65	0.43	0.24	0.73

other INM treatments however, siliquae, and seed weight per plant were at par with application of 50 per cent RDN + 50 per cent N (FYM), respectively. This could be attributed to better development of roots and increased microbial activities because of balanced nutritional environment probably both in soil rhizosphere and plant system which consequently enhanced values of yield attributes. Significantly higher seed yield (12.43 q ha^{-1}) over other treatments were recorded by application of 75 per cent recommended dose of nitrogen (40 kg N ha^{-1}) + 25 per cent N through FYM. Overall increase in seed yield was 15 per cent over 100 per cent RDN. This could be owing to beneficial effect on yield attributes of mustard which in turn resulted in higher seed yield. Similar trend was observed in oil content (39.11 %). Mishra *et al*. (2006) also reported that for obtaining higher yield of basmati rice with lesser investment 25 per cent of RDN should be supplemented through FYM in addition to the 75 per cent nitrogen through urea was significant. This emphasized the need of organic manuring along with chemical fertilizer. Application of 75 per cent N through urea + 25 per cent N through FYM showed their significant superiority in increasing seed yield (12.43 q ha^{-1}) than rest of treatments.

Irrigation regimes : Irrigation regimes had significant effect on growth, yield and yield attributes. Irrigation applied at 100 mm CPE recorded significantly higher values of growth attributes (Table 1) like plant height (151.53 cm), plant spread (76.27 cm), number of primary (8.18) and secondary branches (11.77) and dry matter $plant^{-1}$ (43.27 g) and all yield contributing characters (Table 2) like number of siliquae $plant^{-1}$ (224.33), length of siliquae

Table 2. Yield, yield parameters and economics of mustard as influenced by integrated nitrogen management and irrigation regimes.

Treatments	Siliquae $plant^{-1}$	Length of siliq-uae (cm)	Seeds siliq-uae^{-1}	Seed weight $plant^{-1}$ (g)	1000 seed weight (g)	Seed yield (q ha^{-1})	Oil (%)	Cost A (Rs. ha^{-1})	Gross mone-tary returns (Rs. ha^{-1})	Net mone-tary returns (Rs. ha^{-1})	B : C ratio
Integrated nitrogen management :											
100% RDN	205.20	4.53	11.47	7.42	4.36	10.80	38.16	13167	26988	13820	2.06
75% RDN + 25% N (FYM)	238.00	5.45	12.05	8.65	5.03	12.43	39.11	13911	31068	17156	2.24
50% RDN + 50% N (FYM)	228.33	5.03	11.64	8.23	4.75	11.15	38.91	14506	27875	13369	1.93
25% RDN + 75% N (FYM)	187.80	4.37	10.59	5.97	3.66	8.36	37.65	15006	20893	5886	1.40
S. E. ±	2.98	0.05	0.20	0.18	0.02	0.20	0.19	-	500.60	500.50	0.03
C. D. at 5%	10.30	0.16	0.71	0.61	0.06	0.69	0.66	-	1732.38	1732.04	0.12
Irrigation regimes (mm CPE) :											
60	207.25	4.71	10.32	6.12	3.79	9.43	38.04	14867	23583	8715	1.59
80	209.50	4.76	10.53	6.92	4.16	9.69	38.33	14441	24233	9791	1.69
100	224.33	4.98	13.63	9.20	4.93	12.60	38.68	14164	31510	17346	2.24
120	214.50	4.87	11.15	7.51	4.46	10.49	38.60	13613	26231	12617	1.94
At critical growth stages	218.58	4.91	11.55	8.07	4.90	11.19	38.64	13615	27972	14321	2.06
S. E. ±	0.88	0.06	0.33	0.22	0.10	0.21	0.16	-	523.78	523.55	0.03
C. D. at 5%	2.54	0.17	0.94	0.63	0.30	0.60	0.46	-	1508.90	1508.23	0.10

plant^{-1} (4.98 cm), number of seeds plant^{-1} (13.63), seed weight plant^{-1} (9.20 g) and thousand seed weight (4.93 g) than other irrigation regimes, however, plant spread, dry matter and length of siliquae plant^{-1}, was at par with 120 mm CPE, respectively. Highest seed yield (12.60 q ha^{-1}) was obtained with irrigation applied at 100 mm CPE being 12.60 and 20.11 per cent higher than irrigation applied at CGS and 120 mm CPE. More over better nutrient uptake with timely irrigation might have also contributed indirectly towards better growth and yield. The per cent oil content in seed was also higher at 100 mm CPE. Siag and Verma (1990) reported that yields of mustard were similar to the treatments receiving irrigations at 100 mm CPE and at CGS.

The increase in seed yield at 100 mm CPE may be attributed to timely and adequate moisture availability which helped in proper utilization of nutrients and also better formulation and accumulation of photosynthets. The results support the findings of Bandopadhyay (1997) and Mishra *et al*. (2004).

Interaction : Integrated nitrogen management and irrigation regimes interacted significantly in respect of seed yield of mustard (Table 3). Application of 75 per cent nitrogen through urea + 25 per cent N through FYM with irrigation applied at 100 mm CPE recorded significantly higher seed yield (14.40 q ha^{-1}) than rest of combinations. However, it was at par with 100 per cent RDN with same level of irrigation (13.82 q ha^{-1}). Crop responses to applied nitrogen depends on moisture supply, because it increases the availability, absorption and utilization of nitrogen by plant which results in greater photosynthesis and thereby better crop growth rate. Consequently the highest seed yield was obtained when irrigation released at 100 mm CPE with application of 75 per cent RDN through urea + 25 per cent N though FYM. Similar trends were also reported by Pramanik *et al.* (1995) and Kanungo and Mahapatra (2002) in Patchouli during dry season.

Table 3. Interaction effect of integrated nitrogen management and irrigation regimes on seed yield (q ha^{-1}) of mustard.

Irrigation regimes	Integrated nitrogen management			
	100% RDN	75% RDN + 25% N (FYM)	50% RDN + 50% N (FYM)	25% RDN + 75% N (FYM)
60 mm CPE	8.58	11.01	10.80	7.34
80 mm CPE	9.78	11.66	10.03	7.30
100 mm CPE	13.82	14.40	12.59	9.60
120 mm CPE	9.97	12.61	11.00	8.39
At critical growth stages	11.82	12.45	11.33	9.16
S. E. ±	0.42	-	-	-
C. D. at 5%	1.21	-	-	-

Table 4. Effect of Irrigation regimes on Irrigation depth. CU, WUE and moisture use rate.

Irrigation regimes	Irrigations	Depth of irrigation (mm ha^{-1})	CU (mm)	WUE (kg ha^{-1} mm)	Moisture use rate day^{-1}
60 mm CPE	6	384.9	354.11	2.66	3.25
80 mm CPE	5	333.2	300.00	3.23	2.75
100 mm CPE	4	280.5	230.01	5.48	2.11
120 mm CPE	3	227.7	193.55	5.42	1.78
At critical growth stages	3	227.9	186.90	5.99	1.71

Economics : The gross and net monetary returns as well as benefit : cost ratio were influenced significantly due to integrated nitrogen management (Table 2). The application of nitrogen through FYM exhibited higher cost of production with increase in level of nitrogen through FYM. The application of 75 per cent RDN + 25 per cent N through FYM registered significantly higher gross

monetary returns (Rs. 31068 ha^{-1}), net monetary returns (Rs. 17156 ha^{-1}) and benefit: cost ratio (2.24) than rest of treatments. The application of 100 per cent nitrogen through urea ranked second in terms of net monetary returns and benefit : cost ratio, and it was at par with application of 50 per cent nitrogen each through fertilizer and FYM. Similar results were recorded by Wagh (2002) and Mishra *et al*. (2006).

Scheduling of irrigation at 100 mm CPE gave significantly the highest gross (Rs. 31510 ha^{-1}) and net monetary returns (Rs. 17346 ha^{-1}) with more benefit: cost ratio (2.24), than rest of irrigation regimes. The cost of production decreased with increase in CPE and it was lowest in irrigation scheduled at 120 mm CPE (Rs. 13613 ha^{-1}). The irrigation released at CGS ranked second in order of economics. Thus application of irrigation at 100mm CPE to mustard was found much economical as compared to other irrigation treatments. Singh *et al*. (2001) reported that gross and net returns in mustard obtained with 2 irrigations were statistically at par with 3 irrigations. Similar findings were also reported by Chauhan *et al*. (2002).

Moisture studies : The depth of irrigation was highest when water applied at 60 mm CPE (384.9 mm ha^{-1}) and lowest at 120 mm CPE (227.7 mm ha^{-1}). The highest CU of water and WUE was recorded when 3 irrigations were applied at CGS of mustard at branching (27 days), flowering (52 days) and siliquae formation (77 days) and values were 186.9 mm and 5.99 kg ha^{-1} -mm. Irrigation applied at CGS of crop recorded higher WUE (5.99 kg ha^{-1} -mm) than rest of irrigation regimes which was closely followed by 100 mm CPE (5.48 kg ha^{-1} -mm). Bhalerao (2001) and Singh *et al*. (2001) found that consumptive use was progressively increased with increase in irrigation levels but reverse trend was observed in water use efficiency (WUE). Rate of moisture used was higher under the treatment of CGS.

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Effect of Organic and Inorganic Sources of Nutrients on Growth and Flower Quality of Hybrid Tea Rose cv. Gladiator

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ABSTRACT

The treatment 50 per cent RDF + 50 per cent vermicompost was found with highest plant height, number of shoots, length and diameter of flowering shoot, number of leaves, leaf area, spread of plant and lowest number of blind shoots. The flower quality was also found significantly superior with same treatment *viz*., length and diameter of flower bud, weight of flower, petals of flower and longivity of flower on plant. Lowest growth and quality of flower were recorded in treatment 100 per cent RDF alone (control).

Key words : Organic, inorganic, growth, quality, rose.

Maharashtra is a leading state in rose production. Roses are grown particularly in Nasik, Pune, Sangli, Ahmednagar, Nagpur, Aurangabad and some part of Marathwada region. The area under rose cultivation in Marathwada is negligible. So demand of the flower of this region is fullfilled from rest of the Maharashtra. In order to expand the area under rose cultivation and to promote the farmers towards the rose farming, an experiment was planned on the effect of organic and inorganic sources of nutrients on growth and flower quality of hybrid tea rose cv. Gladiator.

MATERIALS AND METHODS

The present investigation was undertaken at Department of Horticulture, Marathwada Agricultural University, Parbhani during 2006-2007. The experiment was laid out in a randomized block design having three replications on rose cv. Gladiator along with seven treatments. The treatment consisted of T_1 - 100 % recommended dose of fertilizer (RDF) as control, T_2 - 75 % RDF + 25 % vermicompost, T_3 - 50 % RDF + 50 % vermicompost, T_4 - 75 % RDF + 25 % FYM, T_5 - 50 % RDF + 50 % FYM, T_6 - 75 % RDF + 25 % poultry manure, T_7 - 50 % RDF + 50% poultry manure. The recommended dose of inorganic fertilizer as per M.A.U. Parbhani is 14 g N, 10 g P_2O_5 and 10 g K_2O plant^{-1}. Organic manures were applied 2 to 3 days after pruning in the month of December. Manures were well incorporated and then covered with soil. Full dose of manure was applied as a basal dose. The uniform framework of rose plant was maintained by light pruning carried out in December keeping the uniform height of 45cm above ground level. Flat bed had a plot size of 23.04 m^2. One year old rose plants cv. Gladiator were selected for investigation. Twenty one individual plots with a spacing of 1.2 x 1.2 m size were demarcated in experimental field leaving 1 m distance between two treatments and two replications. Regular weeding was carried out. Irrigations were given to the plots at an interval of 8-10 days. The pests *viz.* thrips, jassids, white ants, leaf eating caterpillars noticed on the crop were

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controlled effectively by application of 0.05 per cent quinolphos and disease i.e. powdery mildew was controlled by spraying 80 per cent wettable sulphur. Five plants were taken in each treatment in each replication for recording the data. Flowers were harvested at tight bud stage after the sepals curled back and outer one or two petals just started to unfold. Observations on growth and flower quality of rose cv. Gladiator were recorded. Statistical analysis of the data was carried out by the methods suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect on growth attributes : From the data recorded in Table 1, at 120 days after pruning showed maximum plant height in treatment T_3 (124.60cm) followed by T_7 (123.60cm), T_6 (122.90cm), T_2 (122.5cm) and T_5 (122.16cm). The lowest plant height (117.70 cm) was observed at treatment T_1 (control). The combined application of manures and fertilizers showed significant effect on plant height. These results obtained might be due to supply of an adequate nutrients to the plants during its growth period, because organic matter has the property to release the nitrogen slowly which may be taken up by the plants as per their requirements. Similar results were obtained by Nethra *et al.* (1999) and Hidalgo and Harkess (2002).

The highest number of shoots (13.24) were observed in treatment T_3 (50 % RDF + 50% vermicompost) and found superior over all other treatments, whereas treatments T_7 (12.47) and T_6 (12.45) were found at par with each other. Lowest number of shoots were recorded in treatment T_1 (100% RDF) with 11.12 shoots plant^{-1}. Similar results were also obtained by Nethra *et al.* (1999) on China aster.

Maximum length of flowering stem (68.35cm)was observed in treatment T_3 however, minimum length of flowering stem was found with treatment T_1 (62.19 cm). Data in respect of diameter of flowering stem showed statisfically significant results. The maximum diameter of flowering stem .was found in the treatment T_1 (5.2 cm), where as the treatment T_3 (4.76 cm) recorded minimum diameter of the flowering stem. Maximum stem length may be due to the availability and gradual release of the required micro and macro

Table 1. Effect of organic and inorganic sources of nutrients on gorwth of hybrid tea-rose cv. Gladiator.

Treatment	Plant height (cm)	Shoot plant^{-1}	Stem length (cm)	Diameter of flowering stem (cm)	Blind shoots	Leaves flowering stem^{-1}	Leaf area flowering stem^{-1}	Plant spread (cm^2)
T_1 - 100% RDF (control)	117.70	11.12	62.19	5.20	1.30	42.60	90.67	81.78
T_2 - 75% RDF + 25% vermicompost	122.50	12.21	66.54	4.93	0.80	44.23	95.17	93.24
T_3 - 50% RDF + 50% vermicompost	124.60	13.24	68.35	4.76	0.60	46.43	98.59	95.24
T_4 - 75% RDF + 25% FYM	120.40	11.27	63.85	4.99	1.00	43.50	92.31	82.14
T_5 - 50% RDF + 50% FYM	122.16	11.34	64.16	4.95	1.10	43.80	93.42	87.36
T_6 - 75% RDF + 25% poultry manure	122.90	12.45	67.27	4.80	1.0	44.36	95.74	89.93
T_7 - 50% RDF + 50% poultry manure	123.60	12.47	67.75	4.80	1.0	44.43	97.42	91.14
S. E. ±	0.66	0.01	0.01	0.01	0.2	0.05	0.07	0.12
C. D. at 5%	1.99	0.03	0.04	0.03	NS	0.16	0.22	0.38

All figures in the table are average.

nutrients through different sources of manures. Similar results were noticed by Nethra *et al*. (1999) and Hidalgo and Harkess (2002).

The mimimum number of blind shoots plant^{-1} (0.6) were observed in treatment T_3 (50% RDF + 50 % vermicompost) whereas maximum (1.3) in treatment T_1 (control). Similar findings were noticed by Bano (1998).

The treatment T_3 (46.43) was found significantly superior in respect of average number of leaves per flowering stem over rest of the treatments, lowest number of leaves were recorded at treatment T_1 (42.60) i.e. control. Similarly maximum leaf area was recorded in treatment T_3 (98.59 cm^2) followed by treatment T_7 (97.42 cm^2) which were found at par with each other whereas, minimum leaf area was recorded at the treatment T_1 (90.67 cm^2). All the above results were in accordance with the results obtained by Jagannath (1998) in china aster and Salial.

The treatment T_3 (95.24 cm^2) was found significantly superior in spread of the plant over rest of the treatments. Whereas, the treatment T_1 (control) recorded minimum spread of the plant i.e. 81.78 cm^2. Similar results were noted by Jagannath (1998) in Salial and Bano (1998) in China aster.

Effect on flower quality attributes : From the data recorded in Table 2, it was revealed that maximum length (7.93 cm) and diameter of flower bud (7.06 cm) was found in the treatment T_3 (50 % RDF + 50 % vermicompost). Whereas, minimum length (6.77cm) and diameter (5.36 cm) of flower bud was found with treatment T_1 (control). The results obtained may be due to the continuous supply of micro and macro nutrients to the plants. The similar results were recorded by Atiyeh *et al*. (2002).

Period of just opening of flower bud to shedding of petals was recorded under each treatment and averages were worked out. The significantly more longivity of flower (21.14 days) was recorded under treatment T_3 (50 % RDF + 50 % vermicompost) followed by treatment T_2 (20.93 days) and T_7 (18.24 days). Whereas, the short period of longivity was recorded (14.25 days) at the treatment T_1 (control). The similar results were also reported by Nethra *et al*. (1999).

The treatment T_1 (74.18) was found significantly superior in respect of number of petals flower^{-1} over rest of the Treatments, whereas the treatment T_1 (control) showed lowest number of petals flower^{-1} (52.54). From

Table 2. Effect of organic and inorganic sources of nutrients on quality of hybrid tearose cv. Gladiator.

Treatment	Length of flower bud (cm)	Diameter of flower bud (cm)	Longivity of flower (days)	Petals flower^{-1}	Weight of flower (g)
T_1 - 100 % RDF (control)	6.77	5.36	14.25	52.54	25.19
T_2 - 75% RDF + 25% vermicompost	7.69	7.06	20.93	72.28	32.48
T_3 - 50% RDF + 50% vermicompost	7.93	7.06	21.14	74.18	34.93
T_4 - 75% RDF + 25% FYM	7.27	5.76	16.12	56.79	27.12
T_5 - 50% RDF + 50% FYM	7.34	5.93	16.78	58.14	28.34
T_6 - 75% RDF + 25% poultry manure	7.46	6.03	17.31	63.27	30.78
T_7 - 50% RDF + 50% poultry manure	7.64	6.33	18.24	65.75	31.16
S. E. $\pm$	0.01	0.01	0.02	0.22	0.02
C. D. at 5%	0.05	0.04	0.05	0.65	0.05

All figures in the table are average.

the above results, it was noticed that application of manures in combination with inorganic fertilizers showed significant results. These results are in accordance with Barreto *et al.*, (2002).

Maximum weight of flower (34.93 g) was found in the treatment T_3 (50% RDF + 50% vermicompost). However, treatment T_1 (control) was found with the lowest weight of the flower (25.19 g). Hidalgo and Harkess (2002), also observed similar results.

Thus, it may be concluded that the treatment 50 per cent RDF + 50 per cent vermicompost was found with highest growth and quality charecters of hybrid tea rose cv. Gladiator.

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Integrated Nutrient Management in Chickpea-Safflower Crop Rotation under Rainfed Conditions

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ABSTRACT

The pooled data of six years revealed that the application of 100 per cent N + 50 per cent P + PSB to chickpea preceding with safflower receiving 100 per cent NP recorded the highest seed yield, gross monetary returns and B:C ratio of chickpea, while the application of 100 per cent N + 50 per cent P + PSB to chickpea preceding with safflower receiving 100 per cent N + 50 per cent P + PSB gave the highest net monetary returns of chickpea. In safflower, application of 100 per cent NP recorded significantly highest seed yield than the rest of the treatment and it was on par with 50 per cent NP + *Azotobacter* + PSB culture to safflower preceding with chickpea receiving 100 per cent N +50 per cent P + PSB. The application of 100 per cent NP to safflower preceding with chickpea receiving 100 per cent NP gave highest gross returns of safflower but the net monetary returns and B:C ratio of safflower was high in application of 100 per cent NP to safflower preceding with chickpea receiving 100 per cent N +50 per cent P +PSB followed by 50 per cent NP to safflower preceding with chickpea receiving 50 per cent NP. The 100 per cent NP to both safflower preceding with chickpea recorded significantly high safflower equivalent yield followed by 50 per cent NP + *Azotobacter* + PSB culture to safflower preceding with chickpea receiving 100 per cent N + 50 per cent P +PSB and 100 per cent NP to safflower preceding with chickpea receiving 100 per cent N + 50 per cent P +PSB.

Key words : Safflower, chickpea, *Azotobacter*, *Azospirillum*, PSB culture, B:C ratio, safflower equivalent yield.

In rainfed farming, intercropping provides an insurance against total crop failures and helps in maximization of system productivity and efficient use of applied nutrients and application of biofertilizer improves the N availability to safflower (Reddy *et al*. 1994). The use of costly chemical fertilizers can be minimized or replaced with cheaper bio-fertilizers and locally available organic manures *viz*. FYM or compost (Hegde, 1998). The information pertaining to the effect of organic manures and inoculation of biofertilizers (*Azospirillum*, *Azotobacter* and phosphorus solubilizing bacteria) either alone or in combination with each other as well as inorganic fertilizers on oilseed crops is very meagre. Thus, the present study was conducted with the objective of integrated use of different sources of plant nutrients for safflower based cropping system to economize inorganic fertilizer use and sustain the productivity.

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MATERIALS AND METHODS

Field experiment was conducted at Agriculture Research Station, Mohol during rabi season 2000-01 to 2006-07 in vertisol under rainfed condition. The soil was low in available N (180 kg ha^{-1}), medium in available P (14 kg ha^{-1}) and high in available K (680 kg ha^{-1}) with pH 7.6. The twelve treatments consisted of various nutrient combinations as shown in Table-1 were tested in a randomized block design with two replications. Nitrogen was given through urea and DAP

while phosphorus through single super phosphate and DAP as per the treatments. The microbial cultures *viz*. *Azotobacter*, *Azospirillum* and PSB were inoculated to seed just before sowing @ 250 g 10^{-1} kg. All the fertilizers were applied as basal dose as per the treatment. The treatment sites were fixed for all the years. The experimental sites were kept fallow during *kharif* season and *in-situ* moisture conservation practices were carried out. The chickpea-safflower rotation was followed. The recommended safflower variety Bhima and chickpea variety Vishal were used. The sowing was completed at recommended time. The pooled analysis for seed yield and its economics was worked out. Safflower equivalent yield was calculated based upon market price of safflower and chickpea every year and statistically analyzed. Safflower oil content from each treatment was estimated in NMR. The safflower oil yield based upon safflower equivalent seed yield was calculated for each treatment.

RESULTS AND DISCUSSION

The pooled data of six years revealed that, the seed yield of chickpea, safflower, safflower equivalent yield and economics were significantly influenced by integrated nutrient management treatments under dry land conditions.

Chickpea : The treatment differences were found to be statistically significant (Table-1). The application of 100 per cent N + 50 per cent P + PSB to chickpea preceding with safflower receiving 100 per cent NP recorded highest seed yield of chickpea (1316 kg ha^{-1}) followed by the application of 100 per cent N + 50 per cent P + PSB to chickpea preceding with safflower receiving 50 per cent NP + PSB + Azp + Asp (1291 kg ha^{-1}). The treatments were statistically significant over control treatment (No NP) and with 50 per cent NP application to chickpea while it was at par with rest of the treatments i.e. treatment combinations with recommended dose of

Table 1. Effect of integrated nutrient management on seed yield and oil yield in safflower based cropping systems (Pooled mean of six year).

Chickpea	Safflower	Seed yield (kg ha^{-1})		Saff-lower oil content (%)	Saff-lower oil yield (kg ha^{-1})	Safflower equivalent yield (kg ha^{-1})
		Chickpea	Safflower			
No NP	No NP	787	764	28.8	220.0	1762
50% NP	50% NP	978	1072	29.5	316.2	2256
50%NP	100% NP	1083	1241	30.1	373.5	2567
100% NP	50% NP	1303	1084	29.8	323.0	2627
100% NP	100% NP	1268	1261	31.1	392.2	2787
100% NP	50% N + 100% P	1252	1094	30.0	328.2	2642
100% NP	Azp / ASP + 100% P	1214	1000	29.8	298.0	2510
100% NP	50% N + Azp / ASP + 100% P	1251	1089	30.0	326.7	2563
100% NP	Azp / ASP + PSB	1263	925	29.1	269.2	2449
100% NP	50% NP + Azp / ASP + PSB	1245	1060	29.7	314.8	2620
100% N + 50% P + PSB	100% NP	1316	1202	29.5	354.6	2698
100% N + 50% P + PSB	50% NP + Azp / ASP + PSB	1291	1181	30.1	355.5	2747
S. E. ±		33	34			49
C. D. at 5%		93	97			140
C. V.		10	11			8.40

chickpea. The similar trend was also observed in economics of chickpea (Table-2). The application of 100 per cent N + 50 per cent P + PSB to chickpea preceding with safflower receiving 100 per cent NP gave the highest gross monetary return of chickpea (Rs. 21609 ha^{-1}) while application of 100 per cent N + 50 per cent P + PSB to chickpea preceding with safflower receiving 50 per cent NP + Azp/Asp + PSB recorded the highest net monetary returns of chickpea (Rs. 9943 ha^{-1}) and B:C ratio (1.88). The low cost of cultivaton (Rs. 11255 ha^{-1}) might be due to the saving of 50 per cent NP as compared to the treatment of application of 100 per cent N + 50 per cent P + PSB to chickpea preceding with safflower receiving 100 per cent NP.

Safflower : The treatment differences were observed to be statistically significant. (Table-1). The application of 100 per cent NP to safflower preceding with chickpea receiving 100 per cent NP recorded significantly highest seed yield of safflower (1261 kg ha^{-1}) but it was at par with application of 100 per cent NP to safflower preceding with chickpea receiving 50 per cent NP (1241 kg ha^{-1}), 100 per cent NP to safflower preceding with chickpea receiving 100 per cent N, 50 per cent P + PSB (1202 kg ha^{-1}) and application of 50 per cent NP, *Azotobacter* + PSB culture to safflower preceding with chickpea receiving 100 per cent N + 50 per cent P + PSB (1181 kg ha^{-1}). Similar results were reported by Khadnse *et al.* (1991) and Sudhakar and Sudha Rani (2007).

The safflower oil content and oil yield was also influenced by the various integrated nutrient management treatments (Table-1). The application of 100 per cent NP to safflower preceding with chickpea receiving 100 per cent NP gave highest oil content and oil yield (31.1 % and 392 kg ha^{-1} respectively), which was followed by T_3 (30.11 and 373.5 kg ha^{-1}). The economics of safflower also influenced by various integrated nutrient management treatments (Table-2). The application of 100 per cent NP to safflower

Table 2. Effect of integrated nutrient management on economics of safflower based cropping system. (Av. of six year).

Treatment		Gross returns (Rs. ha^{-1})		Cost of cultivation (Rs. ha^{-1})		Net returns (Rs. ha^{-1})		B:C ratio		Combine system B:C ratio
Chickpea	Safflower	Chickpea	Safflower	Chickpea	Safflower	Chickpea	Safflower	Chickpea	Safflower	
00 NP	00 NP	12266	10826	9327	6817	2939	4009	1.31	1.58	1.44
50% NP	50% NP	16059	15190	10518	8319	5541	6871	1.52	1.82	1.67
50%NP	100% NP	17783	17585	11738	8750	6045	8835	1.51	2.00	1.75
100% NP	50% NP	21395	15360	11786	8184	9609	7176	1.81	1.87	1.84
100% NP	100% NP	20821	17868	11788	9113	9033	8755	1.76	1.96	1.86
100% NP	50% N + 100% P	20558	15501	11821	8112	8737	7389	1.73	1.91	1.82
100% NP	Azp / ASP + 100% P	19934	14170	11634	7513	8300	6657	1.71	1.88	1.79
100% NP	50% N + Azp / ASP + 100% P	20542	15431	11730	8441	8812	6990	1.75	1.82	1.78
100% NP	Azp / ASP + PSB	20740	13107	11769	6922	8971	6185	1.76	1.89	1.82
100% NP	50% NP + Azp / ASP + PSB	20442	15020	11895	8144	8547	6876	1.72	1.84	1.78
100% N + 50% P + PSB	100% NP	21609	17032	11718	8019	9891	9013	1.84	2.12	1.98
100% N + 50% P + PSB	50% NP + Azp / ASP + PSB	21198	16734	11255	8417	9943	8317	1.88	1.98	1.93

preceding with chickpea receiving 100 per cent NP gave highest gross returns (Rs 17868 ha^{-1}) than the other treatments but the net monitory returns and B:C ratio was high in 100 per cent NP to safflower preceding with chickpea receiving 100 per cent N +50 per cent P + PSB (Rs. 9013 ha^{-1} and 2.12 respectively) followed by 100 per cent NP to safflower preceding with chickpea receiving 50 per cent NP (Rs. 8835 ha^{-1} and 2.00 respectively).

Safflower equivalent yield : The safflower equivalent yield of chickpea - safflower year to year crop rotation cropping system significantly influenced by different INM treatments (Table-1). The application of 100 per cent NP to safflower preceding with chickpea receiving 100 per cent NP recorded significantly high safflower equivalent yield (2787 kg ha^{-1}) followed by 50 per cent NP + *Azotobacter* + PSB culture to safflower preceding with chickpea receiving 100 per cent N + 50 per cent P + PSB (2747 kg ha^{-1}) and 100 per cent NP to safflower preceding with chickpea receiving 100 per cent N + 50 per cent P + PSB (2698 kg ha^{-1}). These treatments were on par with each and significant over rest of the treatments. The combine system B:C ratio was highest in application of 100 per cent N + 50 per cent P + PSB to chickpea with safflower receiving 100 per cent NP (1.98) followed by application of 100 per cent N+ 50 per cent P + PSB to chickpea preceding with safflower receiving 50 per cent NP + Azp/Asp + PSB (1.93).

In the chickpea - safflower year to year crop rotation, highest seed yield was obtained by applying the recommended dose of fertilizers. However, in INM of 100 per cent N +50 per cent P + PSB to chickpea preceding with safflower receiving 50 per cent recommended NP + *Azotobacter/Azospirillum* + PSB was found economical. This might be due to the application of *Azotobacter* and *Azospirillum* which can fix 10 to 40 kg N ha^{-1} in soil (Subba Rao, 1981) and PSB can contribute about 50 per cent of P (30 kg P_2O_5) to most oilseed crops (Prabhakara Rao *et al*. 2007). There is saving of 50 per cent P in chickpea and 50 per cent NP in Safflower. Hence, for saving of NP, the application of 50 per cent recommended NP + biofertlizers (*Azotobacter*, *Azospirillum*, PSB culture) should be given in chickpea - safflower year to year rotation under rainfed conditions.

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Effect of Chemicals on Uniform Flowering, Yield and Quality of Mango cv. Alphonso

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ABSTRACT

The treatment KNO_3 @ 3 per cent recorded significantly maximum number of fruit set panicle^{-1} (21.44 fruits) followed by thiourea @ 0.25 per cent (18.66 fruits) and KNO_3 @ 5 per cent (17.36 fruits) per panicle which were on par in pooled mean. The maximum yield was observed in the treatment KNO_3 @ 3 per cent (3.71 t ha^{-1}) followed by thiourea @ 0.25 per cent (3.47 t ha^{-1}). The maximum acidity was found in treatment KNO_3 @ 3 per cent (0.50 per cent). Significantly maximum ascorbic acid was found in the treatment, Thiourea @ 0.50 per cent (68.52 mg 100^{-1} g) followed by KNO_3 at the rate of 3 per cent (67.82 mg 100^{-1} g). Significantly maximum β-carotene was observed in NH_4NO_3 @ 3 per cent treatment (15651.25 µg 100^{-1} g) followed by thiourea @ 0.25 per cent and 0.50 per cent (15621.04 and 14495.54 µg 100^{-1} g) and were on par.

Key words : Chemical, mango, bud break, flowering, yield, and quality.

Mango, (*Mangifera indica* L.), is one of the most celebrated tropical fruits. Alphonso is the leading commercial cultivar of mango in the Konkan region having great demand for export market owing to its typical sugar-acid blend, attractive pulp and fruit color without fiber, with long keeping quality. However, it has serious drawback of irregular bearing habit, poor sex ratio, poor pollination, more flowering flushes in a season, poor fruit set and fruit retention resulting low productivity and existence of spongy tissue on ripening. Chacko (1991) reported that, the flowering in mango is still an enigma, because of many biological and chemical factors are correlated with the process. The buds of mango tree undergo a short rest period after each flush of the growth (Tongumpai *et al*. 1996). The dormant bud may be broken by treating the plant with KNO_3. The result of pp333 at 15 g a.i. induced good yield. Similarly with KNO_3 at 36 g l^{-1} gave more yield (Sergent *et al*. 1996). Ataide and Sao Jose (2000) reported that, 3 per cent KNO_3 gave the higher yield in cv. Tomy Atkins. Perez-Barraza *et al*. (2000) studied the effect of three flowering chemicals, flowering promoters on the time of inflorescence initiation in apical bud of the Tomy Atkins mango. There was early flowering initiation only in pp333 treated plants but NH_4NO_3 and ethrel were found to be ineffective. Suresh Kumar *et al*. (2003) reported that spraying of 1 per cent KNO_3, produced early flowering (148.92 days) as compare to control (172.5 days).

MATERIALS AND METHODS

The experiment was conducted in a randomized block design with ten treatments and three replications with a single tree unit^{-1} treatment. Spraying of chemicals *viz*. Thiourea (@ 0.25,0.50 and 0.75%), Potassium Nitrate (KNO_3 @ 1, 3 and 5%) and Ammonium Nitrate (NH_4NO_3 1, 2 and 3%) were done during 15th, 30th Oct., 15th and 30th Nov. All the recommended cultural practices such as application of growth retardant, fertilizer and

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plant protection measures were adopted during the course of experimentation.

RESULTS AND DISCUSSION

Flowering flushes : It was observed from the Table 1 that, during first year only one flowering flush was observed except in control where two flowering flushes were noticed. During second year of experimentation similar results were observed. During first year of experimentation application of NH_4NO_3 at all concentrations gave earlier flowering by 7 days over control followed by thiourea at all concentrations by 5 days earlier, while in case of KNO_3 at all concentrations only 3 days earlier flowering was observed than control. Similar trends were recorded during second year only the earliness period was maximum over control. Application of NH_4NO_3 recorded 15 days thiourea by 12 days and KNO_3 by 10 days earlier flowering at all concentrations over control. This could be due to the chemicals that changed carbohydrate occurred during inflorescence development. Pandey, (1988) and Nartvaranan *et al*. (1998) reported that flowering flush can probably be accomplished urea spray. The chemicals like KNO_3, NH_4NO_3 and thiourea play a role in maintaining the C:N ratio thereby favoring the flower bud differentiation.

Flowering behaviors : The per cent male and hermaphrodite flowers were not found to differ significantly as observed from the data presented in Table 2 during both the years of experimentation as well as in pooled mean. The sex ratio i.e. male to hermaphrodite flowers was ranged from 1:7.54 to 1:14.55 (in pooled mean). It was highest in thiourea @ 0.25 per cent followed by the treatment NH_4NO_3 @ 3 per cent (1:12.77), KNO_3 @ 1 per cent (1:12.72), KNO_3 @ 1 per cent (1:12.28) and KNO_3 @ 3 per cent (1:11.37) and lowest in the control i.e. 1 :7.54. During first year of experimentation it was found to range from 1:6.75 to 1:14.11 and second year of experimentation 1:8. 34 to 1:15.00. The increase in hermaphrodite flowers could be attributed to the variation in climatic conditions. Burondkar *et al*. (1996) reported that all the pruned trees, which received different doses of pp333, recorded significantly higher percentage of hermaphrodite flowers (17.7 to 21.71 %). Where as Shinde *et al*. (2001) reported that the minimum, maximum temperature and relative humidity of the respective periods seems to play an important role in the production of hermaphrodite flowers. The minimum temperature below 17°C appeared to induce more maleness in Alphonso mango.

Table 1. Effect of chemicals on number and time of flowering flushes per season in mango (*Mangifera indica* L.) cv. Alphonso.

Treatments	Date of first flowering (2003-04)	Date of first flowering (2004-05)
Thiourea @ 0.25%	3/11/03	16/11/04
Thiourea @ 0.50%	3/11/03	16/11/04
Thiourea @ 0.75%	3/11/03	16/11/04
KNO_3 @ 1%	5/11/03	18/11/04
KNO_3 @ 3%	5/11/03	18/11/04
KNO_3 @ 5%	5/11/03	18/11/04
NH_4NO_3 @ 1%	1/11/03	13/11/04
NH_4NO_3 @ 2%	1/11/03	13/11/04
NH_4NO_3 @ 3%	1/11/03	13/11/04
Control	8/11/03	28/11/04

Fruit set, fruit retention and yield : The data presented in Table 2 revealed that, the treatment KNO_3 @ 3 per cent recorded significantly maximum number of fruit set panicle^{-1} (21.44 fruits) followed by thiourea @ 0.25 per cent (18.66 fruits), KNO_3 @ 5 per cent (17.36 fruits), NH_4NO_3 @ 3 per cent (16.90 fruits) and KNO_3 @ 1 per cent (16.33 fruits), which were on par in pooled mean, while it was only 9.16 fruits in control. The

higher fruit set could be attributed to the maximum number of hermaphrodite flowers recorded in the said treatments.

Significantly maximum number of fruits panicle^{-1} were harvested from the treatments KNO_3 @ 3 per cent (2.50) followed by thiourea @ 0.25 per cent (2.25) while, minimum number of fruits panicle^{-1} were harvested in control (1.05) and thiourea @ 0.75 per cent. Fruit retention per panicle was found almost similar to that of pooled mean. Maximum fruit retention could be attributed to the less disease and pest problems, sufficient nutrition as reported by Randhawa and Chadhha (1982).

The pooled means were not found to differ significantly as far as fruit yield was concerned. However, the trend was positive. The maximum yield was recorded in the treatment KNO_3 @ 3 per cent (3.71 ton ha^{-1}) followed by thiourea @ 0.25 per cent (3.47 ton ha^{-1}) whereas the results from individual years and pooled were found to differ significantly. Significantly maximum yield was recorded in the treatment KNO_3 @ 3 per cent (1.74 ton ha^{-1}) during both the year followed by thiourea @ 0.25 per cent (1.55 ton ha^{-1}) and minimum yield was recorded in control (1.01 ton ha^{-1}). In the present investigation, uniform maximum hermaphrodite flowering was observed. The controlled pest and disease incidence might have reduced the fruit drop. Alphonso being irregular bearer, variation in the yield during both the years were observed. The similar results were also reported by Young, (1942),

Total soluble solid, acidity and pH : The data pertaining to the total soluble solids presented in Table 3 revealed that, in pooled mean maximum TSS was observed in thiourea @ 0.75 per cent treatments (19.42 °B) followed by NH_4NO_3 @ 1 per cent (18.70 °B) where as it was minimum in KNO_3 @ 3 per cent (16.88 °B). In normal case the TSS of Alphonso mango fruits ranged from 17-19 °B. Increase in TSS during ripening process of mango fruits could be attributed to the hydrolysis of starch into sugars. The similar results were also

Talbe 2. Effect of chemicals on flowering behavior and yield in mango (*Mangifera indica* L.) cv. Alphonso.

Treatments	Per cent male flower panicle^{-1}	Per cent perfect flowers panicle^{-1}	Sex ratio (Perfect : Male)	No. of fruits set panicle^{-1}	Fruit retention penicle^{-1}	Yield (ton ha^{-1})
Thiourea @ 0.25%	92.64 (74.47)	7.36 (15.53)	1:13.62	18.66	2.25	3.47
Thiourea @ 0.50%	91.06 (72.71)	8.94 (17.29)	1:10.77	15.11	1.72	2.09
Thiourea @ 0.75%	87.97 (70.14)	12.03 (19.86)	1:8.86	10.61	1.29	2.10
KNO_3 @ 1%	91.79 (73.50)	8.21 (16.50)	1:12.28	16.33	1.85	2.29
KNO_3 @ 3%	90.42 (72.36)	9.58 (17.64)	1:14.55	21.44	2.50	3.71
KNO_3 @ 5%	90.72 (72.35)	9.28 (17.65)	1:10.19	17.36	2.09	3.36
NH_4NO_3 @ 1%	91.85 (73.63)	8.15 (16.37)	1:10.20	11.61	1.40	2.02
NH_4NO_3 @ 2%	88.17 (70.31)	11.83 (19.69)	1:8.86	15.35	1.63	2.56
NH_4NO_3 @ 3%	91.99 (73.77)	8.01 (16.23)	1:12.77	16.90	2.19	2.62
Control	87.66 (69.56)	12.34 (20.44)	1:7.54	9.16	1.05	1.52
S. E. ±	1.12	1.12	-	1.92	0.10	0.52
C. D. at 5%	-	-	-	5.92	0.32	-
F, test	NS	NS	-	Sig.	Sig.	NS

Figures in parentheses indicate the Arc-sin value.

Table 3. Effect of chemicals on chemical composition in mango (*Mangifera indica* L.) cv. Alphonso.

Treatments	T. S. S. (°B)	Acidity as a citric acid (%)	pH	Ascorbic acid (mg 100 g^{-1})	β-carotene (µg 100 g^{-1})
Thiourea @ 0.25%	18.50	0.41	4.44	56.04	15621.04
Thiourea @ 0.50%	18.42	0.43	3.83	68.52	14495.54
Thiourea @ 0.75%	19.42	0.37	3.79	47.74	14212.54
KNO_3 @ 1%	18.50	0.48	3.81	65.26	12187.25
KNO_3 @ 3%	16.88	0.50	3.78	67.82	11642.25
KNO_3 @ 5%	17.15	0.38	3.77	62.85	9096.25
NH_4NO3 @ 1%	18.70	0.40	3.89	55.92	12391.17
NH_4NO3 @ 2%	18.47	0.35	3.45	63.53	12399.08
NH_4NO3 @ 3%	17.92	0.40	3.61	60.07	15651.25
Control	18.25	0.36	3.24	50.82	13859.71
S. E. ±	0.40	0.02	0.13	2.19	448.75
C. D. at 5%	1.24	0.05	0.41	6.75	1380.70
F, test	Sig.	Sig.	Sig.	Sig.	Sig.

reported by Gautam, (2000). Acidity (citric acid) was found significantly maximum in treatment KNO_3 @ 3 per cent (0.50 per cent) followed by KNO_3 @ 1 per cent (0.48 per cent) which was on par and found significantly superior over rest of the treatments. While, minimum was noticed in NH_4NO_3 @ 2 per cent (0.35 per cent) followed by control (0.36 per cent) in pooled means. The increase and decrease in acidity during ripe stage could be attributed to the degeneration of organic acids. Findings analogous to this observation have also been reported by Joshi and Roy (1985).

The pH was also found to differ significantly. It ranged from 3.24 to 4.44 in pooled means. The pH was maximum in thiourea @ 0.25 per cent (4.44 per cent) followed by NH_4NO_3 @ 1 per cent (3.89 per cent) treatments in pooled mean. The trend was same during both the years of experimentations. The differences in pH could be due to the corresponding decrease in acidity caused by degradation of organic acid during ripening. Similar findings were reported by Joshi, (1983).

Ascorbic acid and β-carotene : Significantly maximum ascorbic acid was found in the treatment, Thiourea @ 0.50 per cent (68.52 mg 100^{-1} g) followed by (67.82 mg 100-1 g) in KNO_3 at the rate of 3 per cent (Table 5), where as minimum ascorbic acid was noticed in thiourea @ 0.75 per cent (47.74 mg 100^{-1} g) of the pulp followed by control (50.82 mg 100^{-1} g). Similar trend was observed during both the years of experimentation. The variation in the ascorbic acid in the fruits could be attributed to the degradation during ripening and storage. The similar findings were also reported by Limaye *et al.* (1984) in mango.

Significantly maximum β-carotene was observed in NH_4NO_3 @ 3 per cent treatment (15651.25 µg 100^{-1} g) followed by 15621.04 and 14495.54 µg 100^{-1} g in thiourea @ 0.25 and 0.50 per cent respectively and were on par. In pooled mean minimum β-carotene was noticed in KNO_3 @ 5 per cent (9096.25 µg 100 g) followed by 3 per cent (11642.25 µg 100^{-1} gm). The similar trend was observed during both the years of experimentation. The increase in β-carotene content in mango fruits could be due to their accelerated biosynthesis

during ripening process (Singh, 1995).

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Digvijay - An High Yielding, Wilt Resistant Chickpea Variety for Maharashtra State

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ABSTRACT

Digvijay (Phule G-9425-5) chickpea variety is derived by hybridization through pedigree selection method from a cross Phule G-91028 x Bheema. It has semi-spreading growth habit with medium bold seed size (24.0 g 100^{-1} seeds). The variety is resistant to *Fusarium* wilt. In various state and regional varietal trials, the genotype Phule G-9425-5 consistently recorded best performance. In irrigated conditions the genotype gave 2239 kg ha^{-1} seed yield which was 20.83 per cent higher than Vijay and 12.34 per cent higher than Vishal. Under rainfed condition the genotype gave 1391 kg ha^{-1} seed yield which was equivalent to Vijay but 9.87 per cent higher than Vishal. Under late sown condition the genotype gave seed yield of 2137 kg ha^{-1} which was 19.25 and 15.58 per cent higher than Vijay and Vishai respectively. The variety is released and notified under the name "Digvijay" for early sown rainfed condition, optimum sown irrigated and late sown conditions of Maharashtra state in February 2007.

Key words : Phule G- 9425-5, resistance, high yield, rainfed, irrigated, late sown.

Among several pulse crops chickpea occupies first rank for area, production and productivity at National level as well as in Maharashtra. It's area has been increased from 4.10 lakh ha in year 1980-81 to 12.83 lakh ha in year 2006-07 with production 1.37 lakh tons to 10.50 lakh tons and productivity 335 to 819 kg ha^{-1}. It was an immediate need to develop a new genotype with resistance to *Fusarium* wilt having high yield under rainfed, irrigated and late sown condition for Maharashtra. The efforts were therefore, made to develop a desi chickpea variety which is high yielding, wilt resistant and suitable to all the three growing situations i.e. rainfed, irrigated and late sown condition.

MATERIALS AND METHODS

The genotype Phule G-9425-5 has been evolved from a cross of Phule G-91028 x Bheema at Pulses Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar during the year 1994. Among the several selections made in segregating populations, a strain Phule G-9425-5 appeared to be most promising. It was therefore, tested in small scale yield trial along with the checks like Vijay and Vishal at Rahuri in the year 1999-2000. Looking to the promising performance, this strain was promoted to regional varietal trial (rainfed, irrigated and late sown conditions). For rainfed condition the genotype was tested at Rahuri and Mohol, for irrigated condition Rahuri and Savalivihir and for late sown condition Rahuri and Pune during 2000-2001 . Due to superior performance under rainfed, irrigated as well as late sown conditions the genotype was promoted to state multilocation trial for rainfed condition at 10 locations, for irrigated condition at 7 locations and for late sown condition at 3 locations over three years. The genotype was also tested in All India Co-ordinated Initial

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Varietal Trial (bold seeded) over 10 locations in Central Zone during 2002-03. The performance of this genotype was consistently superior over the national check varieties BG-256, BGD-72 and SAKI-9516 for yield as well as resistance to wilt. It was therefore, released for commercial cultivation under rainfed, irrigated and late sown conditions of Maharashtra in year 2006 under the name "Digvijay". The statistical analysis was carried out according to Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

Performance of Phule G-9425-5 in different trials : In station trial conducted during 1999-2000 at Rahuri the yield differences due to genotypes were significant.

Table 1. Grain yield performance of chickpea variety Phule G-9425-5 in various trials.

Year	Trial	No. of trials/ locations	Yield (kg ha^{-1})			% increase of Phule G-9425-5 over	
			Phule G-9425-5	Vijay (Ch)	Vishal (Ch)	Vijay (Ch)	Vishal (Ch)
Irrigated :							
1999-2000	Station trial	1	3132	-	1667	-	87.88
2000-01	Regional varietal trial	2	1959	1508	1739	29.91	12.65
2001-02	State multilocation varietal trial	7	2407	1835	1950	31.17	23.44
2002-03	State multilocation varietal trial	8	2406	1954	2160	23.13	11.39
2003-04	State multilocation varietal trial	9	2224	-	1896	-	17.30
2002-03	Initial varietal trial (AICRP trial)	10	1931	1813 (SAKI-9516)	-	-	-
2004-05	State multilocation varietal trial	9	2303	-	2068	-	11.36
Mean		46	2239	1853	1993	20.83	12.34
Rainfed :							
2000-01	Regional varietal trial	1	903	852	958	5.98	-0.11
2001-02	State multilocation varietal trial	10	1375	1319	1097	4.25	25.34
2002-03	State multilocation varietal trial	10	1195	1185	1047	0.84	14.14
2003-04	State multilocation varietal trial	7	1855	1910	1751	(-)2.88	5.94
2004-05	State multilocation varietal trial	10	1328	1428	1350	(-)7.00	(-)1.63
Mean		38	1391	1438	1266	(-) 1.28	9.87
Late sown :							
2000-01	Regional varietal trial	2	2385	1929	2440	23.64	-
2001-02	State multilocation varietal trial	3	2157	1742	1809	23.82	19.24
2002-03	State multilocation varietal trial	3	2232	1915	1750	16.55	27.54
2003-04	State multilocation varietal trial	3	1987	1639	1644	21.23	20.86
2004-05	State multilocation varietal trial	3	2005	1782	1798	12.51	11.51
Mean		14	2137	1792	1849	19.25	15.58
General Mean		98	1896	1596	1656	18.80	14.49

Note :

1. In 46 trials under irrigated condition the genotype Phule G-9425-5 showed 20.83 per cent higher yield than Vijay and 12.34 per cent than Vishal.
2. In 14 trials under the late sown condition, Phule G-9425-5 showed 19.25 and 15.58 per cent higher yield over Vijay and Vishal respectively.
3. In rainfed trial it was equivalent to Vijay but 9.87 per cent higher yield than Vishal.

The culture Phuie G-9425-5 gave grain yieid of 3132 kg ha^{-1} (Table 1) which was 87.88 per cent higher than the check Vishal (1667 kg ha^{-1}). In the regional varietal trial under early sown rainfed condition, Phule G -9425-5 recorded 5.98 per cent higher yield (903 kg ha^{-1}) than the check Vijay (852 kg ha^{-1}), whereas under irrigated optimum condition, it gave mean grain yield of 1959 kg ha^{-1} which was 29.91 and 12.65 per cent higher than the checks Vijay (1508 kg ha^{-1}) and Vishal (1739 kg ha^{-1}). Under late sown condition the genotype Phule G-9425-5 gave grain yield of 2385 kg ha^{-1} which was 23.64 per cent higher than the check Vijay (1929 kg ha^{-1}) (Anon., 2005).

Under early sown rainfed condition, it gave grain yield of 1391 kg ha^{-1} which was equivalent to Vijay and 9.87 per cent higher than the check Vishal (1266 kg ha^{-1}). In state multilocation trials conducted during 2001-02 to 2004-05 under normal sown irrigated condition the genotype Phule G-9425-5 gave grain yield of 2239 kg ha^{-1} which was 20.83 and 12.34 per cent higher than the checks Vijay (1853 kg ha^{-1}) and Vishal (1993 kg ha^{-1}) respectively. Under late sown condition, it gave grain yield of 2137 kg ha^{-1} which was 19.25 and 15.58 per cent higher than the checks Vijay (1792 kg ha^{-1}) and Vishal (1849 kg ha^{-1}) respectively. In initial varietal trial conducted during 2002-03 at 10 locations the genotype Phule G-9425-5 gave grain yield of 1931 kg ha^{-1} which was 6.51 per cent higher than the check SAKI-9516 (1813 kg ha^{-1}).

In 98 trials conducted on research field during 1999-2000 to 2004-05, the genotype Phule G-9425-5 showed superior performance and gave 1896 kg ha^{-1} mean grain yield over the check varieties Vijay (1596 kg ha^{-1}) and Vishal (1656 kg ha^{-1}) which was 18.80 and 14.49 per cent higher than the best check varieties Vijay arid Vishal respectively (Table 1).

Table 2. Performance of Phule G-9425-5 in adaptive trials (2004-05).

District	No. of trials	Yield (kg ha^{-1})	
		Phule G-9425-5	Vijay (Ch)
Ahmednagar	21	2050	1731
Sangli	3	1717	550
Nandurbar	1	2100	1750
Akola	2	2025	1500
Solapur	6	1467	1292
Dhule	3	1810	1860
Nashik	5	880	730
Pune	1	2925	2575
Beed	2	575	575
Mean	44	1750	1510
% Increase	-	-	15.89

Table 3. Reaction of major pests.

Years	% pod damage by *Helicoverpa armigera*		
	Phule G-9425-5	Vijay (Ch)	Vishal (Ch)
2001-02	6.88	14.22	11.45
2002-03	21.51	18.58	21.14
2003-04	29.15	33.05	35.07
2004-05	12.46	8.89	7.98
Mean	17.50	18.69	19.36

Table 4. Reaction to major diseases.

Year	Mean % wilt (wilt sick plot)				
	Phule G-9425-5	Vijay (Ch)	Vishal (Ch)	Phule G-5 (Ch)	JG-62 (Susceptible check)
2000-01	4.00	8.62	0.00	87.71	100.00
2001-02	8.21	7.85	7.29	-	100.00
2002-03	7.47	58.55	5.71	-	100.00
2003-04	9.92	62.07	6.15	89.06	100.00
2004-05	4.33	35.91	7.33	88.90	100.00
Mean	6.97	34.60	5.26	88.56	100.00

The genotype Phule G-9425-5 was evaluated along with the check Vijay on farmers field for grain yield in various districts of

Table 5. Quality parameters of chickpea variety Phule G-9425-5.

Quality parameters	Characters	Phule G-9425-5	Vijay (Ch)	Vishal (Ch)	Phule G-5 (Ch)	Phule G-12 (Ch)
Milling quality	Clean dhal (%)	67.4	64.4	78.7	73.1	59.1
	Broken dhal (%)	8.6	15.3	6.0	7.7	12.8
	Churi + Gota (%)	5.2	6.8	4.3	2.8	4.1
	Husk + Whole seeds	18.8	17.5	11.0	16.9	24.9
Cooking quality	Cooking period (Min.)	22	20	24	23	22
Protein content	Protein (%)	23.4	24.8	28.5	25.6	26.9

Table 6. Consumers preference for grain quality and roasted gram (Chane) quality.

Character variety	Phule G-9425-5	Vijay (Ch)	Vishal (Ch)
Grain :			
Size	3.1	2.3	3.8
Shape	3.4	1.8	3.4
Colour	3.1	2.3	3.7
Mean	3.2	2.1	3.6
Roasted grain (Chane) :			
Appearance	3.92	2.33	3.00
Flavour	3.42	2.50	2.67
Taste	3.83	2.92	3.17
Mean	3.72	2.58	2.95

Where, 4 : Excellent, 3 : Good, 2 : Fair and 1 : Poor

Maharashtra. The data of 44 trials conducted during 2004-05, the Phule G-9425-5 gave higher grain yield (1750 kg ha^{-1}) than Vijay (1510 kg ha^{-1}) by 15.89 per cent (Table 2).

Pests and diseases : The screening in wilt sick plot revealed that the variety Phule G-9425-5 was consistently resistant to *Fusarium* wilt (Table 3 and 4). Similarly, it has shown less susceptibility to *Helicoverpa armigera* than the check varieties Vijay and Vishal.

Quality characters : In quality studies Phule G-9425-5 recorded second highest dhal recovery (67.4 %) next to Vishal (78.7 %). The consumers preference recorded for roasted gram revealed that there was excellent preference regarding appearance (3.92), flavour (3.42) and taste (3.83) than Vijay and Vishal (Table 5 and 6).

It had a medium maturity duration (100-105 days), semi-spreading in growth habit, small leaves, medium bold seed size (24.0 g 100^{-1} seeds), responsive to recommended fertilizer dose, performing high yield under early sown rainfed condition, timely sown irrigated condition and late sown condition.

Being high yield potential and consistent resistance to *Fusarium* wilt, the variety Phule G-9425-5 was identified for release during 2006 for early sown rainfed condition, timely sown irrigated condition and late sown conditions of Maharashtra for commercial cultivation to the farmers.

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Variable Rates of Primary and Secondary Metabolites During Different Seasons and Physiological Stages in *Datura metel* L.

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ABSTRACT

In the present investigation attempts have been made to investigate the rate of plant metabolism during different seasons and physiological stages in *Datura metel* L. Leaf pigments, proline, protein content, alkaloids and phenols worked out during summer, monsoon and winter season showed variable rates of synthesis. Proline and protein content were maximum in summer season. Leaf pigments, alkaloids and phenols were higher in monsoon during flowering stage. Alkaloid and phenol content was found insignificant in seedling stage.

Key words : *Datura metel*, leaf pigments, proline, protein, alkaloids, phenols, seasons and growth stages.

Rate of assimilation, translocation and its utilization indicates the growth potential of plants under prevailing conditions. Limits of abiotic stress vary with the stage of development. Period of accumulation, nature and quality of metabolism in the plants is variable with the season. Maximum production of metabolites depends on age and growth phase of the plant. Harvesting of crude drugs with higher concentration of active principle is prerequisite in preparation of efficacious drugs. *Datura metel* L. leaves contain about 0.5 per cent of alkaloids, chiefly scopolamine (hyoscine) with traces of hyoscyamine and atropine (Jaggi *et al.* 1989). The seeds contain about 0.2 per cent alkaloids. Atropine has a stimulant action on the central nervous system and depresses the nerve endings to the secretary glands and plain muscles. Hyoscine lacks the central stimulant action of atropine; its sedative properties enable it to be used in the control of motion sickness. Atropine and hyoscine are used to a large extent in the ophthalmic practice to dilate the pupil of the eye (Trease and Evans, 1985). Atropine is well known antidote.

Datura is one of the Kayakalpa medicines used for rejuvenation therapy (Rajalakshmi, 1998). It is reported to cure bronchitis (Jain, 1994) and skin diseases (Chopra *et al*. 1956) and hydrophobia (Janardhan, 1997). Present investigation was aimed to understand an optimum time of harvest with maximum amount of metabolites.

MATERIALS AND METHODS

In the present investigation sets of *Datura metel* L. plants were raised by sowing the seeds in circular cement pots of 40 x 30 cm size for three consecutive seasons. Seeds obtained from Dhanwantari Udyan (Medicinal Plant Garden), Mahatma Phule Agricultural University, Rahuri (M.S.) were used to raise the plants. The pots were filled with 10 kg of sun dried garden soil and well rotten compost in the ratio of 3:1. Cultivation was designed in quadruple. About 10 seeds of uniform size were sown

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equidistantly at an equal depth. Pots were irrigated on the basis of water holding capacity of the soil. In each pot plants were thinned out 15 days after germination and three well-established and uniform plants were kept at equal distance from one another.

The leaf samples were collected at different developmental stages such as seedling, vegetative, flowering and maturity (senescence). At maturity (105 days) capsules were dehiscing and other plant parts were dried. For polyphenols, protein and alkaloid estimation, leaf material was initially sun dried for the period of one week. After sun drying the leaf material was oven dried at 70°C ± 2°C till the constant weight obtained (Sestak *et al*. 1971).

Chlorophyll and proline content were estimated by using fresh fully expanded leaves by the method of Arnon (1949) and Bates *et al*. (1973) respectively. Values for leaf proline were converted for dry weight on the basis of moisture content. Protein contents were estimated by the method of Miller (1959). Alkaloids were estimated by the method of Freeman (1955). Polyphenols were estimated by the method of Swain and Hills (1959). All the estimations were done in triplicate. The data obtained was statistically analysed according to "analysis of variance" (Mungikar, 1997).

RESULTS AND DISCUSSION

Maximum chlorophyll contents (Table 1) were recorded in rainy season with the highest concentration in flowering stage. Minimum values were recorded in summer. Increase in chlorophyll in monsoon indicates high efficiency of photosynthetic apparatus. However, the results are contradictory to Swami *et al*. (2008) who reported highest chlorophyll content in *Convolvulus microphyllus* during summer.

Proline content was maximum at maturity stage during summer followed by winter season. Minimum values were recorded in rainy season. Proline is an excellent stress indicator. The accumulation of free proline depends on the type and intensity of stress. (Tamayo and Bonjoch, 2001). Water deficit is believed to stimulate the synthesis of an osmoregulator proline during summer (Levitt, 1972).

Maximum protein contents were recorded in summer at flowering stage. Minimum values were recorded in rainy season. Water stress

Table 1. Variations in physiological parameters of *Datura metel* L. under different seasons and growth stages.

Paratmeters	**Seasons**			**Growth stages**			
	Summer	**Rainy**	**Winter**	**Seedling (30 DAS)**	**Vegetative (45 DAS)**	**Flowering (75 DAS)**	**Maturity 105 DAS)**
Total chlorophylls (mg 100^{-1} g F. wt)	93.77±1.6	119.46±3.1	101.86±2.4	56.19±1.2	71.88±1.9	99.37±2.4	68.14±1.3
Proline (mg 100^{-1} g F. wt)	162.28±4.2	138.49±3.9	143.33±6.0	71.00±2.1	89.70±1.7	93.00±3.9	113.00±4.1
Proteins (mg 100^{-1} g D. wt)	417.00±3.8	366.82±5.1	384.00±4.3	292.00±1.71	314.67±2.1	362.71±1.7	316.00±3.2
Total alkaloids (mg 100^{-1} g D. wt)	378.12±5.7	432.00±5.2	406.00±4.6	*	102.72±1.9	457.11±5.3	402.30±3.8
Polyphenols (g 100^{-1} g D. wt)	1.13±0.24	1.73±0.29	1.60±0.20	0.68±0.08	1.1±0.68	1.32±0.13	0.98±0.23

Observations are mean of three determinations ±Indicates standard deviation. * Non formation of alkaloids. DAS = days after sowing.

causes both reductions in the role of protein synthesis as well as changes in the type of proteins produced. Formation of free amino acids in *D. metel* may have lead to the synthesis of new desired proteins during summer.

Maximum alkaloid contents were recorded in rainy season at flowering stage followed by winter (Table 1). Minimum values were recorded in summer. Rainy season has positive impact on plant growth as well as the formation of alkaloids. Alkaloid synthesis increases with progressive maturity. It reaches to highest concentration at flowering stage. In the present work alkaloid synthesis could be recorded in the order flowering stage> maturity stage> vegetative stage. Seedling stage has shown no synthesis of alkaloids. Most alkaloids are formed in young and actively growing tissues (Waller and Nowacki, 1978). Results of alkaloid accumulation are in consonance with Nandi (1996) who reported maximum accumulation of alkaloids in the leaves of of *D. innoxia* during flowering stage. Verma and Kasera (2007) reported maximum accumula-tion of alkaloids and phenols in *Asparagus racemosus, Boerhavia diffusa* and *Sida cordifolia* at flowering stage during summer and no alkaloids accumulation in seedling stage.

Highest concentration of polyphenols was recorded in rainy season during flowering stage followed by winter and lowest in summer. The results are contradictory to Senea *et al*. (2001) who observed increased phenolic compounds in sorghum due to water stress. The stage of growth of the plant has an impact on phenolic contents.

From the present study it is concluded that growth stages and seasons show effect on ecophysiological parameters. Favorable climatic conditions are believed to stimulate the secondary metabolite synthesis in *D. metel* L. Rainy season was found to be most favorable for maximum production of leaf pigments, alkaloids and polyphenols.

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Genetic Divergence Studies in *Rabi* Groundnut (*Arachis hypogaea* L.)*

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ABSTRACT

Divergence analysis among thirty eight genotypes of groundnut was carried out by using Mahalanobis's D^2 statistics. The genotypes were grouped into nine clusters. The maximum inter-cluster distance was observed between cluster VI and VII (23.70), followed by cluster II and IX (22.09), cluster II and VIII (21.97), cluster V and VII (21.93), cluster VI and VIII (21.43), and cluster VII and IX (21.41). Indicated that these groups of genotypes were highly divergent from each other. The genotype in above clusters revealed substantial differences in the means for important yield contributing characters. The genotypes VRR 257, 17-15-36-1, VRR 368, IC 16-6-4, AH 7179 and TKGB were found to be potential parents based on cluster mean and genetic diversity.

Key words : Genetic diversity, groundnut.

Success of plant breeding programme depends on the choice of appropriate parents. It is expected that the utilization of divergent parents in hybridization result in promising recombinants. Hence, the present investigation was undertaken to study the genetic divergence in groundnut (*Arachis hypogaea* L.) germplasm to identify potential genotypes for various yield traits which could be utilized in further improvement programme.

MATERIALS AND METHODS

Thirty eight genotypes of groundnut, 36 genotypes from National Research Centre for groundnut, Junagarh and 2 varieties from Department of Agril. Botany, College of

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Agriculture, Dapoli were raised in a randomized block design with three replications during *rabi* 2006-07 at Research Farm, Department of Agricultural Botany, College of Agriculture, Dapoli. Each genotype was grown in four rows of 2 m length with spacing 30 x 10 cm. All the recommended cultural practices were adapted. Five plants were selected at random from each genotype in each replication for recording observations on characters, *viz*. days to first flowering, days to 50 per cent flowering, days to maturity, plant height (cm), number of primary branches plant^{-1}, number of pods plant^{-1}, shelling percentage, pod length (mm), 100 seed weight (g), number of kernels plant^{-1}, kernel yield plant^{-1} (g), oil percentage and dry pod yield plant^{-1} (g). The analysis of genetic diversity was carried out by using Mahalanobis's (1936) D^2 statistics. The grouping of genotypes into clusters was made as per Tocher's method (Rao, 1952).

Table 1. Grouping of groundnut genotypes into different clusters by Tocher's method.

Cluster	Number of genotypes included in cluster	Genotypes
I	18	VRR 422, VRR 389, VRR 278, VRR 424, Smallpod, VRR 180, RS 181, K3, VRR 203, VRR 187, PIRCOMA 43, VRR 200, VRR 396, OG-69-6, VRR 328, VRR 245, VRR 232, NG 5144
II	7	VRR 257, VRR 173, VRR 194, Pollachired, VRR 242, IC 22942, Bigjapan
III	6	VRR 210, DH-3-30, VRR 209, VRR 361, VRR 221, VRR 368
IV	2	VRR 252, VRR 251
V	1	17-15-36-1
VI	1	Konkan Gaurav
VII	1	IC 16-6-4
VIII	1	AH 7179
IX	1	TKGB

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among 38 genotypes of groundnut for all the thirteen characters studied. The 38 genotypes were grouped into 9 clusters (Table 1). Cluster I was the largest with 18 genotypes followed by cluster II included 7 genotypes and cluster III and IV included 6 and 2 genotypes respectively. The remaining five clusters V, VI, VII, VIII and IX were solitary. Based on divergence existed among population Katule *et al.* (1992) grouped 14 genotypes in 8 clusters, Golakia and Makne (1991) grouped 24 genotypes in 6 clusters, Nadaf *et al.* (1986) grouped 83 genotypes in 9 clusters, Venkataramana *et al*. (2001) grouped 144 genotypes into 6 clusters, Mahalakshmi *et al.*

Table 2. Intra and inter cluster distance D^2 (above the diagonal) and D values (below the diagonal) among the genotypes of groundnut.

Cluster	I	II	III	IV	V	VI	VII	VIII	IX	Intra cluster
I		284.34	87.08	65.11	263.69	274.06	226.12	134.17	272.54	64.12
II	16.86		406.66	335.07	202.63	260.34	284.86	482.84	488.10	44.01
III	9.33	20.17		92.78	362.55	377.02	233.01	107.50	294.19	79.99
IV	8.07	18.30	9.63		298.15	271.62	250.43	145.92	278.91	63.81
V	16.24	14.23	19.04	17.27		98.20	481.00	383.23	188.70	0.00
VI	16.55	16.14	19.42	16.48	9.91		561.73	459.29	211.78	0.00
VII	15.04	16.88	15.26	15.82	21.93	23.70		174.80	458.52	0.00
VIII	11.58	21.97	10.37	12.08	19.58	21.43	13.22		279.90	0.00
IX	16.51	22.09	17.15	16.70	13.74	14.55	21.41	16.73		0.00
Intra cluster	8.01	6.63	8.94	7.99	0.00	0.00	0.00	0.00	0.00	

Table 3. Cluster means for 13 characters in 38 genotypes of groundnut .

Characters	Clusters									Population mean
	I	II	III	IV	V	VI	VII	VIII	IX	
Days to first flowering	27.70	27.57	27.61	27.67	27.67	30.00	27.00	26.33	29.30	27.71
Days to 50% flowering	31.02	30.53	30.62	31.17	31.67	38.67	28.67	29.67	35.33	31.11
Days to maturity	113.37	112.95	112.39	113.50	120.00	120.00	108.00	112.00	120.00	113.49
Plant height (cm)	37.41	37.62	36.55	42.00	30.33	34.00	42.33	31.67	34.33	37.18
Primary branches plant^{-1}	4.54	4.87	5.46	4.60	4.40	5.07	4.97	4.87	5.13	4.79
Pods plant^{-1}	14.88	15.63	16.51	12.14	10.40	13.67	15.00	10.53	14.60	14.86
Shelling percentage	81.30	81.36	79.22	77.84	79.76	68.88	82.77	79.14	68.27	80.07
Pod length (mm)	22.53	21.59	23.71	22.04	25.00	22.57	30.83	31.20	30.93	23.25
100 seed weight (g)	36.92	36.34	40.49	37.79	53.23	44.44	38.32	42.13	57.25	38.76
Kernels plant^{-1}	26.03	27.60	28.13	22.14	16.07	15.58	33.27	23.87	22.40	25.95
Kernel yield plant^{-1} (g)	9.67	10.55	11.57	8.72	8.16	8.57	12.87	9.00	12.23	10.16
Oil percentage	44.08	50.83	42.78	43.42	47.83	46.83	47.50	43.00	44.83	45.33
Dry pod yield plant^{-1} (g)	11.95	13.01	14.65	11.25	10.25	12.44	15.59	11.37	17.97	12.74

(2005) grouped 57 genotypes into 7 clusters and Awatade (2007) grouped 40 genotypes into 12 clusters.

Among the clusters high intra cluster distance was recorded within cluster III (8.94) followed by cluster I (8.01) and cluster IV (7.99). The clusters VI and VII (23.70) followed by clusters II and IX (22.09), cluster II and VIII (21.97), clusters V and VII (21.93), clusters VI and VIII (21.43) and clusters VII and IX (21.41) recorded relatively higher inter cluster D^2 values than other clusters (Table 2). The criteria used for hybridization using D^2 analysis is the inter cluster distance. Those genotypes included in clusters with maximum inter cluster distance are obviously genetically more divergent. Hence, it would be logical to choose genotypes from these clusters in the breeding programme. Mahalakshmi *et al*. (2005) observed maximum divergence between cluster IV and VII. Maximum inter cluster D^2 values were observed between cluster II and IV in both the environment by Venkataramana *et al*. (2001). Cluster means for different characters (Table 3) showed that cluster II exhibited highest mean value for the character oil percentage. Cluster III had maximum number of pods plant^{-1}. Cluster V had desirable least plant height. Clusters VII had less number of days to 50 per cent flowering and days to maturity, while exhibited maximum kernel yield plant^{-1}, number of kernels plant^{-1} and shelling percentage. Golakia and Makne (1992) observed highest mean for the character kernel yield plant^{-1}, pod yield plant^{-1}, biomass yield plant^{-1} and recovery percentage in cluster-Ill. Cluster VIII had less number of days to first flowering and maximum pod length. Cluster IX had maximum number of primary branches plant^{-1}, 100 seed weight and dry pod yield plant^{-1}. Golakia and Makne (1991) reported that genotypes for important characters like pod yield, 100-kernel weight, oil and recovery percentage recording maximum mean performance were grouped into cluster II, III and IV.

Based on cluster mean and genetic diversity studies genotypes VRR 257 (cluster II) for oil percentage, 17-15-36-1 (cluster V) for plant height, VRR 368 (cluster III) for number of pods plant^{-1},1C 16-6-4 (cluster VII) for days to 50 per cent flowering, days to maturity, kernel

yield plant^{-1}, number of kernels plant^{-1} and shelling percentage, AH 7179 (cluster VIII) for days to first flowering and pod length and TKGB (cluster IX) for number of primary branches plant^{-1}, 100 seed weight and dry pod yield plant^{-1} were considered as potential parents for breeding programme.

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Effects of Different Growth Chemicals on Quality of Thompson Seedless Grapes

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ABSTRACT

The highest berry weights were recorded due to the application of IAA. The increase in weight might be due to an increase in the endogenous auxin in response to exogenously applied IAA. Significantly higher berry volumes were recorded due to application of Boric Acid (2000 ppm) up to 30 days and then surpassed by IAA at 45 and 60 days with sucrose. It might be due to auxin induced cell enlargement after 45 days of veraison. The lowest acidity was observed due to application of Ethephon (1000ppm) which might be due to release of ethylene from Ethephon at much faster rate. The highest total acidity was recorded due to the application of sodium diethydithio carbamate (0.7 % w/v). Application of Ethephon (1000 ppm) resulted in an increase in the total soluble solids during ripening.

Key words : Growth chemicals, grapes quality.

Polyphenols and its distribution in grape deserve attention in understanding physiology and bio-chemistry of berry development and maturation with special reference to pigment formation in the pericarp. It is well known that

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the anthocyanin content of grapes is significantly influenced by environmental conditions (Ribereau Gayon, 1972). In many plants the bright red anthocyanin colouration is abundant in young and senescing leaves. Anthocyanin biosynthesis is often initiated due to drought, insect and potassium deficiency (Lee, 2007). Wong *et al*. (1974) observed that sucrose played regulatory role over activities of enzymes of biosynthetic pathway of phenolics or anthocyanin formation. Steenkamp *et al*. (1977) found that ethephon treatment had pronounced effect on the anthocyanin concentration in berries. Mapson and Wardale (1968) observed an inhibition of ethylene synthesis by diphenols. Walton and Sondheimer (1968) observed that abscisic acid (ABA) posed regulatory role during phenol and anthocyanin biosynthetic pathway, therefore, ABA has been proposed possible trigger of ripening process in grapes (Coombe and Hale 1973). Cytokinin usually causes two to four fold increase in ethylene production (Abeles 1973). Many workers have reported that auxins alone and with GA are effective in increasing berry weight and volume. Reddy (1968) observed significantly increase in size of Anab - e - Shahi berries due to application of GA + IAA than GA alone. Ascorbic acid also prevents inhibition arising from oxidation products due to the action of polyphenoloxidase. Anthocyanin levels are influenced by seasonal environmental, cultural, physiological and genetic factors (Winkler *et al.* 1972). Nitrogen fertilization is known to promote vegetative growth and delay fruit maturation in grape vines. Lavee *et al*. (1977) observed that fruit colour and total soluble solids were significantly less where as total amino acids were significantly higher with high levels of nitrogen fertilization. It was therefore, proposed to study the effects of certain growth chemicals on quality of Thompson Seedless grapes.

MATERIALS AND METHODS

A field experiment was laid out in vineyard at Manjri farm, Maharashtra Rajya Draksha Bagaitdar Sangh, Pune for consecutive two

Table 1. Influence of different growth chemicals with and without sucrose on 100 berry weights (g) and volume (ml) of grapes at different interval.

Growth chemicals	Days after veraison								Pooled mean	
	15		30		45		60			
	Weight	Volume	Weight	Volume	Weight	Volume	Weight	Volume	Weight	Volume
Control	146.50	123.00	181.00	162.50	230.50	218.00	240.75	228.00	199.69	182.88
Ethephon (2 - CEPA)	156.50	122.50	196.50	175.50	244.00	232.50	259.25	249.50	214.06	195.00
ABA	147.00	116.50	187.25	169.00	226.00	212.50	234.75	223.50	198.75	180.38
N^6 - BA	155.25	125.50	199.25	183.00	235.00	220.00	251.00	235.50	210.25	191.00
IAA	169.75	137.00	224.00	204.00	262.75	250.00	280.25	269.50	234.19	215.13
CHM	148.00	124.50	183.50	169.00	231.25	217.50	253.50	231.50	204.06	185.63
SDDTC	145.50	128.00	189.25	176.50	237.00	226.50	244.00	232.50	203.94	190.88
KNO_3	154.75	126.00	208.50	187.50	242.00	228.00	251.75	240.50	214.25	195.50
H_3BO_3	168.50	142.50	225.75	206.50	257.50	242.50	278.75	267.00	232.63	214.63
$CuSo_4$	149.00	126.50	190.25	172.50	235.75	224.00	248.00	232.50	205.75	188.00
Mean	154.08	127.50	198.53	180.60	240.23	227.15	254.20	241.00	211.76	193.99
	L x S	L x S	L x S	L x S	L x S	L x S	L x S	L x S	-	-
S. E. ±	2.57	4.21	3.55	4.62	2.42	5.39	2.62	5.55	-	-
C. D. at 5%	NS	NS	NS	NS	7.17	NS	7.76	NS	-	-

L = Levels, S = Chemicals

years of 2006-07 to 2007-08 to study the effects of growth chemicals from veraison to maturity. The vines were at 3.00 x 1.80 m apart and were trained to a bower system. The clusters were dipped for 30 seconds in a test solution at 15 days interval from veraison to maturity. The treatment comprised of control (distilled water), Ethephon (2 - CEPA) 1000 ppm, abscisic Acid (ABA) 25 µM, N^6 - Benzyl adenine (N^6BA) 25 µM ν), Indol Acetic Acid (IAA) 50 ppm, Cycloheximide (CHM) 1 x 10^{-3} M, Sodium diethyldithio carbamate (SDDTC) 0.7 %, Potassium nitrate (KNO_3) 100 mM, Boric acid (H_3BO_3) 2000 ppm and Copper sulphate ($CuSO_4$) 2000 ppm. Samples consisted of 250 randomly selected berries. From each sample 10 berries with known mass were analysed for total acidity and brix. The mass and volume of berries were also recorded.

RESULTS AND DISCUSSION

Berry weight : At all the samplings, the highest berry weights were recorded due to the application of IAA (Table 1). Synergism was observed with sucrose. Since there is a sharp decrease in auxin content in the second rapid growth phase of berries, the increase in weight might be due to an increase in the endogenous auxin in response to exogenously applied IAA. Following IAA, Boric acid (2000 ppm) was found to increase berry weights from veraison to maturity. The possibility of increased sugar transport into berries due to Boric acid cannot be overruled (Gauch, 1973). It was observed more effective with sucrose. The lowest berry masses were recorded due to dipping of clusters in ABA, either alone or with sucrose. This might be due to advancing maturity resulting in lower berry masses.

Berry volume : Significantly higher berry volumes were recorded due to Boric acid at first 2 samplings and due to IAA for the last two samplings. These growth substances were more effective with sucrose. The increasing volume might be due to auxin induced cells enlargement in stage III of berry development. Auxins are also responsible for an increased

Table 2. Influence of different growth chemicals with and without sucrose on total acidity (g 100 mg^{-1}) and total soluble solids (%) of grapes at different interval (g 100 ml^{-1}).

Growth chemicals	Days after veraison								Pooled mean	
	15		30		45		60			
	Weight	Volume	Weight	Volume	Weight	Volume	Weight	Volume	Weight	Volume
Control	0.81	15.20	0.72	17.00	0.63	18.90	0.54	20.85	0.67	17.99
Ethephon (2 - CEPA)	0.69	16.35	0.62	18.75	0.50	22.65	0.39	24.95	0.55	20.68
ABA	0.73	16.00	0.63	17.70	0.54	21.50	0.44	23.25	0.58	19.61
N^6 - BA	0.76	15.50	0.66	17.15	0.57	18.90	0.52	21.80	0.62	18.34
IAA	0.73	16.20	0.62	18.30	0.51	22.10	0.48	24.00	0.58	20.15
CHM	0.78	15.10	0.70	17.05	0.60	18.75	0.56	21.00	0.66	17.98
SDDTC	0.80	15.75	0.75	16.55	0.65	18.00	0.59	20.05	0.69	17.59
KNO_3	0.75	05.40	0.68	17.10	0.57	18.80	0.51	21.80	0.63	18.28
H_3BO_3	0.70	16.35	0.62	17.95	0.52	21.75	0.44	23.35	0.57	19.85
$CuSo_4$	0.75	15.35	0.72	17.90	0.61	19.45	0.55	21.35	0.66	18.31
Mean	0.75	15.62	0.67	17.55	0.57	20.08	0.50	22.23	0.62	18.87
	L x S	L x S	L x S	L x S	L x S	L x S	L x S	L x S	-	-
S. E. ±	0.01	0.14	0.01	0.17	0.01	0.23	0.01	0.19	-	-
C. D. at 5%	0.03	NS	0.03	0.49	0.03	NS	0.03	-	-	-

water uptake as a result of cell wall loosening and subsequent enlargement with enhanced sugar transport. Endogenous ABA in the pericarp rapidly increases at the start of ripening, the higher level of ABA and subsequent enhanced ripening must have resulted in lower berry volume. (Coombe and Hale, 1973).

Total acidity : It was revealed from the Table 2 that lowest acidity was observed due to use of ethephon (l000 ppm) which might be due to release of ethylene from ethephon at much faster rate. The highest total acidity was recorded due to application of SD (0.7 %), followed by cyclohexamide. It might be due to delayed maturity as a result of inhibition of protein synthesis during ripening (Frankel *et al*. 1968).

Total soluble solids : The application of ethephon resulted in an increase in the total soluble solids (TSS) during ripening. IAA and Boric acid were the next effective growth substances in this respect. There was synergism of these growth substances with sucrose, Ethephon along with sucrose was most effective treatment in increasing TSS.

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Effect of Planting Pattern and Intercropping of Soybean - Pigeonpea on Growth and Yield

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ABSTRACT

The highest grain yield was obtained in planting pattern 4:2 of soybean and pigeonpea in intercropping system soybean (JS -335) + pigeonpea (BSMR - 736). Similarly growth and yield contributing characters recorded the highest values in planting pattern 4:2 and in intercropping system soybean (JS - 335) + pigeonpea (BSMR -736). Soybean (JS-335) was found significantly superior over other soybean genotypes in intercropping with pigeonpea under study. Planting pattern 4:2 was found more productive than other planting patterns in study.

Key words : Genotype, planting pattern, intercropping, soybean, pigeonpea.

As there is little scope to increase area under oilseeds and pulses, the production can be increased by enhancing the productivity through various means. Legumes have a well recognized role in restoring soil fertility and improving soil physical properties. They are valued for protein rich food, feed and fodder and therefore, have been rightly described as unique jewels of Indian crop husbandry.

Amongst the evolved agricultural systems, an intercropping system has been proved as a boon to the Indian farmers. It is a mean to stabilize the crop productivity in dry land areas and to increase its stability in rainfed area under existing inadequate land and rainfall situations. Under the climatic conditions of Marathwada region, soybean and pigeonpea crop are recently being considered to be valuable crops as *kharif* legumes like green gram and black gram.

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MATERIALS AND METHODS

An agronomic investigation was carried out at Agriculture College Farm, Latur on clayey soil. A factorial randomized block design with three planting patterns and five intercropping systems treatment combinations, replicated three times was tested. Three planting patterns *viz*., 6:3, 3:3 and 4:2 with five intercropping systems sole soybean (JS-335), sole pigeonpea (BSMR-736), soybean (MAUS-71) + pigeonpea (BSMR-736), soybean (MAUS-81) + pigeonpea (BSMR-736) and soybean (JS-335) + pigeonpea (BSMR-736) were included in the investigation. The gross plot size was 6.0 x 5.4 m^2 and net plot sizes were varied according to planting patterns. The recommended fertilizer doses of 30:60:30 kg NPK ha^{-1} for soybean and 25:50:00 kg NPK ha^{-1} for pigeonpea were applied to all the plots. The crops were sown by dibbling method. Soybean was sown at 45 x 5 cm spacing and pigeonpea of 45 x 20 cm. The data on pre-harvest studies *viz*. mean plant height, leaf area, number of branches and post harvest studies *viz*. pods $plant^{-1}$ of soybean and pigeonpea were recorded from five plant samples selected randomly from each plot.

RESULTS AND DISCUSSION

Plant height : The plant height of soybean and pigeon pea (Table 1 and 2) was influenced significantly by planting patterns. It was observed that planting pattern 4:2 had taller plants and it was significantly superior to other planting patterns under study. Similar results were recorded by Dubey *et al*. (1991) and Roy *et al*. (1981). While considering the effect of intercropping system, it was observed that the plant height of soybean and pigeonpea were significantly higher in intercropping system soybean (JS-335) + pigeonpea (BSMR-736) than the other intercropping system under study. Height of soybean cultivars was more in intercropping when grown as intercrop in pigeonpea than grown as pure crop as reported by Singh *et al*. (1991).

Leaf area : Effect of planting pattern in respect of mean leaf area plant^{-1} of soybean and pigeonpea was found to be significant. Both the crops recorded significantly maximum values of leaf area in planting pattern 4:2 than other planting patterns due to more number of functional leaves. Less value of leaf area per plant in planting pattern 6:3 and 3:3 might be due to non availability of space for expansions of crop canopy due to competitive effects of inter crop species.

Number of branches : The influence of planting pattern on branching revealed that the number of branches plant^{-1} of soybean were significantly more in planting pattern 4:2 as compared to the planting patterns 6:3 and 3:3. The additional row of intercropped pigeonpea might have resulted in reduction of number of branches of soybean and pigeonpea due to inter and intra species competition for space. Similar results were reported by Dubey *et al*.

Table 1. Mean plant height, leaf area, branches, pod, grain and straw yield of soybean as influenced by diffferent treatments.

Treatments	Soybean					
	Plant height (cm)	Leaf area (dm^2)	Branches plant^{-1}	Pods plant^{-1}	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
Planting patterns :						
P_1 - 6:3	39.12	141.08	8.30	22.27	9.56	16.42
P_2 - 3:3	39.59	141.66	8.38	23.83	10.02	16.77
P_3 - 4:2	39.82	147.05	8.53	26.83	10.54	16.92
S. E. ±	0.001	2.45	0.01	0.04	0.003	0.005
C. D. at 5%	0.004	7.28	0.03	0.14	0.008	0.017
Intercropping systems :						
C_1 - Sole soybean	38.57	142.59	8.07	23.29	12.92	23.73
C_2 - Sole pigeon pea	-	-	-	-	-	-
C_3 - Soybean (MAUS-71) + pigeon pea (BSMR - 736)	39.66	142.70	8.40	22.96	8.74	14.11
C_4 - Soybean (MAUS-81) + pigeon pea (BSMR-736)	39.82	142.90	4.50	24.20	9.18	14.30
C_5 - Soybean (JS-335) + pigeon pea (BSMR-736)	39.99	143.96	8.63	26.78	9.32	14.69
S. E. ±	0.006	2.82	0.003	0.05	0.005	0.009
C. D. at 5%	0.019	8.39	0.010	0.15	0.015	0.029
Interaction (P x C) :						
S. E. ±	0.01	4.89	0.06	0.09	0.008	0.017
C. D. at 5%	NS	NS	NS	NS	NS	NS
Mean	39.51	143.26	8.40	24.31	10.04	16.70

(1991). The intercropping system influenced the number of branches plant^{-1} of soybean and pigeonpea. Significantly more number of branches of soybean and pigeon pea were found in intercropping system of soybean (JS-335) + pigeonpea (BSMR-736) among the intercropping system under study. This is mainly due to growing habit of soybean genotype and competitive effect between the same spacies of pigeonpea for space. Jaganathan *et al*. (1974) found increase in number of branches of soybean due to intercropping of maize in different row proportions.

Number of pods : The mean number of pods per plant was influenced significantly by planting pattern at all growth stages. It was observed that planting pattern 4:2 recorded significantly more number of pods per plant of soybean as well as pigeonpea as compared to the other planting patterns under study. Reduction in number of pods plant^{-1} of soybean and pigeonpea in planting pattern 3:3 and 6:3 might be due to more competitive effect of pigeonpea which resulted in less number of functional leaves and less photosynthetic leaf surface resulting in less dry matter production and its transfer from source to sink. Significant effect of intercropping system on pod number of soybean and pigeonpea was observed. Intercropping system of soybean (JS-335) + pigeonpea (BSMR-736) increased number of pods. This might be due to genetic character of soybean. Increased number of pods plant^{-1} of soybean in intercropping with maize was recorded by Gawad *et al*. (1985).

Grain yield : The planting pattern 4:2 produced maximum grain yield of soybean and

Table 2. Mean plant height, leaf area, branches, pod, grain and straw yield of pigeonpea as influenced by diffferent treatments.

Treatments	Pigeonpea					
	Plant height (cm)	Leaf area (dm^2)	Bran-ches plant^{-1}	Pods plant^{-1}	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
Planting patterns :						
P_1 - 6:3	197.15	50.54	13.12	108.42	17.40	21.96
P_2 - 3:3	197.27	50.58	13.09	110.85	17.56	22.73
P_3 - 4:2	197.33	50.65	13.53	116.11	17.90	23.04
S. E. ±	0.08	0.008	0.012	0.02	0.05	0.005
C. D. at 5%	0.025	0.026	0.035	0.07	0.016	0.017
Intercropping systems :						
C_1 - Sole soybean	-	-	-	-	-	-
C_2 - Sole pigeon pea	196.04	50.28	13.03	107.91	21.60	29.04
C_3 - Soybean (MAUS-71) + pigeon pea (BSMR - 736)	197.11	49.85	13.23	110.13	15.99	20.17
C4 - Soybean (MAUS-81) + pigeon pea (BSMR-736)	197.74	50.75	13.24	112.34	16.30	20.37
C_5 - Soybean (JS-335) + pigeon pea (BSMR-736)	197.78	51.47	13.48	116.80	16.62	20.73
S. E. ±	0.10	0.005	0.01	0.03	0.005	0.006
C. D. at 5%	0.31	0.015	0.03	0.11	0.015	0.020
Interaction (P x C) :						
S. E. ±	0.18	0.009	0.02	0.06	0.91	0.011
C. D. at 5%	NS	NS	NS	NS	2.70	NS
Mean	197.25	50.59	13.25	111.79	17.62	22.58

pigeonpea which was significantly superior over planting patterns 6:3 and 3:3. The growth characters i.e. height, number of functional leaves, leaf area, number of branches and number of pods were highest in planting pattern 4:2 which contributed for more grain yield unit^{-1} area. Similarly, corresponding growth and yield contributing characters of soybean and pigeonpea were also highest in intercropping system soybean (JS-335) + pigeonpea (BSMR-736). The maximum grain yield was recorded in sole soybean (JS-335) and sole pigeonpea (BSMR-736) due to maximum plant population unit^{-1} area. Similar results were obtained by Rafey and Varma (1988) and Holkar *et al.* (1991).

Grain yield of soybean and pigeonpea was influenced by interaction of planting pattern and intercropping system. The maximum yield was found in interaction of planting pattern 4:2 and intercropping system soybean (JS-335) + pigeonpea (BSMR-736). This may be because of initial growth of pigeonpea (BSMR-736) is slow which resulted in more space for soybean development. The results are in conformity with Danawale and Shinde (1996).

Straw yield : Straw yield of soybean and pigeonpea was recorded highest in planting pattern 4:2. Sole soybean and sole pigeaonpea recorded maximum straw yield followed by intercropping system soybean (JS-335) + pigeonpea (BSMR-736) due to maximum values of mean plant height and branches.

From this study, it can be inferred that planting pattern 4:2 was found more productive with intercropping system soybean (JS-335) + pigeonpea (BSMR-736).

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Evaluation of Sowing Time for *Kharif* Pearl Millet and Validation by DSSAT-3.5

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ABSTRACT

The treatment of sowing of pearl millet during 25th mw (18th to 24th June) produced significantly the best phenological growth in case of panicle initiation, anthesis, physiological maturity, LAI and grain, fodder and biomass yield over remaining sowing dates. It was followed by the treatment of sowing of pearl millet during 26th mw (25th June to 1st July). The predicted characters by DSSAT-3.5 such as panicle initiation, anthesis, physiological maturity, LAI, grain, fodder and biomass yield fairly matched with the observed values.

Key words : Pearl millet, yield, validation, DSSAT-3.5.

Pearl millet *(Pennisetum glaucum* (L.) R. Br.) is grown on a variety of soils from sandy to medium black (Vertisol) and thrives well on heavy types of soils. The CERES (Crop Environment RE sources Synthesis) pearl millet model is one of the dynamic crop growth model incorporated under DSSAT-3.5 (Decision Support System for Agro-Technology Transfer) by IBSNAT (International Benchmark Sites Network for Agro-Technology Transfer). This study was undertaken to simulate the growth and yield of pearl millet crop sown on different sowing times in the present study.

MATERIALS AND METHODS

The experiment was conducted on the farm of Department of Agricultural Meteorology at College of Agriculture, Pune during the *kharif* season of 2004 in a randomized block design with five treatments and four replications. The treatments under study were sowing in different meteorological week's *viz*. S_1 (25mw), S_2 (26 mw), S_3 (27 mw), S_4 (28 mw) and S_5 (29 mw). The experimental field was laid out in twenty unit plots each of 16.2 m^2 (4.50 x 3.60 m) gross and 9.72 m^2 (3.60 x 2.70 m) net size. A distance of 2 m was kept between the plots. The soil of the experimental field was vertisol (medium black) clayey in texture. The recommended dose of fertilizer (60 kg N + 30 kg P + 30 kg K_2O ha^{-1}) and all the recommended agronomic practices were adopted during the experimental period. The various phenological characters *viz*. No. of days required for panicle initiation, anthesis and physiological maturity were recorded. The grain, fodder and biomass yields were recorded at the time of harvest.

RESULTS AND DISCUSSION

Effect on phenology : Data presented in Table 1 revealed that phenology as well as yield contributing characters differed significantly due to different sowing time from the initial stage of the crop up to the harvest. The rate of growth during panicle initiation stage was controlled by photoperiod. The mean number of predicted and observed days required for panicle initiation (PI) were 20.6 and 20.4 respectively with mean difference of 0.2 days and standard deviation of

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±0.84 days. The days required for anthesis depends upon the number of days required for panicle emergence. The mean value of the predicted days for anthesis was 52.4 as against observed days of 53.0 with mean difference 1.2 days and standard deviation of ±0.80 days. The mean predicted days for physiological maturity were 84.4 as against observed days of 82.6 with mean difference of 1.4 and standard deviation of ±0.45 days. The mean predicted and observed LAI was 2.9 and 3.32 respectively with difference of-0.34 and the standard deviation of ±0.86. Since all the growth stages predicted by the model DSSAT-3.5 with per cent error were less than 25 per cent, , the prediction was matching with the observed number of days for aforesaid phenological characters due to sowing of pearl millet with different sowing times.

Effect on grain yield : The mean predicted and observed values in grain yield (Table 2) were 2829.6 and 2439 kg ha^{-1} respectively, with a mean difference of 340.4 kg ha^{-1}. Further, the mean difference between predicted and observed values of fodder yield was 423.35 kg ha^{-1} with standard deviation of ± 811.66 kg, while, the mean difference

Table 1. Predicted and observed values of phenological characters of pearl millet as influenced by different sowing times.

Treatments	Phenology									Growth		
	Panicle initiation (PI) (days)			Anthesis (days)			Physiological maturity (days)			Leaf area index (LAI)		
	P	O	D	P	O	D	P	O	D	P	O	D
S_1	21	20	1	51	53	-1	86	85	1	4.24	4.06	0.18
S_2	20	21	-1	51	52	-2	85	83	1	2.90	3.84	-0.94
S_3	20	20	0	52	54	-2	84	82	1	2.49	3.86	-1.37
S_4	21	20	1	54	54	0	84	82	2	2.48	2.81	-0.33
S_5	21	21	0	54	55	-1	83	81	2	2.78	2.00	0.78
Mean	20.6	20.4	0.2	52.4	53.0	1.2	84.4	82.6	1.4	2.98	3.32	-0.34
S.D. ±	0.84	0.55	0.84	1.52	0.82	0.80	1.14	1.52	0.45	0.73	0.88	0.86

Table 2. Predicted and observed grain, fodder and biomass yield (kg ha^{-1}) and yield contributing characters of pearl millet as influenced by different sowing dates.

Treatments	Yield (kg ha^{-1})								
	Grain			Fodder			Biomass		
	P	O	D	P	O	D	P	O	D
S_1	3963	3651	304	8294	7888.75	405.25	12257	11547.5	709.5
S_2	3801	3000	801	6012	6873.5	-861.5	9813	9873.5	-60.5
S_3	3044	2380	664	6295	5495.0	800	9339	7875	1464
S_4	2259	1853	406	5592	5160.0	432	7852	7013	83.9
S_5	1081	1554	-473	5336	3995.0	1341	6418	5549	86.9
Mean	2829.6	2439	340.4	6305.8	5882.4	423.35	9135.8	8371	764.3
S. D. ±	1189.3	854.49	496.01	1171.5	1520.03	811.66	2195.24	2366.51	545.2

P = Model prediction, S. D. = Standard deviation, O = Observed value P. I. = Panicle initiation, D = (P-O), LAI = Leaf area index

Table 3. Summarized data set of observed and predicted phenology and yield parameter as influenced by different sowing times of peralmillet.

Variable	Units	N	O	P	So	Sp	D
Panicle initiation	Days	5	20.4	20.6	0.55	0.84	0.46
Anthesis	Days	5	53.0	54.4	0.82	1.52	0.63
Physiological maturity	Days	5	82.6	84.4	1.52	1.14	0.43
Leaf area index	Number	5	3.32	2.98	0.88	0.73	0.62
Biomass	kg ha-1	5	8371.6	9135.8	2366.51	2195.24	0.95
Fodder yield	kg ha-1	5	5882.4	6305.8	1520.03	1171.5	0.87
Grain yield	kg ha-1	5	2439.2	2829.6	854.49	1189.3	0.90

D = Degree of agreement, N = Number of sowing times, So = Std deviation of observeal value, Sp = Std. deviation of predicted values.

between predicted and observed values of biomass was 764.3 kg ha^{-1} with standard deviation of 545.2 kg ha^{-1}. Indicating that the observed and model predicted values fairly matching for the first two sowings of 25 and 26 mw over remaining delayed sowing times of pearl millet.

Hence, it can be concluded that the model over predicted the growth parameters for the last two sowings in 28 and 29 mw with error ranging between 10 and 25 per cent. Probably this may be influenced by the large errors in predictions of the maximum LAI by the model.

Summary measures : The summarized means of observed (O) and predicted (P) values of variables along with the standard deviation of observation (So) and prediction (Sp) and the degree of agreement (D) are presented in Table 3. This describes the quality of simulation. Willmott (1982) pointed out that the degree of agreement (D) is an important parameter in crop modelling. It should be within 0 (zero) and ±1 kg. However, in this study the values ranged between 0 and ±0.95 in case of all the phenological and yield parameters indicating the predicted values by DSSAT-3.5 model of above referred parameters were very well matched with observed value of different sowing times of pearl millet. These results are in agreement with the result of Mokashi, (2002) and Bhakad, (2003).

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Variability Studies in Physical Parameters of Fruit in Jackfruit (*Artocarpus heterophyllus* Lam.) Clones of Coastal Zone of Karnataka

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ABSTRACT

A significant variation in physical characters of fruit was observed among the 30 jackfruit selections surveyed and studied in this zone. A high coefficient of variation for cylinder mass (74.00%), fruit mass (62.84%), rind mass (56.39%); for bulb parameters such as flake mass (74.79%), bulb mass (71.17%) and single bulb mass (50.11%); and seed number (65.82%) and seed mass (75.25%) in seed related traits. The results are useful to select Jackfruit clones for crop improvement.

Key words : Jackfruit, variability, physical parameters, fruit, bulb, seed.

Jackfruit being cross pollinated comprises innumerable trees differing from each other in fruit characteristics. These types may be further divided depending on size of fruit, taste, odour of flesh, nature, shape and diversity of prickles on the rind for the maintenance of separate varieties (Singh, 1995).

Crop improvement programme in jackfruit has been initiated at the University of Agricultural Sciences, Dharwad, Karnataka, India during 2003-2005 under National Agricultural Technology Project with the aim of producing improved jackfruit cultivars for commercial production. In order to attempt crop improvement in this crop, there is a need to study the variability of jackfruits for physico-chemical qualities. In the present investigation, our goal was to study the variability existing in physical qualities jackfruits of coastal zone of Karnataka situated in Western Ghats of India where the jackfruit diversity exists.

MATERIALS AND METHODS

The 30 jackfruit types selected from coastal zone of Karnataka situated in Western Ghats of India were covered (Table 1). The districts of the trees were marked to facilitate frequent visits if fruits of desired stage were not available during the initial trip. The fruits were harvested at mature unripe stage to study the physico-chemical characters at edible ripe stage. The minimum sample size in each clone was three fruits.

Eighteen physical parameters were measured. Total fruit mass (kg), fruit length (cm), total number of bulbs, mass of total rind (kg), mean of rind thickness (cm) at 3 locations for each fruit was observed. Rind colour of fruit was recorded by visual observation. Mass of pulp without seeds (flake) in kilograms, flake thickness (cm), length and breadth each bulb (cm) inedible cylinder mass (kg) was also measured. Total mass of bulbs of each fruit was divided by total number of bulbs in that fruit to work out average mass of bulb. Colour of the bulb was visually observed and recorded. Flake percentage (edible portion) was calculated by dividing total mass of edible constituents (flakes = bulbs without seed) by total mass of fruit. Seed mass (kg) and number of seeds in each

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fruit were recorded. Per cent flake, seed, rind and cylinder were calculated. Shape of fruit was visually observed and recorded as per IPGRI descriptors for jackfruit (Anon., 2000).

The above 18 physical characters were considered for variability studies through the statistical methods viz., Standard Deviation and Coefficient of Variation.

RESULTS AND DISCUSSION

A significant variation in physical characters of fruit was observed among the 30 jackfruit selections surveyed and studied from the coastal zone of Karnataka. For convenience to proceed with discussion, these characters have been classified as fruit related traits (fruit mass, length, breadth, rind mass and cylinder mass), bulb characters and seed characters.

Fruit mass : Among the fruit related traits, maximum variability was found for cylinder mass (74.00%) followed by fruit mass (62.84%) and rind mass (56.39%) (Table 2). The minimum percentage of cylinder and rind was found in the selection UKH-26 (3.89%) and DKB-5 (27.22%) respectively. Cylinder and rind are inedible portions in a jackfruit making substantial contribution to the fruit mass. Hence, wide variability in these two traits in the present study offers scope for selecting the types with lower cylinder and rind mass, so that much of the fruit mass is determined by the edible part. Fruit mass is the most important character in popularization of jackfruit. In the present study, fruit mass had a range from 2.15 kg (UDB-14) to 18.74 kg (UKB-24) (Table 3). Large size of the fruit contributes to low acceptance of jackfruit (Schnell *et al*., 2001). Small to medium sized fruits with all favourable quality parameters are consumer friendly for dessert purpose. However, large sized fruits excelling in qualitative traits are more suitable for industrial purpose *viz*., canning or for selling in minimally processed form. Due to wide variation occurring in the fruit mass, the character may be considered for selecting the types from the view point of commerce. Such wide variations for these characters in jackfruit were also observed by Guruprasad (1981), Muralidharan *et al*. (1997), Mitra and Mani (2000) and Reddy *et al*. (2004). However, the coefficient of variation for fruit length, fruit breadth and rind thickness was low indicating that these traits are conserved in the process of evolution.

Bulb characters : Bulb characters portrayed appreciably high coefficient of

Table 1. List of dessert purpose jackfruit selections studied from coastal zone of Karnataka.

District/taluka	Selections with code	Total
Uttar Kannada	74°9' - 75°10' Longitude (E), 13°55' - 15°31 Latitude (N)	
Honnavar	UKH-15] UKH-18] UKH-22] UKH-26, UKH-27	5
Bhatkala	UKH24, UKB-25	2
Udupi *		
Kundapura	UDK-1, UDK-2, UDK-3, UDK-4, UDK-5, UDK-6, UDK-7	7
Udupi	UDP-9, UDP-10, UDP-11, UDB-13, UDB-14, UDB-15, UDB-16, UDP-17, UDP-31, UDP-32	10
Dakshina Kannada*	74°35' - 75°40 Longitude (E), 12°27' - 13°58' Latitude (N)	
Mangalore	DKM-1	1
Puttur	DKP-2, DKP-3	2
Bantwala	DKB-5, DKB-6, DKB-7	3

*It represents latitude and longitude of erstwhile Dakshina Kannada district which included Udupi also.

variation for flake mass (74.79%) followed by bulb mass (71.17%) and single bulb mass (50.11%) (Table-2). Bulb is the economically important part of jackfruit as it comprises the edible part (flake). The selection UDK-5 (43.55%) in the coastal zone recorded maximum percentage of edible portion (flake percentage) followed by UDP-17 (42.75%) and DKB-7 (41.91%) (Table-3). Bulbs with higher single bulb mass are attractive and commercially important especially when jackfruit is sold in minimally processed form. Single bulb mass was maximum in UDK-7 (71.36 g), UDB-15 (59.04 g) and DKP-2 (43.13 g). Hence, flake, bulb and single bulb mass need due consideration for selection of elite jackfruit types. Flake thickness, flake percentage, bulb length and bulb breadth exhibited lower coefficient of variation than the other bulb parameters investigated. Few published reports indicated the variation for bulb characters in jackfruit clones (Muralidharan *et al*. 1997; Mitra and Mani, 2000; and Reddy *et al*. 2004).

Table 2. Variations in fruit physical parameters of dessert type jackfruit selections of coastal zone of Karnataka.

Parameters character	Mean	CV (%)	SD	Rang	
				Mini-mum	Maxi-mum
Fruit mass (kg)	6.54	62.84	4.11	2.15	18.74
Fruit length (cm)	33.02	24.95	8.24	20.11	58.00
Fruit breadth (cm)	20.33	18.64	3.79	13.11	28.50
Rind thickness (cm)	0.94	26.59	0.25	0.23	1.38
Rind mass (kg)	2.66	56.39	1.50	1.03	7.37
Rind percentage	44.08	25.20	11.11	27.22	73.38
Cylinder mass (kg)	0.50	74.00	0.37	0.10	1.53
Cylinder percentage	7.25	27.72	2.01	3.89	12.67
Bulb mass (kg)	3.40	71.17	2.42	0.59	10.03
Single bulb mass (g)	26.58	50.11	13.32	12.16	71.36
Bulb length (cm)	5.71	19.09	1.09	4.23	7.83
Bulb breadth (cm)	3.32	16.56	0.55	2.38	5.03
Flake mass (kg)	2.42	74.79	1.81	0.40	7.84
Flake thickness (cm)	0.39	28.21	0.11	0.17	0.63
Flake percentage	34.22	20.69	7.08	14.24	43.55
Seed number	141.86	65.82	93.37	19.00	445.00
Seed mass (kg)	1.01	75.25	0.76	0.20	3.67
Seed percentage	15.43	34.74	5.36	7.00	24.67

CV = Coeffieicent of variance, SD = Standard deviation

Seed characters : Seed related traits namely seed mass (75.25%) and seed number (65.82%) also showed higher coefficient of variation. Mitra and Mani (2000) and Reddy *et al*. (2004) made similar observations in jackfruit selections. Seed number and seed mass respectively had a range from 19.00 (UDK-6) to 445.00 (DKB-5) and 0.20 kg (UDK-6) to 3.67 kg (DKB-5). More the number of seeds per fruit indicate more number of bulbs per fruit, although it may not guarantee the quantity and quality of edible portion. Hypothetically, between the two different jackfruits of equal mass, being rind and cylinder parameters and seed size constant, the fruit with less number of bold seeds will have more flake thickness and vice-versa. Higher seed percentage in total fruit mass will reduce the net edible portion. Hence selection may be carefully exerted for these traits taking thickness of flakes also into account.

Singh and Srivastava (2000) identified 18 clones of jackfruit as superior in various parts of eastern Uttar Pradesh based on fruit shape, weight, length and circumference, rind thickness, skin and pulp colour, fibre length, number of bulbs per fruit, bulb weight, length and width, cylinder percentage, TSS, total sugars, acidity, total minerals, seed weight, length, width, shape and colour, bearing, yield and fruit maturity. Wide variation of fruit physical parameters noticed in the jackfruit selections in the present study may be attributed to highly heterozygous nature of the crop and the clones covered in the study are of seedling origin. Such wide variations in other fruit crops have also been reported by several workers

Table 3. Fruit characters in dessert type jackfruit types of coastal zone of Karnataka.

Selection	Fruit mass (kg)	Fruit length (cm)	fruit breadth (cm)	Rind thickness (cm)	Edible portion (%)	Fruit shape	Fruit colour	Bulb mass (kg)	Flake mass (kg)	Flake thickness (cm)	Bulb colour	Seed mass (kg)	Rind percentage	Cylinder percentage	Edible (Falke) portion (%)	Seed percentage
UKH-15	3.52	30.00	16.50	0.70	30.17	3	G	1.54	1.60	0.350	Light yellow	0.477	57.69	4.60	30.17	13.54
UKH-18	3.99	28.10	18.00	0.23	26.84	3	*	1.85	1.07	0.390	Yellow	0.775	48.42	5.29	26.84	19.44
UKH-22	4.56	34.11	17.25	0.97	26.93	3	*	2.17	1.23	0.220	Yellow	0.940	45.39	7.04	26.93	20.63
UKB-24	18.74	58.00	28.50	1.38	41.81	3	GY	10.03	7.84	0.560	Yellow	2.192	39.33	7.16	41.81	11.70
UKB-25	3.74	28.50	18.00	0.53	37.43	*	*	2.23	1.40	0.170	Deep Yello	0.830	31.02	9.36	37.43	22.19
UKH-26	2.62	25.00	13.11	1.07	31.81	3	*	1.03	0.83	0.330	Yellow	0.442	47.42	3.89	31.81	16.88
UKH-27	4.41	29.03	19.00	0.73	41.21	3	*	2.62	1.82	0.420	Yellow	0.812	34.39	6.00	41.21	18.40
UDK-1	12.62	47.03	26.20	1.30	41.52	*	*	6.16	5.24	0.540	Yellow	0.920	44.69	6.50	41.52	7.29
UDK-2	4.59	25.50	19.50	0.80	34.72	3	G	1.92	1.59	0.590	Light Yellow	0.322	50.94	7.32	34.72	7.02
UDK-3	5.88	32.10	20.50	0.77	37.80	*	*	3.58	2.22	0.380	Light Yellow	1.358	34.14	4.98	37.80	23.08
UDK-4	14.32	39.13	27.20	0.90	41.29	3-4	G	7.46	5.91	0.430	Yellow	1.547	41.43	6.47	41.29	10.80
UDK-5	6.20	32.25	20.10	0.70	43.55	3	YG	3.60	2.70	0.440	White	0.900	32.90	9.03	43.55	15.52
UDK-6	2.79	30.11	17.00	1.20	14.24	6	G	0.59	0.40	0.420	Yellow	0.195	73.38	5.38	14.24	7.00
UDK-7	5.66	40.16	20.20	1.23	36.28	6	GY	2.59	2.05	0.630	Yellow	0.537	44.38	9.71	36.28	9.49
UDP-9	5.23	34.14	23.15	0.73	33.19	3	G	2.75	1.74	0.310	Yellow	1.014	40.15	7.99	33.19	19.38
UDP-10	8.20	34.50	26.50	0.83	38.69	4-5	LG	4.36	3.17	0.310	Lemon yellow	1.187	36.96	9.86	38.69	14.49
UDP-11	6.90	29.50	20.50	0.97	33.90	3	BG	3.40	2.34	0.380	Yellow	1.061	42.77	7.94	33.90	15.38
UDP-13	2.37	20.11	1618	0.93	32.07	3	*	1.17	0.76	0.330	Yellow	0.414	64.63	6.83	32.07	17.47
UDP-14	2.15	22.50	14.10	1.00	28.02	3	BG	0.93	0.60	0.430	Yellow	0.333	51.24	5.22	28.02	15.52
UDP-15	3.60	20.20	18.00	1.23	27.22	*	*	1.24	0.98	0.350	Yellow	0.260	60.56	5.00	27.22	7.22
UDP-16	7.31	34.22	23.19	0.73	36.86	2-3	*	4.17	2.70	0.310	Light Yellow	1.471	36.21	6.81	36.86	20.12
UDP-17	5.04	33.50	21.50	1.03	42.75	3	G	2.87	2.15	0.420	Light Yellow	0.716	34.41	8.63	42.75	14.21
UDP-31	10.66	35.50	22.50	1.13	38.65	*	*	6.24	4.12	0.430	Deep Yello	2.120	33.02	8.44	38.65	19.89
UDP-32	4.30	36.25	17.12	1.20	29.53	*	*	1.59	1.27	0.350	Orange	0.320	53.49	9.53	29.53	7.44
DKM-1	5.12	34.50	18.13	1.17	17.60	3	YG	1.88	0.90	0.300	Light Yellow	0.983	57.47	5.73	17.60	19.20
DKP-2	9.99	40.17	22.50	0.93	37.42	3	G	4.87	3.74	0.530	Yellow	1.129	44.93	7.30	37.42	11.30
DKP-3	8.21	36.50	22.50	0.78	34.23	3	G	4.81	2.81	0.320	Light Yellow	1.997	28.77	12.67	34.23	24.33
DKB-5	14.86	45.50	22.50	1.23	37.81	4	YG	9.28	5.62	0.340	Light Yellow	3.666	27.22	10.30	37.81	24.67
DKB-6	2.39	20.33	17.25	0.93	31.24	3	*	1.11	0.75	0.210	Yellow	0.361	47.83	5.85	31.24	15.08
DKB-7	6.30	34.08	23.10	1.00	41.91	3	G	3.89	2.90	0.380	Cream	0.988	37.30	6.53	41.91	14.27
Mean	6.54	33.02	20.33	0.94	34.22			3.40	2.42	0.386		1.009	44.08	7.25	34.22	15.43

(Jauhari *et al*. 1969 in bael, Sadhu and Bose, 1976 and Parida and Rao, 1988 in mango; Taeotia *et al*. 1968 in aonla. Gangaprasad. 1993 and Hanamashetti, 1996 in tamarind; Prabhuraj *et al*., 2003 in jamun). The information related to these parameters enables to select the jackfruit clones for crop improvement.

Variability studies for physico-chemical parameters in 30 dessert type jackfruits belonging to coastal zone of Karnataka revealed a high coefficient of variation for cylinder mass, fruit mass, and rind mass; for bulb parameters such as flake mass, bulb mass and single bulb mass; and seed number and seed mass in seed related traits. All these physical parameters may be given due consideration to operate selection procedure for identifying elite selections for dessert purpose. Other characters such as fruit length and fruit breadth were observed to have comparatively lower coefficient of variation pointing that these parameters are conserved during the process of evolution.

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Investigations on Physiological Parameters of Khirni (*Manilkara hexandra*, L.) Seedlings under Open and Shade Net House Conditions

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ABSTRACT

Among the various foliar treatments given to khirni seedlings after fifth and sixth months from the date of sowing, urea 1.5 per cent, cow urine 75 and 100 per cent foliar spray were found to be the best treatments for increasing the physiological parameters of khirni seedlings under shade net house and open conditions, while the treatment control i.e. no spray recorded the least increase in physiological parameters of khirni.

Key words : Physiological parameters, khirni, open and shade net house conditions, GA_3, cow urine, urea spray.

The most common commercial method of propagation of sapota at present are inarching and softwood grafting on khirni or rayan which is considered as the best rootstock for sapota in India. The growth of the khirni seedlings is dead slow and to attain graftable size, it requires about 2-3 years. The physiological parameters like chlorophyll content, stomatal count and N, P, K content of leaves has great significance in plant. The changes in these parameters due to the application of growth regulators, chemicals and organic waste in khirni plant will be highly informative. With this view point, the present study was undertaken to study the physiological parameters of khirni seedlings.

MATERIALS AND METHODS

Studies on physiological parameters of khirni seedlings were carried out at Marathwada Agricultural University, Parbhani by adopting the following treatments and using randomized block design for open condition and completely randomized block design for shade net house condition. The various treatments were T_0 - control (no spray), T_1-water spray, T_2 - GA_3 (100 ppm) spray, T_3 - GA_3 (125 ppm) spray, T_4 - GA_3 (150 ppm) spray, T_5 - urea spray (0.5 %), T_6 - urea spray (1.0 %), T_7 - urea spray (1.5 %), T_8 - cow urine (50 %), T_9 - cow urine (75 %) and T_{10} - cow urine (100 %) spray. Two foliar sprays with all above treatments were given after fifth and sixth months from the date of sowing on khirni seedlings and after that treated seedlings were kept under shade net house and open conditions for further studies. Fifty per cent shade net house having green colour was used for the experiment. Seeds were soaked in distilled water for 24 hours as a common treatment and sowing was done in polythene bags filled with 2 parts of soil + 1 part of sand and 1 part of FYM. Observations on physiological parameters like chlorophyll a, b and total chlorophyll contents of leaves, stomatal count and N, P, K content of khirni leaves were recorded at the end of the experiment i.e. 210 days after spraying.

RESULTS AND DISCUSSION

Chlorophyll content of leaves (mg g^{-1}): Under open condition, (Table 1) maximum a, b

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and total chlorophyll contents of khirni leaves (1.48, 1.45, 2.96 mg g^{-1}, respectively) was produced by the treatment urea spray 1.5 per cent, followed by urea spray 1.0 per cent (1.42, 1.38 and 2.82 mg g^{-1}, respectively). However, control recorded minimum a, b and total chlorophyll contents (0.56, 0.54 and 1.17 mg g^{-1}, respectively). Under shade net house condition (Table 2), maximum a, b and total chlorophyll contents of khirni leaves (1.51, 1.48 and 2.98 mg g^{-1}, respectively) was produced by the treatment urea spray 1.5 per cent than urea 1.0 and 0.5 per cent spray. It might be due to the fact that urea is a source of N, it contains 46 per cent to N and absorbed nitrogen plays an important role in pigment synthesis, particularly chlorophyll and hence there was increase in chlorophyll concentration

Table 1. Effect of different treatments on physiological parameters of khirni seedlings under open field conditions.

Treatment	Chlorophyll (mg g^{-1})		Cholorophyll total (mg g^{-1})	Stomantal count	Leaf content (%)		
	a	b			N	P	K
T_0 - Control (No spray)	0.56	0.54	1.17	911.65	1.21	0.07	0.90
T_1 - Water (spray)	0.75	0.77	1.54	899.57	2.01	0.08	1.04
T_2 - GA_3 100 ppm spray	0.81	0.86	1.68	882.10	2.56	0.11	1.46
T_3 - GA_3 125 ppm spray	0.84	0.88	1.73	859.15	2.57	0.13	1.48
T_4 - GA_3 150 ppm spray	0.90	0.99	1.87	761.65	5.65	0.16	1.59
T_5 - Urea spray 0.5%	1.37	1.36	2.75	876.76	2.80	0.10	1.30
T_6 - Urea spray 1.0%	1.42	1.38	2.82	870.30	2.83	0.13	1.34
T_7 - Urea spray 1.5%	1.48	1.45	2.95	811.20	2.85	0.14	1.38
T_8 - Cow urine 50% spray	1.17	1.22	2.41	809.24	2.72	0.18	1.76
T_9 - Cow urine 75% spray	1.18	1.23	2.42	735.28	2.77	0.20	1.84
T_{10} - Cow urine 100% spray	1.29	1.32	2.63	755.40	2.79	0.22	1.89
S. E. ±	0.04	0.03	0.08	6.43	0.05	0.01	0.03
C. D. at 5%	1.13	0.10	0.22	20.21	0.14	0.03	0.08

Table 2. Effect of different treatments on physiological parameters of khirni seedlings under shade net house conditions.

Treatment	Chlorophyll (mg g^{-1})		Cholorophyll total (mg g^{-1})	Stomatal count	Leaf content (%)		
	a	b			N	P	K
T_0 - Control (No spray)	0.58	0.57	1.19	912.70	1.24	0.07	0.93
T_1 - Water (spray)	0.77	0.80	1.56	900.61	2.05	0.01	1.07
T_2 - GA_3 100 ppm spray	0.83	0.88	1.71	883.15	2.59	0.15	1.48
T_3 - GA_3 125 ppm spray	0.86	0.90	1.76	860.20	2.61	0.17	1.51
T_4 - GA_3 150 ppm spray	0.92	1.02	1.86	762.70	5.68	0.20	1.63
T_5 - Urea spray 0.5%	1.40	1.39	2.78	877.80	2.84	0.14	1.33
T_6 - Urea spray 1.0%	1.45	1.40	2.84	871.35	2.86	0.16	1.37
T_7 - Urea spray 1.5%	1.51	1.48	2.98	812.25	2.88	0.17	1.41
T_8 - Cow urine 50% spray	1.20	1.24	2.43	810.30	2.75	0.21	1.79
T_9 - Cow urine 75% spray	1.21	1.25	2.45	736.33	2.80	0.24	1.87
T_{10} - Cow urine 100% spray	1.31	1.35	2.65	756.45	2.82	0.25	1.92
S. E. ±	0.04	0.03	0.07	6.43	0.02	0.01	0.04
C. D. at 5%	1.13	0.10	0.23	20.21	0.08	0.04	0.13

in khirni leaves. The effect of urea on increase in chlorophyll has been reported by many workers *viz*. Patil (2003) in sapoten, Kachave (2004) in kagzi lime, and Wankhede (2006) in khirni.

Stomatal count : The physiological parameters like stomatal count has great significance in plant, as it is directly related with the loss of water from the plant. In the present study, the stomatal structure was only observed in the lower surface of the leaves. Under open condition, it was observed that cow urine 75 per cent spray recorded minimum number of stomata (735.28), followed by cow urine 100 per cent spray (755.40). However, control recorded maximum number of stomata (911.65). Under shade net house condition, cow urine 75 per cent spray recorded minimum number of stomata (736.33) followed by cow urine 100 per cent to spray (756.45). However, control recorded maximum number of stomata (912.70). The results are in agreement with the findings of Wankhede (2006) in khirni.

N, P and K contents of leaves : It was observed that maximum N, P and K contents of khirni leaves (2.79, 0.22 and 1.89, respectively) was produced in the treatment cow urine 100 per cent spray. However, minimum N, P and K contents of khirni leaves was recorded in control (1.2, 0.07 and 0.90 per cent, respectively). Under shade net house condition, maximum N, P and K contents of khirni leaves (2.82, 0.25 and 1.92%, respectively) was produced by the treatment cow urine 100 per cent spray. However, control recorded minimum N, P and K contents of khirni leaves (1.2, 0.07 and 0.93 %, respectively). This might be because of the fact that nutrients present in cow-urine is helpful for increasing the N, P and K contents of the leaves. The results are in agreement with the findings of Deshpande (2003) in green gram, Rahudkar (2004) and Wankhede (2006) in khirni.

Thus, it may be concluded that urea 1.5, cow urine 75 and 100 per cent foliar spray were found to be the best treatments for increasing the physiological parameters of khirni seedlings under shade net house and open conditions when applied after fifth and sixth month from the date of sowing to khirni seedlings. Also shade net house was found superior over open condition in respect of physiological parameters of khirni.

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Effect of Organic Manures and Biofertilizers on Growth and Yield of Tomato

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ABSTRACT

The effect of different biofertilizers and inorganic fertilizers revealed that plant height, number of branches were significantly influenced by different biofertilizers in tomato. However, the increase in yield attributes like number of fruits, average weight of fruit, yield plant^{-1} and yield hectare^{-1} due to inorganic fertilizers was more or less similar with that produced by biofertilizers.

Key words : Tomato, *Trichoderma*, *Azospirillum*, PSB, trap crop, neemcake.

Recently due to introduction and successful breeding programmes the yield potential of tomato has increased considerably in India. The considerable high yield of tomato is due to heavy doses of inorganic fertilizers which arouses serious salinity or alkalinity problems of soils .as well as heavy application of plant protection measures which causes high residual effect in tomato fruit which is hazardous to human being. To date, the registration of number of agricultural chemicals have been voluntarily withdrawn because of toxicity problems. (Anon, 1988)

Biofertilizers have come to be known as low cost inputs in agriculture which give high results under favourable conditions. *Azospirillium* inoculation is reported to cause not only increase in yield of field crops but save nitrogen 20 to 40 per cent than recommended dose of fertilizers.

MATERIALS AND METHODS

The experiment was conducted during 2002-03 at Tomato Improvement Scheme, Department of Horticulture, MPKV, Rahuri. Dist. Ahmednagar. The experiment was laid out in a randomized block design with three replications. The plot size was 3.6 x 3.3 sqm. There were 14 treatment combinations comprising of seven treatments with marigold as trap crop and without trap crop. Out of 14 treatments, twelve treatments consisted of combination of different biofertilizers and organic manures while two treatments were having control i.e recommended dose of fertilizers.

Uniform soil application of Neemcake, biomeal and farm yard manure was done before transplanting. Seedlings were inoculated with *Azospirillium*, PSB and *Trichoderma* at the time of transplanting. Transplanting was done at the spacing of 90 x 30 cm. The net plot size was 1.8 x 2.7 sq. m. Five plants from each plot were selected randomly for recording the observation. At harvesting, height of plant and number of primary branches were counted.

The ripe fruits from observational plant were harvested and counted at each picking and summed up to obtain the total number of fruits per plant. The average weight of fruit was calculated by dividing weight of fruits plant^{-1} with number of fruits plant^{-1}.

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The fruits were harvested as and when ripened and the weight of fruit was recorded plot wise and then yield hectare^{-1} was calculated.

Table 1. Effect of different treatments on growth, yield and quality of tomato.

Treatment	Treatment details	Plant height (cm)	Primary branches plant^{-1}	Fruits plant^{-1}	Average fruit weight (g)	Yield plant^{-1} (kg)	Yield ha^{-1} (q)	TSS (%)	Pericarp thickness
T_1 :	Control (200:100:100 NPK kg ha) with trap crop of marigold + FYM	68.73	4.18	19.91	73.00	1.45	465.39	4.73	0.53
T_2 :	FYM + Neem cake + soil treatment with *Trichoderma* + *Azospirillum* + PSB with trap crop of marigold	68.80	4.44	19.91	70.99	1.41	452.37	4.33	0.56
T_3 :	Biomeal + neem cake + soil treatment with *Trichoderma* + *Azospirillum* + PSB with trap crop of marigold	68.20	4.18	19.66	70.33	1.38	442.75	4.61	0.65
T_4 :	FYM + soil treatment with *Trichoderma* + *Azospirillum* + PSB with trap crop of marigold	69.06	4.11	18.60	69.78	1.30	415.59	4.71	0.58
T_5 :	FYM + neem cake + soil treatment with *Trichoderma* + PSB with trap crop of marigold	68.73	4.06	18.99	70.34	1.33	426.90	4.48	0.61
T_6 :	FYM + neem cake + soile treatment with *Azospirillum* + PSB with trap crop of marigold	68.53	4.09	18.72	69.29	1.30	418.29	4.03	0.67
T_7 :	FYM + Neem cake + soil treatment with *Trichoderma* + *Azospirillum* + PSB with trap crop of marigold	68.20	4.03	18.42	72.50	1.27	408.52	4.30	0.55
T_8 :	Control (200:100:100 NPK kg ha) + FYM	68.80	4.30	19.73	70.18	1.43	457.76	5.00	0.49
T_9 :	FYM + neem cake + soil treatment with *Trichoderma* + *Azospirillum* + PSB	68.33	4.20	19.58	69.70	1.37	439.95	4.90	0.54
T_{10} :	Biomeal + neem cake + soil treatment with *Trichoderma* + *Azospirillum* + PSB	67.90	4.22	19.43	69.33	1.35	433.49	4.96	0.65
T_{11} :	FYM + soil treatment with *Trichoderma* + *Azospirillum* + PSB	67.66	4.20	18.14	70.06	1.26	402.63	4.76	0.58
T_{12} :	FYM + neem cake + soil treatment with *Trichoderma* + PSB	68.60	4.15	18.71	69.33	1.31	419.55	4.10	0.54
T_{13} :	FYM + neem cake + soil treatment with *Azospirillum* + PSB	69.00	4.15	18.20	68.33	1.26	403.89	4.63	0.58
T_{14} :	FYM + neem cake + soil treatment with *Trichoderma* + *Azospirillum*	68.60	4.26	17.82	68.32	1.22	389.72	4.86	0.64
S. E. $\pm$		0.24	0.19	0.13	0.23	0.007	2.26	0.15	0.029
C. D. at 5%		0.69	NS	0.37	0.67	0.022	6.58	0.44	0.084

RESULTS AND DISCUSSION

Height of plant : The data presented in Table 1 indicated that maximum height of plant was obtained in the treatment T_3 (69.06 cm) where FYM + *Trichoderma* + *Azospirillium* + PSB was applied and marigold was trap crop over control i.e T8 (68.80 cm) (Recommended dose). This could be due to inoculation with *Azospirillium* and PSB which increases N and P uptake and enhances fixation. The enhancement of plant growth ascribed to the influence of nitrogen, the chief constituents of protein, essential for the formation of protoplasm which might have to cell division and cell enlargement (Kuruthamani *et al*. 1995)

Number of branches : Highest number of primary branches plant^{-1} were recorded in T_2 (4.44) followed by T_8 (4.30), T_{14} (4.26), T_{10} (4.22). The results explain that application of nutrition through organic sources of manures is equally effective as that of inorganic fertilizers. A similar trend was recorded by Subbarao and Ravi Sankar (2001) in brinjal.

Number of fruits plant^{-1} : Data regarding number of fruits plant^{-1} revealed that the highest number of fruits plant^{-1} were recorded in the treatment T_1 i.e recommended fertilizer + trap crop and T_2 (19.91) followed by T_8 (recommended fertilizer dose) (19.73). Results indicated that the application of organic manures with biofertiliser was equally effective as that of the chemical fertilizers.

The increased number of fruits in treatments where chemical fertilizer was not applied could be attributed to higher metabolic activities because of optimum nitrogen supplies and phytoharmone which enhanced growth (Goviddan and Purushothaman,1984).

Average weight of fruits and yield : Data in respect of average weight of fruits revealed that the highest weight of fruit (73.00 g) was recorded in the treatment T1 (recommended dose + trap crop) and significantly higher over control was recorded in the treatment T7 (72.50 g). Increase in average weight of fruit due to application of organic manures might be due to favourable action of the microorganisms and positive effect of the manures which might have enhanced the micronutrient availability in the soil (Mahendran and Kumar, 1997). Similar results were reported by Dixit (1997), Patil *et al*. (2000) and Londhe (2002) in cabbage.

Yield : Highest fruit yield was obtained with treatment T1 (recommended dose + trap crop). This was followed by treatment T_8 (1.42) and T_2 (1.41). Both organic and inorganic treatments gave more or less same yield. Application of biofertilizers along with the manures gave same yield as that of yield recommended dose, This might be due to favourable action of combination of different biofertilizers *Azospirillum*, PSB which produced growth harmone like IAA and GA which positively influenced on yield (Kuruthamani *et al*. 1995), PSB increases P_2O_5 uptake and transforms unavailable mineral and organic compounds into available form to plant (Vimala and Natrajan, 1999).

The organic farming may result into low yield as compared to inorganic farming but in the long run it can be compensated as reported by Dayananad *et al*. (2003).

Total soluble solids : In respect of total soluble solid content of fruits, significant difference was recorded amongst the different treatments. Data revealed that the highest TSS (5.0) was recorded in the treatment where recommended dose of fertilizer was applied followed by the treatments T_{10} (4.96) and T_9 (4.90). The increase in TSS by use of inorganic fertilizers was also reported by Mahendran and

Kumar (1997) in cabbage.

Pericarp thickness : Data with respect to pericarp thickness revealed that the highest pericarp thickness was recorded in the treatment T_6 where TSS recorded was 0.67 and it was followed by treatments T_3 (0.65) and T_{10} (0.65). Pericarp thickness where recommended dose of fertilizer was applied was 0.49 cm. Data revealed that application of nutrition through organic source resulted in better pericarp thickness which might have resulted due to balanced nutrition supply and better soil health in these treatment. Parvatham and Vijayan (1989) also reported increase in the pericarp thickness due to application of organic manures.

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N_2 Fixation as Influenced by Various Parameters in Groundnut

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ABSTRACT

The *Rhizobium* inoculation to the seeds of groundnut with half dose of nitrogen at sowing and 30 DAS (12.5 kg ha^{-1}) produced maxium number and dry matter weight of nodules, nitrogen content in nodules, grain and dry matter yield. Half dose of nitrogenous fertilizer applied at 30 DAS, significantly gave higher yield than the application of full dose of nitrogen at sowing or 30 DAS in groundnut. The treatment of *Rhizobium* and split application of nitrogen at 30 DAS also showed increase in 1000 grain weight and protein percentage in the seeds in both the varieties (JL-24 and TAG-24) of groundnut. The groundnut variety JL-24 found suitalble for application of *Rhizobium* inoculation alongwith half dose of fertilizer nitrogen at sowing and 30 DAS than variety TAG-24.

Key words : *Rhizobium*, groundnut.

Groundnut (*Arachis hypogaea* L.) crop occupies a very important place in human diet as well as in Industry. The prices of nitrogenous fertilizers are increasing with increase in the prices of petroleum products. It is therefore, found necessary to use some partially substitutes for nitrogen fertilizers. It has been revealed that the use of *Rhizobium* to groundnut crop was found to reduce the requirement of nitrogenous fertilizers substantially (Subba Rao, 1976).

Inoculation of the seeds of pulses or oilseeds like groundnut with an effective *Rhizobium* strain before sowing has become one of the important practice and an increasing effective nodulation and yield. Host *Rhizobium* interaction is one of the most important factor in the success of symbiotic relationship (Subba Rao, 1976). *Rhizobium* in groundnut plays an important role in nitrogen economy of groundnut (Thakare and Rasal, 2000).

Hence optimum combination between the *Rhizobium* and nitrogenous fertilizer to groundnut crop, needs to be investigated in order to increase the crop production at reasonable price.

The present investigation was therefore, planned to find out the optimum combination between the *Rhizobium* inoculation and nitrogenous fertilizer to groundnut.

MATERIALS AND METHODS

A field experiment was carried out during *kharif* season of 2005 to study N_2 fixation as influenced by various parameters in groundnut in a factorial randomized block design with 8 x 2 treatment combination replicated three times. Two groundnut varieties, JL-24 and TAG-24 were planted at gross plot size of 4.5 x 3.0 m and net plot was 3.6 x 2.5 m. The treatments were T_1 : *Rhizobium* inoculation, T_2 : Nitrogen application at sowing (25 kg ha^{-1}), T_3 : *Rhizobium* inoculation + nitrogen application at sowing (25 kg ha^{-1}), T_4 : Nitrogen application at 30 DAS (25 kg ha^{-1}), T_5 :

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Rhizobium inoculation + nitrogen application at 30 DAS (25 kg ha^{-1}), T_6 : *Rhizobium* inoculation + half dose of nitrogen at sowing (12.5 kg ha^{-1}), T_7 : *Rhizobium* inoculation + half dose of nitrogen at 30 DAS (12.5 kg ha^{-1}), T_8 : Uninoculated control.

Table 1. Nodulation and growth parameters as influenced by different treatments in groundnut.

Treatments	Nodulation plant^{-1} (90 DAS)		Plant height (90 DAS)	Nitrogen content (g 100 g^{-1})			Total chlorophyll (mg g^{-1} fresh weight)	Chlorophyll a/b ratio (%)	Nitrate reductase activity (μ mol NO_2 g^{-1} hr^{-1})
	No.	Dry wt. (mg)		Shoot	Root	Nodules			
Varieties :									
V_1 - JL-24	118.19	132.60	28.50	3.23	2.35	2.78	10.97	2.38	0.321
V_2 - TAG-24	114.36	129.50	26.10	3.11	2.25	2.74	10.50	2.32	0.316
S. E. ±	0.200	0.199	0.59	0.016	0.010	0.007	0.057	0.019	0.002
C. D. (0.05)	0.579	0.573	0.171	0.045	0.028	0.021	0.165	0.054	NS
Treatments :									
T_1	114.48	122.09	27.30	3.08	2.32	2.81	10.89	2.47	0.313
T_2	110.46	118.38	26.14	2.95	2.02	2.68	10.34	2.42	0.310
T_3	119.14	128.91	27.39	3.23	2.42	2.89	11.08	2.47	0.318
T_4	103.58	113.14	25.91	2.71	1.93	2.37	9.57	2.24	0.307
T_5	124.15	141.35	27.59	3.51	2.57	2.98	11.42	2.40	0.324
T_6	128.71	154.07	28.15	3.68	2.62	3.09	11.76	2.31	0.333
T_7	135.10	165.78	30.85	3.85	2.76	3.16	12.24	2.33	0.343
T_8	94.54	104.68	24.98	2.36	1.78	2.09	8.74	2.16	0.303
S. E. ±	0.401	0.397	0.119	0.031	0.019	0.015	0.114	0.037	0.005
C. D. (0.05)	1.158	1.147	0.343	0.090	0.056	0.043	0.331	0.107	0.013
Interaction :									
V_1T_1	116.33	123.19	28.59	3.15	2.46	2.83	11.06	2.48	0.316
V_1T_2	113.28	119.31	27.22	3.00	2.12	2.69	10.83	2.38	0.312
V_1T_3	120.01	130.60	28.65	3.31	2.51	2.91	11.24	2.49	0.319
V_1T_4	104.99	112.55	27.01	2.75	1.96	2.40	9.74	2.26	0.309
V_1T_5	125.53	143.38	28.77	3.60	2.58	3.00	11.54	2.37	0.328
V_1T_6	131.15	157.88	29.18	3.78	2.63	3.12	11.98	2.35	0.335
V_1T_7	138.06	168.16	32.30	3.90	2.79	3.20	12.52	2.57	0.346
V_1T_8	96.15	105.67	26.12	2.40	1.80	2.11	8.90	2.17	0.304
V_2T_1	112.63	120.99	26.01	3.02	2.18	2.80	10.73	2.46	0.310
V_2T_2	107.65	117.45	25.06	2.91	1.92	2.68	9.85	2.28	0.308
V_2T_3	118.27	127.23	26.13	3.16	2.33	2.88	10.93	2.28	0.316
V_2T_4	102.18	113.73	24.82	2.68	1.90	2.35	9.40	2.23	0.305
V_2T_5	122.77	139.32	26.42	3.42	2.56	2.96	11.30	2.44	0.320
V_2T_6	126.28	150.27	27.12	3.59	2.62	3.06	11.55	2.27	0.331
V_2T_7	132.14	163.40	29.40	3.80	2.74	3.13	11.97	2.46	0.340
V_2T_8	92.94	103.58	23.85	2.32	1.76	2.08	8.59	2.14	0.301
S. E. ±	0.567	0.561	0.168	0.044	0.027	0.021	0.162	0.052	0.007
C. D. (0.05)	1.638	1.622	NS	NS	0.079	NS	NS	NS	NS

N. S. : Non-significant

The various observations were recorded on nodulation parameters *viz*., number of nodules, dry weight of nodules, plant height at 30, 60 and 90 DAS. The N content were recorded at 60 days of crop growth. The N content of shoot, root and nodules was determined by Micro-kjeldahl's method (Jackson *et al*. 1971). The growth promoting characters, height, total chlorophyll content of fresh leaves were recorded at 60 DAS. The chlorophyll content of leaves was determined with the help of 80 per cent alcohol and spectrophotometer at 645 and 663 λ as suggested by Arnon (1949). The 1000 grain weight, grain yield, dry matter yield and protein were recorded at harvest. The data were subjected to statistical analysis by following the standard methods (Panse and Sukhatme, 1985).

RESULTS AND DISCUSSION

Nodulation : Nodulation and growth parameters play an important role in increasing grain yield of groundnut. Present study revealed significant differences in number of nodules plant^{-1} at 60 DAS (Table 1). The highest numbers of nodules (69.00, 131.52, 138.06) and (67.69, 125.91, 132.14) were produced in the treatment *Rhizobium* + half dose of nitrogen at 30, 60 and 90 DAS V_1T_7 and V_2T_7 of groundnut varieties JL-24 and TAG-24, respectively. However, all the treatments were found superior to contol. The varieties and treatments differences found significant, while the interaction effect was found statistically non-significant at 60 DAS.

The highest dry matter weight of nodules produced by V_1T_7 (57.77, 145.28, 168.16 mg plant^{-1}) and V_2T_7 (55.89, 139.27, 163.40 mg plant^{-1}) at 30, 60 and 90 DAS in JL-24 and TAG-24, respectively. The interaction effects were found non-significant in respect of dry matter weight of nodules at 60 days of crop growth. The results are in conformity with the results of Gunjal and Shinde, (1983), Hassan *et al*. (1992); Kishinevsky *et al*. (1997) and Thakare and Rasal (2000) in groundut.

Growth and yield parameters : The maximum height of the plant at 30, 60 and 90 days of crop growth (9.63, 21.13, 32.30 cm) and (8.40, 20.12, 29.40 cm) was recorded in the treatments V_1T_7 and V_2T_7 in JL-24 and TAG-24, respectively. The differences within the varieties and treatments were found significant and interaction between varieties x treatments were found non-significant at 30 and 90 DAS crop growth in JL-24 and TAG-24, respectively. While interaction between varieties x treatment were found significant at 60 DAS.

The highest nitrogen content in shoot and root (3.90, 2.79 g 100 g^{-1}) and (3.80, 2.74 g 100 g^{-1}) were recorded in the treatments V_1T_7 and V_2T_7 in JL-24 and TAG-24, respectively. The variety JL-24 recorded more nitrogen content in shoot and root than TAG-24 at 60 days of crop growth.

The highest nitrogen content in nodules (3.20 g 100 g^{-1}) and (3.13 g 100 g^{-1}) were recorded in the treatments V_1T_7 and V_2T_7 in JL-24 and TAG-24, respectively. The differences within the varieties and treatments were found significant while interaction effects found non-significant in respect of nitrogen content in nodules at 60 days of crop growth.

The maximum amount of chlorophyll (12.52 and 11.97 mg g^{-1} fresh weight) were produced by the treatments V_1T_7 and V_2T_7 while least (8.90 and 8.59 mg g^{-1} fresh weight) were produced by the control V_1T_8 and V_2T_8 in JL-24 and TAG-24, respectively. The differences within the varieties and treatments were found significant while for interaction between varieties x treatments were found non-significant for total chlorophyll content at 60

days of crop growth.

The highest chlorophyll 'a' / 'b' ratio (2.57 and 2.46) was found in the treatments V_1T_7 and V_2T_7 in JL-24 and TAG-24 respectively. The trend of chlorophyll a/b ratio was more or less same in all the treatments and also in varieties. The treatment differences were found significant while interaction effects found non-significant at 60 days of crop growth.

The maximum nitrate reductase activity 0.346 and 0.340 µmol of NO^{-}_2 per g wt. h^{-1}

Table 2. Yield parameters as influenced by different treatments in groundnut.

Treat-ments	Pod yield (q ha^{-1})	Dry matter yield (q ha^{-1})	100 kernel weight (g)	Protein content in kernel (g 100 g^{-1})	Oil content (%)	N content in kernels
Varieties :						
V_1 - JL-24	24.26	27.98	29.00	26.49	46.06	4.24
V_2 - TAG-24	22.71	23.93	33.80	25.20	45.04	4.03
S. E. ±	0.022	0.038	0.034	0.127	0.017	0.020
C. D. (0.05)	0.065	0.109	0.099	0.368	0.049	0.059
Treatments :						
T_1	23.01	25.00	30.90	25.43	45.43	4.07
T_2	21.68	23.74	30.13	25.15	44.98	4.02
T_3	23.78	25.83	31.82	25.68	45.62	4.11
T_4	20.97	23.26	29.60	24.77	44.70	3.96
T_5	24.55	27.74	32.64	26.68	45.84	4.27
T_6	26.20	28.93	33.39	27.15	46.55	4.34
T_7	28.51	30.76	34.69	27.62	46.71	4.42
T_8	19.97	22.38	28.05	24.24	44.57	3.88
S. E. ±	0.045	0.075	0.069	0.255	0.034	0.041
C. D. (0.05)	0.130	0.218	0.198	0.735	0.097	0.118
Interaction :						
V_1T_1	24.10	27.04	28.40	25.87	46.01	4.14
V_1T_2	22.37	26.11	27.56	25.49	45.24	4.08
V_1T_3	24.88	27.62	29.82	26.18	46.19	4.19
V_1T_4	21.90	25.51	26.60	25.18	45.11	4.03
V_1T_5	25.63	29.66	30.63	27.74	46.48	4.44
V_1T_6	27.00	30.81	31.30	28.12	47.09	4.50
V_1T_7	29.69	32.86	32.61	28.68	47.33	4.59
V_1T_8	20.10	24.28	25.10	24.62	45.02	3.94
V_2T_1	21.92	22.97	33.40	24.99	44.86	4.00
V_2T_2	21.00	21.37	32.71	24.81	44.72	3.97
V_2T_3	22.68	24.04	33.83	25.18	45.06	4.03
V_2T_4	20.04	21.02	32.61	24.37	44.30	3.90
V_2T_5	23.48	25.83	34.65	25.62	45.20	4.10
V_2T_6	25.40	27.06	35.48	26.18	46.02	4.19
V_2T_7	27.34	28.67	36.78	26.56	46.10	4.25
V_2T_8	19.85	20.48	31.00	23.87	44.12	3.82
S. E. ±	5.44	1.07	0.097	0.360	0.048	0.058
C. D. (0.05)	16.28	3.08	0.280	NS	0.137	NS

NS : Non significant

was recorded in treatments V_1T_7 and V_2T_7 in JL-24 and TAG-24 respectively.

The highest pod yield (Table 2) 29.69 and 27.34 q ha^{-1}, dry matter yield (32.86 and 28.67 q ha^{-1}), 100 kernels weight (32.61 and 36.78 g), protein centent (28.68 and 26.56 g 100 g^{-1}), oil content in kernels (47.33 and 46.10 g 100 g^{-1}) and nitrogen content in kernels (4.59 and 4.25 g 100 g^{-1}) were found in the treatment V_1T_7 and V_2T_7 and minimum attributes were recorded in control V_1T_8 and V_2T_8 in JL-24 and TAG-24 respectively. The variety JL-24 recorded more favorable results than TAG-24. The differences within varieties and within treatments were found significant while interaction effect was found non-significant in respect of nitrogen content in kernels.

The results in the present investigation concluded that the *Rhizobium* inoculation to the seeds of groundnut at the time of sowing and in addition of fertilizer nitrogen i.e. half dose (12.5 kg N ha^{-1}) at 30 DAS resulted in increased plant growth, nodulation, dry matter weight and pod yield of groundnut crop. The groundnut variety JL-24 was superior for the application of *Rhizobium* inoculation and half dose of fertilizer nitrogen at 30 DAS than variety, TAG-24. These results are in agreement with the results reported by Kishinevsky *et al*. (1997) and Thakare and Rasal (2000) in groundut.

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Variability for Nitrogen Fixation in Mungbean [*Vigna radiata* L. Wilczek]

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ABSTRACT

A field experiment was conducted to evaluate 23 mungbean genotypes for 11 characters. Pods plant^{-1} had higher GCV and nitrogen fixation plant^{-1} had higher PCV followed by pods plant^{-1}. High estimates of heritability and genetic advance as per cent of mean were observed for pods plant^{-1} and root nodule volume plant^{-1}. High significant positive correlation was observed for nitrogen fixation plant^{-1} with root nodule volume plant^{-1}, number of root nodules plant^{-1} and main root length at both phenotypic and genotypic level. High significant negative correlation was recorded for root nodule, nodule volume, nodule dry weight and main root length with seed yield.

Key words: GCV, PCV, heritability, genetic advance, correlation coefficient, mungbean.

Mungbean is an important legume crop in India. It is gaining importance due to its wider adaptability and low input requirement. Genetic variability is study about the presence of differences in their genetic constitution. It is of utmost importance as it provides the basis for effective selection. However, very limited attention has been given to improve the nitrogen nutrition of legumes by breeding for increased nitrogen fixation. Many workers have reported that nodule formation and subsequent nitrogen fixation is a heritable character and responds to selection (Singh and Murthy 1988). The present study was undertaken for getting basic information on interrelationship existing among yield and traits governing nitrogen fixation.

MATERIALS AND METHODS

Twenty three mungbean genotypes were grown in a randomized block design with three replications at Research Farm, Allahabad Agriculture Institute-Deemed University, Allahabad during *kharif*, 2007. Each genotype was sown in a plot of 2 x 2 m length maintaining a crop geometry of 30 x 10 cm. Data were recorded on 11 characters *viz*., number of root nodules, nodules volume, nodules dry weight, main root length, nitrogen fixation, plant height, number of clusters, number of pods, pod length, 100 seed weight and seed yield. Observations on nitrogen fixing characters like root nodules, nodules volume, nodules dry weight and main root length were taken four times at 10 days intervals i.e., 30, 40, 50 and 60 DAS and nitrogen content in the plant was estimated by the method suggested by Walkley (1947). Analysis of variance was done by the method given by Fisher (1936), GCV, PCV, heritability and genetic advance as per procedure advocated by Burton (1952), and Johnson *et al*. (1955), respectively. Genotypic and phenotypic correlation were calculated using standard method suggested by Al-Jibouri *et al*. (1958).

RESULTS AND DISCUSSION

Mean performance of all 23 genotypes is presented in Table 1. Genotypes, KM 7-207,

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KM 7-203, KM 7-179 and KM 7-212 recorded more number of root nodules plant^{-1}. Genotypes, KM 7-202, KM 7-194, KM 7-212 and KM 7-176 registered high nodule volume plant^{-1}. Main root length was observed long in genotypes, KM 7-211, KM 7-202, KM 7-212 and KM 7-178 and relatively nitrogen fixation was maximum for KM 7-200, KM 7-203, KM 7-176 and KM 7-202. More number of pods plant^{-1} were recorded for KM 7-173, KM 7-187, KM 7-202 and KM 7-174 and 100-seed weight was high for KM 7-189, KM 7-212 and KM 7-190 whereas seed yield plant^{-1} was recorded high for KM 7-187, KM 7-182, KM 7-173 and KM 7-179 (Table 1). Number of root nodules, nodule volume and nodule dry weight steadily increased from 30 to 50 DAS however, at 60 DAS these characters decreased significantly. Lindermann and Gloves (1972) reported that nodules lose their ability to fix nitrogen because at the time of pod filling, the plants feed the developing seeds rather than the nodules.

The phenotypic expression of the character is the result of interaction between genotype and environment. High phenotypic coefficient of variation (PCV) was observed for nitrogen

Table 1. Mean performance of mungbean genotypes for different characters.

S. No.	Genotypes	Root nodules plant^{-1}	Nodule dry weight plant^{-1} (mg)	Main root length (cm)	Nitrogen fixation plant^{-1}	Plant height (cm)	Clusters plant^{-1}	Pod plant^{-1}	Pod length (cm)	100 seed weight (g)	Seed yield plant^{-1} (g)
1	KM 7-173	17.67	0.21	15.93	0.03	62.20	13.47	55.70	7.30	4.34	15.07
2	KM 7-174	21.33	0.22	15.36	0.03	54.50	10.27	31.10	7.46	3.89	12.07
3	KM 7-178	23.67	0.31	17.43	0.02	62.28	11.40	223.70	7.47	3.83	11.70
4	KM 7-179	24.00	0.32	15.86	0.04	66.70	11.37	23.10	7.93	4.07	11.98
5	KM 7-180	23.67	0.34	14.73	0.04	63.33	11.50	15.10	7.43	3.60	13.27
6	KM 7-181	23.33	0.21	14.00	0.02	72.83	8.37	23.07	7.73	3.66	10.83
7	KM 7-182	18.00	0.29	13.20	0.01	85.67	15.50	22.73	8.06	4.60	17.40
8	KM 7-184	19.67	0.38	15.87	0.02	76.33	12.57	18.97	7.80	4.00	11.20
9	KM 7-187	19.67	0.29	14.98	0.03	69.70	15.17	34.57	7.96	3.94	18.37
10	KM 7-189	21.33	0.30	14.78	0.05	54.40	10.37	23.67	9.70	5.92	12.00
11	KM 7-190	20.00	0.37	15.27	0.03	59.27	12.37	29.17	7.53	5.24	10.77
12	KM 7-191	19.33	0.38	17.10	0.02	56.47	10.13	29.80	8.03	4.03	8.17
13	KM 7-192	19.67	0.30	17.60	0.04	63.47	13.17	22.93	9.33	4.50	7.73
14	KM 7-193	20.67	0.35	16.40	0.04	72.17	11.40	17.50	8.80	4.43	14.67
15	KM 7-194	22.33	0.38	17.16	0.03	64.37	18.47	29.57	7.93	4.40	19.80
16	KM 7-198	22.33	0.22	15.94	0.02	63.77	13.03	19.03	8.03	4.15	12.40
17	KM 7-200	22.67	0.23	16.70	0.05	61.10	12.50	30.60	7.50	4.19	11.67
18	KM 7-202	22.67	0.32	17.97	0.04	62.23	12.70	33.37	7.57	4.26	11.93
19	KM 7-203	24.00	0.29	17.03	0.05	71.80	11.97	17.13	7.60	4.54	10.17
20	KM 7-207	24.33	0.29	15.83	0.02	63.53	15.93	17.87	7.50	3.73	10.07
21	KM 7-211	24.00	0.35	18.00	0.05	56.13	11.57	28.47	7.36	4.07	12.77
22	KM 7-212	22.67	0.22	17.67	0.05	66.17	12.40	19.50	10.13	5.43	12.30
23	KM 7-176	23.00	0.36	16.83	0.05	70.13	13.97	19.13	7.33	3.97	8.53
CV		4.06	9.59	3.82	47.95	4.91	10.92	7.73	8.30	11.07	12.06
SE±		0.51	0.02	0.36	0.01	1.85	0.80	1.14	0.38	0.27	0.83

fixation plant^{-1}, pods plant^{-1} and seed yield plant^{-1}, indicating the favourable effect of environment on these characters. Genotypic coefficient of variation (GCV) measures the range of variability available in a crop and also enables to compare the amount of variability present in different characters. The GCV was high for pods plant^{-1}, nitrogen fixation plant^{-1} and seed yield per plant (Table 2).

The relative magnitude of differences of phenotypic and genotypic coefficient of variation was found to be narrow for the characters root nodules plant^{-1}, nodules volume plant^{-1}, main root length, plant height and pods plant^{-1}, indicating the maximum reflection of genotype into phenotype and least environmental influence in the expression of this trait. In contrast, nitrogen fixation plant^{-1}, clusters plant^{-1}, 100 seed weight, pod length, seed yield plant^{-1} and nodules dry weight plant^{-1} registered a relatively wider magnitudinal differences between PCV and GCV, suggesting greater role of environment interacting with the genetic factors in the expression of these traits (Table 2).

Burton (1952) suggested that genotypic coefficient of variation along with high heritability would give a clear idea about the amount of genetic advance to be expected by phenotypic selection. All the characters except nitrogen fixation plant^{-1} recorded high heritability. Number of pods plant^{-1} recorded highest heritability (95.1) followed by nodule volume (92.4) and plant height (83.6). Heritability for nitrogen fixation plant^{-1} was found to be low (24.3) indicating high degree of non heritable variation for this character (Table 2). Genetic advance as per cent of mean was found to be high for the characters such as pods plant^{-1}, nodule volume plant^{-1}, seed yield plant^{-1}, nodules dry weight plant^{-1}, clusters plant^{-1} and nitrogen fixation plant^{-1}. As such these characters were under the control of additive gene.

Table 2. Genetic parameters for different characters in mungbean

Character	PCV	GCV	h^2(bs) (%)	GA	GA% mean
Root nodule plant^{-1}	9.90	9.03	83.2	3.69	16.98
Nodule volume plant^{-1} (ml)	21.21	20.44	92.8	0.27	40.57
Nodule dry weight plant^{-1} (mg)	20.87	18.54	78.9	0.10	33.92
Main root length (cm)	8.58	7.68	80.2	2.29	14.18
Nitrogen fixation plant^{-1} (%)	55.12	27.18	24.3	0.009	27.61
Plant height (cm)	12.13	11.08	83.6	13.59	20.86
Clusters plant^{-1}	19.53	16.19	68.7	3.48	27.65
Pods plant^{-1}	34.73	33.86	95.1	17.32	68.01
Pod length (cm)	11.86	8.47	50.9	0.99	12.45
100 seed weight (g)	16.06	11.64	52.5	0.75	17.38
Seed yield plant^{-1} (g)	23.91	20.65	74.6	4.39	36.74

High heritability coupled with high genetic advance as per cent of mean were recorded for pods plant^{-1}, nodule volume plant^{-1}, seed yield plant^{-1}, nodule dry weight plant^{-1} and clusters plant^{-1}, suggesting preponderance of additive gene action in expression of these characters. Therefore, selection for these characters will be effective. However, other characters such as root nodules plant^{-1}, main root length, plant height, pod length and 100 seed weight had high heritability with moderate genetic advance, suggesting greater role of non additive gene action in their inheritance. Therefore, heterosis breeding could be used to improve these traits. Low heritability coupled with high genetic advance recorded by nitrogen fixation plant^{-1} confirmed that the character is governed by additive gene action. Hence, selection for these traits would be effective for genetic improvement (Table 2).

Table 3. Estimates of genotypic (rg) and phenotypic (rp) correlation coefficient for 10 characters in 23 genotypes of mungbean.

Characters	Phe-no-type	Nodule volume plant^{-1}	Nodule dry weight plant^{-1}	Main root length	Nitro-gen fixation	Plant height	Clus-ters plant^{-1}	Pods plant^{-1}	Pod length	100 seed weight	Seed yield plant^{-1}
Root nodule plant^{-1}	rg	0.405**	-0.064	0.332**	0.503**	-0.200	-0.148	-0.506**	-0.246*	-0.368	-0.368**
	rp	0.332**	-0.023	0.270**	0.236**	-0.187	-0.165	-0.460**	-0.105	-0.225	-0.304**
Nodule volume plant^{-1}	rg		-0.065	0.559**	0.684**	-0.057	0.479**	0.007	0.004	0.011	-0.263*
	rp		-0.047	0.509**	0.326**	0.028	0.385	0.012	-0.019	0.069	-0.251*
Nodule dry weight plant^{-1}	rg			0.219	-0.007	0.010	0.185	-0.246*	-0.119	0.050	-0.284*
	rp			0.187	0.029	0.053	0.163	-0.209	-0.079	-0.049	-0.236*
Main root length	rg				0.578**	-0.414**	0.086	0.056	0.099	-0.009	-0.518**
	rp				0.312**	-0.324**	0.037	0.058	0.049	0.037	-0.431**
Nitrogen fixation plant^{-1}	rg					-0.435**	-0.026	-0.015	0.575**	0.575**	-0.139
	rp					-0.185	-0.141	-0.014	0.048	0.237*	-0.009
Plant height	rg						0.440**	-0.035	0.004	-0.189	0.394**
	rp						0.207	-0.306*	0.007	-0.055	0.266**
Clusters plant^{-1}	rg							0.107	-0.123	0.028	0.165
	rp							0.121	-0.043	-0.023	0.133
Pods plant^{-1}	rg								0.317**	0.198	0.293**
	rp								-0.208	0.019	0.255
Pod length	rg									0.891**	0.078
	rp									0.500**	0.059
100 seed weight	rg										0.090
	rp										0.060

Number of root nodules plant^{-1}, nodule volume and main root length were found significant and positively correlated with nitrogen content plant^{-1}, indicated that these observations were more important for biological nitrogen fixation (Table 3). These supported the findings of Singh and Murty (1988), while nodule dry weight was not a good indicator of nitrogen fixation potential in mungbean. Seed yield was observed positively and significantly correlated with number of pods plant^{-1} and plant height at both genotypic and phenotypic levels. Thus, selection for high yield on the basis of above two characters would be reliable.

Significant negative correlations were observed for number of root nodules, nodule volume, nodule dry weight and main root length with seed yield, further negative correlation also existed between nitrogen content plant^{-1} and seed yield. This suggested that the high nitrogen fixing genotypes might not be high yielder because of the antagonistic relationship between grain yield and total nitrogen content in plant. Hence it might not be possible to mix yield and biological nitrogen fixing characters together (Singh and Murty, 1988). The possible reasons for this negative correlation might be that all the pulses are C_3 plants and for biological nitrogen fixation, the host plant had to sacrifice carbon to grain nitrogen (Bergersen, 1971). Hence this might affect the carbohydrate synthesis to a great extent.

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Randomly Amplified Polymorphic DNA Fingerprinting of Bacterial Leaf Blight Resistant and Susceptible Rice (*Oryza sativa* L.) Genotypes

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ABSTRACT

A set of 29 bacterial blight resistant and susceptible rice (*Oryza sativa* L.) genetypes was subjected to RAPD analysis. PCR with 33 arbitrary 10-mer oligonucleotide primers, applied to 29 genotypes, produced a total of 305 different marker bands of which 75.8 per cent were polymorphic. The size range of amplified DNA was mostly between 120 bp and 5125 bp. Visual examination of electrophoresis gels and analysis of banding patterns confirmed that, resistant genotypes produced particular banding pattern and susceptible differs from that of resistant genotypes. This was further exhibited after dendrogram construction which reveals the clustering of resistant genotypes in one group and susceptible in other group.

Key words : Rice, BLB, RAPD, fingerprinting.

The development of molecular marker based diagnostic tools for the selection of resistant genotypes is one of the goals of rice breeding programs (Blair and McCouch, 1997). In case of disease resistance, availability of markers tightly linked to the resistant genes will help in identifying plants carrying these genes simultaneously, without subjecting them to pathogen or insect attack and with no limitation on the number of rounds of selection in a year. RAPD has been used to quickly identify markers within a genomic region of interest using Near isogenic Lines (NILs) (Williams *et al*. 1990). RAPDs have been used for evaluation of genetic diversity in *O. saliva* cultivars (Fukuoka *et al*. 1992) and upland and lowland varieties (Yu and Nguyen, 1994), identification and parentage determination (Wang *et al*. 1994).

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RAPD analysis is also a useful tool in determining the genetic relationships among rice cultivars as investigated by Yu and Nguyen (1994). Akagi *et al*. (1997) has classified japonica rice cultivars using RAPD and STMS markers. The genetic similarities and diversity among seven Egyptian rice genotypes was established by Saker *et al*. (2005) with the help of RAPD, SSR and AFLP primer combinations, in their genetic analysis of Egyptian (japonica) rice genotypes.

In this investigation, RAPD was employed to study the divergence using RAPD markers present in cultivar/genotype and to assess the possibility of clustering the genotypes according to their susceptibility and resistant reaction by comparing them with genotypes such as NILs possessing known genes for resistance. This study was also carried out to identify any polymorphism existing in different genotypes using RAPD primers.

MATERIALS AND METHODS

The seeds of 29 rice genotypes (Table 1) used in the study were obtained from the Main Rice Research Station, Anand Agricultural University, Nawagam. The genotypes selected including NILs namely, CRMAS-2231-36, CRMAS-2231-37, CRMAS-2231-48 carrying resistance genes *xa5*, *xa13* and *xa21* as well as IRBB7 with *Xa7* gene and IR72 with *Xa4* gene and some genotypes with known resistance reaction but unknown gene as well as few susceptible genotypes.

DNA extraction and Polymerase Chain Reaction : The tender, fresh 3 g of leaves were ground to a fine powder with liquid N_2 and added 15ml of DNA extraction buffer [3% CTAB, 100 mM Tris-HCl (pH 8.0), 20 mM EDTA (pH 8.0), 1.4 M NaCl and 1% PVP] and 120 µl of Proteinase K (Fermentas, AG) and mixed thoroughly. The tubes were incubated at 65°C for 60 minutes in water bath with occasional mixing. Equal volume of Chloroform:Isoamyl alcohol was added and mixed gently by inversion. The tubes were then centrifuged at 10,000 rpm for 10 minutes at 4°C. The upper aqueous phase was transferred to a fresh tube and re-extracted with equal volume of C:I solution. The DNA was precipitated with $1/10^{th}$ volume of 3M Sodium acetate (pH 5.2) and double volume of chilled ethanol (absolute) and mixed. These tubes were kept overnight at -20°C. The DNA was pelleted by centrifugation at 15,000 rpm for 15 min at 4°C. The DNA pellet was washed twice with 70 per cent ethanol, air dried and dissolved in 800 µl of TE buffer. 16 µl of DNase free RNase A (Fermentas, AG) was added to the crude DNA and incubated in a water bath at 37°C for 1 hour.

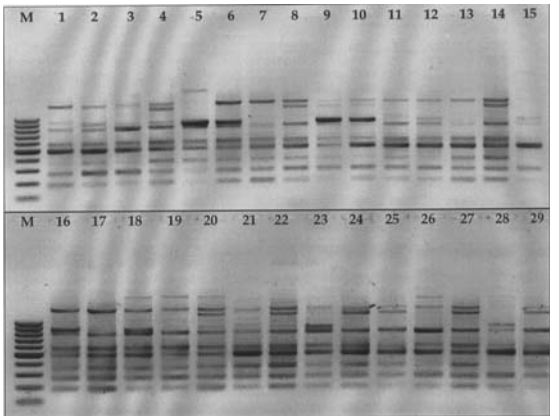
The 33 10-mer primers (Operon Technologies, USA) were used. The amplification was performed in a volume of 25 µl containing approximately 50ng genomic DNA, 200 µM each of dNTP, 0.2 µM primer, 1.5U Taq DNA polymerase and Buffer (1X) containing 15mM magnesium chloride (Bangalore Genei Pvt. Ltd.). The amplification was performed in a thermocycler (Biometra TGradient AG) programmed as follows: 1 cycle of 95°C for 5 minutes followed by 40 cycles of 45 seconds at 95°C, 30 seconds at 38°C and 45 seconds at 72°C and finally 1 cycle of 72°C for 10 minutes. 15 µl of amplification products were loaded on 1.4 per cent (w/v) agarose gels for electrophoresis in 1 x TAE buffer (Sambrook *et al*. 1989). Gels were stained with ethidium bromide (0.5 µg ml^{-1}) and photographed under UV light using Alpha EaseFC 4.0.0 Gel Documentation system (Alpha Innotech Corporation, USA). RAPD products were scored as present (1) or absent (0) for each of the primer-genotype combinations and analyzed with the software POPGENE 32 version 1.31 and the diploid

data analysis for dominant marker was performed with the assumption of Hardy-Weinberg equilibrium. Multiple populations were used for the estimation of polymorphic loci, Nei's (1978) unbiased measures of genetic identity and genetic distance as well as for dendrogram construction using UPGMA based method.

RESULTS AND DISCUSSION

Sixty 10-mer arbitrary primers were used to amplify genomic DNA of 29 rice genotypes, out of these only 33 primers gave amplification. Therefore PCR with 33 primers produced a total of 305 DNA fragments out of which 232 were polymorphic. The average polymorphism recorded by the RAPD primer was 75.8 per cent (Table 2). The size varied from 120 bp to 5125 bp (Fig. 1). OPH-11 and OPH-16 differentiated all the 29 rice genotypes.

The similar findings were recorded by Yu and Nguyen (1994), who detected 80 per cent



M-100 bp DNA ladder, 1-GR 3, GR-4, 3-GR, 4-GR 7, 5-GR 8, 6-GR 9, 7-GR 11, 8-GR 12, 9-GR 101, 10-GR 102, 11-GR 103, 12-GR 104, 13-GRDandi, 14-Gurjari, 15-Narmada, 16-IR 72, 17-SK 20, 18-Jaya, 19-IET 16312, 20-IET 16309, 21-CRMAS 2231-36, 22-PR 106, 23-PR 115, 24-CRMAS 2231-37, 25-CRMAS 2231-48, 26-IRBB 7, 27-Kamod Deshi, 28-TN 1, 29-Purple Indicator.

Fig. 1. RAPD patterns of different rice genotypes produced by primer OPF-17.

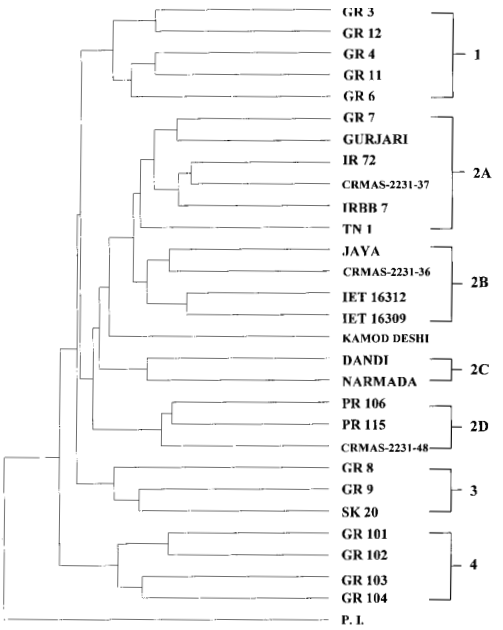


Fig. 2. Dendrogram showing the genetic relationships between different near-isogenic lines, bacterial leaf blight resistant and susceptible genotypes based on Nei's (1978) similarity coefficients using UPGMA as the clustering method for the polymorphism data obtained as 33 RAPD loci.

polymorphism with RAPD primers among upland and lowland rice cultivars, whereas Saker *et al.* (2005) analyzed genetic similarity and diversity of some Egyptian rice genotypes, where they obtained 12.2 per cent polymorphism. On the contrary Vikal *et al.* (1997) in the study of BLB resistant gene in rice using RAPD markers, observed 26 per cent polymorphism in rice. Mackill (1995) also reported low level of polymorphism (24%) for 21 primers in the study of japonica cultivars while 35 per cent average polymorphism between *indica* and *japonica* accessions.

The high level of polymorphism obtained in the present investigation is because most of the genotypes are from different locations,

adaptations, some are NILs, and local selections while majority are cultivars.

The minimum genetic identity observed between GR-104 and GR11 (0.69) whereas maximum between CRMAS-2231-37 and IR72 (0.86). Similar observations were recorded by Saker *et al.* (2005) for genetic identity of rice genotypes.

Dendrogram (Fig. 2) based on Nei's (1978) unbiased measures of genetic distance by UPGMA method formed four major clusters which grouped all the 29 genotypes. The first cluster contains five genotypes *viz*., GR-3, GR-12, GR-4, GR-11 and GR-6. The second cluster formed four sub-groups in which all resistance genes carrying genotypes were dispersed along with most of genotypes. The 2A sub-group contained GR-7, Gurjari, IR-72, CRMAS-2231-37 and IRBB-7, from which TN-1 was out grouped in same cluster. The grouping of GR-7 and Gurjari with multiple resistance genes bearing genotypes strongly revealed the possibility of them possessing the same genes. Except CRMAS-2231-36, all genotypes *viz*., Jaya, IET-16312 and IET-16309 in 2B subgroup were susceptible to BLB. The Kamod Deshi out grouped from both

Table 1. List of genotypes used in the present investigation.

Genotype	Pedigree	Reaction to Xoo
GR3	Nawagam 19 x IR 60	Moderately Susceptible
GR4	Zinnia 31 x IR 8-246	Susceptible
GR6	GR 3 x Pusa 33	Moderately Resistant
GR7	GR 3 x Basmati 370	Moderately Resistant
GR8	Pure line selection (Vyara 55, IET 17510)	Not observed
GR9	Sathi 34-36 x CR 544-1-2	Not observed
GR11	Zinia 31 x IR 8-246	Susceptible
GR12	GR 4 x IR 64	Moderately Resistant
GR101	IR 8 x Pankhali 203	Moderately Resistant
GR102	IR 8 x Pankhali 203	Moderately Resistant
GR103	GR 11 x Mahsuri	Resistant
GR104	GR 101 x Basmati 370	Resistant
Dandi	PNL 2 x IET 8320	Resistant
Gurjari	Asha x Kranti	Moderately Resistant
Narmada	T (N) 1 x Basmati 370	Moderately Resistant
SK20	Selection from local Sukhwel	Not observed
Kamod Deshi	Selection from local Kamod	Not observed
Jaya	TN 1 x T 141	Susceptible
IR72	IR 19661-9-2-3/ IR 15795-199-3-3/ IR 9129-209-2-2-2-1	Resistant
PR106	IR 8 / Peta 5 / Bella Patna	Susceptible
PR115	RP 215/- 173-1-8/- PR 133	Resistant
IRBB 7	DRR culture	Moderately Resistant
TN 1	Dwarf Chow-wu-gen x Tsai-Yuan-Chunj	Highly Susceptible
Purple Indicator	Selected from Nagkesar Nungi (?)	NA
CRMAS-2231-36	IR 64/ IRBB 13 / IRBB 21	Moderately Resistant
CRMAS-2231-37	IR 64/ IRBB 13 / IRBB 21	Moderately Resistant
CRMAS-2231-48	IR 64/ IRBB 13 / IRBB 21	Moderately Resistant
IET-16312	Basmati restorer line	Moderately Susceptible
IET-16309	Basmati restorer line	Moderately Susceptible

2A and 2B sub-groups. Dandi and Narmada formed 2C while PR-106, PR-115 and CRMAS-2231-48 formed 2D sub-group. Third cluster included the genotypes GR-8, GR-9 and SK-20. Whereas GR-101, GR-102, GR-103 and GR-104 formed the fourth cluster. The Purple Indicator with its diverse characteristics was out grouped from all the other genotypes used for RAPD analysis.

The genotype GR-7, SK20, Dandi, Kamod Deshi and PR115 repeatedly clustered with NILs or genotypes with known resistant genes. The potent markers identified in the present investigation for resistance genes were OPH-03, OPH-07, OPH-12 and OPH-14. The data of this study confirmed the efficacy of RAPD as a molecular marker which could be used to distinguish the resistant genotypes and to generate information regarding the resistant genes present in them as well as the identification of marker when the NILs or genotypes with known resistant genes were used. The RAPD analysis was also used as an initial step to identify potential marker linked to the gene *xa13* in the study of Zhang *et al*. (1996). Further the possibility of clustering of resistant genotypes will be explored by using NILs and genotypes with known resistant genes. Raghunathachari *et al*. (2000) noted that PCR-based RAPD analysis would be offering a rapid and reliable method for the estimation of variability between different accessions of Indian scented rice varieties.

This study indicated that the use of RAPD techniques to detect genetic variation at DNA level among BLB resistant and susceptible rice genotypes was sensitive and powerful. This will be useful in the future for determining the best choice of parents in order to generate mapping populations for tagging BLB resistant genes. For example, GR-7, SK-20, Kamod Deshi and PR-115 either of these genotypes can be used as resistant parent for crossing with one of the susceptible genotype/cultivar. This observation needs further confirmation through different

Table 2. Per cent polymorphisms revealed by RAPD analysis.

Primer	Sequence	Total number of bands	Polymorphic bands	Per cent polymorphism
OPF-02	GAG GAT CCC T	8	7	87.50
OPF-04	GGT GAT CAG G	9	7	77.78
OPF-06	GGG AAT TCG G	14	13	92.86
OPF-11	TTG GTA CCC C	12	10	83.33
OPF-12	ACG GTA CCA G	10	7	70.00
OPF-13	GGC TGC ACA A	8	4	50.00
OPF-14	TGC TGC AGG T	12	10	83.33
OPF-15	CCA GTA CTC C	10	7	70.00
OPF-16	GGA GTA CTG G	7	5	71.43
OPF-17	AAC CCG GGA A	13	10	76.92
OPF-18	TTC CCG GGT T	9	7	77.78
OPF-20	GGT CTA GAG G	3	2	66.67
Total F		115	88	76.52
OPG-03	GAG CCC TCC A	6	5	83.33
OPG-04	AGC GTG CTC G	11	8	72.73
OPG-07	GAA CCT GCG G	11	9	81.82
OPG-09	CTG ACG TCA C	12	10	83.33
OPG-10	AGG GCC GTC T	13	9	69.23
OPG-11	TGC CCG TCG T	9	5	55.56
OPG-12	CAG CTC ACG A	6	5	83.33
OPG-14	GGA TGA GAC C	6	4	66.67
OPG-16	AGC GTC CTC C	6	2	33.33
OPG-18	GGC TCA TGT G	9	6	66.67
OPG-19	GTC AGG GCA A	7	5	71.43
Total G		96	68	70.83
OPH-02	TCG GAC GTG A	12	10	83.33
OPH-03	AGA CGT CCA C	12	9	75.00
OPG-06	ACG CAT CGC A	10	7	70.00
OPH-07	CTG CAT CGT G	10	8	80.00
OPH-11	CTT CCG CAG T	7	7	100.00
OPH-12	ACG CGC ATG T	8	7	87.50
OPH-14	ACC AGG TTG G	8	2	25.00
OPH-16	TCT CAG CTG G	9	9	100.00
OPH-18	GAA TCG GCC A	9	8	88.89
OPH-19	CTG ACC AGC C	10	8	80.00
Total H		95	75	78.95
Total RAPD		305	232	75.82

classical breeding techniques such as Marker Assisted Selection where the improvement of susceptible lines can be possible by recurrent backcrossing or by use of NILs for molecular characterization and for gene confirmation.

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Persistance and Residual Toxicity of Different Insecticides Against First Instar Larvae of *Helicoverpa armigera*

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ABSTRACT

Six insecticides were tested for their persistence and residual toxicity against first instar larvae of *H. armigera* on okra fruits. The order of residual efficacy of different insecticides against first instar larvae of *H. armigera* on fruits based on LT_{50} and PT values was spinosad 0.005 per cent (12.44 days and 1146.46) followed by indoxacarb 0.01 per cent (12.22 days and 1138.2), profenofos 0.08 per cent (11.42 days and 1082.2) and imidacloprid 0.004 per cent (9.74 days 1016.9). The spinosad was found to be most effective insecticide against *H. armigera*.

Key words : Persistence, residual toxicity, insecticides, mortality.

The pest problem of okra (*Abelmoschus esculentus* (L.) Moench) is more or less similar to that of cotton crop. Okra is attacked by a number of sucking pests and bollworms (*Earias vittella*), American bollworm (*Helicoverpa armigera*) (Devasthali and Saran, 1997).

The losses in the yield of okra by fruit borer were 69.0 per cent (Rawat and Sahu, 1973). Krishnaiah (1980) reported that losses in okra due to leafhopper (*A. biguttula biguttula*) and fruit borer were 50 to 52 and 49 to 74 per cent respectively. The residual toxicity resulting from foliar spray of insecticides could be of great significance in indicating an effective period over which an insecticide could persist in biologically active stage and the periodic evaluation for their effectiveness is also essential under the field conditions. The present study was undertaken to study the residual toxicity of different insecticides against *H. armigera* on okra fruits.

MATERIALS AND METHODS

The experiment was conducted during kharif 2007 at the Experimental Farm, Department of Entomology, College of Agriculture, Latur, in a randomized block design with three replications. Arka Anamika cultivar was sown in plot size of 3.90 x 3.00 sq m. The treatments included in this experiment were spinosad 0.005 per cent, indoxacarb 0.01 per cent, imidacloprid 0.004 per cent, cypermethrin 0.01 per cent, profenofos 0.08 per cent, endosulfan 0.06 per cent and untreated control. Foliar sprays were given at 20 days interval with pneumatic knapsack sprayer, using 500 liters of spray fluid per hectare. The residual toxicity of different insecticides was studied against first instar larvae of *H. armigera* after third spray on okra fruits. The laboratory culture of *H. armigera* was initiated by collecting infested fruits of okra having large number of larvae during April - May. The larvae of *H. armigera* were reared individually in 5 x 5 cm circular plastic boxes. They were fed on fresh pieces of okra fruits daily in the morning until pupation.

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Table 1. Persistence of different insecticides in / on fruits of okra applied as third spray against first instar larvae of *H. armigera*.

Insecticides	Corrected percentage mortality after different intervals (days)						P	T	PT	R. E.	O.R.E.
	1	3	7	10	14	21					
Spinosad 0.005 per cent	100	90.00	86.60	80.00	53.30	0	14	81.89	1146.5	1.27	1
Indoxacarb 0.01 per cent	100	93.30	80.00	76.60	56.60	0	14	81.30	1138.2	1.26	2
Imdacloprid 0.004 per cent	100	80.00	76.60	66.60	40.00	0	14	72.64	1016.9	1.12	4
Cypermethrin 0.01 per cent	100	90.00	60.00	56.60	43.30	0	14	69.98	979.7	1.08	5
Profenofos 0.08 per cent	100	93.30	76.60	70.00	46.60	0	14	77.30	1082.2	1.20	3
Endosulfan 0.06 per cent	100	86.60	53.30	46.60	36.60	0	14	64.62	904.7	1.00	6

Table 2. Relative efficacy of different insecticides against first instar larvae of *H. armigera* on fruits of okra applied as third spray.

Insecticides	Heterogeneity		Regression Equation (y = ...)	Log LT_{50} ± S. Em	LT_{50} (days)	Fiducial limit (days)	R.E.	O.R.E.
	d. f.	$\chi 2$						
Spinosad 0.005 per cent	4	2.6134	y = 8.8218-3.4904x	1.0949±2.7682	12.44	6.74 22.96	1.53	1
Indoxacarb 0.01 per cent	4	2.5362	y = 8.7755-3.4731x	1.0871±2.1652	12.22	8.97 17.90	1.51	2
Imdacloprid 0.004 per cent	4	2.4419	y = 7.7074-2.7392x	0.9884±1.9299	9.74	6.63 14.34	1.20	4
Cypermethrin 0.01 per cent	4	1.9246	y = 7.9968-3.1111x	0.9633±1.6390	9.19	6.40 12.82	1.13	5
Profenofos 0.08 per cent	4	1.0226	y = 10.6724-5.3637x	1.0576±1.3754	11.42	8.98 14.38	1.40	3
Endosulfan 0.06 per cent	4	1.1065	y = 7.9634-3.2615x	0.9086±1.4691	8.10	5.44 11.04	1.00	6

Table 3. "t" values for testing the differences between Log LT50 values of different insecticides used against first instar larvae of *H. armigera* on okra fruits.

Insecticides	Log LT_{50} ± S.Em	1	2	3	4	5
Spinosad 0.005 per cent	1.0949 ± 2.7682	-	-	-	-	-
Indoxacarb 0.01 per cent	1.0871 ± 2.1652	0.002	-	-	-	-
Imdacloprid 0.004 per cent	0.9884 ± 1.9299	0.031	0.034	-	-	-
Cypermethrin 0.01 per cent	0.9633 ± 1.6390	0.041	0.045	0.010	-	-
Profenofos 0.08 per cent	1.0576 ± 1.3754	0.012	0.011	0.029	0.044	-
Endosulfan 0.06 per cent	0.9086 ± 1.4691	0.059	0.068	0.033	0.025	0.073

The newly emerged male and female moths of *H. armigera* were placed in oviposition cage made up of plastic containers having size of 19 cm height and 21 cm diameter for the purpose of egg laying. The cotton swabs dipped into 50 per cent honey solution were kept in petridish and placed at the bottom of cage to serve as food for moths. The containers were covered

with black cloth and tightened with rubber band. In order to maintain humidity in containers, the cover cloth was sprinkled with water to keep the cloth moist. The eggs laid by female moths on cloth were removed daily. The newly hatched larvae were reared in plastic boxes on small cut pieces of fruits of okra. First instar larvae of *H. armigera* was used for determination of residual toxicity of different insecticides on okra fruits. The number of dead or moribund test insects were counted after 24 hours of exposure. Similarly control mortality of test insects was also observed by releasing them on untreated okra fruits. Data obtained on mortality of test insects were converted into percentage mortality. The average percentage mortality was calculated from the observations in 3 replications. The observations on percentage mortality thus obtained were corrected with Abbott's (1925) formula. The values of LT_{50} (time required to give 50 per cent mortality) for different insecticides applied on okra plants were calculated by using software of probit analysis as suggested by Finney (1971). The product (PT) of average residual toxicity (T) and the period (P) for which the toxicity persisted was used as an index of persistent toxicity. The values of corrected percentage mortalities at various specified periods were added. This sum was then divided by number of observations in order to obtain residual toxicity (T). The procedure followed by Saini (1959) and elaborated further by Pradhan (1967) and Sarup *et al*. (1970) was utilized the log LT_{50} values obtained for different insecticides were compared by employing the 't' test.

RESULTS AND DISCUSSION

The data pertaining to PT index and LT50 values of different insecticides applied against first instar larvae of *H. armigera* on fruits of okra are presented in Table 1 and 2. The order of relative residual toxicity of various insecticides based on PT index and LT_{50} values was spinosad 0.005 per cent (1.27 and 1.53) > indoxacarb 0.01 per cent (1.26 and 1.51)> profenofos 0.08 per cent (1.20 and 1.40)> imidacloprid 0.004 per cent (1.12 and 1.20) > cypermethrin 0.01 per cent (1.08 and 1.13) and endosulfan 0.06 per cent (1.00 and 1.00). The order of residual efficacy of different insecticides against first instar larvae of *H. armigera* on fruits based on LT_{50} and PT values was spinosad 0.005 per cent (12.44 days and 1146.46) followed by indoxacarb 0.01 per cent (12.22 days and 1138.2), profenofos 0.08 per cent (11.42 days and 1082.2) and imidacloprid 0.004 per cent (9.74 days and 1016.9). Yadav *et al*. (2003) recorded PT values of endosulfan 0.07 per cent and cypermethrin 0.006 per cent to the extent of 681.32 and 718.65 during 1991-92 and 690.68 and 718.68 during 1992-93, respectively against 5 to 6 days old larvae of *H. armigera* on field pea. The values of 't' for testing differences of log LT_{50} values of different insecticides against first instar larvae are presented in Table 3. On the basis of 't' values no significant differences were observed in the residual toxicity among all the groups of insecticides under the investigation. The order of residual efficacy of different insecticides against first instar larvae of *H. armigera* on fruits based on LT_{50} and PT values was spinosad 0.005 per cent (12.44 days and 1146.46) followed by indoxacarb 0.01 per cent (12.22 days and 1138.2), profenofos 0.08 per cent (11.42 days and 1082.2) and imidacloprid 0.004 per cent (9.74 days 1016.9).

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Effect of Microbially Enriched Organic Manures on Growth of Maize Crop

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ABSTRACT

Application of *Azotobacter chroococcum* and *Bacillus polymyxa* enriched organic manures to soil improved the biometric observations in maize crop significantly over their respective uninoculated control. Application of poultry manure enriched with *Azotobacter* and *Bacillus polymyxa* recorded significant increase in seed germination (98%), plant height (155.10 cm), number of leaves plant^{-1} (18), shoot biomass (18.56 g plant^{-1}), total biomass (22.18 g plant^{-1}) and N uptake (0.42 g plant^{-1}) over all other enriched organic manures. However, highest root biomass (3.98 g plant^{-1}) and P uptake (0.027 g plant^{-1}) was recorded in the treatment pressmud cake enriched with *Azotobacter* and *Bacillus polymyxa* due to higher phosphorus content and lowest in uninoculated FYM.

Key words : Biofertilizers, maize, yield, quality, nutrient uptake, organic manures.

Maize (*Zea mays*) is emerging as the third most important crop in India after rice and wheat. Owing to its high yield potential, it requires high amount of nutrients in comparison to other crops. Integrated nutrient management is essential for sustaining crop yield. It has been found that if chemical fertilizers are partially supplemented with biofertilizers and organic manures, maize could be significantly benefited (Singh *et al*. 2006 and 2007). It was therefore, proposed to study the effect of organic manures enriched with nitrogen fixing and phosphate solubilizing bacteria on maize crop.

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MATERIALS AND METHODS

The experiment was conducted at Department of Plant Pathology and Agril. Microbiology, College of Agriculture, Pune under glass house condition. Four organic manures *viz*. farmyard manure (FYM), vermicompost (VC), poultry manure (PM) and pressmud cake (PMC) were inoculated with commercial microbial inoculants *Azotobacter* and *Bacillus polymyxa* individually or in combination and incubated for a period of one month. After incubation period these microbial enriched organic manures were mixed with soil in 1:1 proportion and filled in the earthen pots.

The experiment was conducted in a factorial completely randomized design replicated twice. The five seeds of Karveer variety of maize were sown at equidistant in each pot. Pots were irrigated periodically and the crop was grown up to 90 days (tasseling stage). The data on seed germination, plant height, leaves plant^{-1}, shoot biomass, root biomass, total biomass, N and P uptake were recorded. The data obtained were statistically analysed through methods described by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

Seed germination : The data in Table 1 revealed that enrichment of organic wastes with microbial inoculants increased the maize seed germination significantly over their respective uninoculated control. The significantly highest germination (98%) was recorded in poultry manure enriched with *Azotobacter* and *Bacillus polymyxa* and lowest in FYM alone (85%).

Across the organic manures, significantly maximum germination (96.13%) was recorded due to combined inoculation of *Azotobacter* and *Bacillus polymyxa* followed by individual inoculation with *Azotobacter* (93%) and *Bacillus polymyxa* (91.63%). However, results

Table 1. Effect of different organic manures and their microbial enrichment on seed germination (%)of maize.

Microbial inoculants (MI)	Organic manures (OM)				Mean
	FYM	VC	PM	PMC	
Control	85.00	91.00	92.00	91.00	89.75^{c}
Azo.	90.00	94..00	96.00	92.00	93.00^{b}
B.p.	90.00	92.00	94.00	90.50	91.63^{b}
Azo. + B.p.	94.00	96.50	98.00	96.00	96.13^{a}
Mean	89.75^{c}	93.38^{ab}	95.00^{a}	92.38^{b}	92.63
	OM	MI	OMxMI		
S.E ±	0.69	0.69	1.38		
C.D. at 5%	2.07	2.07	NS		

The figures denoted by alfabets differ significantly from each other.

Table 2. Interaction between organic manures and their enrichment on plant height of maize (cm).

Microbial inoculants (MI)	Organic manures (OM)				Mean
	FYM	VC	PM	PMC	
Control	108.65	126.60	135.65	116.15	121.76^{d}
Azo.	128.05	142.30	148.10	133.0	137.86^{b}
B.p.	121.80	136.15	142.75	122.35	130.76^{c}
Azo. + B.p.	138.20	148.55	155.10	142.95	146.20^{a}
Mean	124.18^{d}	138.40^{b}	145.40^{a}	128.61^{c}	134.15
	OM	MI	OM x MI		
S. E. ±	0.48	0.48	0.97		
C. D. at 5%	1.45	1.45	2.90		

The figures denoted by alfabets differ significantly from each other.

due to the inoculation of *Azotobacter* and *Bacillus polymyxa* were at par with each individual inoculation and uninoculated control. Similar results were also reported by Karmegam *et al.* (1999) and Sharma *et al*. (2003).

Plant height and leaves : An application of organic manures and their enrichment with microbial inoculants significantly increased the plant height of maize from 108.65 to 155.10 cm and leaves per plant from 9.84 to 18.00 respectively over their respective uninoculated control (Table 2 and 3). Significantly highest

plant height (155.10 cm) and leaves (18.00) were recorded in poultry manure enriched with *Azotobacter* and *Bacillus polymyxa* and lowest in FYM alone (108.65 cm and 9.84).

Dual inoculation of *Azotobacter* and *Bacillus polymyxa* across the organic manures showed significantly highest plant height (146.20 cm) and leaves (15.50) followed by individual inoculation of *Azotobacter* (137.86 cm and 13.96) and *Bacillus polymyxa* (130.76 cm and 12.38). Plant height and leaves due to *Azotobacter* were significantly superior over *Bacillus polymyxa* inoculated treatment. Among the organic manures, across the microbial inoculants, poultry manure recorded highest plant height (145.40 cm) and leaves (15.13) which were significantly superior over vermicompost (139.40 cm and 13.50), pressmud cake (128.61 cm and 12.71) and FYM (124.18 cm and 11.33). The lowest germination (89.75%) was recorded due to uninoculated control. Among the organic manures across the microbial inoculants, poultry manure recorded highest germination (95%) followed by vermicompost (93.38%), pressmud cake (92.38%>), and FYM (89.75%>). The germination due to poultry manure and vermicompost, vermicompost and pressmud cake were at par with each other. The interaction due to organic manures and microbial inoculants were found to be non significant.

An inoculation of diazotroph *Azotobacter* has the ability to supress the growth of antagonists present in the soil and release the plant growth promoting substances around the seed sown. Further they fix atmospheric nitrogen, which is made available to growing plants and utilized it for their healthy growth at initial stages. This type of phenomenon also had been reported earlier by Rasal and Patil (1993) and Barraquio *et al*. (1999). Further germination of seed increased due to dual inoculation of different organic manures with nitrogen fixer and phosphate solubilizer. which provide more phosphorus along with nitrogen for initial growth of the plant. Therefore, combined inoculation of organic manures recorded highest germination over microbial inoculants and were found to be significant for plant height and non significant for number of leaves.

Table 3. Interaction between organic manures and their enrichment on number of leaves in maize (Number of leaves plant^{-1}).

Microbial inoculants (MI)	Organic manures (OM)				Mean
	FYM	VC	PM	PMC	
Control	9.84	11.17	11.83	1.49	10.83^{d}
Azo.	11.50	14.33	16.34	13.67	13.96^{b}
B. p.	11.17	12.00	14.34	12.00	12.38^{c}
Azo. + *B. p.*	12.84	16.50	18.00	14.67	15.50^{a}
Mean	11.33^{d}	13.50^{b}	15.13^{a}	12.71^{c}	13.17
	OM	MI	OM x MI		
S. E. ±	0.38	0.38	0.75		
C. D. at 5%	1.13	1.13	NS		

The figures denoted by alphabets differ significantly from each other.

The results showed that inoculation of high nitrogen containing poultry manure enriched with *Azotobacter* and *Bacillus polymyxa* recorded highest height and number of leaves over individual inoculation and uninoculated control. It is due to population of *Azotobacter* increased 2 to 4 fold due to inoculation with PSB. As nitrogen fixer *Azotobacter* made more nitrogen and phosphorus available to the growing plants when applied with *Bacillus polymyxa* increased the vegetative growth of the plant over their individual inoculation. Similar results were also reported by Patidar and Mali (1997), Hegde *et al*. (1999), and Chellamuthu *et al.* (2000).

Shoot and total biomass : The highest shoot and total biomass (18.56, 22.18 g plant^{-1}) were observed (Table 4) in poultry

manure enriched with *Azotobacter* and *Bacillus polymyxa* as compared with individual inoculations. The least shoot and total biomass (9.69, 11.14 g plant^{-1}) were recorded in uninoculated control i.e. FYM alone.

Across the organic manures the highest mean shoot and total biomass (16.64, 20.29 g plant^{-1}) were recorded in treatment having dual inoculation of *Azotobacter* and *Bacillus polymyxa* followed by individual inoculation of *Azotobacter* (15.15, 17.65 g plant^{-1}) and *Bacillus polymyxa* (12.95, 16.05 g plant^{-1}). The lowest shoot and total biomass (11.54, 13.55 g plant^{-1}) were observed in uninoculated control. Among the organic manures across the inoculants, poultry manure gave highest shoot and total biomass (16.13, 18.78 g plant^{-1}) followed by vermicompost (14.66, 17.38 g plant^{-1}), pressmud cake (13.31, 16.69 g plant^{-1}) and FYM (12.19, 14.69 g plant^{-1}). Shoot and total biomass due to poultry manure were significantly superior over vermicompost. The interaction due to organic manures and microbial inoculants were found to be non significant.

The results showed that due to availability of more nitrogen through *Azotobacter* and phosphorus through *B. polymyxa* when applied along with high nitrogen containing poultry manure boost the crop growth which increased the shoot and total biomass to the maximum extent. Similar results were also reported by Balasaraf (1990) and Sharma *et al*. (2003).

Root biomass : The significantly highest root biomass (3.98 g plant^{-1}) was recorded (Table 4) in pressmud cake enriched with *Azotobacter* and *Bacillus polymyxa* than individual inoculations and lowest in uninoculated control i.e. FYM alone (1.45 g plant-1).Highest mean root biomass (3.65 g plant-1) was recorded due to combined inoculation of *Azotobacter* and *Bacillus polymyxa* across the organic manures followed by individual inoculation with *Bacillus polymyxa* (3.09 g plant^{-1}) and *Azotobacter* (2.50 g plant^{-1}). The lowest root biomass (2.01 g plant^{-1}) was recorded due to uninoculated control.

Among the organic manures across the microbial inoculants, pressmud cake recorded highest root biomass (3.38 g plant^{-1}) followed by vermicompost (2.73 g plant^{-1}), poultry

Table 4. Interaction of organic manures and their microbial enrichment on dry matter of maize (g plant^{-1}).

Microbial inoculants (MI)	Organic manures (OM)				Mean
	FYM	VC	PM	PMC	
Shoot biomass					
Control	9.69	12.22	13.71	10.56	11.54^{d}
Azo.	13.20	15.66	17.60	14.14	15.15^{b}
B. p	11.29	13.75	14.65	12.13	12.95^{c}
Azo. + B. p.	14.57	17.00	18.56	16.42	16.64^{a}
Mean	12.19^{d}	14.66^{b}	16.13^{a}	13.31^{c}	14.07
	OM	MI	OM x MI		
S. E. ±	0.29	0.29	0.058		
C. D. at 5%	0.86	0.86	NS		
Root biomass					
Control	1.45	2.08	1.90	2.62	2.01^{d}
Azo.	2.30	2.14	2.28	3.20	2.50^{c}
B.p.	2.90	2.93	2.83	3.73	3.09^{b}
Azo. + B. p.	3.26	3.77	3.62	3.98	3.65^{a}
Mean	2.50^{c}	2.73^{b}	2.65^{b}	3. 38^{a}	2.81
	OM	MI	OM x MI		
S. E. ±	0.029	0.029	0.058		
C. D. at 5%	0.086	0.086	0.17		
Total biomass					
Control	11.14	14.30	15.60	13.17	13.55^{d}
Azo.	15.59	17.80	19.87	17.34	17.65^{b}
B.p.	14.19	16.68	17.47	15.85	16.05^{c}
Azo. + B. p.	17.83	20.77	22.18	20.40	20.29^{a}
Mean	14.69^{c}	17.38^{b}	18.78^{a}	16.69^{b}	16.88
	OM	MI	OM x MI		
S. E. ±	0.29	0.29	0.57		
C. D. at 5%	0.86	0.86	NS		

manure (2.65 g plant^{-1}) and FYM (2.50 g plant^{-1}). Root biomass due to vermicompost and poultry manure were at par with each other. The interaction due to organic manures and microbial inoculants were found to be significant.

The results showed that combined inoculation of *Azotobacter* and *Bacillus polymyxa* along with high phosphorus containing pressmud cake gave highest root biomass. It is due to phosphate solubilizing bacteria *Bacillus polymyxa* which solubilized the unavailable phosphate into available form and make it available to the crop growth. Phosphorus is the major nutrient for root growth and development. Results are in agreement with the results obtained by Wani *et al*. (1978), Kshirsagar *et al*. (1992), Khamparia (1995) and Gyaneshwar *et al*. (2001).

Nitrogen uptake : The highest nitrogen uptake by maize (0.419 g plant^{-1}) was observed (Table 5) in poultry manure enriched with *Azotobacter* + *Bacillus polymyxa*. Lowest nitrogen uptake (0.054 g plant^{-1}) was recorded in FYM uninoculated control. Highest nitrogen uptake (0.309 g plant^{-1}) across the organic manures was recorded when combined enrichment with *Azotobacter* + *Bacillus polymyxa* was done followed by *Azotobacter* (0.229 g plant^{-1}) and *Bacillus polymyxa* (0.177 g plant^{-1}) alone. Among organic manures across the microbial inoculants poultry manure showed highest nitrogen uptake (0.326 g plant^{-1}) followed by vermicompost (0.257 g plant^{-1}) and pressmud cake (0.152 g plant^{-1}). Lowest nitrogen uptake (0.123 g plant^{-1}) was observed in FYM. Interaction due to organic manures and microbial inoculants for nitrogen uptake were found to be non significant.

The results showed that with the advancement of crop growth period, *Azotobacter* count and nitrogen content of soil were increased which increased the nitrogen uptake of crop. Similar findings were also recorded by Agarwal *et al*. (2000) and Radhakrishna and Raghavendra Rao (2001).

Table 5. Uptake of nitrogen and phosphorus in maize as influenced by organic manures and their microbial enrichment (g plant^{-1}).

Microbial inoculants (MI)	Organic manures (OM)				Mean
	FYM	VC	PM	PMC	
Nitrogen uptake					
Control	0.054	0.187	0.251	0.074	0.142^{d}
Azo.	0.141	0.261	0.347	0.168	0.229^{b}
B. p.	0.087	0.224	0.286	0.113	0.177^{c}
Azo. + B. p.	0.211	0.354	0.419	0.253	0.309^{a}
Mean	0.123^{d}	0.257^{b}	0.326^{a}	0.152^{c}	0.214
	OM	MI	OM x MI		
S. E. ±	0.004	0.004	0.008		
C. D. at 5%	0.012	0.012	NS		
Phosphorus uptake					
Control	0.009	0.013	0.013	0.013	0.012^{c}
Azo.	0.014	0.018	0.018	0.019	0.017^{b}
B. p.	0.013	0.019	0.022	0.019	0.018^{b}
Azo. + B. p.	0.018	0.026	0.020	0.027	0.023^{a}
Mean	0.014^{b}	0.019^{a}	0.018^{a}	0.019^{a}	0.017
	OM	MI	OM x MI		
S. E. ±	0.001	0.001	0.002		
C. D. at 5%	0.003	0.003	NS		

Phosphorus uptake : The highest phosphorus uptake was recorded (0.027 g plant^{-1}) in pressmud cake enriched with *Azotobacter* + *Bacillus polymyxa* (Table 5). Lowest phosphorus uptake was recorded in FYM alone (0.009 g plant^{-1}). Highest phosphorus uptake (0.023 g plant^{-1}) across the organic manures was recorded when combined enrichment of *Azotobacter* and *Bacillus polymyxa* was done followed by *Bacillus polymyxa* (0.018 g plant^{-1}) and *Azotobacter* (0.017 g plant^{-1}) individual enrichment. However phosphorus uptake due to *Bacillus polymyxa* and *Azotobacter* were at par with each other. Lowest phosphorus uptake (0.012

g plant^{-1}) was recorded in uninoculated control.

Among organic manures across the microbial inoculants, highest phosphorus uptake (0.019 g plant^{-1}) was recorded in pressmud cake and vermicompost followed by poultry manure (0.018 g plant^{-1}) and FYM (0.014 g plant^{-1}). However, phosphorus uptake due to vermicompost, pressmud cake and poultry manure were at par with each other but significant over FYM. Interaction between organic manures and microbial inoculants for phosphorus uptake were found to be nonsignificant. This showed that with the advancement in crop growth period, *Bacillus polymyxa* count and phosphorus availability went on increasing thereby the phosphorus uptake of maize crop was also increased. Further increase in uptake is due to application of *Bacillus polymyxa* with organic manure and *Azotobacter* which increased the availability of nitrogen and phosphorus and other micronutrients. Similar type of results were also reported by Ram and Dwivedi (1992), Rasal and Patil (1992), Kaushik *et al*. (1996) and Sapatnekar *et al*. (2001). It was concluded that *Azotobacter* and *Bacillus polymyxa* enriched organic manures not only meet the nutritional requirement but also improve the biometric observations of maize crop to a great extent.

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Technological Gap in Sugarcane Production Technology

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ABSTRACT

The present study was conducted in two tahsil of Latur district. The sample of 150 respondents was studied. It was revealed that majority of the respondents were belonged to middle age group, (30 to 45 years), 35.33 per cent were educated up to higher secondary level (8^{th} to 10^{th} standard) and 42.67 per cent possessed semi-medium land holding. Majority of respondents (79.34 %) were in medium income group (Rs. 56, 651/- to Rs. 1, 49,883/-), 68.66 per cent of the respondents had medium scientific orientation and 73.33 per cent of the respondents had medium risk preference ability. Majority (56.00 per cent) of the respondents had medium extension contact, About three fifth (62.66 per cent) of the respondents were having medium market orientation and majority (61.33 per cent) of the respondents had medium level of knowledge . The 60.00 per cent of the respondents were found in medium technological gap group followed by 24.00 per cent and 16.00 per cent respondents in low and high technological gap group, respectively. As there is medium technological gap and to minimize technological gap there should be adequate and timely supply of production inputs like quality seeds, fertilizers, pesticides etc. at subsidized rates. Multiple regression analysis showed 99.52 per cent variation in the technological gap in recommended sugarcane production practices, caused by selected nine independent variables.

Key words : Sugarcane, production technology, technological gap.

Sugarcane is one of the most important commercial crops grown in Marathwada region of Maharashtra state. There are enough viable and adoptive sugarcane technologies developed but its adoption has been found to be low. Sugarcane and sugar output can be increased if the growers adopt the sugarcane production technology. By considering the above fact, the present study has been undertaken to examine the socio-personal and psycho-economic characteristics of sugarcane growers, technological gap in production among them and relationship among them.

MATERIALS AND METHODS

The present study was conducted in two tahsils of Latur district *viz*., Latur and Ausa. Five villages from each tahsils were selected having the maximum area under sugarcane crop. The data were collected from 150

1. Post graduate student, 2. Professor and 3. Assistant Professor.

respondents of ten villages.

The data were collected with the help of structured interview schedule. The interview schedule constituted the information about independent variables namely age, education, land holding, annual income, scientific orientation, risk preference, extension contact, market orientation and knowledge alongwith the information about dependent variables namely technological gap in sugarcane production technology. The data were analysed by using percentage, correlation and multiple regression.

RESULTS AND DISCUSSION

It was revealed that majority (56.00%) of the respondents belonged to middle age group, (30 to 45 years) (Anchule, 2000), 35.33 per cent were educated up to higher secondary level (8^{th} to 10^{th} standard), and 42.67 per cent possessed medium land holding i.e. up to 6 hectares. Higher percentage of respondents (79.34 per cent) were in medium income group (Rs.56,651 to Rs. 1,49,883/-), 68.66 per cent of the respondents had medium scientific orientation and 73.33 per cent of the respondents had medium risk preference ability. Most (56.00 %) of the respondents had medium extension contact. More than three fifth (62.66 %) of the respondents were having medium market orientation and majority (61.33 %) of the respondents had medium level of knowledge.

Data presented in Table 2 indicated that there was no technological gap in respect of selection of soil and processing after harvesting. It means that all the respondents were planting sugarcane on recommended soil type and were adopting processing after harvesting.

Further it was noticed that less than 25 per cent technological gap was observed in case of cultivation practices namely planting distance (7.87 per cent), use of varieties (8.33 per cent), seed rate (11.66 %), intercultivation and

Table 1. Distribution of sugarcane growers according to their socio-personal and psycho-economical characteristics (N=150).

Character categories	Frequency	Percentage
Age :		
Young	43	28.67
Middle	84	56.00
Old	23	15.33
Education :		
Illiterate	17	11.33
Primary	26	17.33
Secondary	41	27.33
Higher secondary school	53	35.33
College level	13	8.68
Land holding :		
Marginal	9	6.00
Small	38	25.33
Semi-medium	64	42.67
Medium	36	22.66
Big	5	3.34
Annual income :		
Low	10	6.66
Medium	119	79.34
High	21	14.00
Scientific orientation :		
Low	16	10.68
Middle	103	68.66
High	31	20.66
Risk preference :		
Low	15	10.00
Medium	110	73.33
High	25	16.67
Extension contact :		
Low	26	17.34
Medium	84	56.00
High	40	26.66
Market orientation :		
Low	30	20.00
Medium	94	62.66
High	26	17.34
Knowledge :		
Low	26	17.34
Medium	92	61.33
High	32	21.33

planting time (24.00 %). The medium technological gap was observed in case of packages of practices namely harvesting of sugarcane (25.00 %), preparatory tillage (29.99 %) and planting method (50.00 %). Whereas maximum technological gap was observed in case of cultivation practices namely, seed treatment (86.66 %), pest and disease control (68.33 %) and fertilizer management (58.16 %).

It was observed that majority (60.00 per cent) of the respondents were found in medium technological gap group followed by 24.00 per cent and 16.00 per cent respondents in low and high technological gap group, respectively. This finding is in conformity with Bhama (2003).

The results of correlation coefficient (Table 3) showed that independent variables namely education (-0.933), land holding (-0.376), annual income (-0.929), scientific orientation (-0.538), risk preference (-0.369), extension contact (-0.900), market orientation (-0.493) and knowledge (-0.996) were negatively and significantly correlated with the technological gap in adoption of recommended sugarcane production practices. Whereas age (0.512) was positively and significantly related with the technological gap in adoption of recommended sugarcane production practices.

Independent variables *viz*., education, land holding, annual income, scientific orientation, risk preference, extension contact, market orientation and knowledge had negative and highly significant relationship with technological gap in adoption of recommended sugarcane production practices. Similar findings were reported by Kabra, (1989) and Waman *et al*. (2006). Whereas, age had positive and significant relationship with technological gap in adoption of recommended sugarcane production practices.

Table 2. Practicewise technological gap in sugarcane production practices.

Practices	**Technol. gap (%)**
Selection of soil	00.00
Preparatory tillage	29.99
Use of varieties	8.33
Planting time	24.00
Planting distance	7.87
Seed rate	11.66
Set tretment	86.66
Planting method	50.00
Intercultivation	24.00
Fertilizer management	58.16
Water management	29.00
Pest and disease control	68.33
Harvesting of sugarcane	25.00
Processing after harvesting	00.00

Table 3. Relationship between socio-personal, psycho-economic variables and technological gap.

Independent variables	**Correlation coefficient ('r')**
Age	0.512**
Education	-0.933**
Land holding	-0.376**
Annual income	-0.929**
Scientific orientation	-0.538**
Risk preference	-0.369**
Extension contact	-0.900**
Market orientation	-0.493**
Knowledge	-0.996**

** Significant at 1% level of probability

In multiple regression analysis nine independent variables (socio-personal and psycho-economic characteristics) were fitted to explain the variation in the technological gap in sugarcane production practices. It is apparent from the data presented in Table 4 that multiple regression analysis showed 99.52 per cent variation in the technological gap was explained by nine independent variables. It was also observed that, out of nine independent variables namely age, scientific orientation and

knowledge about recommended technology had significant effect on technological gap in adoption of recommended production technology of sugarcane.

It was revealed that majority respondents were of middle age group and educated up to higher secondary level. Majority possessed semi-medium land holding with medium income. More than 60 per cent of the respondents had medium scientific orientation and medium risk preference ability. Most of the respondents had medium extension contact. About 60 per cent of the respondents were having medium market orientation and medium level of knowledge.

Independent variables *viz*., education, land holding, annual income, scientific orientation, risk preference, extension contact, market orientation and knowledge had negative and highly significant relationship with technological gap in adoption of recommended sugarcane production practices. Whereas, age had positive and significant relationship with technological gap in adoption of recommended sugarcane production technology (Tyagi and Tyagi, 1988)

Multiple regression analysis showed 99.52 per cent variation in the technological gap in sugarcane production technology, caused by selected nine independent variables. It is also observed that out of nine independent variables namely age, scientific orientation and knowledge had significant effect on technological gap in recommended sugarcane production practices.

Based on the findings of the present investigation it was concluded that to minimize technological gap there should be adequate and timely supply of production inputs like quality seeds, fertilizers, pesticides etc. at subsidized rates, provision should be made for supply of credit at low interest rate for adopting new sugarcane technologies. The findings also indicated that majority of the respondents lack technical information about seed treatment, fertilizer application and plant protection due to which there was more technological gap in these aspects. The extension agencies, therefore, need to orient their programme towards educating the farmers regarding these practices by giving training, organizing demonstration and tours to visit the successful demonstration on farmer's field.

Table 4. Multiple regression analysis of independent variables with the dependent variable.

Independent variables	Regression coefficient (Bi)	Standard error (±)	t' value
Age	-0.0080	0.0037	2.172*
Education	-0.0099	0.1439	0.069
Land holding	-0.0252	0.0185	1.370
Annual income	0.0012	0.0024	0.531
Scientific orientation	0.0329	0.0116	2.836**
Risk preference	-0.0020	0.0268	0.075
Extension contact	0.1386	0.0786	1.765
Market orientation	-0.0401	0.0366	1.096
Knowledge	-1.4475	0.0402	36.029**

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Women Entrepreneurship Development Through Udyogini Scheme*

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ABSTRACT

The results revealed that among the income generating activities, dairy was the major activity carried out by 30.83 per cent of the beneficiaries followed by shop keeping (14.16 per cent), tailoring (10.83 per cent) and beauty parlor (9.16 per cent). The cost and returns analysis of major income generating activities taken up by the beneficiaries of Udyogini scheme revealed that, highest amount of net returns were found in beauty parlor and lowest net returns were observed in case of dairy enterprise. The highest B:C ratio was found in case of tailoring. About 55.83 per cent of the beneficiaries opined as 'yes' with respect to timeliness and convenience to get credit through the scheme. About 58 per cent of the beneficiaries opined that the scheme has increased their social participation and 40.83 per cent of the beneficiaries were of the opinion that it had helped them in the overall development of the family. Among the opinions of beneficiaries with respect to banks supporting Udyogini scheme, majority of the beneficiaries (53.33 per cent) opined that repayment terms are easy. Among social problems, about 90 per cent of the beneficiaries opined that the problem of casteism in the village was low. Among the economic problems 60.83 per cent of the beneficiaries opined that profit earned was not sufficient as a moderate problem. Among marketing problems, non availability of transport facility as a moderate problem was opined by 73.33 per cent of the beneficiaries. Among the personal problems, encouragement or support from the family as a meager problem was expressed by 93.3 per cent of the beneficiaries.

Key words : Udyogini scheme, entrepreneurship development, income generating activities, social participation, family development.

Women are not only the carriers of human race but civilization and sustainable development rests on them. They are the best upholders of environmental, ecological and Socio-economic balances, yet a victim of man dominated patriarchal system, neglected in their day to day life, neither considered equal to man in wage or social status. In a society that has been thriving for egalitarian status, empowering women should be among the top priorities, about 40 per cent of entire women population in the country is below poverty line (Annapurna., 2004 and Dasaratharamaiah *et al*., 2006). Udyogini is an innovative scheme, sanctioned by the government of Karnataka through Karnataka State Women Development Corporation in the year 1997-98. Udyogini assists women in gaining self reliance through self employment, especially in the trade and service sector. Udyogini empowers women by providing loans through banks and other financial institutions. It also provides a subsidy from the Karnataka state women development corporation for undertaking business activities or micro enterprises. Keeping all these in view, the present study was designed to study the various income generating activities taken up by the beneficiaries of Udyogini scheme and also the cost and returns structure of the major income generating activities taken up by the beneficiaries of Udyogini scheme.

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MATERIALS AND METHODS

The present study was conducted during 2007-08 in Mandya district of Karnataka. The Udyogini scheme is implemented in all the 7 talukas of the district. For the study 120 beneficiaries were selected randomly from all over the district. Based on the objectives of the study an interview schedule was prepared, containing the questions related to information on respondents and their family members, asset position, investment pattern, loan availed from Udyogini scheme, savings, economic activity taken up by respondents, problems faced by respondents their socio economic empowerment. The interview schedule was pre-tested in the study area. Based on the experience gained during pre-testing, modifications were done especially to ensure that the instructions and questions were clear and unambiguous.

The final schedule was used to collect the information from the respondents by personally interviewing the respondents. The information was also collected from books, registers, and office bearers of women and child development office. The data collected were tabulated and analyzed by using frequency and percentages for interpretation.

RESULTS AND DISCUSSION

Income generating activities : The results presented in the Table 1 show that for majority of the members (30.53%) major income generating activity was dairying. The district is having a network of 500 dairy cooperative societies, where regular weekly payment is effected to the milk suppliers and even the value of the cow is insured. Majority of these beneficiaries took dairying as income generating activity as these members were also involved in agricultural activities. Petty shop keeping was undertaken by 14.16 per cent of the beneficiaries, because in rural areas it would help to avoid going to town or city for purchase of small useful houshold products. Thus this activity had a larger demand in the rural area and also petty shops could be run in their home itself without additional unproductive investment. About 10.83 per cent of the beneficiaries had taken tailoring as an income generating activity, since the beneficiaries had undergone short courses on stitching and earned from their neighborhood. About 9.16 per cent of the beneficiaries had taken beauty parlor as the economic activity, because of rural people particularly youngsters have become beauty conscious due to awareness through mass media and consequently beauty parlors have become good revenue earners and also training and short beautician courses were provided through the scheme to the beneficiaries. Cloth business was taken up by 6.66 per cent of the beneficiaries followed by agarbathi making (4.16 per cent) and doll making (4.16per cent), it might be due to the fact that they can earn money using their leisure time at home.

Table 1. Income generating activities undertaken by the beneficiaries of the scheme (2007-08) .

Activities	No. (%)
Dairy	37 (30.83)
Provision store	17 (14.16)
Tailoring	13 (10.83)
Beauty parlor	11 (9.16)
Vegetable vending	4 (3.33)
Cloth business	8 (6.66)
Boarding	2 (1.66)
Pickle making	4 (3.33)
Agarbatthi making	5 (4.16)
Fancy store	4 (3.33)
Doll making	5 (4.16)
Vada shop	3 (2.50)
Tea stall	3 (2.50)
Chocolate making	2 (1.66)
Xerox shop	1 (0.83)
Bakery	1 (0.83)
Total	120 (100.00)

The other economic activities like vegetable vending, pickle making and fancy stores were taken up by 3.33 per cent each of the beneficiaries followed by Vada shop (2.5 per cent), tea stall (2.5 per cent), chocolate making and boarding by 1.66 per cent each, Xerox shop (0.83 per cent) and bakery (0.83 per cent). The diversification in activities is noticed as the beneficiaries belonged to different villages and available resources and opportunities varied. Majority of the members (30.16 per cent) had taken up dairy enterprise as an income generating activity. The average number of animal per member per household is only one because of the limited loan amount availed from the scheme.

It is evident from the Table 2 that the annual average total cost in case of dairy enterprise was Rs. 15884, of which variable cost contributed to the tune of 78.3 per cent and fixed cost 21.6 per cent. Variable cost included, cost of dry fodder, green fodder, concentrates, labour and veterinary charges and the fixed cost included apportioned investment cost, interest on fixed capital, depreciation and electricity charges.

The average gross returns were found to be Rs. 19782, which included returns from milk production and cow dung production and net returns were Rs. 3898 and the B:C ratio for dairy enterprise was found to be 1:1.24. The least amount of total returns were found in dairy enterprise because of low quality of milk based on which the MPCS fixes the price.

Petty shop keeping as income generating activity was taken up by 14.16 per cent of the beneficiaries. The total annual cost in case of petty shop was calculated as Rs. 24474.5 of which variable cost contributed to 84.97 per cent and fixed cost contributed to 15.02 per cent. The fixed cost consisted of apportioned investment cost, depreciation, interest on fixed capital and electricity charges and variable cost consisted of expenditure on ingredients of shop. The annual gross returns were found to be Rs 30956 and net retunes Rs. 6481.5. The B.C ratio for petty shop as an income generating activity was calculated to be 1 : 1.26.

Tailoring was taken up by 10.83 per cent of the beneficiaries The total annual cost in case of tailoring activity was found to be Rs. 18983. The variable cost contributed to the extent of 88.4 per cent to the total cost which includes the cost of needles, threads, buttons and the wage rate of the person engaged in the tailoring activity.

The net returns in case of tailoring was found to be Rs. 12273 and the B:C ratio was 1:1.6. In case of beauty parlor 9.16 per cent of the beneficiaries had taken up beauty parlor as income generating source. The total cost was found to be Rs. 27700, of witch variable cost contributed to the extent of 81.9 per cent, which included the cost of the wages of the

Table 2. Cost and returns structure in major income generating activities undertaken by the beneficiaries of Udyogini scheme (2007-08) (Rs. $year^{-1}$).

Activites	Fixed cost	Variable cost	Total cost	Total returns	Net returns	Benfit cost ratio
Dairy	3442 (21.6)	12442 (78.3)	15884	19782	3898 (19.7)	1.24
Petty shop	3678.5 (15.2)	20796 (84.97)	24474.5	30956	6481.5 (20.9)	1.26
Tailoring	2200 (11.5)	16783 (88.5)	18983	31256	12273 (39.2)	1.65
Beauty parlor	4575 (16.7)	22700 (83.23)	27275	38850	11150 (28.7)	1.40

Note : Figures in parentheses indicate percentage to the cost and total revenue, respectively.

person engaged in the activity and the cost of cosmetics and other beauty products. The net returns were found to be Rs 11,150, the B:C ratio was calculated as 1:1.4.

Among the activities highest amount of total cost was involved in beauty parlor which accounted for Rs. 27700, this may be owed to high cost of beauty products and cosmetics followed by petty shop (Rs. 21792) which might be due to higher ingredient cost.

The least amount of total cost was involved in dairy enterprise. In the case of returns, highest amount of gross returns were found in beauty parlor due to its high demand amongst youngsters. The least amount of total returns were found in dairy enterprise because of low quality of milk based on which the MFCS fixes the price. In case of cost- benefit ratio, highest B:C ratio was found in tailoring 1:1.65 followed by beauty parlor which was 1.4 owing to higher net returns in service activities. The least B:C ratio was found in petty shops 1:1.2 because of less returns in this activity.

The opinion of beneficiaries about Udyogini presented in Table 3 reveals that nearly, 56.03 per cent of the beneficiaries opined that Udyogini scheme could provide them loans timely and it was convenient for them to get loan through the scheme. About 53.33 per cent of the members opined that the repayment terms were easy. Since the scheme did not have rules, based on the income of the beneficiaries they were allowed to repay, 48.33 per cent of the beneficiaries opined that the scheme is partly beneficial. The scheme is beneficial to members in a number of ways as it increased social and economic empowerment of women.

Table 3. Opinions of the beneficiaries about Udyogini scheme (2007-08).

Opinion of respondents	Positive	Partly	Negative
Timely and convenient to get loan	67 (55.83)	41 (34.16)	12 (10.00)
Repayment terms are easy	64 (53.33)	25 (20.84)	31 (25.83)
The scheme is beneficial	43 (35.83)	58 (48.34)	19 (15.83)
Lower interest rate	94 (78.33)	13 (10.84)	13 (10.83)
Easy procedure in advancing	43 (35.83)	48 (40.00)	29 (24.16)
Increased social participation	70 (58.33)	39 (32.50)	11 (09.16)
Helps overall development of the family	19 (05.83)	49 (40.83)	52 (43.33)

Figures in parentheses indicate percentage to the cost and total revenue, respectively.

About 78.33 per cent of the members opined that the interest rate was lower on loan availed through the scheme. This interest rate, compared to interests rates of money lenders and other informal sources from which the members previously availed was less. About 49 per cent of the beneficiaries opined that the scheme had partly helped the overall development of the family. It is because, through the income generating activities they

Table 4. Opinions of the beneficiaries (%) about Bank's supporting Udyogini scheme (2007-08).

Opinion of respondents	Positive	Partly	Negative
It is easy to get the loan	49.16	31.66	19.16
Easy for repayment	53.33	20.84	25.83
ROI is lower than general loans	78.33	10.84	10.83
Amount sanctioned by the bank is adequate to perform the activities.	18.33	43.34	38.33
Better supervision by the bank staff avoids misutilisation of the loan amount	33.33	49.17	17.50
Bank staff gives clear guidance about the scheme	65.00	30.00	05.00

undertook, there was increase in income earned which was used by women in better consumption and increase in household assets.

Majority of the beneficiaries had positive opinion about the scheme. Since the scheme is implemented by Government of Karnataka through Department of Women and Child Development, reservation has been effected in advances to all categories of beneficiaries including SC/ST. Wherever needed, training is imparted through nodal agencies like VIBSETI and dairy cooperative societies unions. The financial banks have kept the regular contact with the beneficiaries through their expert agents and ensured success of the scheme.

Table 4 presents the opinions of the respondents towards the banks supporting Udyogini scheme. Majority of the members have positively opined as with respect to ease in getting loan from the bank. Nearly 53.33 per cent of the beneficiaries opined that repayment terms were easy. The percentage of members who opined negative was 25.83 per cent and partly positive was 20.83 per cent.

Rate of interest is lower than the general loan as it was opined by about 78.33 per cent of the beneficiaries, since, they had realized very high interest on loans availed through other financial institutions or money lenders.

With respect to the adequacy of loan amount sanctioned by the bank to perform the activities, 43.33 per cent of the members opined as partly positive. It is because of the technical guidance provided by the Department of Women and Child Development to the beneficiaries of the Udyogini scheme, around 50 per cent of the beneficiaries opined partly yes for better supervision by the bank staff, in avoiding mis-utilization of the loan amount and 65 per cent of the beneficiaries opined positive with respect to whether the bank staff gives clear guidance about the scheme.

Table 5. Problems faced by the beneficiaries (%) of Udyogini scheme.

Problems	High	Moderate	Low
Social problems			
Casteism in the village	00.00	10.00	90.00
Economic problems			
Non avialability of loan on time	18.33	49.17	32.50
Profit is not sufficient	17.50	60.83	21.66
Problem in raw material procurement	9.24	75.63	15.12
Marketing problems			
Facilities not avaiable	05.88	73.95	20.17
Transportation problem	17.50	63.33	19.16
Personnel problems			
Other household activities	07.50	79.1	13.33
Education level of the members	11.66	28.33	60.00
Age of the members	05.88	18.46	75.63
Lack of training	28.33	39.17	32.50
Lack of encouragement or support from the family	0	93.33	6.67

About 65 per cent of the beneficiaries opined the better supervision by the bank staff avoids mis-utilization of the loan amount. As the loan amount is given to the beneficiaries by the banks, the banks keep regular contact with the beneficiaries to ensure success of the scheme.

About 65 per cent of the beneficiaries opined that the bank staff gives clear guidance about the scheme, 30 per cent of the beneficiaries opined partly positive and only five per cent of the beneficiaries opined that the clear guidance is not provided by the bank. Since banks are the initiators for starting income generating activities, their clear guidance is very much needed. Similar results were also reported by Virenderkumar and Sharma (2008).

It can be observed that caste system in the

village was not a severe problem. It might be because most of the benficiaies were the members of the same caste.

Among economic problems, non-availability of loan in time, profit not sufficient and problem in raw material procurement were found to be moderate problems. Availability of loans might be based on the beneficiaries socio-economic status as the lending banks had considered repayment capacity to ensure regular repayment of installments. Profit earned is not sufficient and the problem of raw material procurement might be based on particular income generating activities the beneficiaries have undertaken.

Among the marketing problems, the distance from local market and town and non availability of transportation facilities was opined as moderate problem by majority of the members. It is because some villages were located far from the town (or) local market. Since milk union has wide network of MPCs, marketing was not at all a problem for those who had taken dairy as the income generarting activity.

Among the personnel problems, lack of training or skill upgradation was a moderate problem, as not much training was provided as well as the members showed reluctance to go for training to other places. They had other household activities, thus they were burdened with dual responsibilities. Education level was opined as a meager problem, since most of the beneficiaries of the scheme were educated.

Though more than hundred activities have been listed under Udyogini scheme it is found that only 15-20 activates are being taken up by the beneficiaries. Hence, creation of awareness about other activities among the women needs to be taken up by the implementing agency KSWDC. With the financial assistance from the scheme women are coming forward to take up income generating activities. Thus the Udyogini scheme is helping in women entrepreneurship development. The beneficiaries have good opinion about Udyogini scheme and the banks supporting the scheme. Similar results were also reported by Puhahendhi and Saryasai (2000) and Josily and Kunnal (2009).

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Effect of Moisture Conservation Practices on Yield and Economics of Cotton Genotypes Under Rainfed Condition of Northern Maharashtra

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ABSTRACT

The experiment was conducted with four types of moisture conservation practices and two cotton genotypes under rainfed condition of Northern Maharashtra. Among the various moisture conservation practices, tied ridges and furrow produced significantly higher seed cotton yield, stalk yield and was found at par with ridges and furrow. Same moisture conservation practice has recorded higher gross monetary net monetary returns and B : C ratio per hectare. In case of cotton genotypes, deshi cotton Y-1 produced significantly higher seed cotton yield and stalk yield per hectare than JLH-168. Genotype Y-1 also produced higher gross monetary, net monetary returns and B:C ratio than genotype JLH-168 in medium deep soil (Inseptisols) for scarcity zone (rainfall III and IV) of Northern Maharashtra.

Key words : Cotton genotypes, tied ridges and furrow, moisture conservation.

Rainfall is the most important input in dry land agriculture. Major part of the country performs under rainfed agriculture, which receives rainfall from south - west monsoon. Hence, it's onset, frequency, continuity, intensity and distribution patterns have a tremendous influence on the agricultural production. Generally the rain in dryland area fall in high intensities causing runoff, erosion and produce volumes of water beyond the intake capacity of the soil and may leave the soil dry at lower depths. This happens even through the water storage capacity of the soil is far from full. The runoff losses from field can amount of 20-40 per cent of storm rainfall. The inter terrace management practices for *in situ* conservation of rainwater and ensuring its uniform distribution within the field and throughout the crop growth period for improving water-holding capacity are the two basic requirements in drylands. To enhance the productivity in rainfed agriculture adoption of soil moisture conservation practices are very essential. In view of this the research trial on moisture conservation practices and genotypes was conducted for dryland agriculture.

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MATERIALS AND METHODS

The present investigation was carried out during *kharif* 2002-03 to 2006-07 in a factorial randomized block design with four replications at National Agricultural Research Project, College of Agriculture, Dhule. Four types of moisture conservation practices *viz*., sowing on flat bed, compartment bunding, ridges and furrows and tied ridges and furrows were tried in main plot treatment while two genotypes *viz*., JLH-168 and Y-1 were tried in sub plots. The soil of the experimental site was medium deep black in texture having pH 8.1, organic carbon 0.4 per cent and 235, 12 and 329 kg ha^{-1} as available nitrogen, phosphorus and potash respectively. The sowing of cotton was done at 60 x 30 cm and 45 x 22.5 cm spacing. The cotton was fertilized with 80 kg N: 40 kg $P_2 0_5$: 40 kg K_2O. The recommended cultural operations and plant protection

measures were carried out as and when required. In one season 2 to 3 picking from cotton crop was done. An observation in respect of yield was recorded and data per hectare was statistically analyzed as per Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

Effect of moisture conservation practices : The pooled data presented in Table 1 indicated that seed cotton yield and stalk yield differed significantly due to different moisture conservation practices. Moisture conservation practice of tied ridges and furrow produced significantly higher seed cotton yield (1410 kg ha^{-1}) and was at par with moisture conservation practice of ridges and furrow (1346 kg ha^{-1}). Moisture conservation practices of tied ridges and furrow produced significantly higher stalk yield (5402 kg ha^{-1}) and was at par with moisture conservation practices of ridges and furrow (4870 kg ha^{-1}) and compartment bunding (4558 kg ha^{-1}). Goudreddy *et al*. (1995) reported that sowing of cotton in ridges and furrow obtained higher yield (1406 kg ha^{-1}) than flat bed method (1396 kg ha^{-1}) Katyal *et al.* (1992) stated that in places, where kharif fallow is a practice, compartment bunds are prepared to enhance infiltration of rain water into soil profile for raising *rabi* crop on conserved moisture.

The difference in monetary return and B : C ratio were significant due to different moisture conservation practices. Moisture conservation practice of tied ridges and furrow produced significantly higher gross monetary (Rs. 31098) and net monetary returns (Rs. 13489) per hectare and it was on par with ridges and furrow moisture conservation practice which have recorded gross monetary return of Rs. 29565 and net monetary return of Rs. 12435. The highest B : C ratio (1.77) was recorded by tied ridges and furrow whereas lowest B:C ratio was recorded by flat bed method (1.49). Similar results were also reported by Singh *et al*. (1990) that due to *in situ* moisture conservation for dry land soil higher moisture

Table 1. Pooled mean seed cotton yield, straw yield and monetary returns as influenced by moisture conservation practices and genotypes.

Treatment	Seed cotton yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Monetary returns (Rs. ha^{-1})		B:C ratio
			Gross	Net	
Moisture conservation practices :					
Sowing on flatbed	1087.50	4031	23734	7856	1.49
Compartment bunding	1188.75	4558	26179	9821	1.60
Ridges and furrows	1346.00	4870	29565	12435	1.72
Tied ridges and furrows	1410.00	5402	31098	13489	1.77
S. E. ±	81.77	292.20	2949.51	-	-
C. D. at 5%	240.37	858.87	4669.76	-	-
Genotypes :					
JLH-168	1132.50	4152	24957	8356	1.50
Y-1	1379.75	5284	30242	13641	1.82
S. E. ±	57.82	206.61	2085.62	-	-
C. D. at 5%	181.55	642.55	6507.13	-	-
Interaction :					
S. E. ±	115.65	413.22	4171.24	-	-
C. D. at 5%	NS	NS	NS	-	-
CV %	18.41	17.52	29.04	-	-

status in the profiles provides a favorable environment for plant growth which leads to increase yield and B:C ratio.

Effect of genotypes : The genotypes JLH-168 and Y-1 differed significantly in respect of seed cotton yield. Genotype Y-1 produced significantly higher seed cotton yield (1379.75 kg ha^{-1}) than JLH - 168 (1132.50 kg ha^{-1}). Similar trend was also observed in stalk yield of cotton. The difference in monetary returns was statistically significant due to different genotypes. Genotype Y-1 produced significantly higher gross monetary returns (Rs. 30242 ha^{-1}) than JLH-168 (Rs.24957 ha^{-1}). Similar trend was observed in case of net monetary returns. Numerically maximum B:C ratio was recorded by genotype Y-1 (1.82) than JLH-168 (1.50).

Interaction effect : The interaction effect between moisture conservation practices and genotype were found non-significant.

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Estimation of Annual Erosivity Indices and their Probability Distribution at Rahuri (M.S.)

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ABSTRACT

The average annual erosivity index for 23 years (1975-80 to 1987-2003) for Rahuri is estimated to be 245.93 metric units with standard deviation of 156.33 metric units. In the absence of data for longer duration, theoretical probability distribution fitting the data needs to be checked so as to predict the event with more recurrence interval than the observed database. Normal distribution fits to the annual rainfall erosivity indices for Rahuri, which can therefore be used for predicting the rainfall erosivity index having larger recurrence interval.

Key words : Erosivity indices, probability distribution.

Soil loss from agricultural land mainly depends on rainfall erosivity and soil erodibility. Erosivity of rainfall is its potential ability to cause erosion. Wischmeier (1959) found that one hundredth of the product of kinetic energy

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of rain storm and the 30 minute intensity (I_{30}) is the most reliable single estimate of rainfall erosion potential.

The present procedure requires working out kinetic energy of different durations of rainfall having uniform intensities and then determining the total kinetic energy and rainfall erosion index using Wischmeier, (1959) equations

This method is quite laborious and requires rainfall charts of recording rain gauge for analysis. In India, mostly data of non-recording rain gauge are available, which poses the problem in determining the erosion potential at various stations. Atre *et al*. (1997) analyzed the rain gauge charts of ten years (1975 - 80 and 1987-90) to compute erosion indices and these values were correlated with daily, seasonal and annual rainfall amounts at Rahuri.

MATERIALS AND METHODS

This study was carried out at Dr. A. S. College of Agricultural Engineering, MPKV, Rahuri during 2003. The rainfall charts for thirteen years i.e. 1991 - 2003 were available. The rainy days having rainfall equal to or more than 2.5 mm were selected and charts were analysed to determine rainfall erosivity indices using Wischmeier equations. The values of rainfall erosivity indices for Rahuri from 1975 to 2003 are given in Table 1.

Table 1. Annual rainfall erosion indices for Rahuri.

Year	Annual 'R' (meteric units)	Year	Annual 'R' (meteric units)
1975	215.77	1994	51.70
1976	208.55	1995	205.70
1977	332.45	1996	271.40
1978	153.05	1997	256.10
1979	511.82	1998	251.0
1980	395.70	1999	183.7
1987	431.30	2000	69.84
1988	440.0	2001	98.30
1989	430.02	2002	71.80
1990	595.67	2003	96.30
1991	59.80	Mean	245.93
1992	158.87	S. D.	156.33
1993	167.54	CV (%)	63.57

Three seasons *viz*. pre monsoon (February 7 - June 6), monsoon (June 7 - October 6) and post monsoon (October 7 - February 6) were considered in the study. Daily rainfall erosivity index values were used to compute the seasonal and annual values of erosivity indices. These values of rainfall erosion indices (R) were then correlated with daily, seasonal and annual rainfall amounts (P), respectively. In order to arrive at best model, polynomial equations of first, second and third order were tried along with exponential and power functions for fitting the rainfall amount and erosivity index data.

Frequency analysis is done to extend the experience of observed events, so that the design return period can be considered sufficiently larger. In order to carryout the frequency analysis, it is necessary to decide the probability distribution fitting the observed data

Table 2. Relationship between rainfall erosivity and rainfall amounts for different seasons.

Season	Relatioships	r (coefficient of correlation)
Monsoon (*kharif*)	$Rk = 0.065\ Pk - 29.398\ (111.5 < Pk < 338.5)$	0.9240
Post-monsoon (*rabi*)	$Rr = -3 \times 10^{-5}\ Pr^3 + 0.009Pr^2 - 0.0058\ Pr + 0.7533\ (24.0 < Pr < 230.5)$	0.9879
Annual	$Ra = 0.6363\ Pa - 41.145\ (111.5 < Pa < 484.5)$	0.9819

(Rk, Rr, Ra are erosion index (metric unit) and Pk, Pr, Pa are rainfall amounts (mm) during monsoon, post-monsoon and annual season respectively.)

and then using the relation given by Chow (1951), the values of event (X_T) can be worked out for different return periods using mean ($\bar{X}$), coefficient of variation (C_V) and frequency factor (K_T).

$$X_T = \bar{X}(1 + C_V K_T) \quad \ldots (1)$$

RESULTS AND DISCUSSION

The daily rainfall amount (P) and daily erosivity index (R) value (s) were used to obtain the best fit equation. The relationship between daily rainfall amount and daily erosion index was best described by power function, equation (2) with correlation coefficient 0.7995. This equation can be used to determine daily values of "R" from daily values of "P", which are obtained from non-recording rain gauges.

$$R = 0.0234\ P^{1.2888} \quad \ldots (2)$$

Where, R is daily rainfall erosivity index (metric units) and P is daily rainfall amount, mm ($2.5 < P < 91$).

In scarcity region of Maharashtra, monsoon rains are most erratic and have more erosive power. Hence the relationship between seasonal rainfall (P_k , P_r and P_a) and seasonal erosion indices (R_k, R_r and R_a) which can be directly used in universal soil loss equation for determining seasonal and annual soil loss, were developed (Table 2). This shows that for monsoon and annual seasons the relationship is of linear nature, for post monsoon season the best fit equation is polynomial function of third order.

The rainfall erosion index can be estimated from daily, seasonal and annual rainfall amounts. These prediction equations will save considerable time and labours required for estimation of rainfall erosivity index at Rahuri and adjoining areas.

The annual rainfall erosivity indices, R, were arranged in descending order (Table 3) and the plotting positions were computed using Weibull's formula. The R values were plotted against probability on the normal probability paper, which suggested that the normal probability distribution fits the data. The 'R' values for 10 and 25 year return period, computed using equation (1), are found to be 446.29 and 519.69 metric units. Thus using the normal distribution the annual R values can be predicted for higher return periods in the absence of data for Rahuri and adjoining areas having similar rainfall pattern. Similar results were also reported by Shinde *et al*. (1996) for Maharashtra State.

Table 3. Probability and return period (year) for annual erosivity indices at Rahuri.

Rank	R' values in descending order	Probability (m / n+1)	Return period (n+1 / m)
1	595.67	0.0417	24
2	511.82	0.0833	12
3	440.0	0.1250	8
4	431.30	0.1667	6
5	430.02	0.2080	4.80
6	395.70	0.2500	4.0
7	332.45	0.2917	3.4286
8	271.4	0.3333	3.0
9	256.10	0.3750	2.6667
10	257.0	0.4167	2.40
11	215.77	0.4583	2.1818
12	208.55	0.50	2.0
13	205.70	0.5417	1.8462
14	183.70	0.5833	1.7143
15	167.54	0.6250	1.60
16	158.87	0.6667	1.50
17	153.05	0.7083	1.4118
18	98.30	0.7500	1.3333
19	96.30	0.7917	1.2632
20	71.80	0.8337	1.20
21	69.84	0.8750	1.1429
22	59.80	0.9167	1.0909
23	51.70	0.9583	1.0435

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Effect of Blending Goat and Buffalo Milk on Physico-chemical and Sensory Quality of Paneer

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ABSTRACT

The goat milk could be successfully utililized for preparation of paneer in combination with buffalo milk. The most acceptable quality paneer can be preparted by using buffalo and goat milk in the proporation of 75:25. Goat milk alone makes inferior quality paneer.

Key words : Paneer, goat milk, buffalo milk, physico-chemical-sensory quality.

In India, paneer production has been largely confined to the un-organized sector of the dairy industry. About 5 per cent of the total milk produced in our country is converted into paneer (Mathur, 1991).

Goat milk has been recognized for its value in medicine and infant feeding. Goat milk contributes 3 per cent of the national milk supply. The annual output of milk from goat is 2.55 million tonnes (Sharma and Kumar, 2004). Though goat milk in India is often consumed as such or mixed with cow and buffalo milk for sale, a range of value-added products from goat milk can be prepared and sold profitably in the market. Various dairy products are prepared from goat milk such as khoa (Jailkhani and De, 1979), chhana (Jailkhani and De 1980, Moorty and Rao 1982, Joshi *et al*., 1991), beverages, yoghurts, ice cream, and cheese (Loewenstein *et al*. 1986), ghee (Ishwarsingh and Gupta 1984, Arora and Singh 1986), rasogolla (Bhargave *et al*. 1992), shrikhand (Agnihotri and Pal, 1998). However, information on its suitability for paneer preparation is meagre.

Buffalo milk is preferred for preparation of desirable quality paneer. Buffalo milk containing considerably higher level of casein and minerals particularly calcium and phosphorus, tends to produce hard and rubbery body. Buffalo milk retains higher fat, protein and ash content and less moisture and lactose as compared with paneer from cow's milk (Boghra and Mathur, 1995). There is a stress

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on the availability of buffalo milk for consumption. To alleviate the stress on buffalo milk and considering the increased availability of goat milk, it is proposed to explore the possibility of utilization of goat milk for preparation of paneer. In the present study, attempts were made to study the effect of blending goat and buffalo milk on physico-chemical and sensory characteristics of paneer. The study was aimed at to determine suitability of goat milk for preparation of paneer.

MATERIALS AND METHODS

Paneer was manufactured by the procedure standardized by Bhattacharya *et al*. (1971). Goat milk was added to buffalo milk with different levels. Milk was heated to 85°C for 10 min. and then cooled to a temperature of 70 °C. It was then coagulated by addition of 1 per cent citric acid solution. The whey was drained out through muslin cloth. The curd was collected and filled in rectangular hoop. Hooping and pressing was carried out. The pressed curd was then removed from hoop and cut into small pieces. Then fresh samples of paneer were subjected for organoleptic evaluation to a panel of ten judges.

The treatments were 100 per cent buffalo milk (T_1), 75:25 per cent buffalo and goat milk (T_2), 50:50 per cent buffalo and goat milk (T_3), 25:75 per cent buffalo and goat milk (T_4), and 100 per cent goat milk (T_5). The fat content of paneer was estimated using standard Gerber's method as per the procedure stated by Chaudhari (1959). The protein and total solids were determined as per the method described in IS:1479 (part II, 1961). Titratable acidity was determined according to method given by Chaudhari (1959) and ash was determined as per the method mentioned in A.O.A.C, 1995. The sensory characteristics of paneer such as colour and appearance, body and texture, and flavour were studied by house panel of ten judges using nine point hedonic scale as per IS:6273 (part II, 1971)

RESULTS AND DISCUSSION

The data given in Table-1 indicates that fat, total solids and protein percentage of pure buffalo milk (T_1) is higher than that of pure goat milk (T_5). However, acidity of buffalo milk is lower than that of goat milk. The chemical quality of pure buffalo (T_1) and goat milk (T_5) is in close agreement with the average chemical composition mentioned by De (1980) and Joshi *et al.* (1991).

The highest fat content (Table 2) in paneer (26.10 per cent) was obtained at the 100 per cent level of buffalo milk (T_1) and lowest (23.90 per cent) at 100 per cent level of goat milk (T_5). Increase in the level of goat milk decreased fat content of paneer, which may be due to the fact that goat milk contains less amount of fat i.e. 4.57 per cent than buffalo milk (6.67 per cent). The average fat content of buffalo milk paneer was 26.10 per cent. This value compared well with those reported by Rajorhia *et al*. (1984), Boghra and Mathur (1995) and Pal *et al*. (1996). They reported 27.13, 26.50 and 26.17 per cent fat in buffalo milk paneer, respectively.

Same trend like fat was noticed in case of total solids content of paneer. The total solids content were decreased with the increase in the level of goat milk, which may be obviously due to replacement of buffalo milk by goat milk.

Table 1. Chemical analysis of buffalo, goat and mixed milk (per cent).

Treat-ments	Fat	Total solids	Protein	Acidity
T_1	6.67	15.67	4.25	0.14
T_2	6.38	15.29	4.13	0.14
T_3	6.08	14.96	3.81	0.15
T_4	5.55	13.93	3.52	0.16
T_5	4.57	19.71	3.45	0.16

The average value for total solids content in paneer depicted in Table-2 are more or less similar to the figures reported by Boghra and Mathur (1995), Pal and Agnihotri (1995) and Pal *et al*. (1996). They reported 49.15 per cent total solids for buffalo milk paneer, 42.22 to 51.80 per cent for goat milk paneer and 48.67 per cent for buffalo milk paneer, respectively. Pal *et al*. (1999) reported 44.90 per cent total solids for paneer prepared from standardized buffalo milk using citric acid as a coagulant.

The protein content of paneer was significantly decreased from the treatment T_1 to T_5, which was probably due to low protein content in goat milk. Boghra and Mathur (1995) observed 18.64 per cent protein where as Nayak and Bector (1998) noticed 19.94 per cent in buffalo milk paneer. Pal and Agnihotri (1995) reported that protein content of goat milk paneer ranged from 17.86 to 21.88 per cent.

The titratable acidity of paneer showed increasing trend with an increase in the level of goat milk as it (T_5) possessed higher initial acidity than buffalo milk (T_1) as shown in Table-1. The highest acidity level was noticed in goat milk paneer (0.85 per cent) while the lowest in buffalo milk paneer (0.69 per cent). These values were more or less similar with those recorded by Rajorhia *et al*. (1984) as 0.78 per cent for buffalo milk paneer and Nayak and Bector (1998) as 0.70 per cent for paneer sold in Delhi market.

From Table-3, it was observed that treatment T_2 and T_3 recorded the highest score

Table 2. Physico-chemical quality of paneer.

Treatments	Chemical composition				
	Fat	**Total solids**	**Protein**	**Titratable acidity**	**Ash**
Buffalo milk 100 per cent (T_1)	26.10	49.30	19.11	0.69	2.01
75:25 per cent buffalo : goat milk (T_2)	25.65	48.35	18.87	0.71	1.92
50:50 per cent baffalo : goat milk (T_3)	25.15	47.27	18.43	0.74	1.84
25:75 per cent buffalo : goat milk (T_4)	24.55	46.25	18.18	0.81	1.77
100 per cent goat milk (T_5)	23.90	45.26	17.95	0.85	1.69
S. E. ±	0.14	0.04	0.04	0.01	0.01
C. D. at 5%	0.42	0.11	0.11	0.04	0.03

Table 3. Sensory quality of paneer (based on nine point hedonic scale).

Treatments	Sensory characteristics			
	General appearance	**Body and texture**	**Flavour**	**Overall acceptability**
Buffalo milk 100 per cent (T_1)	7.93	7.68	7.62	7.74
75:25 per cent baffalo : goat milk (T_2)	8.05	7.95	7.61	7.87
50:50 per cent baffalo : gaot milk (T_3)	8.05	7.95	7.45	7.80
25:75 per cent baffalo : goat milk (T_4)	7.68	7.22	6.73	7.21
100 per cent goat milk (T_5)	7.17	6.41	5.51	6.36
S. E. ±	0.16	0.15	0.24	0.16
C. D. at 5%	0.46	0.45	0.71	0.46

for general appearance. Paneer prepared from buffalo and goat milk in the proportion of 75:25 and 50:50, respectively, showed clean appearance with appealing even and white coloured product where as the paneer with 100 per cent goat milk showed moist appearance and dull colour than rest of the treatments, which might have reduced the score for general appearance for that treatment.

The paneer with treatments T_1, T_2 and T_5 exhibited firm and cohesive body. However, paneer with higher proportion of goat milk and pure goat milk i.e. T_4 and T_5; respectively had loose body and coarse texture and lacked cohesiveness, which resulted into lower scores. This illustrated that goat milk when used upto 50 per cent level as a substitute for buffalo milk imparted acceptable body and texture.

Good quality paneer is characterized by its acidic flavour with slightly sweet taste (Singh *et al*. 1984). From results it was observed that the highest score has obtained by 100 per cent buffalo milk with score of 7.62 closely followed by buffalo and goat milk in the proportion of 75:25 with score of 7.61 and lowest score was recorded by 100 per cent goat milk with score of 5.51. This lowest score may be due to acidic smell and sour taste, which was not liked by the judges.

From overall acceptability scores it can be affirmatively stated that amongst different levels of buffalo and goat milk used, buffalo and goat milk in the proportion of 75:25 treatment was found most acceptable but equally good paneer was obtained from buffalo and goat milk in the proportion of 50:50 and 100 per cent buffalo milk. Higher proportions of goat milk (75 and 100 per cent) produced inferior quality paneer.

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Milk Production Performance of Phule Triveni Crossbred Cows Under Field Conditions

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ABSTRACT

The least squares means of lactation milk yield, lactation length, fat and SNF content in milk of crossbred cows was 3616.92 ± 42.74 kg, 363.98 ± 2.94 days, 4.20 + 0.02 and 9.03 ± 0.04 per cent respectively. The effects of season of calving on lactation length and lactation order on SNF content in milk were significant. The lactation length of cows calved during rainy season (375.51 + 10.30 days) was significantly higher than those calved in winter and summer season. The SNF content in milk of cows of L_4 group (8.28 ± 0.19) was significantly lower than in cows of L_1 to L_3 groups. The correlations of lactation milk yield and lactation length with fat and SNF content in milk were positive and significant ($P < 0.05$).

Key words : Phule Triveni, milk yield, fat, SNF.

The economics of dairy enterprise mainly depends on lactation milk yield of cows. The productive life, number of lactations in lifetime and lifetime milk yield are related to lactation length of cows. The fat and SNF content in milk determines the quality and price of milk. In order to know the productivity of crossbred cows, their performance should be tested under farm and field conditions. After testing the overall performance of Phule Triveni crossbred cows at farm condition, these cows were distributed to farmers for testing their performance under field condition. Hence, the present investigation was undertaken to study milk production performance of Phule Triveni crossbred cows under field condition.

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MATERIALS AND METHODS

The data pertaining to production traits of Phule Triveni crossbred cows under field condition were generated from the records maintained at research-cum-development project on cattle, MPKV, Rahuri during 1997 to 2002. The least squares means of lactation milk yield, lactation length, fat and SNF content in milk of crossbred cows was estimated by considering season of calving (SOC) and lactation order (LO) effects (Harvey, 1990). The Duncan's Multiple Range Test (DMRT) as modified by Kramer (1957) was used to make pair wise comparison between two mean values. As per the prevailing climatic conditions year was divided into three seasons *viz*. rainy (June to September), winter (October to January) and summer (February to May). Simultaneously, the correlations between production traits and milk quality traits were also estimated.

RESULTS AND DISCUSSION

The overall least squares means and effects wise least squares means of lactation milk yield, lactation length, fat and SNF content in milk of Phule Triveni crossbred cows are presented in Table 1. and 2 respectively.

The overall least squares means of lactation milk yield in Phule Triveni crossbred cows under field conditions was 3616.92 ± 42.74 days. These results were in close agreement with Bhoite and Kale (1999) reported in FJG (50% Friesian + 25% Jersey + 25% Gir) triple cross cows. The effects of season of calving and lactation order on lactation milk yield in crossbred cows were non significant. The non-significant effect due to SOC on lactation milk yield might be due to proper feeding and management of crossbred cows throughout the year.

The least squares means of lactation length in crossbred cows was 363.98 ± 2.94 days. The influence of season of calving on lactation length was significant ($P < 0.05$). However, lactation length was not significantly affected by lactation order. Significant effect of SOC on LL was reported by Thakur and Singh (2000) in Sahiwal crossbred cows. In present study lactation length (days) of cows calved during rainy season (375.51 ± 10.30) was significantly higher than those calved in winter (358.24 ± 2.89) and summer (357.59 ± 5.67) seasons. The difference between the LL of winter and summer calves was non-significant.

Table 1. Least squares means of some production traits in Phule Triveni crossbred cows.

Traits	n	Mean ± S. E.
Lactation milk yield (kg)	202	3616.921 ± 42.744
Lactation length (days)	202	363.980 ± 2.946
Fat (%)	164	4.205 ± 0.022
SNF (%)	164	9.038 ± 0.042

The overall least squares means of fat content in milk of Phule Triveni crossbred cows under field conditions was 4.20 ± 0.02 per cent. The variations due to SOC and LO in fat content of crossbred cows milk were non-significant. Similar non-significant effect of season of calving on fat content in milk of Gir triple cross was reported by Naikare (1993). These results revealed that neither season of calving nor lactation order of cows affected fat content in milk of crossbred cows. This might be due to proper feeding of cows.

The least squares means of SNF content in milk of crossbred cows was 9.03 ± 0.04 per cent. Puranik *et al*. (2000) observed slightly lower values of SNF content in milk of HF x Deoni crossbred cows. The influence of SOC on SNF content in milk of cows was non-significant. However, lactation order significantly ($P < 0.01$) affected SNF content in milk of crossbred cows. The SNF content in

Table 2. Least squares means of some production traits.

Traits/ Effect	Lactation milk yield (kg)			Lactation length (days)			Fat (%)			SNF (%)		
	n	Mean	± SE	n	Mean	± SE	n	Mean	± SE	n	Mean	± SE
Population mean	202	3645.824	68.592	202	363.782	4.719	164	4.200	0.034	164	8.885	0.060
Lactation order :												
L_1	100	3535.995	99.126	100	361.859	6.820	85	4.192	0.053	85	9.071[a]	0.094
L_2	62	3764.720	76.320	62	368.321	5.250	45	4.217	0.043	45	9.087[a]	0.078
L_3	32	3738.472	107.064	32	378.461	7.366	26	4.267	0.057	26	9.097[a]	0.102
L_4	8	3544.110	228.154	8	346.488	15.697	8	4.124	0.111	8	8.286[b]	0.197
Season of calving :												
S_1	45	3783.639	149.758	45	375.514[a]	10.303	43	4.205	0.076	43	8.920	0.135
S_2	71	3567.769	85.740	71	358.242[b]	5.899	56	4.242	0.046	56	8.926	0.082
S_3	86	3586.065	82.415	86	357.591[b]	5.670	65	4.153	0.044	65	8.810	0.087

milk of cows of 4th lactation (8.28 ± 0.19) was significantly lower than those calved for 1st to 3rd lactations.

The correlations of lactation milk yield and lactation length with fat and SNF content in milk of Phule Triveni crossbred cows were positive and significant ($P < 0.05$) and correlation values were 0.298, 0.280 and 0.303 and 0.292 respectively. This indicated that neither milk yield nor lactation length adversely affect the quality of milk of crossbred cows.

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RESEARCH NOTES

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Effect of Preservatives on Vase Life of Gladiolus cv. American Beauty

In cut flower industry, the most important aspect is post harvest handling in order to maintain flowers freshness and original colour for longer period. Normally gladiolus spikes last for 4-5 days when placed in water (Murali and Reddy, 1993). Extended vase life of cut flower depends on their water relations and retarding rate of senescence, which can be achieved by using right stage of cutting of flower and pulsing treatment. In present investigation the attempt has been made to develop appropriate pulsing solution for prolonging the vase life of gladiolus flower and to study the changes associated with extended vase life during winter season.

Uniform five gladiolus spikes of cv. American Beauty were harvested and placed immediately in the water. In laboratory the spikes were cut at uniform stalk length of 60 cm. The selected spikes were kept in conical flask containing different holding solutions and preservatives. Each conical flask was filled with 300 ml preservative solution as per the treatment. The bottom ends of spikes were cut about 5 mm every day to prevent clogging of vascular bundles and five spikes were kept in conical flask for each treatment. The experiment was carried at Department of Horticulture, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli with various six pulsing treatment (Table 1) and replicated four times in CRD during the year 2002. The observations on cumulative uptake of water (CUW), cumulative loss of water and water balance, florets opened day^{-1}, total number of florets opened spike^{-1}, percentage of opened florets, and scoring in retention of colour and geotropically bending at end of vase were recorded and statistically analyzed following method suggested by Panse and Sukhatme (1985).

Cumulative uptake of water (CUW) was significantly influenced by various pulsing treatments. The highest cumulative uptake of water (52.50 ml) was recorded in spikes pulsed in treatment sucrose 5 per cent as compared to spikes pulsed in distilled water or control (33.88 ml) and also higher cumulative loss of solution was recorded by the pulsing same treatment. The minimum quantity of balanced water for all days was with treatment sucrose 5 and sucrose 2.5 per cent. These findings are

Table 1. Effect of different pulsing treatment on opening of florets and vase life of gladiolus spikes cv. American beauty.

Treatment	Uptake of solution (ml)	Florets opended day^{-1}	Florets opended spike^{-1}	Retention of colour	Geotropically banding	Vase life (days)
Sucrose - 2.5%	46.88	0.76	11.25	6.9	7.0	15.75
Sucrose - 5%	52.50	0.75	12.00	7.1	7.5	17.25
Sucrose - 7.5%	44.38	0.80	10.75	6.1	6.5	15.25
$AgNO_3$ - 250 ppm	39.63	0.76	11.00	5.7	5.9	15.50
$AgNO_3$ - 500 ppm	40.88	0.76	11.25	5.5	5.5	15.75
Control (Distilled water)	33.88	0.96	8.25	5.0	5.0	9.50
S. E. ±	0.42	0.018	0.20	-	-	0.26
C. D. at 5%	1.24	0.055	0.61	-	-	0.78

in line with the earlier reports of Ramanujarao and Mohanram (1981). Reduction in transpiration loss of water was recorded in spikes pulsed in distilled water, might be due to early completion of vase life and also due to petals expansion causes severe depletion of water. The increase in water uptake may be due to increase in transpiration losses in pulsing treatment sucrose 5 per cent in order to maintain water balance in spikes and it was at par with 2.5 per cent sucrose treatment. The findings of Mayak *et al*. (1973) and Bhattacharya (1997) in gladiolus, are similar to the results of this investigation. The increased transpiration loss of water by 5 per cent sucrose pulsing treatment may be due to increased uptake solution and effect of sucrose on stomatal openings due to increase in osmotic concentrations (Murali, 1990) and also to meet improved water balance.

The significantly maximum number of florets opened day^{-1} was recorded in control (0.96) than other treatments. Significantly maximum number of florets (12.00) and highest percentage of opening of florets (85.71%) was recorded by 5 per cent sucrose pulsing treatment followed by 2.5 per cent sucrose as compared to silver nitrate and control. The higher percentage of sucrose i.e. 7.5 per cent decreased the number of florets opened spike^{-1}. These results are in line with the results reported by Parmar *et al*. (2002) who reported that highest number of florets that opened perfectly was recorded at 4 per cent sucrose and with reports reported by Murali and Reddy (1993).

The significant highest percentage of opened florets in 5 per cent sucrose treatment support the reports of Mayak *et al*. (1973), Jiang *et al*. (1983) who reported that sucrose addition will serve as building blocks and supply the required energy for growth processes. Sucrose delays the onset of excessive protein degradation and thus extends the longevity of florets. Murali (1990) observed that supplementation of sucrose provides sufficient intracellular carbohydrates reserves and inhibit ethylene production in cut gladiolus spikes supports the investigation.

Sucrose 5 per cent pulsing treatment proved most effective with maximum vase life (17.25 days) followed by the treatment sucrose 2.5 per cent and $AgNO_3$ 500 ppm with vase life of 15.75 days as compared to control (9.50 days). Vase life was highest in treatment 5 per cent sucrose with highest score for colour retention and bending. The higher score for colour retention and geotropically bending was recorded in sucrose 5 per cent pulsing treatment and is in conformity with the findings of Murali and Reddy (1993) and Parmar *et al*. (2002). Hence the present study indicates that, the florets showing colour stage of harvesting with 5 per cent sucrose as pulsing treatment can help in prolonging the post harvest life of the gladiolus spikes in cv. American Beauty.

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Induced Chlorophyll Mutations in Black gram

A large number of desirable varieties have been developed through mutation breeding in field and horticulture crops. But the application and success of mutation breeding in improvement of grain legume crops is relatively limited except perhaps soybean and groundnut. Chlorophyll mutations offer one of the most reliable indices for the assessment of genetic effects of mutagenic treatments. Genotypic differences in response to induction of chlorophyll mutations can be observed as frequency of induced chlorophyll mutations in M_2 generation. Azide induces high frequencies of chlorophyll and morphological mutations with negligible frequency of chromosomal aberrations when used in acidic conditions. As expected, about 250-300 loci might be involved for breakdown of the chlorophyll apparatus in barley (Swaminathan 1957). So also Von Wettstein (1980) in barley and Haque and Godward (1986) in lectuceae reported involvement of considerable number of genes at different stages of plastid development as revealed from the plastid ultra structure of leaves. Hence, the probability of occurrence of such category of mutation is obvious in all mutagen treatments.

The cultivar IPU-982 of urdbean was employed as experimental material during the present study. Seeds of this variety were irradiated with 10, 20, 40 and 60 kR doses of gamma radiation at ^{60}Co gamma cell and for chemical treatment seed samples were presoaked in the distilled water for 14 hours at room temperature and treated with sodium azide at 0.01, 0.02, 0.03, 0.04, 0.05, 0.06 and 0.07 per cent concentrations. Irradiated seeds along with sodium azide treated seeds and control (parental variety), were grown in randomized block design to study the M_1 generation during *kharif* 2003-2004.

The M_2 population was screened for frequency and spectrum of chlorophyll mutations per 1000 M_2 plants. Lethal chlorophyll mutations were scored within 10 to 25 days of sowing whereas viable chlorophyll mutations were scored throughout the life period of plants. The spectrum of chlorophyll mutations was studied and the mutants were classified as per the scheme of Gostafason (1940).

Chlorophyll mutations provide one of the most dependable indices for the evaluation of genetic effects of mutagenic treatments and have been reported in various pulse crops by several workers including Gautam *et al*. (1992). The data was recorded on the frequency of chlorophyll mutations per 1000 M_2 plants (Table 1). Chlorophyll mutations were found in

Table 1. Effect of different combinations of gamma rays and sodium azide on frequency and spectrum of chlorophyll mutations and other macro mutations in M_2 generation of black gram.

Treatments	Number of M_2 plants	Chlorophyll mutants		Spectrum / Frequency of chlorophyll mutants/ 1000 M_2 plants					
		Number	Frequency (per 1000 M_2 plants)	Albina	Xantha	Dark xantha	Chlorina	Viridis	Striats
0 kR + 0.00% SA	1354	00	0.00	-	-	-	-	-	-
0 kR + 0.01% SA	1317	7	5.31	2.28	-	1.51	1.51	-	-
0 kR + 0.02% SA	1414	8	5.65	-	1.41	-	2.12	2.12	-
0 kR + 0.03% SA	1345	9	6.69	2.23	-	1.48	-	-	2.97
0 kR + 0.04% SA	1256	11	8.81	1.60	2.40	1.60	-	2.40	1.60
0 kR + 0.05% SA	1242	5	4.05	-	-	1.61	-	2.41	-
0 kR + 0.06% SA	1211	0	0	-	-	-	-	-	-
0 kR + 0.07% SA	1201	5	4.16	1.66	-	1.66	-	0.83	-
10 kR + 0.00% SA	1315	7	5.32	2.28	1.52	-	1.52	-	-
10 kR + 0.01% SA	1302	3	2.30	-	0.76	-	0.76	0.76	-
10 kR + 0.02% SA	1248	9	7.16	0.79	0.79	-	1.59	-	-
10 kR + 0.03% SA	1205	8	6.64	2.48	2.48	-	-	1.65	-
10 kR + 0.04% SA	1200	4	3.33	0.83	0.83	-	-	1.66	-
10 kR + 0.05% SA	1191	5	4.19	1.67	-	0.83	-	-	-
10 kR + 0.06% SA	1176	3	2.55	-	0.85	-	-	-	-
10 kR + 0.07% SA	1152	8	6.94	-	1.73	-	2.60	2.60	-
20 kR + 0.00% SA	1234	9	7.29	3.24	2.43	-	-	-	1.62
20 kR + 0.01% SA	1215	5	4.11	1.64	-	-	0.82	1.64	-
20 kR + 0.02% SA	1137	3	2.64	-	1.76	0.87	-	-	-
20 kR + 0.03% SA	1126	6	5.32	2.66	0.88	-	1.77	-	-
20 kR + 0.04% SA	1111	4	3.60	-	-	0.90	-	1.80	0.90
20 kR + 0.05% SA	1096	8	7.29	2.73	-	1.82	2.73	-	-
20 kR + 0.06% SA	1048	7	6.68	-	-	-	-	-	-
20 kR + 0.07% SA	1024	3	2.92	-	1.95	-	-	0.97	-
40 kR + 0.00% SA	1246	5	4.01	-	-	0.80	1.60	1.60	-
40 kR + 0.01% SA	1213	8	6.59	2.47	1.64	-	2.47	-	-
40 kR + 0.02% SA	1175	9	7.66	3.40	-	1.70	2.55	-	-
40 kR + 0.03% SA	1134	9	7.93	-	-	0.88	-	2.64	1.76
40 kR + 0.04% SA	1127	6	5.32	3.22	0.88	0.88	-	0.88	-
40 kR + 0.05% SA	1046	3	2.86	-	0.95	-	0.45	0.95	-
40 kR + 0.06% SA	1028	3	2.91	0.97	-	0.97	0.97	-	-
40 kR + 0.07% SA	846	5	5.28	-	2.11	-	-	1.05	1.05
60 kR + 0.00% SA	1085	4	3.68	-	-	0.92	1.84	0.92	-
60 kR + 0.01% SA	985	5	5.07	2.03	-	2.03	1.01	-	-
60 kR + 0.02% SA	923	4	4.33	-	1.08	-	-	1.08	1.08
60 kR + 0.03% SA	901	8	8.87	2.22	4.43	-	2.22	-	-
60 kR + 0.04% SA	846	0	0.00	-	-	-	-	-	-
60 kR + 0.05% SA	826	4	4.84	1.21	-	3.63	1.21	-	-
60 kR + 0.06% SA	764	5	6.54	2.61	1.31	-	-	-	2.61
60 kR + 0.07% SA	613	3	4.89	1.63	-	1.63	-	1.63	-

almost all the mutagenic treatments High frequency of chlorophyll mutations were found in the combination treatment of gamma rays and sodium azide and in the doses of sodium azide alone. The highest frequency of chlorophyll mutations (8.87) was reported in the combination of 60kR + 0.03 per cent SA while the lowest (2.30) frequency of chlorophyll mutations was found with the treatment combination of 10kR + 0.01 per cent SA. Sodium azide was found to be more effective for inducing chlorophyll mutations in comparison to gamma rays and their combinations.

Spectrum of chlorophyll mutations in segregating M_2 generation (Table 1) indicates presence of broad chlorophyll mutant spectrum comprising 5 types (maximum) was induced by 0.04 per cent SA followed by 40kR + 0.04 per cent SA treatment which induced four types of chlorophyll mutants. Xantha mutant recorded highest frequency (4.43) in 60kR + 0.03 per cent SA treatment. Highest frequency of chlorina mutants was found with 20kR + 0.05 per cent SA and dark xantha in case of 60kR + 0.05 per cent SA (3.63) treatment. The higher frequency of viridis was observed in the treatment 40kR + 0.03 per cent SA (2.64), while albina mutants were found in 40kR + 0.02 per cent SA (3.40) and striata mutant was found under 0.03 per cent SA treatment.

The combination treatments of gamma rays with sodium azide enhanced the frequency of chlorophyll mutations, which is supported by previous results of Gautam and Mittal, (1998) in black gram. Mutation frequency in sodium azide with gamma ray treatments was higher than the sum of the two single treatments. Six different types of chlorophyll mutants produced in the present study are in agreement with the findings of several workers in the past Ignacimuthu and Babu (1988) reported albina, viridis, chlorina, xantha mutants in three species of *Vigna*. Out of six mutants induced in the present study, dark xantha and xantha mutants were most frequent while striata type was the least frequent. Earlier studies have revealed as many as 6 types of chlorophyll mutation by Gastafason (1940).

There was a dose dependent increase in the spectrum and frequency of chlorophyll mutations in M_2. The spectrum and frequency of chlorophyll mutations increased with dosage as reported by Ignacimuthu and Babu (1988) which is similar to the present study. A progressive increase in mutation frequency of chlorophyll mutations was observed with increasing doses. Manju *et al*. (1983) observed that chlorophyll mutation frequency in M_2 seedlings showed dose dependence in horse gram. In the present study, interaction of sodium azide with gamma rays increased the chlorophyll mutation frequency, which is in agreement with the findings of Cheng and Gao (1988). Viable chlorophyll mutations, i.e., chlorina and viridis were produced more at lower doses/concentrations of mutagen whereas lethal mutants, namely, albina, xantha and dark xantha were observed more frequently at relatively higher doses/concentrations of the mutagens.

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Relative Performance of New Sugarcane Genotypes in Western Maharashtra

Varietal improvement and development is no doubt a continuous process to find out the suitable replacement of sugarcane varieties to the existing ones under cultivation in the particular area. The major emphasis in sugarcane is on development of improved cultivars with high cane and sugar yield and multiple resistance characters over the existing released varieties. The performance of promising genotypes changes with change in the environmental factors and therefore they need to be evaluated in a particular region for their stability.

The interest of sugar factory lies with high sugar content whereas farmer's interest is restricted to only higher cane yield. It is difficult to breed a plant type possessing all the desired qualities and quantitative traits like high cane yield, sucrose content, ratooning ability, disease and pest resistance and resistance to various a biotic stresses. All the desirable parameters are difficult to combine together in a single clone but a compromise has to be made for obtaining optimum productivity.

Fifteen new sugarcane hybrids *viz*. MS 0202 (Co 8371 x Co 775), MS 0209 (Co 8371 x Co 775), MS 0211 (Co 92020 x CoM 8511), MS 0217 (Co 92020 x CoM 8511), MS 0219 (Co 92020 x CoM 8511), MS 0221 (Co 92020 x CoM 8511), CoM 0238(Co 8371 x CoT 8201), CoM 0250 (Co 87044 GC), CoM 0251 (Co 87044 GC), CoM 0254 (Co 86002 GC), CoM 0260 (Co 82023 x Co 8001), CoM 0261 (Co 88025 x Co 1148), CoM 0264 (Co 7201 x CoC 671), CoM 0265 (Co 87044 GC), CoM 0272 (Co 88028 GC) and three checks

i.e. Co 86032 (Co 62198 x CoC 671), CoC 671 (Q-63 x Co 775) and Co 94012 (somaclone of CoC 671) were evaluated for yield and quality characters in a randomized block design with two replications at three locations i.e. Padegaon, Kolhapur and Pravaranagar in suru season (January planting) during 2004-05. Each plot consisted of 4 rows of 6m length spaced at 1m. The experiment was planted on 7.1.2004, 14.1.2004 and 16.1.2004 at Padegaon, Kolhapur and Pravaranagar respectively. The soil of experimental plot was deep black. All the recommended agronomic practices were followed for raising the crop. Data were recorded at 12 months age of the crop for yield and quality characters and at 10 months for juice quality characters viz. sucrose per cent in juice, commercial cane sugar (CCS) and purity per cent. Statistical analysis was done by the method suggested by Panseand Sukhatme (1978).

The mean cane yield ranged from 103.02 t ha^{-1} (CoM 0264) to 159.4 t ha^{-1} (CoM 0265) with a mean of 125.5 t ha^{-1}. The genotype CoM 0265 recorded significantly higher cane yield than the three check varieties i.e. Co 86032, CoC 671 and Co 94012 and was followed by the genotype MS 0209 (145.6 t ha^{-1}).

The mean CCS yield ranged from 13.74 t ha^{-1} (MS 0221) to 21.86 t ha^{-1} (CoM 0265) with a mean of 17.68 t ha^{-1}. The genotype CoM 0265 recorded significantly higher CCS yield than the check varieties i.e. Co 86032 (18.51 t ha^{-1}) and CoC 671 (17.68 t ha^{-1}).

The sucrose at 10 months age ranged from 14.34 (CoM 0238) to 19.40 per cent (CoM 0254) with a mean of 16.15 per cent. The CCS at 10 months age ranged from 9.90 (CoM 0238) to 14.03 per cent. (CoM 0254) with a mean of 11.42 per cent. The highest purity per cent was observed in the genotype CoM 0254 (96.73%) followed by CoM 0265 (94.62%) and CoM 0260 (94.08%).

The sucrose at 12 months age ranged from 17.74 (MS 0211) to 21.86 per cent (Co 94012) with a mean of 19.66 per cent. None of the genotype recorded higher CCS than the check variety Co 94012 (15.73%). The mean highest purity was observed in the genotype MS 0202 (95.91%) followed by CoM 0250 (95.86%) and MS 0221 (95.83 %).

The mean germination at 45 days after planting ranged from 60.6 (CoC 671) to 71.4 per cent (MS 0217) with a mean of 67.4 per cent. Number of tillers at 120 days after planting ranged from 1, 34,000 (MS 0217) to 1, 97,000 ha^{-1} (CoM 0265) with a mean of 155060 ha^{-1}. The number of millable canes at harvest ranged from 80,000 (CoM 0238) to 96,000 (Co 86032) with a mean of 90,710. The average cane weight at harvest ranged from 1.170 (MS 0221) to 1.770 kg (CoM 0265) with a mean of 1.440 kg. The millable cane height at harvest at ranged from 243 (MS 0221) to 300cm (CoM 0251) with a mean of 270cm. The cane girth at harvest ranged from 8.3 (CoM 0254) to 11.5cm (CoM 0261) with a mean of 9.7cm. The number of internodes at harvest ranged from 17 (MS 0221) to 25 (CoM 0265) with a mean of 21 internodes.

Looking to overall performance of the genotypes, CoM 0265 and CoM 0261 were found superior for cane and CCS yield while the genotype CoM 0254 was found early maturing and high sugar containing at 10 months age among the genotypes tested.

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Effect of Integrated Nutrient Management on Yield of Summer Sesamum (*Sesamum indicum* L.)

Sesamum is probably the most ancient oilseed known and used by man and is the second most important oilseed crop next to groundnut. Sesamum seeds are rich source of food, nutrition, edible oil (42-52 %), health care and bio-medicine. Sesamum is used in manufacture of soap and paints, pyrethrum insecticidal industry, preparation of tonic for the hair. Sesamum oil is useful for dry cough, asthma diseases of lungs, burning sensation, diseases of the ear and eyes. Recently omega-6 fatty acid desaturase also got from sesamum which is helpful for heart patients (Jin *et al.* 2001).

The low productivity has been attributed to the imbalanced nutritional status of plant particularly, the inadequate use of nutrients is an important factor limiting the full expression of sesamum yield potential. This results in low production of oil without fulfilling the requirement of our country, which has led to high prices, unavailability of oils and their adulteration. By approaching modern crop production technology stresses the need for integrated nutrient management which

Table 1. Mean sesamum grain yield, grain to straw ratio, gross and net monetary returns as affected by different treatments.

Treatments (ha^{-1})		Seed yield		Straw yield (q ha^{-1})	Grain to straw ratio	Gross monetary returns (Rs. ha^{-1})	Net monetary returns (Rs. ha^{-1})
		Per plant (g)	Per ha (q)				
T_1	Control	2.68	5.77	9.06	0.64	28845	8097
T_2	60:40:20 NPK (RDF)	5.57	11.95	25.09	0.48	59750	36943
T_3	75% N (urea) + 25% N (FYM)	5.43	11.69	23.62	0.50	58460	32037
T_4	50% N (urea) + 50% N (FYM)	4.9	9.19	15.99	0.57	45960	15810
T_5	75% N (urea) + 25% N (Vermi.C.)	4.29	9.47	18.46	0.51	47340	21172
T_6	50% N (urea) + 50% N (Vermi.C.)	3.98	8.61	14.63	0.59	43030	13390
T_7	75% N (urea) + Seed tr. *Azo.* + PSB	4.33	9.30	17.02	0.55	46500	23855
T_8	50% N (urea) + Seed tr. *Azo.* + PSB	3.21	6.87	11.47	0.60	34350	11949
T_9	RDF + 5 t FYM ha^{-1} + 5 t Vermi. C. + Seed tr. Azo + PSB	7.07	15.19	33.86	0.45	75930	48971
T_{10}	75% RDF + 5 t FYM + 5 t Vermi. C. + Seed tr. *Azo.* + PSB	6.85	14.63	31.74	0.46	73130	46769
Mean		4.78	10.27	20.10	0.54	51330	25899
S. E. ±		0.06	0.13	0.25	0.09	664	664
C. D. at 5%		0.19	0.39	0.74	0.30	1972	1972

PSB = Phosphate solubilizing bacteria

embraces a combination of organic manure with inorganic fertilizers for providing better nutrients to the crop plants and maintaining soil fertility.

The present investigation was carried out at Post Graduate Institutional Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri during summer, 2007. The experiment was laid out in a randomized block design with three replications and ten treatments. The different treatments comprised of T_1- absolute control, T_2 - 100 per cent (60:40:20 NPK kg ha^{-1}) recommended dose of fertilizer (RDF), T_3 - 75 per cent N (urea) + 25 per cent N (FYM) + recommended P_2O_5 and K_2O, T_4 - 50 per cent N (urea) + 50 per cent (FYM) + recommended P_2O_5 and K_2O, T_5 - 75 per cent N (urea) + 25 per cent N (vermicompost) + recommended P_2O_5 and K_2O, T_6 - 50 per cent N (urea) + 50 per cent N (vermicompost) + recommended P_2O_5 and K_2O, T_7 - 75 per cent N (urea) + seed treatment of *Azospirillum* and PSB + recommended P_2O_5 and K_2O, T_8 - 50 per cent N (urea) + seed treatment of *Azospirillum* and PSB + recommended P_2O_5 and K_2O, T_9 -RDF + 5 t FYM ha^{-1} + 5 t vermicompost ha^{-1} + seed treatment of *Azospirillum* and PSB, T_{10} - 75 per cent RDF + 5t FYM ha^{-1} + 5 t vermicompost ha^{-1} + seed treatment of *Azospirillum* and PSB. The gross and net plot sizes were 4.5 x 4.0 m and 3.6 x 3.6 m, respectively. The soil of the experimental field was clayey in texture with low in available nitrogen (237.67 kg ha^{-1}), medium in available phosphorus (22.18 kg ha^{-1}) and high in available potassium (427.52 kg ha^{-1}). The soil was moderately alkaline in reaction (pH 8.3). The experimental crop was sown by dibbling at 45 x 10 cm spacing on 12th March, 2007 and harvested on 6th June, 2007.

At harvest, the seed yield of five observational plants was recorded and from this per plant seed weight was calculated, the plants from net plot were separately harvested and the seed and straw yields were recorded on hectare basis.

Table 1 revealed that application of RDF + 5 t FYM ha^{-1} + 5 t vermicompost ha^{-1} + seed treatment of *Azospirillum* and PSB recorded the highest seed yield (15.19 q ha^{-1}; and seed weight per plant (7.07g) and it was significantly superior to other treatments. The lowest seed yield per ha and per plant was observed with the control (5.77 q and 2.68g). This finding corroborate the findings of Tiwari *et al*. (2000), Palaniappan *et al*. (1999), Singh *et al*. (2001) and Duhoon *et al*. (2004). Similar response was recorded with straw yield also. The application of RDF + 5t FYM ha^{-1} + 5 t vermicompost ha^{-1} + seed treatment of *Azospirillum* and PSB recorded the minimum grain to straw ratio (0.45) indicating efficiency of producing more seed with available straw and was significantly superior to most of the treatments. However, it was at par with the application of 75 per cent RDF + 5 t FYM ha^{-1} + 5 t vermicompost ha^{-1} + seed treatment of *Azospirillum* and PSB (0.46) and RDF application (0.48).

The highest grain to straw ratio was recorded in case of control (0.64) and it was at par with the application of 50 per cent N (urea) + seed treatment of *Azospirillum* and PSB + recommended P_2O_5 and K_2O (0.60) followed by application of 50 per cent N (urea) + 50 per cent N (vermicompost) + recommended P_2O_5 and K_2O (0.59) and treatment of 50 per cent N (urea) + 50 per cent N (FYM) + recommended P_2O_5 and K_2O (0.57). Application of nutrients through organic and inorganic sources favourably influenced the growth and yield contributing characters and seed yield which resulted in more grain with unit weight of straw which in turn more grain to straw ratio. These results are similar to those reported by Ahmad *et al*. (2000) and Sujathamma *et al.* (2003).

The highest gross (Rs. 75930 ha^{-1}) and net

monetary returns (Rs. 48971 ha^{-1}) were recorded due to application of RDF (60:40:20 NPK kg ha^{-1} + 5t FYM ha^{-1} + 5 t vermicompost ha^{-1} + seed treatment of *Azospirillum* and PSB.

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Performance of Different Genotypes for Nutritive Characters in Sweet Potato

Sweet potato (*Ipomea batatas* L.) is one of the world's highest yielding crops and is grown over a wide range of environmental conditions throughout the world. The crop is being recognized as a crop with potential for high productivity and energy output to be consumed both in the fresh and processed forms. It ranks third among tuber crops in terms of its contribution to agricultural economy in India. *Per se* performance is considered as the most simple and effective way to get first hand information on the genotypes. Parents with good per se performance are expected to give desirable recombination for yield and nutritive traits.

Twenty genotypes of sweet potato were collected from germplasm available with the All India Co-ordinated Research Project on Tuber crops (other than potato) sub center, Wakawali, Taluka - Dapoli, Dist. - Ratnagiri (M.S.). Sweet potato crop was grown during *kharif* and *rabi*, 2003-04 in 4 different environments i.e. *kharif* 2003, *rabi* 2003, *kharif* 2004 and *rabi* 2004. The experiment was laid out in randomized block design with three replications. All the recommended intercultural practices were carried out as and when necessary, so as to maintain good stand of the crop. Observations were recorded on randomly selected 5 plants from every net plot in each replication and used for statistical analysis. Analysis of variance was done by using technique outlined by Panse and Sukhatme (1957).

The analysis of variance was found to be highly significant except for moisture, acidity and crude fiber indicating genotypic variability. The moisture content in freshly harvested sweet potato tubers varied non-significant. The range of moisture content was 67.40 to 73.27 per cent with general mean of 69.99 per cent. Among all the twenty genotypes, genotype Amroli recorded the lowest moisture content (67.40 %) while the highest was in the genotype X 110- 2 (73.27 %). It was further observed that H 82/6, IB 90-15-9, IB 700, IGSP 12, Nante Red, S 30/25. S 56-2, S 73, Sree Bhadra and X 110-2 had more moisture content while rest of the genotypes had lower moisture content than general mean. Total soluble solids among all sweet potato genotypes varied significantly. It was in the range of 6.27 to 7.47°Brix with general mean of 6.73 °Brix. IB 90-11-1 had significantly highest T.S.S. (7.47 °Brix) and was superior over all the genotypes except H 82/6. H 90-15-9, S 56-2, S 73 and Sree Vardhini.

The genotype Konkan Ashwini had significantly lowest total soluble solids (6.27 °Brix) and Amroli, Belgaon, Doorshet Khandala, IB 700, IGSP 12. Nante Red, S 22, S 30/25, S 62, Sree Bhadra, X 5, X 109-2 and X 110-2 were at par with it. While going through mean performance, above general mean, H 82/6, IB 90-11-1. IB 90-15-9, S 56-2, S 73 and Sree Vardhini showed greater value of T.S.S. than general mean (6.73 °Brix). Acidity of all sweet potato genotypes varied non-significant. However it was in the range of 0.073 to 0.098 per cent with general mean of 0.090 per cent. The genotype X 5 had numerically lowest acidity (0.073%) while IB 90-15-9 and IB 700 had highest acidity (0.098%). All the twenty sweet potato genotypes significantly varied for ascorbic acid content with a range of 19.33 to 27.47 mg 100 g^{-1} with mean of 23.71 mg 100 g^{-1}.The genotype H 82/6 recorded significantly highest ascorbic acid conlent (27.47 mg 100g^{-1}) and was at par with IB 700, S 73, Sree Bhadra. Sree Vardhini and X 109-2, Lowest ascorbic acid content was observed in the genotype Nante Red (19.33 mg 100 g^{-1}) and was at par with IB 90-11-1, IB 90-15-9, IGSP 12, Konkan Ashwini, S 30/25, S 62 and S 62. Further, it could be observed that Belgaon, H 82/6, IB 700, S 22, S 56-2, S 73, Sree Bhadra, Sree Vardhini, X 109-2 and X 110-2 had higher value of ascorbic acid than general mean. Performance for reducing sugars varied significantly. Highest reducing sugars were estimated in the genotype S 56-2 (1.47%) while IB 700, Konkan Ashwini, S 73 and Sree Vardhini were at par with it. Lowest content was in the genotype X 5 (1.20) and was at par with Amroli. Belgaon, Doorshet Khandala, H 82/6, IB 90-11-1, IB 90-15-9, Nante Red, S 22, S 62. Sree Bhadra, X 5, X 109-2 and X 110-2. Thus, range of ascorbic acid content was 1.20 to 1.47 with general mean of 1.31 per cent. Further it could be observed that Doorshet Khandala, IB 700, IGSP 12, Konkan Ashwini, S 30/25, S 56-2, S 62, S 73 and Sree Vardhini had higher value of reducing sugars than population mean of 1.31.

Non-reducing sugars also varied significantly with a range of 3.51 (S 22) to 5.13 per cent (S 73) and general mean of 4.33. However, the genotypes H 82/6, IB 90-11-1, IB 700, Konkan Ashwini, S 56-2, S 73, Sree Bhadra and Sree Vardhini had greater value of non-reducing sugars over general mean (4.33). The genotype S 73 had significantly highest value of 5.13 per cent non-reducing sugars and was significantly superior over all the genotypes except IB 700, Konkan Ashwini, S 56-2, Sree Bhadra and Sree Vardhini. Total sugars in all the sweet potato genotypes varied significantly. The range of total sugars was 4.91 to 6.56 per cent with general mean of 5.64 per cent. Significantly highest total sugar (6.56%) was observed in the genotype S 73 and was

significantly superior over all the genotypes except Konkan Ashwini, S 56-2. Sree Bhadra and Sree Vardhini. Starch content varied significantly in all the twenty genotypes which was estimated on dry weight basis and ranged from 52.03 to 66.20 per cent with general mean of 57.51 per cent. Highest starch content was noticed in the genotype Konkan Ashwini (66.20%). However, it was at par with H 82/6 and Sree Bhadra. Lowest starch content was in S 22 (52.03%) and was at par with Belgaon, IGSP 12, Nante Red, S 22, S 62 and X 5. The genotypes H 82/6, IB 90-11-1. IB 90-15-9, IB 700, Konkan Ashwini, S 73, Sree Bhadra and Sree Vardhini had starch content above general mean.

Carotene content also varied significantly in all the twenty sweet potato genotypes studied. Carotene content was in the range of 658.33 to 2532.67 µg 100 g^{-1} with mean of 1225.17 µg 100 g^{-1}. Highest carotene content was observed in the genotype IB 90-15-9 (2532.67 µg 100 g^{-1}). Crude fiber in different genotypes were in the range of 1.08 to 1.24 per cent with population mean of 1.14 per cent. Such variation in nutritive parameters was also studied by Jadhav (2001), Parulekar (2002), Teshorne Anshebo *et al*. (2002) and Sabale (2005) in sweet potato.

Thus, the genotype S 73 showed comparatively better performance in most of the nutritive characters except carotene content. However, IB 90-15-9 and IB 90-11-1 showed better carotene content. Among all the sweet potato genotypes studied, yield of tubers per vine was in the range of 93.83 to 315.57 g with mean of 190.03 g. Significantly highest tubers were observed in genotype Sree Bhadra followed by S-56-2 (305.85 g) and Konkan Ashwini (297.26 g) which was greater than general mean. Yield of tubers per hectare ranged in between 5.42 to 22.99 ton.. Highest yield was observed in genotype Sree Bhadra (22.99 ton) followed by S 56-2 (22.28 ton) and Konkan Ashwini (21.93 ton) which was greater than mean value. Shirke (2000), Teshome Anshebo *et al*. (2002). Rasede (2002) and Lokhande (2003) observed wide as well as narrow range of variability in more or less similar trend in sweet potato genotypes for yield of tubers per vine and per hectare.

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Economics of Jaggery Production in Maharashtra

Sugarcane in India is processed into sugar, jaggery and khandsari. Maharashtra is one of the leading producers of jaggery apart from sugar. Large numbers of jaggery production units are located in state. However, many of the jaggery producers are unaware of cost of production of jaggery and hence cannot compare its relative profitability with that of cane supplyed to sugar mills. Hence this study was undertaken with the objectives to analyse the returns to investment in jaggery processing untits and to estimate the cost and returns structure in jaggery production. From each selected three tahsils 30 Jaggery processing units were selected. The tabular presentation was followed for estimating cost and returns. The break-even volume of output is determined with help of formula

$$\text{Break even output} = \frac{\text{Fixed cost}}{\text{Unit output price} - \text{Unit variable cost}}$$

An average investment required for establishing a jaggery processing unit with a capacity of six quintal per day was estimated to Rs. 1,40,336. The share of shed in the total investment was maximum (31.98 per cent) followed by investment on land (21.52 per cent) and cane crusher (17.28 per cent). The share of miscellaneous item in total investment was 29.32 per cent. In most of the processing units, the structure consisted of brick shed and roofing with tin sheets. Size of shed depended on the number of furnaces. It was noticed that all the processing units had one furnace.

The total cost of jaggery processing unit having capacity of six quintal jaggery day^{-1} was Rs. 7,78,489. The cost of raw materials was the major item of variable cost accounting for 67.09 per cent of the total cost. Labour charges accounted for 18.72 per cent and the cost of chemicals shared 7.05 per cent of the

Table 1. Cost and returns in jaggery production.

Particulars	Cost (Rs.)
Cost and returns for own jaggery preparation :	
Total cost	1436.29
Returns	
Total returns	1812.06
Net returns	375.77
Costs and returns for rent basis jaggery preparation :	
Cost incurred for rent basis jaggery preparation	431.82
Rent received for preparation of jaggery	554.24
Profit earned from jaggery making of other's sugarcane	122.42
Net returns from jaggery processing unit = (Net returns from own jaggery preparation + Profit earned from jaggery making of other's sugarcane as, rent basis)	498.19

Table 2. Average profitablity of jaggery processing unit.

Particulars	Cost (Rs.)
Total cost of jaggery preparation (Average of 539.34 quintals own jaggery)	7,78,489/-
Gross returns	9,77,317/-
Net returns from own jaggery preparation	1,98,828 (79.80)
Rent received for preparation of 410.90 quintals of other's jaggery.	2,27,737/-
Cost incurred for crushing of other's sugarcane	1,77,439/-
Net returns as a rent	50,299/- (20.20)
Total net returns (Net returns from own jaggery preparation + Net returns received as a rent)	2,49,127/- (100.00)

(Figures in the parentheses are percentages to the total net returns)

total cost.

It was noticed that the processors used more quantities of chemicals than the required. This calls for standardizing the methods of jaggery processing. The share of fixed cost in the total cost was 2.13 per cent. Findings revealed that the cost of sugarcane is the major item of cost in jaggery processing units. The result further indicated that, on an average, 539.34 quintals of own jaggery was produced annually. The net return realized in jaggery processing was to the tune of Rs. 1,98,828. On an average 0.87 tonnes of sugarcane was used to produce one quintal of jaggery. The per quintal cost of jaggery production was Rs. 1436.29 and B: C ratio was 1:26. Thus, the recovery in jaggery processing unit was estimated at 11.47 per cent (Teggi *et al*. 1998).

The average per quintal total cost incurred (Table 1) for own jaggery preparation including the cost of raw material (sugarcane) was worked out to Rs. 1436.29. Per quintal average price realized for jaggery was Rs. 1812.06 and thereby the net return obtained from own jaggery preparation was Rs. 375.77 per quintal.

The per quintal cost incurred for the jaggery preparation on rental basis was Rs. 431.82 and the rent received for preparation of per quintal jaggery was Rs. 554.24 and therefore, the per quintal profit earned from rent basis jaggery preparation was Rs. 122.42.

The per quintal net returns from jaggery processing unit (Net returns from own jaggery preparation + profit earned by making jaggery from other's sugarcane (rent basis) was estimated to Rs. 498.19.

It is observed from the Table 2 that the per unit total cost of jaggery preparation (539.34 quintal own jaggery) was Rs. 7,78,489. The gross returns obtained from own jaggery preparation was Rs. 9, 77,317 and thereby the net returns obtained were Rs. 1,98,828 to the producers. The cost required for the rent basis jaggery preparation was Rs. 1,77,439 and the rent received for 410.90 quintals of jaggery production from other's sugarcane growers was Rs. 2,27,737, with the net profit earned from receipts of rent was Rs. 50,299. The per unit total net returns from jaggery processing unit were Rs. 2,49,127 (Net returns from own jaggery preparation + net profit earned from jaggery making of other's sugarcane, i.e. as a rent).

Table 3. Break-even point analysis of jaggery processing unit.

Items	Cost (Rs.)
Establishment cost	1,40,336.00
Variable cos (Rs / quintal)	1436.29
Price of output (Rs / quintal)	1812.06
Quantities of jaggery production for Break - Even (quintal)	373.46
Actual quantities of jaggery production (quintal) (Own jaggery preparation + other's jaggery preparation)	950.24

The estimated break-even quantity of jaggery production (Table 3) was 373.46 quintals. The actual quantity of jaggery production was 950.24 quintals, being higher than the quantities of jaggery production required for break-even point. It is therefore, inferred that the performance of the jaggery processing unit was satisfactory (Teggi *et al*. 1998).

The cost of sugarcane is the major item of cost in jaggery processing units. The study showed that the jaggery processing units are profitable, even if only own sugarcane is processed. However, it was more profitable when the jaggery processing unit prepares the jaggery of other's on rent basis. However, one can further compare the relative profitability of jaggery production versus supply of cane to

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Growth Response of *Jatropha curcas* to Spacing and Irrigation in Dry lands

Jatropha plant produces seeds with an oil content of 37 per cent (21% saturated and 79% unsaturated fatty acids). The oil cake can be used as organic manure as it contains 4.44 per cent nitrogen, 2.09 per cent phosphorus and 1.68 per cent potassium. This non-conventional oil seed crop is gaining importance because of its oil value to mix with diesel (biodiesel) and the wasteland area of these districts can be better utilized for the cultivation of this multipurpose crop (Lele, 2006). Under this situation, the package of practice is required before introducing this crop for cultivation under wasteland. The experiment was designed with the objectives of assessing the optimum plant population and to fix the irrigation requirement for better growth and yield under dry lands.

A field experiment on jatropha was conducted with the objective of finding optimum spacing and irrigation requirement for jatropha on wastelands ecosystem at Agricultural College and Research Institute, Killkulam during 2005 to 2007. The spacing treatments included P_1 - 2 x 2 m (2500 plants ha^{-1}), P_2 - 2 x 1.5 m (3333 plants ha^{-1}), P_3 - 2 x 1.0 m (5000 plants ha^{-1}) and P_4 - 3 x 3.0 m (1111 plants ha^{-1}). The treatments included I_1 Irrigation once in 5 days interval; I_2 Irrigation at 10 days interval; I_3 Irrigation at 15 days interval; I_4 Irrigation as and when required and I_5 No irrigation. The rainfall received during the crop growth period was 508.4, 757.6 and 373.4 mm in 24, 33 and 17 days during 2005, 2006 and 2007 years respectively.

A mean height of 89.5 and 96.9 cm were recorded for spacing and irrigation treatments respectively. A maximum mean height of 114.0 cm was registered under a spacing of 2 x 1 m and irrigation once in 5 days. Maximum of 15.7 and 16.3 cm plant girth was registered in spacing and irrigation treatments

respectively. The interaction was non significant. Maximum No. of branches (5.1) were registered in the spacing of 2 x 2 m while maximum branches (5.2) were registered in I_3.

After 19 months of planting it was observed that among the spacing treatments, plant grown at 2 x 2 m had maximum mean height of 233.3 cm.

Maximum mean height of 267.0cm was registered by plants that received irrigation once in five days. However, the tallest plants (272.6 cm), were produced by the plants grown at 2 x 2 m and irrigated once in 15 days. The similar trend was observed in plant girth also. On contrast, Irrigating once in 15 days had produced more branches (10.6).

The plants received irrigation once in 5 days had a plant height of 267.0cm while the plant geometry of 2 x 2 m produced plants with a height of 233.3 cm. However, the interaction was found to be significant. The plants that received irrigation once in 5 days had a plant girth of 44.7 cm while a plant geometry of 2 x 2 m produced plants girth of 40.7 cm. However, the interaction was found to be significant. The combination of spacing 2 x 2m and irrigation once in 15 days produced the tallest plants (272.6 cm). Among the spacing 2 x 2 m had produced 8.9 branches while irrigation once in 15 days produced 10.6 branches. The interaction was significant. The combination, irrigation once in 15 days and a spacing of 2 x 2 m interaction had 11.3 branches.

The irrigation once in 15 days has been found to be good in producing more No. of branches while taller plants with better girth were produced with irrigation once in 5 days. The plant geometry of 2 x 2 m showed a consistent influence on all the growth parameters studied by recording maximum values for plant height, plant girth and No. of branches. Similar results were also reported by Paramathma (2006) and in http://www.krishiseva.com.

From the study, it may be inferred that planting of jatropha at 2 x 2 m with a population of 2500 plants ha^{-1} and irrigating the plants once in 15 days under dry land ecosystem would increase the No. of branches in the plant and also the thickness of the plant, which in turn ensures better productivity.

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Economic Impact of Bt Cotton Techology on Cotton Growers of North Maharashtra

Recently, ICAR has reconfirmed that there is a net increase of 33.7 per cent yield in Bt over non-Bt cotton hybrids in frontline demonstrations (Chaudhary, 2007). The study was undertaken to ascertain the economic impact of Bt cotton technology among the Bt cotton growers.

From Jalgaon and Dhule districts four tahsils were selected purposively i.e. Chopda, Jamner, Shirpur and Shindkheda, as they covered highest area under Bt cotton. Five villages were randomly selected from each tahsil. Total twenty villages were selected for the study. A list of Bt and non-Bt cotton growers from the selected villages was prepared. A sample of 175 and 107 Bt and non-Bt cotton growers, respectively was drawn by 'lottery method' of random sampling. An interview schedule was prepared in light of the objective of the study and data were collected by personal interview of the selected respondents. Measurement of economic impact of Bt cotton technology on cotton growers was done by using teacher made test.

The profit in growing Bt cotton was significantly higher (Rs. 11341/- per acre) as compared to non-Bt cotton (Rs. 6465/- per acre). The mean difference of net return was Rs. 4876/- per acre over non-Bt cotton. Though there was a higher return in Bt cotton, the overall expenditure had also increase while growing Bt cotton. The total variable cost in Bt cotton production had significant increased by Rs. 880/- per acre over non-Bt cotton. The total cost for growing non-Bt cotton was Rs. 4302/-, while for growing Bt cotton it was Rs.5182. The higher production cost in Bt cotton was due to cost on seed, fertilizer, labour and pesticides for sucking pests.

The cost of Bt cotton seed (only Bt-I hybrids) had reduced from Rs. 1600 to Rs. 750 per packet, from June 2006. However, in study year, most of the Bt cotton growers had purchased Bt cotton seed before June. Similarly, cost of Bt-II and fusion-Bt traits, Bt cotton seed was between Rs. 1600 to Rs. 1800. Hence, actually purchased cost of seed was considered for calculating cultivation cost.

It is noticed that, the expenditure on fertilizer application for Bt cotton cultivation was higher by Rs. 412/- per acre over non-Bt cotton. It could be due to the recommended dose of fertilizer for Bt cotton which was more than non Bt cotton. Secondly, due to retention of more number of bolls, fertilizer management was very crucial in Bt cotton. Hence, growers had applied more fertilizers to Bt cotton which increased the cost.

As regards the use of pesticides to control bollworms (American bollworm, Spotted bollworm and Pink bollworm), which are the most destructive pests of cotton, the data showed that the expenditure over pesticides for bollworm control in Bt cotton was significantly less (Rs. 237) than non-Bt cotton (Rs. 689). The reduction in pesticides cost due to Bt cotton was found up to Rs. 452/- per acre. It is therefore, concluded that due to inbuilt resistance from Bt gene in cotton plants, the number of sprays for bollworm control reduced drastically due to low bollworm pressure and thereby Bt cotton growers could save pesticides costs significantly.

Further, it was observed that there was no significant difference between Bt and non-Bt

cotton growers in expenditure on pesticides for control of sucking pests. The expenditure on sucking pests in Bt cotton was quite high (Rs. 481) over non-Bt cotton (Rs. 470). From the above data, it could be inferred that there was no difference in sucking pests pressure in both the cotton and the growers were well aware about this. Hence, equal amount of sprays might have been used in Bt and non-Bt cotton crop.

An expenditure on labour in Bt cotton was significantly higher than non-Bt cotton. The mean difference of Rs 349/- showed needs to spend more in Bt cotton. Though, it was seen that there was little saving in labour cost due to reduction of number of pesticide sprays, but it was compensated with the picking cost. Due to higher yield of Bt cotton, the picking cost went up as compared to non-Bt cotton.

It was noticed that the price per unit of Bt cotton sold by Bt cotton growers was more, i.e. Rs. 1969/- per quintal as compared to non-Bt cotton, i.e. Rs. 1907/- per quintal and difference in price was significant i.e. Rs. 62/- per quintal. The reason for getting more market price could be the good quality of lint from Bt cotton.

In case of revenue i.e. gross return, the value of output from Bt cotton was significantly higher (Rs. 16,523) as compared to non-Bt cotton (Rs. 10,767). The difference in gross return between Bt and non-Bt cotton was significant by Rs. 5756/- per acre. It could be due to the better yield obtained from Bt cotton.

The adoption of Bt cotton could be closely related to its benefits to the cotton growers. Therefore, it was important to ascertain the impact of Bt cotton technology on the economics of Bt cotton growers. The impact of Bt cotton on yield was increased significantly over non-Bt cotton. The estimated yield impact of Bt cotton was about 47.61 per cent higher than the yield of non-Bt cotton. Further, there was a highly significant impact of Bt cotton on revenue. The economic impact of revenue from Bt cotton was 53.46 per cent higher as compared to non-Bt cotton. The impact in respect to profit of Bt cotton was remarkable. The profitable impact from the Bt cotton was reported by 75.41 per cent. It indicates that the profit from Bt cotton was substantially increased as compared to non-Bt cotton. The cost benefit ratio of Bt cotton was 1:3.19 than the non-Bt cotton 1:2.50 which shows the profitability of the Bt cotton. Similar results were reported by Barwale *et al*. (2004), Bennett *et al*. (2004), Morse *et al*. (2005), Gandhi and Namboodiri (2006) and Chaudhary (2007).

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Genetic Variability, Heritability and Genetic Advance for Fruit Yield and Component Traits in Muskmelon (*Cucumis melo* L.)

Genetic variability in a population is a result of genetic and environmental factors. To apportion the observed variability of these two factors, parameters such as genotypic and phenotypic coefficients of variation (GCV and PCV) have to be assessed. Heritability is another index for calculating the influence of environment on the expression of the genotype. Burton (1952) suggested that GCV together with heritability estimates would give best picture about the extent of advance to be expected by selection. Muskmelon is an unexploited vegetable crop and very less breeding programmes have been used to exploit available genetic variability. Therefore, an attempt was made to gather information on extent of variability, heritability and genetic advance for twelve quantitative characters in 44 diverge genotypes of muskmelon.

The experimental material consisting of forty-four genotypes of muskmelon from different geographical conditions was grown during summer 2003 at research farm of Main Vegetable Research Station, Anand Agricultural University, Anand (Gujarat). The material was planted in a completely randomized block design with three replications. Each plot consistsed of two rows of 5 meter length with ten plants sown at a distance of 1.5 meter between rows and 1 meter between plants. Three seeds per hill were dibbled at the time of sowing and subsequently thinned out to single plant per hill. Observations were recorded on five randomly selected plants leaving the border ones from each plot of all the three replications for twelve characters *viz*. number of node on which first female flower appear, days to first picking, fruit weight, fruit length, fruit girth, pulp thickness, fruits per plant, fruit yield per plant, moisture percentage, total soluble solids, total soluble sugars and acidity percentage. The mean value of data were subjected to statistical analysis to obtain analysis of variance according to Panse and Sukhatme (1978), genotypic and phenotypic coefficients of variation (GCV and PCV) as suggested by Burton and Devane (1953), heritability in broad sense by Allard (1960) and expected genetic advance by Johnson *et al.* (1955).

The analysis of variance, mean values, range and coefficient of variation revealed significant variation for all the characters, indicated presence of sufficient variability in the material. The genotypic variance contributed a major proportion of total variance in characters like fruit yield per plant (0.55), number of node on which first female flower appear (0.85), days to first picking (2.96), fruit girth (16.63), pulp thickness (0.053), fruits per plant (1.08), total soluble solids (1.91), total soluble sugars (5.64) and acidity percentage (0.002) suggesting that these characters were under control of the genetic system.

The moderately high genotypic and phenotypic coefficient of variation was observed for fruit yield per plant followed by acidity percentage, fruits per plant and total soluble sugar. Similar results have also been reported earlier by Dhaliwal *et al*. (1996) and Tarsem and Singh. (1997). Moderate estimates were obtained for number of node at which first female flower appear and fruit weight, which has been strongly supported by findings of Dhaliwal *et al*. (1996). Moderately low estimates were observed for total soluble solids, pulp thickness and fruit girth, which are in agreement with Kalloo *et al*. (1983). Whereas,

fruit length recorded low and days to first picking and moisture percentage exhibited very low GCV and PCV in comparison to the other traits and these are in the concordance with Somkuwar *et al*. (1997).

Very high heritability estimates were obtained for total soluble sugar (99.94), total soluble solids (99.66) and fruit yield per plant (96.12). These results were strongly supported by Tarsem and Singh (1997). While, days to first picking (87.81), moisture percentage (84.59), number of node at which first female flower appear (80.00), fruits per plant (79.07), fruit girth (77.63), pulp thickness (75.29) and fruit weight (73.82) exhibited moderately high estimates of heritability, which are in accordance with Dhaliwal *et al*. (1996) and Tarsem and Singh (1997). Only fruit length (25.46) showed moderately low heritability.

Johnson *et al*. (1955) reported that character having high heritability and high genetic advance generally indicates that heritability is more due to the additive gene effects and advocated the use of high estimates of heritability along with high magnitude of genetic advance for genetic improvement in any trait through selection.

In the present investigation high to moderately high heritability accompanied with high to moderately high genetic advance as per cent of mean was observed for traits like, fruit yield per plant, acidity percentage, total soluble sugar, fruits per plant, number of node at which first female flower appear and fruit weight indicating the importance of additive gene effects and selection based on this would bring significant improvement in the genotypes of muskmelon.

The characters like moisture percentage and days to first picking showed moderately high estimates of heritability but genetic advance as per cent of mean was low because of lower value of genotypic coefficient of variation and phenotypic coefficient of variation (GCV and PCV), indicating the presence of lower amount of variability for these traits.

The findings of the present investigation lead to the conclusion that, isolation of a high yielding type with good quality is possible amongst the genotypes studied. For this, emphasis should be given to fruit weight, fruit girth, pulp thickness, fruit length, fruits per plant and moisture percentage. These characters should be studied in detail over number of seasons and locations, so as to obtain a more precise estimate of variability and inter character associations.

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Effect of Integrated Nutrient Management on Yield and Quality of Okra Grown on Lateritic Soils of Konkan

Ever increasing cost of energy would be an important constraint for increased use of chemical fertilizers in crop production, Use of organic manures to meet the requirement of crop would be an inevitable practice in years to come for sustainable agriculture. Integrated nutrient management involves the combine use of chemical fertilizers, organic manures and biofertilizers which ensures higher crop production, helps to restore and sustain the soil fertility. Though, the lateritic soils are best suited for okra cultivation, the traditional methods of farming and less use of organic manures reduces the magnitude and quality of okra. Therefore, the present investigation was undertaken to study the effect of integrated nutrient management on growth, yield and quality of okra in lateritic soil of Konkan region.

An experiment was conducted during *kharif* season of the year 2007 at Central Experiment Station, Wakawali, Dr.Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoii with okra variety Parbhani Kranti. The soil was clay loam in texture having organic carbon 21.0 g kg^{-1}, pH 5.17 and EC 0.10 dS m^{-1}. The available N content was 244.60 kg ha^{-1}, P_2O_5 12.94 kg ha^{-1} and K_2O 314.34 kg ha^{-1}, available Zn 1.21 ppm and available B 0.07 ppm. The bacterial count in the soil was 0.53 x 10^6 CFU g^{-1}. The experiment was conducted in a randomized block design with nine treatments and replicated thrice. The treatments were T_1 control; T_2 RDF (recommended dose of fertilizer); T_3 RDF + $ZnSO_4$ (25 kg ha^{-1}); T_4 RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}); T_5 RDF + FYM (10 t ha^{-1}); T_6 RDF + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}); T_7 RDF + Borax (5 kg ha^{-1})+ *Azospirillum* (2 kg ha^{-1}); T_8 RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}); T_9 RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}). The field was thoroughly prepared and the full dose of single super phosphate and muriate of potash were applied at the time of sowing. Nitrogen in the form of urea was applied in three splits i.e. 50 per cent dose at the time of sowing, 25 per cent at 30 DAS and remaining 25 per cent at 60 DAS. Full dose of zinc sulphate and borax was applied at the time of sowing. Farm yard manure @ 10 t ha^{-1} and *Azospirillum* @ 2 kg ha^{-1} were applied as per treatment schedule. The observations regarding the growth parameters, yield attributing characters and fruit yield were recorded from five representative plants from each plot. The okra fruit were harvested at 2-3 days interval. Quality parameters were estimated by adopting standard methods. The moisture content in the fruit was estimated on oven dry basis and was expressed in percentage. The crude fat content in the fruit was estimated by Ra-fa-tec extraction method (Randall, 1974). The crude protein content of the fruit was estimated by multiplying its nitrogen content (in percentage)

with 6.25 and expressed in percentage (Lorenz and Maynard, 1980). The carbohydrate content of the fruit was estimated by Shaffer somogyi micro method (Ranganna, 1985) and expressed in gram of fruit. The ascorbic acid content in the fruit was estimated by 2-6 dichlorophenol indophenol titration method (Ranganna, 1995). The ash content in the fruit was estimated by using gravimetric method (Ranganna, 1985).

Growth parameters : The data pertaining to the effects of different treatments of INM on the dry matter production and its contributory components are presented in Table 1. Maximum plant height (141.80 cm) was noticed with application of RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}) followed by application of RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) (124.26 cm). Similarly dry matter production was highest (16.24 q ha^{-1}) due to application of RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}) as compared to all other treatments. The treatment consisting RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}) recorded significantly highest (11.98) number of leaves $plant^{-1}$ as compared to all other treatments. Application of RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) as well as RDF + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}) recorded the higher plant height, dry matter production, number of leaves $plant^{-1}$ than RDF + FYM (10 t ha^{-1}), RDF + $ZnSO_4$ (25 kg ha^{-1}) and RDF alone. The lowest growth attributing characters were found in control. The possible reason for this acceleration of growth might be due to the activation of cell division and cell elongation in the axillary buds, which had a promoting effect

Table 1. Effect of different treatments on growth, yield and quality parameters of okra.

Treatments	Dry matter production (q ha^{-1})	Fruit length (cm)	Fruit yield (q ha^{-1})	Crude fat (%)	Carbo hydrates (g)	Crude protein (%)	Ascorbic acid (mg 100 g^{-1})	Ash (%)
T_1 : Control	6.15	6.28	23.30	0.10	6.63	15.13	12.25	1.02
T_2 : RDF	10.49	11.42	58.68	0.12	6.77	15.69	13.48	1.15
T_3 : RDF + $ZnSO_4$ (25 kg ha^{-1})	11.76	11.86	65.59	0.14	6.94	15.81	14.08	1.08
T_4 : RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1})	15.58	12.08	96.89	0.14	7.21	16.63	14.26	1.21
T_5 : RDF + FYM (10 t ha^{-1})	12.95	13.32	78.02	0.13	7.39	16.84	15.89	1.39
T_6 : RDF + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1})	15.13	15.72	84.87	0.17	7.54	17.00	16.14	1.30
T_7 : RDF + Borax (5 kg ha^{-1}) + *Azospirillum* (2 kg ha-1)	12.43	12.48	67.62	0.20	7.02	16.13	15.47	1.27
T_8 : RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1})	16.02	14.22	111.64	0.2	7.62	17.13	16.87	1.46
T_9 : RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1})	16.24	14.78	113.94	0.23	7.68	17.50	17.35	1.53
S. E. ±	0.32	0.14	0.75	0.01	0.03	0.12	0.03	0.02
C. D. at 5%	1.18	0.52	2.75	0.05	0.10	0.43	0.12	0.09

in increased plant height, dry matter production and number of branches plant^{-1}. Increased dry matter production might be due to well established root system in addition to increased plant height and number of branches and leaves. Tripathi *et al*. (2004) reported significant increase in number of leaves due to combined application of chemical fertilizers and biofertilizer (*Azotobacter* + *Azospirillum*).

Yield : Application of RDF+ $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1})+ FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}) brought significant improvement in yield attributing characters of okra followed by RDF+ $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1})+ FYM (10 t ha^{-1}) resulted in higher fruit length, number of fruits plant^{-1} and fruit weight plant^{-1}. The lowest fruit length, number of fruit plant^{-1} and fruit weight plant^{-1} was observed in the control treatment. These findings are similar to those of Vennila and Jayanthi (2008) in okra. As far as the fruit yield of okra is concerned, it differed significantly between different treatments. Application of RDF+ $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}) resulted in significant improvement in yield (113.94 q ha^{-1}), however, it was at par with RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) as compared to RDF alone (58.68 q ha^{-1}). These results clearly indicated that only inorganic sources can not maintain instant flow of nutrients in increasing crop yield. There is a need to use organic, chemical fertilizers and biofertilizers in combinations so as to increase crop productivity. The increase in the fruit yield (128.59 q ha^{-1}) due to application of 75 kg N + biofertilizer + FYM was also reported by Patil *et al*. (2000). These results are also in conformity with the results obtained by Kadlag *et al*. (2005) and Ray *et al*. (2005).

Quality parameters : The treatments receiving RDF+ $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}) resulted in significantly highest moisture (83.56%) and ascorbic acid content (17.35 mg 100 g) as compared to all other treatments. Similar findings of increased ascorbic acid content of okra with combined application of organic with inorganic fertilizers have been reported by Bhadoria et al. (2002). The crude fat, crude protein, carbohydrates and ash content was significantly highest with the application of RDF+ $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}), however, it was at par with the application of RDF+ $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}). The lowest quality parameters were observed in control. Similar observations have also been reported by Raj and Geetha Kumari (2001) and Tripathy and Maity (2009).

On the basis of results obtained during the present investigation, it was observed that the integrated use of manures, fertilizers and biofertilizers is essential to improve growth, yield and quality of okra grown in lateritic soils of Konkan.

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Resistance Against Pod borer Complex in Pigeonpea

Pigeonpea (*Cajanus cajan* (L) Millsp.) is one of the pulse crops grown in India. Due to the biotic factor, yield of the pigeonpea is less. Pod borers comprising of lepidopteran borers i.e. pod borer, (*Helicoverpa armigera* (Hubner), tur plume moth, (*Exelastis atmosa* (Walshingham) and tur pod fly, (*Melanagromyza obtusa* (Malloch) are the major insect pests on tur which reduce the yield considerably . In India the total pod damage due to pod borer complex has been reported to be 33.8 to 49.9 per cent (Vishwa Dhar *et al*. 2005). Host plant resistance is a major component of IPM, it is cheap, non polluting and compatible with other methods of pest control (Sachan, 1990). Considering the severity of the borers in this crop, the study was undertaken to find out resistance source in this crop.

Eleven pigeonpea genotypes were screened for pests during *kharif* 2006-07 to 2008-09 at Pulses Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra). The genotypes which had initially exhibited resistance/moderate resistance against lepidopteran borers and pod fly were grown in a plot of two rows of 4m length with two replications. The check Vipula was grown for confirmatory test against these pests under natural field conditions for conducive

Table 1. Field reaction of pigeonpea genotypes against pod borer complex (2006-07 to 2008-09).

Genotypes	Pod damage (%)		Pest susceptibility rating	
	Pod borer	Pod fly	Pod borer	Pod fly
PT-04-119	28.82	30.95	6	9
PT-04-149	22.94	17.34	5	9
PT-04-159	25.98	13.83	6	8
PT-04-196	25.21	14.02	5	8
PT-2000- 12-6-4	14.15	8.38	4	4
PT-2000- 1-25-1	14.98	10.03	4	6
PT-2000- 17- 12-2	19.54	7.55	4	4
PT-2000-4-16-2	12.01	5.35	3	3
PT-2004-31	16.27	13.18	4	7
PT-2000-5-7-4	19.33	10.02	4	5
Vipula (check)	28.36	11.23	5	6

infestation. For assessment borer damage was recorded on five randomly sampled plants at the time of harvest by counting the total number of healthy and damaged pods. From this per cent pod damage was calculated and these percentages were further converted into pest susceptibility rating (PSR) (1-9 scale) for individual genotypes as per Abbott (1925).

Pod damage : The lepidopteran pod borer damage (Table 1) revealed that the pod damage among the test genotypes ranged from 12.01 per cent in PT- 2000-4-16-2 to 28.82 per cent in PT - 04-119. From the pest susceptibility rating, the genotypes PT-2000-4-16-2 recorded PSR 3 and PT - 2000-12-6-4, PT-2000-1-25-1, PT- 2000-17-12-2, PT-2004-31 and PT-2005-7-4 recorded PSR 4 and were most promosing against lepidopteran pod borers, whereas, PT-04-119 and PT-04-159 genotypes scored PSR 6 and found more susceptible than check Vipula. Rest of the genotypes were promising and scored PSR 5.

The pod fly damage ranged between 5.35 per cent in PT - 2000-4-16-2 to 30.95 per cent in PT -04-119. On the basis of pest susceptibility rating, the genotypes PT- 2000-4-16-2 scored PSR 3 and another genotypes namely PT -2000-17-12-2 and PT 2000-12-6-4 scored PSR 4 and were the most promising against pod fly. Rest of the genotypes had PSR above 6 and were more susceptible than check Vipula.

The results clearly indicated that pigeonpea genotypes PT-2000-4-16-2 had dual resistance and high degree of resistance against tur pod fly (*Melanagromyza obtusa* (Malloch)). Therefore, these genotypes can be used further in pigeonpea breeding programme.

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Biochemical Changes Associated with Hydrogen Cyanamide Induced Bud Break in Grapes

Bud break is a basic requirement for initiation of new growth by the grapevine. In temperate countries, the perennial plants cease development and assume dormancy and protect the buds against unfavourable conditions (Saure, 1985). The process of bud break can be enhanced by application of growth regulators as it regulates the vegetative

and reproductive growth of a vine. For efficient bud break in grape, hydrogen cyanamide is being used during each pruning. The sprouting of bud is basically depends on the reserve available in canes and ultimately the vine. The quantity of carbohydrate reserve varies with the conditions available with the plants and hence the atmospheric temperature plays an important role in sprouting (Shikhamany and Manjunath, 1992). In India, though the bud dormancy is experienced only in northern condition, the dormancy induction and release is genetically and environmentally controlled and photoperiod and low temperature plays a major role in these processes. However, little is known about the events that occur in the bud during the process of bud sprout. Considering this, a study was conducted to know the biochemical changes associated with hydrogen cyanamide induced bud break in grapes.

The field experiment was conducted on four- year old Thompson Seedless vines grafted on Dog-Ridge rootstock during 2003-04 in the commercial vineyards in the Pune region. The experimental site is situated in Mid West Maharashtra at an altitude of 599 m above sea level; it lies on 18.32 °N latitude and 73.51°E longitudes. The climate is mild to slightly dry. In order to understand the changes associated with hydrogen cyanamide induced bud break in grape, variation in bud break was induced by pruning Thompson Seedless vines on three different dates (18th October, 31st October and 15th November). At every pruning 50 per cent of the vines were treated uniformly with hydrogen cyanamide @ 1.5 per cent and the rest were considered as untreated control. Thompson Seedless vines were drip irrigated and were trained to Flat Roof Gable system of training. All the vines were subjected to the cultural practices commonly used in this region. The experiment was designed as randomized block design with five replications. During the fruit pruning time, the vines were pruned to 6-7 bud position per cane. Hydrogen cyanamide, a commercial formulation containing 50 per cent H_2CN_2, was applied as swabbing at a concentration of 1.5 per cent. The canes were swabbed manually with cotton cloth. Five canes $vine^{-1}$ were selected randomly and tagged for

Table 1. Variation in peroxidase enzyme activity (Δ O.D./ min) in grape buds treated with hydrogen cyanamide on different dates.

Pruning	**P x T X D**						**Pruning mean**	**P x T**		**P x D**		
	T_1			**T_2**				**T_1**	**T_2**	**D_1**	**D_2**	**D_3**
	D_1	**D_2**	**D_3**	**D_1**	**D_2**	**D_3**						
P_1	0.009	0.012	0.017	0.015	0.013	0.019	0.014	0.012	0.015	0.012	0.014	0.018
P_2	0.021	0.017	0.029	0.021	0.027	0.028	0.024	0.022	0.025	0.021	0.022	0.029
P_3	0.016	0.025	0.027	0.022	0.026	0.033	0.025	0.023	0.027	0.019	0.026	0.030
T x D mean	0.015	0.018	0.024	0.019	0.022	0.027	0.014	0.019	0.022	0.017	0.021	0.025

	SEM ±	C D at 5%
Pruning (P)	0.0003	0.0010
Treatments (T)	0.0003	0.0008
Days (D)	0.0004	0.0010
Interaction of P x T	0.0005	NS
Interaction of P x D	0.0005	NS
Interaction of T x D	0.0006	NS
Interaction of P x T x D	0.0009	0.0030

Pruning
P_1 : 18th October
P_2 : 31st October
P_3 : 15th November

Treatments
T_1 : No H_2CN_2
T_2 : 1.5% H_2CN_2

Observation taken on
D_1 : imediately after treatments
D_2 : 3 days after treatments
D_3 : 6 days after treatments

recording observation. Likewise, there were 50 canes per treatment under each replication. Buds from both treated and untreated vines were excised on the 0, 3 and 6th day after treatment. The first and third apical nodes on each cane were selected for estimation of peroxidase enzyme activity, total sugar content and protein content. The excised buds were then brought to the laboratory in the ice box and were subjected for the biochemical studies. From the collected samples, total sugars, proteins, peroxidase enzyme activity was analysed. The total sugar was estimated according to the method suggested by Somogyi (1952) and expressed in per cent. Protein estimation was carried out by using Lowry *et al*. (1951) method and expressed as milligram gram^{-1} of dry weight basis. For estimation of peroxidase enzyme activity, 1g extract of fresh plant tissue in 3 ml of 0.1 M phosphate buffer pH 7 was taken and grinded with a pre cooled mortar and pestle. The sample was then centrifuged and homogenized at 18000 g at 5°C for 15 min. The supernatant was used as enzyme source within 2-4 h. The prepared samples were then preserved in ice box till the assay is carried out. It was presented in units litre^{-1}. The weekly average day temperatures prevailed during the different pruning dates were 26.01, 23.08 and 20.07°C respectively.

Among the different pruning dates, significant differences were recorded for peroxidase enzyme activity in the analysed buds. Minimum peroxidase activity was recorded (0.014 O.D/min) in the early pruned vines as compared to the late pruned vines. The quantity was increased from early pruned to the late pruned vines. However, the differences for peroxidase activity between second and third pruning date were at par (Table 1). The interaction of pruning time and hydrogen cyanamide treatment had significant effect on peroxidase activity. Maximum enzyme activity (0.033) was recorded on 6th day after hydrogen cyanamide treatment of late pruned vines (15th November). The activity of peroxidase was less in earlier pruning. In all the pruning, the increase in peroxidase activity was observed as the days for sprouting were approaching. This indicates that the activity

Table 2. Variation in protein content (%) in grape buds treated with hydrogen cyanamide on different dates.

Pruning	**P x T X D**						**Pruning mean**	**P x T**		**P x D**		
	T_1			**T_2**				**T_1**	**T_2**	**D_1**	**D_2**	**D_3**
	D_1	**D_2**	**D_3**	**D_1**	**D_2**	**D_3**						
P_1	9.64	8.83	8.13	10.75	9.63	8.52	9.25	8.86	9.25	10.20	9.23	8.33
P_2	8.05	9.93	8.79	8.23	10.00	12.11	9.52	8.92	9.52	8.14	9.97	10.46
P_3	9.35	10.14	11.00	9.25	10.42	10.60	10.13	10.16	10.13	9.30	10.28	10.80
T x D mean	9.01	9.63	9.31	9.41	10.02	10.41	9.63	9.32	9.63	9.21	9.83	9.86

	SEM ±	C D at 5%
Pruning (P)	0.18	NS
Treatments (T)	0.15	0.44
Days (D)	0.18	NS
Interaction of P x T	0.26	NS
Interaction of P x D	0.26	NS
Interaction of T x D	0.32	0.94
Interaction of P x T x D	0.45	NS

Pruning
P_1 : 18th October
P_2 : 31st October
P_3 : 15th November

Treatments
T_1 : No H_2CN_2
T_2 : 1.5% H_2CN_2

Observation taken on
D_1 : imediately after treatments
D_2 : 3 days after treatments
D_3 : 6 days after treatments

increased as the temperature goes down and also as the sprouting approaches. The activity catalyase activity increased during the recess period of buds, reaching a maximum and thereafter decreased to less than one third of its maximal activity (Perez and Lira, 2005). However, Shulman *et al*. (1983) reported that the peroxidise activity was remain unchanged with the application of hydrogen cyanamide in grapevine. Sabrout (1998) also reported the increase in peroxidise activity in the buds treated with hydrogen cyanamide as compared to the control.

Application of hydrogen cyanamide had significant influence (Table 2) on protein content in grape buds at different dates of pruning. The treated buds recorded significantly more proteins than the untreated. Significantly higher amount of protein (10.13%) was recorded in late pruned vines as compared to the early pruned vines (9.25%). Significant differences were also recorded for the dates after the pruning. The vines treated with hydrogen cyanamide recorded higher amount of protein in the buds analysed. Higher amount of protein was recorded (10.41%) in late pruned vines as compared to the early pruned vines (9.41%). The differences for the interaction between pruning and the different date of protein estimation was found to be non significant.

The interaction between hydrogen cyanamide application and days of protein estimation was significant. The protein accumulation was also more on 6 days of application of hydrogen cyanamide in treated buds. Higher amount of total protein was recorded in mango treated with hydrogen cyanamide as compared with the untreated (Pandey *et al.* 1999). The reserve in the form of metabolites in the different parts of vine plays an important role in bud sprout after the pruning is done. Significant differences were recorded for total sugar content from the excised buds. Minimum quantity of total sugar was estimated from the buds scooped in the first pruning (11.97%) as compared to the late pruned vines (Table 3). The amount was increased with the pruning of vines. Higher amount of total sugar was recorded in the late pruned vines (18.74%). The significant

Table 3. Variation in total sugar (mg g^{-1} DW) in grape buds treated with hydrogen cyanamide on different dates.

Pruning	**P x T X D**						**Pruning mean**	**P x T**		**P x D**		
	T_1			**T_2**				**T_1**	**T_2**	**D_1**	**D_2**	**D_3**
	D_1	**D_2**	**D_3**	**D_1**	**D_2**	**D_3**						
P_1	11.25	10.15	9.87	14.90	13.25	12.40	11.97	10.42	13.52	13.07	11.70	11.13
P_2	20.50	19.90	18.00	15.00	14.40	14.75	17.09	9.46	14.71	17.75	17.15	16.37
P_3	24.25	21.45	17.25	18.3	16.20	15.00	18.74	18.74	16.50	21.28	18.83	16.12
T x D mean	18.67	17.17	15.04	16.07	14.61	14.05	15.93	15.93	14.91	17.37	15.59	14.54

	SEM ±	C D at 5%
Pruning (P)	0.14	0.41
Treatments (T)	0.11	0.33
Days (D)	0.14	0.41
Interaction of P x T	0.19	0.58
Interaction of P x D	0.19	0.58
Interaction of T x D	0.23	0.71
Interaction of P x T x D	0.34	1.01

Pruning
P_1 : 18th October
P_2 : 31st October
P_3 : 15th November

Treatments
T_1 : No H_2CN_2
T_2 : 1.5% H_2CN_2

Observation taken on
D_1 : imediately after treatments
D_2 : 3 days after treatments
D_3 : 6 days after treatments

differences were also recorded for the total sugar available among the dates of observations. Higher amount of total sugar was recorded in the buds scooped at the beginning and was reduced till the last date of observation. The amount of total sugar available in buds treated with hydrogen cyanamide was less as compared to the controlled buds. The interaction effect between pruning dates and the application of hydrogen cyanamide was recorded for the total sugar available in the buds (Table 3). In general, more sugar was recorded at lower temperature. These results are in accordance with the results obtained by Colapietra *et al*. (2000) who studied the effect of hydrogen cyanamide on sugar content. They reported higher sugar content in the hydrogen cyanamide treated vines. The use of hydrogen cyanamide proved to be effective for basal bud shoot growth in the seedless cv. Sublima.

From the study it was concluded that the metabolic activity during sprouting involves utilization of sugar, protein synthesis and high enzymatic activity. Further it also showed that the metabolic activities are temperature and time dependent.

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Response of Forage Pearl Millet (*Pennisetum glacum* L.) Varieties to Nitrogen Levels

Pearl millet (*Pennisetum glacum* (L.) is one of the most widely grown forage crops and gaining more popularity as *kharif* and summer forage due to its quick growing habit, high yield potential, better palatability, less water requirement. Nitrogen is one of the basic plant nutrients and plays important role in quality forage crops particularly in protein formation. With advent of new high yielding varieties of pearl millet, it is necessary to study the performance of these varieties to different nitrogen levels for forage production. In view of this, the present investigation was undertaken.

An experiment was conducted at Forage Crops Research Project, MPKV, Rahuri during *kharif* 2005 in a factorial randomized block design with three replications. The soil of the experimental field was clayey in texture, medium in organic carbon (0.52 %), low in available nitrogen (209.82 kg ha^{-1}), medium in phosphorus (14.63 kg ha^{-1}) and high in potassium (590.07 kg ha^{-1}). The treatment comprised of four varieties (AVKB - 19, AVKB -69, Raj bajra chari - 2 and Giant bajra) and three nitrogen levels (30, 60 and 90 kg ha^{-1}). The crop was sown on 28th June, 2005 in the shallow opened furrows at 30 cm with the seed rate of 10 kg ha^{-1}. The full dose of phosphorus and potassium @ 30 kg ha^{-1} each was applied as basal dose. The half quantity of nitrogen was applied at the time of sowing and remaining quantity was top dressed at 30 days after sowing as per the treatments. The crude protein content was worked out by multiplying the nitrogen content with a factor of 6.25.

Results obtained in respect of green fodder yield, dry matter production and crude protein yield are presented in Table 1. The variety AVKB - 19 recorded significantly higher green forage of 391.24 q ha^{-1} and dry matter of 80.91 q ha^{-1} than all other varieties except variety Raj bajra chari-2 which was at par in dry matter production. The differences in fodder yield among the varieties might be because of their adaptability and drought tolerance under

Table 1. Green forage, dry matter production and crude protein yield of forage pearl millet as influenced by varieties and nitrogen levels.

Treatment	Green forage yield (q ha^{-1})	Dry matter yield (q ha^{-1})	Crude protein yield (q ha^{-1})
Varieties :			
Rajbajra chari - 2	372.94	79.52	6.26
Giant bajra	338.34	67.82	6.15
AVKB-19	391.24	80.91	5.91
AVKB-69	348.19	72.81	5.65
S. E. ±	5.43	1.15	0.19
C. D. at 5%	15.92	3.38	NS
N levels (kg ha^{-1}) :			
30	337.58	70.78	4.66
60	360.34	75.67	5.91
90	377.82	79.34	7.41
S. E. ±	4.70	1.00	0.17
C. D. at 5%	13.79	2.93	0.49

Table 2. Dry matter production (q ha^{-1}) of forage pearl millet as influenced by interaction of varieties and nitrogen levels.

Varieties/N levels (kg ha^{-1})	30	60	90	Mean
Rajbajra chari - 2	79.78	78.59	80.20	79.52
Giant bajra	59.74	68.36	75.35	67.82
AVKB-19	74.85	80.61	87.27	80.91
AVKB-69	68.77	75.11	74.34	72.81
Mean	70.78	75.67	79.34	
S. E. ±	2.00			
C. D. at 5%	5.86			

rainfed situation. The crude protein yield did not differ significantly due to varieties; however, maximum crude protein was recorded from AVKB - 69. Similar results were reported by Verma and Midha (1989), Verma (1993) and Sharma *et al*. (1999).

An application of nitrogen @ 90 kg ha^{-1} produced maximum and significantly higher green forage (377.82 q ha^{-1}), dry matter (79.34 q ha^{-1}) and crude protein (7.41 q ha^{-1}) than 30 and 60 kg ha^{-1} levels of nitrogen. Increasing levels of nitrogen from 30 to 60 and 60 to 90 kg ha^{-1} improved green forage by 6.74 and 4.85 per cent, dry matter production by 6.91 and 4.85 per cent and crude protein yield by 26.82 and 25.38 per cent, respectively. These results corroborate the findings of Subbian (1991) and Sharma *et al*. (1999). The variety AVKB-19 interacted with 90 kg N ha^{-1} produced significantly higher dry matter yield of 87.27 q ha^{-1} (Table 2).

Thus, growing of cultivar AVKB-19 along with application of 90 kg N ha^{-1} may be found to be suitable for producing maximum green forage and crude protein yield.

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Influence of Varying Spacing and Fertilizer Levels on Yield Performance of Hybrid Napier Varieties

Hybrid Napier grass (*Pennisetum purpureum* Schum) is an important perennial source of green fodder. It is popular among the livestock owners because of its high yielding capacity, palatability, higher nutritive value and suitability to varying climatic/soil conditions (Singh *et al*. 2002). However, cultivation of crop in poor and marginal lands with no or little fertilization is one of the main constraints of low productivity. Similarly, the intensive cropping has led to deficiency of plant nutrients in soil, which not only affects the plant growth and development adversely but also impairs animal health. With advent of new high yielding varieties, it is felt necessary to exploit the forage yield of these varieties with different spacing and various levels of NPK fertilizers. However, the information on the effect of spacing and different levels of NPK fertilizers for raising good crop of hybrid Napier grass is meager. Keeping this in view, the present experiment was conducted.

A field experiment was laid out in a factorial randomized block design with three replications at Forage Crops Research Project. Mahatma Phule Krishi Vidyapeeth Rahuri during *kharif* 2005-06. The treatments comprised of two varieties, three spacing and four NPK fertilizer levels (Table 1). The soil of the experimental field was clayey in texture with low, medium and high in available NPK, respectively. The NPK fertilizers were applied as per the treatments. The 25 kg N was applied as a common dose to all treatments after each cut. The first cut was taken at 75 days after planting and subsequent two cuttings at 60 days interval. In all, three cuts were taken during first year. The recommended packages of practices were adopted for cultivation of hybrid Napier.

The differences in green forage, dry matter and crude protein yields were differed significantly due to varieties. The hybrid Napier variety RBN-13 recorded significantly higher green forage yield of 720.95 q ha^{-1}, dry matter yield of 170.71 q ha^{-1} and crude protein yield of 15.72 q ha^{-1} over variety RBN-9. An increase of green forage, dry matter and crude protein yields to the tune of 11.98, 20.23 and 30.24 per cent were observed by variety RBN-13 over variety RBN-9, respectively.

As regards to spacing, planting of hybrid Napier at 90 x 60 cm produced significantly higher green forage yield (710.99 q ha^{-1}), dry matter yield (159.90 q ha^{-1}) and crude protein yield (14.36 q ha^{-1}) as compared to other spacing; however, crude protein yield was at par with spacing of 90 x 45 cm. Significantly higher yields of green forage (712.06 q ha^{-1}), dry matter (169.85 q ha^{-1}) and crude protein (16.12 q ha^{-1}) were obtained with application of 75:60:30 kg NPK per hectare, respectively as compared to other NPK fertilizer levels. However, it was at par with application of 62.50:50:25 kg NPK fertilizer levels, respectively. These results corroborate with the findings of Krishnamurthy *et al*. (1987), Munegowda *et al*. (1989) and Kajale *et al*. (2001). The beneficial effect of NPK on green forage yield may be attributed to the production of more yield attributes. Similarly, dry matter production totally depends upon green forage yield. Since application of higher level of nitrogen produced more herbage yield and accumulation of more dry matter and crude protein in plants which in turn increased the dry matter and crude protein yield.

The results indicated that the planting of hybrid Napier variety RBN-13 at spacing of 90 x 60 cm with application of 62.50:50:25 kg NPK + 25 kg N after each cut showed better proposition for achieving higher forage yield of hybrid Napier.

Table 1. Mean green forage, dry matter and crude protein yield of Bajra x Napier grass hybrids as influenced by different treatments (Total of three cuts).

Treatment	Green forage yield (q ha^{-1})	Dry matter yield (q ha^{-1})	Crude protein yield (q ha^{-1})
Varieties (V) :			
V_1 - RBN-13	720.95	170.71	15.72
V_2 - RBN-9	643.79	141.99	12.07
S. E. ±	2.53	0.59	0.16
C. D. at 5%	7.19	1.67	0.47
Spacing (S) :			
S_1 - 90 x 45 cm	644.76	153.14	13.35
S_2 - 90 x 60 cm	710.09	159.90	14.36
S_3 - 90 x 75 cm	692.26	156.01	13.99
S. E. ±	3.09	0.72	0.20
C. D. at 5%	8.80	2.04	0.57
NPK (kg ha^{-1}) (F) :			
F_1 - 37.50:30:15	640.99	137.05	10.78
F_2 - 50.00:40:20	667.79	150.27	12.84
F_3 - 62.50:50:25	708.63	168.23	15.85
F_4 - 75.00:60:30	712.06	169.85	16.12
S. E. ±	3.57	0.83	0.23
C. D. at 5%	10.17	2.36	0.66

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Evaluation of Sugarcane Genotypes with Hybrid Napier for Green Forage Yield

In India, the livelihood of about 70 per cent population is dependent mainly on agriculture and animal husbandry. India has a huge livestock population; however, their productivity is very low due to malnutrition and/or under nutrition. There is a huge gap between demand and supply of all kinds of feeds and fodder. In the present scenario of the burgeoning population and increasing use of land for habitation hardly there is any scope for horizontal expansion of the forages.

Sugarcane is the main cash crop of Maharashtra. The average recovery of sugarcane in this state is the highest in the country, which is because of the favorable agro-ecological conditions, resulting in accumulation of more sugar in the cane. The crushing of cane in the state starts in October and ends in May. During that period most of the farmers use sugarcane tops as fodder for animals. Amongst different technological consideration, ratoon management is one of the most important factors. Some genotypes of sugarcane have high tillering habit, better ratooning ability and fast regrowth after cutting. Most of the farmers of Maharashtra are cultivating hybrid Napier grass (RBN -9) owing to its excellent growth habit, better palatability, highly succulent, high tonnage, quick regrowth, responsive to fertilizers and suitable to varying climatic/soil condition (Singh *et al*. 2002). Therefore, with a view to study the performance of new genotypes of sugarcane in comparison to hybrid Napier, the present study was undertaken.

A field experiment was undertaken during 2005-06 at Forage Crops Research Project, Mahatma Phule Krishi Vidyapeeth, Rahuri. The experiment was laid out in a randomized block design with three replications. Treatments comprised of nine genotypes of sugarcane *viz*., MS 0210, MS 0214, CoM 0243, CoM 0247, CoM 0251, CoM 0253, CoM 0257, CoM 9810 and one genotype of hybrid Napier i.e. *Arenthesis* sp. The soil of experimental field was clayey in texture, low in available nitrogen

Table 1. Total green forage, dry matter and crude protein yield (q ha^{-1}), silica content, gross and net monetary returns and benefit : cost ratio of sugarcane as influenced by different genotypes.

Genotypes	Geen forage yield (q ha^{-1})	Dry matter yield (q ha^{-1})	Crude protein yield (q ha^{-1})	Silica (%)	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	Benefit : cost ratio
MS 0210	981.93	199.02	13.05	1.07	54006	8921	1.20
MS 0214	1017.68	205.09	15.26	1.13	55972	10887	1.24
CoM 0243	862.11	189.22	13.66	0.98	47416	2331	1.05
CoM 0247	997.31	222.80	14.12	1.13	54852	8434	1.19
CoM 0251	1151.48	284.10	19.27	1.23	63332	18260	1.41
CoM 0253	891.28	207.14	12.24	1.13	49020	3935	1.09
CoM 0257	968.04	193.42	14.27	1.03	53242	8157	1.18
CoM 9810	1209.82	257.34	19.71	1.20	66540	21455	1.48
Arenthesis sp.	1275.09	294.06	21.23	1.30	70130	25045	1.56
RBN-9	2772.91	507.94	42.86	0.93	124780	62603	2.01
S. E. ±	31.64	7.79	0.70	0.013	1483	1606	-
C. D. at 5%	93.96	23.13	2.09	0.040	4405	4769	-

(217.25 kg ha^{-1}), medium in phosphorus (14.29 kg ha^{-1}) and high in available potash (445.07 kg ha^{-1}). First cut of sugarcane was taken five months after planting and further subsequent cuttings were taken at four months interval. The total five cuts were obtained from sugarcane during experimental period. As regards to hybrid Napier, first cut was taken at three months after planting and subsequent cutting at two months interval. The total eight cuts were obtained from hybrid Napier. Fertilizer application in sugarcane was done @ 225 kg N, 115 kg P and 115 kg K ha^{-1}. The nitrogen was applied in four equal splits (1^{st} at planting and remaining three immediately after cutting of sugarcane for forage). The full dose of phosphorus and potash were applied at the time of planting. While fertilizer application in hybrid Napier was done @ 225 kg N, 40 kg P and 20 kg K ha^{-1}. The full dose of P and K were applied at planting, while 25 kg N ha^{-1} was applied after every cut.

The genotype RBN - 9 of hybrid Napier recorded significantly higher green forage (2772.91 q ha^{-1}), dry matter yield (507.94 q ha^{-1}) and crude protein yield (42.86 q ha^{-1}) as compared to all other genotypes of sugarcane. However, among the other genotypes of sugarcane, genotype *Arenthesis* sp. was at par with genotype COM-9810 and COM-0251 which recorded significantly higher green forage and crude protein yield than the rest of the genotypes of sugarcane. Whereas, *Arenthesis sp*. was found at par with genotype COM-0251 regarding dry matter yield only (Table 1). As regards, silica content, it was observed that hybrid Napier (RBN - 9) registered statistically lowest silica content (0.93 %) as compared to all other genotypes of sugarcane under study. However, genotype *Arenthesis sp*. was recorded significantly higher silica content (1.30 %) than all other genotypes. Similar results were also found by Patel *et al*. (1990).

Perusal of data from Table 1 reveled that genotype RBN-9 of hybrid Napier recorded significantly higher gross returns of Rs. 124780/- and net returns of Rs. 62603/- per hectare and with maximum benefit: cost ratio (2.01). These findings support the results reported by Srivastva *et al*. (1992) and Kajale *et al*. (2001). As only sugarcane genotypes concerned, *Arenthesis* sp. being at par with genotype COM - 9810 registered statistically

higher gross and net returns (Rs. 70130/- and Rs. 25045/- ha^{-1}) than all other genotypes of sugarcane. The same trend was also noticed with regards to benefit:cost ratio (1.56).

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Evaluation of Sowing Time for *Rabi* French bean and Validation by DSSAT-3.5

The CERES (Crop Environment Resources Synthesis) model is one of the dynamic crop growth model incorporated under DSSAT-3.5 (Decision Support System for Agro-Technology Transfer) by IBSNAT (International Benchmark Sites Network for Agro-technology Transfer). This model has been used to simulate the growth and yield of rajmah to validate this model by conducting the experiment.

The experiment was conducted on the farm of Centre of Advanced Studies in Agricultural Meteorology at College of Agriculture, Pune during the *rabi* season of 2005 in a randomized block design with five treatments sowing in different meteorological weeks *viz*. S_1 (42 mw), S_2 (43 mw), S_3 (44 mw), S_4 (45 mw) and S_5 (46 mw) and replicated four times. The experimental data was used for validation of DSSAT model which is a user oriented daily incrementing simulation model estimating french bean growth, development, yield and simulates the effects of weather, soil properties and genotype. DSSAT french bean can be run in either a stand alone mode or as a component of IBSNAT's, DSSAT, IBSNAT. Data Base Management System (DBMS) that provides the user with other applications in addition to the creation of the files for these crop models IBSNAT'S, DBMS programme, also provides the capacity of recording all experimental details (by plot), some statistical analysis and plotting the experimental results (Alagarswamy *et al.* 1989). Input files were created by using DSSAT- 3.5 programme.

Data presented in Table 1 and 2 revealed that the phenology as well as yield contributing characters differed significantly due to different sowing treatments from the initial stage of the crop up to the harvest. The mean value of the predicted days for anthesis was 36.2 as against observed days of 38.2 with mean difference between predicted and observed days of anthesis was -2±0.97 days only, while, the standard deviation was ±0.83 days. The mean

predicted days for physiological maturity were 71 as against observed days of 70.8 with mean difference 0.2 days and standard deviation of ±1.10. The mean predicted and observed LAI was 3.35 and 3.10 respectively with mean difference of -0.55 days and the standard deviation of ±0.27 days. Since all the growth stages were predicted by the model with per cent error less than 10 per cent the values in terms of phenological characters DSSAT-3.5 model was found to be fairly matched with the observed values due to different sowing times of french bean.

The mean predicted and observed seed yield was 1984.8 and 1767 kg ha^{-1} respectively with a mean difference of 271.4kg ha^{-1} and standard deviation of ±162.4 kg. The mean difference between predicted and observed value of straw yield was -628.6 kg ha^{-1} with standard deviation of ±394.70, while, the mean difference between predicted and observed value of biomass was 186 kg ha^{-1} with standard deviation of ± 525.95 kg.

Initial testing of the model showed that the days for anthesis predicted were well matched with observed days. The model predicted physiological maturity correctly at sowing in 42 mw, however it was fairly matched with rest of sowing time. The model predicted LAI correctly at sowing in 46 mw, while LAI did not matched

Table 1. Predicted and observed phenology, contributing characters of french bean as influenced by different sowing times.

Treatment	Phenology								
	Anthesis (days)			Physiological maturity (days)			Leaf area index (LAI)		
	P	O	D	P	O	D	P	O	D
S_1	35	37	-2	69	68	1	3.28	4.08	-0.8
S_2	36	38	-2	70	69	1	3.46	4.11	-0.65
S_3	36	38	-2	72	71	1	3.25	4.01	-0.76
S_4	37	39	-2	72	73	-1	3.29	3.75	-0.46
S_5	37	39	-2	72	73	-1	3.49	3.61	-0.12
Mean	36.2	38.2	-2	71	70.8	0.2	3.35	3.91	-0.55
S. D. ±	0.83	15.61	0.97	1.41	2.28	1.10	0.11	1.60	0.27

Table 2. Predicted and observed values of yield contributing characters of french bean as influenced by different sowing times.

Treatment	Yield								
	Seed yield (kg ha^{-1})			Straw yield (kg ha^{-1})			Biomass (kg ha^{-1})		
	P	O	D	P	O	D	P	O	D
S_1	2019	2063	-34	1383	2480	-1097	4025	4543	-518
S_2	1997	1824	163	1430	2260	-830	4042	4084	-42
S_3	2018	1730	288	1388	2162	-774	4004	3892	112
S_4	1907	1630	277	1449	1740	-291	3945	3410	535
S_5	1983	1590	393	1586	1737	-151	4180	3337	843
Mean	1984.8	1767	217.4	1447.2	2075	-628.6	4039.2	3853	186
S. D. ±	46.03	741	162.42	82.44	897	394.70	86.81	1634.99	525.95

P = Model prediction, O = Observed value, LAI = Leaf area index, S. D. = Standard deviation, D = (P-O)

Table 3. Summarized data set of observed and predicted phenology and yield parameters of french bean as influenced by different sowing times (N=5).

Variable	Units	O	P	So	Sp	D
Anthesis	Days	38.2	36.2	15.60	0.83	0.78
Physiological maturity	Days	70.8	71	2.28	1.41	0.89
LAI	Number	3.91	3.35	1.60	0.11	-0.28
Biomass	kg ha^{-1}	3853	4039.2	1635	86.81	0.95
Straw	kg ha^{-1}	2075.8	1447.2	897	82.44	-3.27
Seed yield	kg ha^{-1}	1767	1984.8	741	46.03	0.99

D = Degree of agreement, So = Standard deviation of observation, Sp = Standard deviation of prediction

with rest of sowing times. The biomass was matching with sowing in 43 mw and fairly matching with sowing in 44 mw, however, that was not matched with rest of sowing times. The straw yield was found matched at sowing in 46 mw, however, it did not matched at rest of sowing times. The observed seed yield was matched with the predicted at sowing in 42 mw and fairly matched with sowing in 43 mw.

The summarized means of observed (0) and predicted (P) values of variables along with the standard deviation of observation (So) and prediction (Sp) and the degree of agreement (D) presented in Table 3, described the quality of simulation. Willmott (1982) reported that the degree of agreement (D) is an important parameter in crop modelling. It should be within 0 (zero) and 1. However, in this study the values ranged within $\pm$0.80 with exception for LAI. The large variability in LAI by the model needs correction.

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Assessment of Agricultural Pumping Systems in Rahuri Region

Besides pump efficiency, pump selection and use of proper water application method is also very important to achieve the desired level of overall irrigation system efficiency. In order to analyze these problems at field level, the study was undertaken on assessment of agricultural pumping system in Rahuri tahsil of Ahmednagar district with the objectives to study of pump sets used by the farmers, their problems and to improve their pumping efficiency.

This study was conducted in Rahuri tahsil of Ahmednagar district in Maharashtra state with more concentration of irrigated sector in five villages. Total 80 pump sets were selected for the study. A comprehensive questionnaire was designed for the survey of pumping systems. The information was collected on general information about farmers and present crop

grown, land holding, source of water and method of irrigation, technical details of pump sets and problems regarding pumping.

By contacting farmers personally, information was collected. Besides suggestions, opinions of farmers were sought about selection and problems in operation. For performance evaluation, the pump discharge was measured volumetrically. The system efficiency was calculated by using the formulae Reddy *et al*. (2001).

With the basic framework, considering different heads the collected data was analyzed. It was observed that, most of the farmers utilized 3 HP and 5 HP pump sets irrespective of land holding and cropping pattern. Energy wastages were observed due to improper practices of farming.

It could be seen that majority of farmers (55%) had small land holding, followed by medium 28.75% land holding and 16.25% had large land holding category. It was observed that the land holding have no association with pump operating hours per day.

The 70 per cent farmers had irrigated the land with the help of open well followed by 13.75 per cent tube well, 8.75 per cent canal and 7.5 per cent rever source. It was also observed that under traditional irrigation system 51.67 per cent farmers used furrow irrigation method for sugarcane followed by 48.33 per cent check basin method for wheat and onion crops. In study area it was observed that, 60 per cent of total 80 pump sets, were standard brand pump sets and 40 per cent were local made (Koppad and Maurya 1994).

Among the problems during operation 50 farmers faced problem of low water delivery. Major problem as expressed by 54 farmers was about leakages. Sixty farmers reported about non-availability of repair and maintenance services in vicinity. The studies also revealed that due to low pump efficiency, pump consumes more energy and it was due to excessive suction lift, clogged foot valve, improper selection and inferior quality of pump, excessive height of delivery pipe from ground level, leakages in joints, use of undersized suction and delivery pipes and misalignments of pump and motor on engine pulley. Hence energy conservation measures should be adopted for agricultural pumping systems.

Based on said information, performance evaluation for the system in MPKV campus was done,

a) For centrifugal pump set : Discharge = 5.265 lps, Head 35 m. Hence WHP = (q x H) / 75 = 2.457 HP.

   1Kwh power required for 20 min.

   Hence IHP = 1/ 0.33 = 3 Kw = 4.02 HP.

   η= WHP/ IHP = (2.4577 / 4.022) x 100 = 61.09 %

b) For submersible pump set : Discharge = 3.978 lps, Head = 50 m

   Hence WHP = (q x H) / 75 = 2.652 HP

   1Kwh power required for 11 min.

   Hence IHP = 1/ 0.183 = 5.45 Kw = 7.31 HP.

   η= WHP/ IHP = (2.652 / 7.31) x 100 = 36.28 %

These systems were analyzed and it was found that in centrifugal system, this efficiency can be improved by minimizing water leakage and proper maintenance. For submersible pump set low efficiency was due to lowering of water table, excessive bends. The numbers of bends were minimized. Resultantly there was increase in discharge for centrifugal pump as 6.325 lps and submersible pump as 5.735 lps. Hence improved efficiencies were 73.38 and

52.43 per cent. These systems can further be improved by changing impeller diameter and reducing speed. Such type of detailed analysis should be compulsory for all future installations. Following preventive measures should be taken during selection and installation of pump sets as well as accessories.

The main points that are to be considered while selecting a pump are, discharge to be pumped, total head, operation at maximum efficiency, range of water level over which the pump has to operate. Having knowledge about discharge to be pumped, total head, pump characteristic to select operating point at maximum efficiency, range of variation of water level for pump operation, water requirement throughout the year as per crop, pump should be selected. This is the most crucial step in acquiring a pumping unit and yet generally ignored by farmers.

For efficient and economic working of a centrifugal pump, suction and delivery pipe should be properly selected such that the total friction losses on the suction side do no exceed 0.5m. The material of the delivery pipe should be such that the frictional losses do not exceed 0.8 to 1.0 m per 10m length of the pipe. The use of unnecessary long delivery pipe should be avoided to keep energy loss minimum as reported by Aware (2004).

It is advisable to install a foot valve on the suction side to facilitate priming. Only ISI marked proper size foot valves should be used. The pump should be located as near to the source of water as possible. The foundation should be sufficiently heavy to provide support to the base plate. The end of suction pipe must well submerge to avoid inrush of air.

Due to adoption of flat rate pricing, a farmer pays a fixed price per horsepower per month for electricity. This leads to energy wastage, over pumping causes loss of water. Currently water supply to farmers is not assured due to electricity crisis. Use of renewable energy sources like solar energy, wind energy or biogas energy may be the best alternative. Depending availability of natural sources, these alternatives can be adopted for generation of electricity.

From the study carried out, it was felt that awareness about energy conservation among farmers is essential. There is good scope in agricultural pumping system to improve energy efficiency in Indian agriculture (Patel, 1999).

It could be concluded that majority of farmers (55%) had small land holding, followed by (28.75%) medium land holding and (16.25%) had large land holding category. It was observed that the land holding have no association with pump operating hours per day. The 70 per cent farmers had irrigated the land with the help of open well followed by (13.75%) tube well, (8.75%) canal and (7.5%) river source. Under traditional irrigation system 51.67 per cent farmers used furrow irrigation method for sugarcane followed by 48.33 per cent check basin method for wheat and onion crops. Among the problems during operation 50 farmers faced problem of low water delivery. Major problems as expressed by 54 farmers was about leakages. 60 farmers reported about non-availability of repair and maintenance services in vicinity. There is a need for proper guidance to the farmers regarding selection and installation of pump sets as well as about efficient operation.

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Occurrence of Rust on Chickpea in Western Maharashtra

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops grown in Asia. Maharashtra has the major share in area i.e 13.08 lakh, ha. with the production of 9.24 lakh tones and the productivity 706 kg ha^{-1} (Anonymous, 2007). According to Nene *et al*. (1996) the crop is attacked by several pathogens. Chickpea rust incited by *Uromyces ciceris* is the widespread in the Mediterranean region, South - East Europe, South Asia , East Africa and Mexico. It is a major factor affecting chickpea production in Central Mexico (Diaz-Franco and Pefez Gracia , 1995 ; Haware , 1998) and at Italy on high altitude. In Northern India, it is very common in Bihar, U.P. and Punjab.

Occurrence of chickpea rust hitherto had not been reported from Western Maharashtra. In Western Maharashtra, the disease was noticed during *rabi* season 2009 on chickpea variety Digvijay, at Agricultural Research Station, Igatpuri, district, Nashik and Agricultural Research Station, Radhanagri, district Kolhapur in the last week of February 2009. The severity of the disease was ranged from 10 to 15 per cent. The incidence of rust was noticed after flowering stage at both the places. Symptoms were observed under field condition. Initially, the leaves were covered with small round or oval, light brown to dark brown pustules which tend to coalesce and form bigger pustules. They were observed on both the sides of the leaves. However, they were more in numbers on the lower surface of leaves.

At the time of occurrence of disease, the maximum and minimum temperature during the first week of February was 24 and 6.2 °C respectively and temperature gradually raised up to 32.6 and 10.3 °C in the last week of February. The pathogen was observed under microscope. The urediospores were globose, echinulate, measuring 20-26 µm in diameter, yellowish brown in color with thick epispore. Based on the symptomatology and morphological characters of urediospores the pathogen was identified as *Uromyces ciceris* and reported under Western Maharashtra conditions.

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Rejuvenation Technology for Improvement of Old Guava (cv. Sardar) Orchard

After 15-20 years of age, the guava orchard generally begins to loose it's vigor and bearing potential and incidence of pests and diseases is much more. Hence, it is essential to manage such senile orchards in order to attain the competitive age in commercial production. In this context an attempt was made to develop the technology to rejuvenate and restore the production potential of 35 years old, unproductive guava orchard infested with pests and diseases.

A procedure to rejuvenate and restore the production potential of old unproductive and wilt-affected orchards has been developed, which employs pruning of branches at 75 cm height from ground level. Crowding and encroachment of guava trees with subsequent inefficient light utilization is an obvious problem with older orchards, if trees are not well managed. The internal bearing capacity of guava trees also decreases with time, due to overshadowing of internal bearing wood (Hema, 2008).

Table 1. Yield performance of rejuvenated plants.

Parameters	Before rajuve-nation (Average of 7 years)	After rejuvenation (Average of 62 trees)		
		2003	2004	2005
Fruits / treet	42.31	27.97	61.6	169.06
Yield / tree (kg)	2.65	4.18	9.34	26.06
Weight of fruit (g)	62.82	149.78	151.84	154.14

The investigation was conducted at Regional Fruit Research Station, National Agricultural Research Project (Plain Zone), Ganeshkhind, Pune, during the year 2002-2005 on cv. Sardar. A 35 years old guava orchard planted in medium black soil had the branches crowded and the fruits were of very small size and inedible. The orchard was infested with mealy bugs, fruit fly, white fly and canker. No marketable fruits were harvested from the orchard for last seven years before rejuvenation.

Sixty-two plants were deheaded at a height of 75 cm with a clean cut, keeping the straight stump as far as possible during December,

2002. All the infected pruned branches were collected and destroyed. The Bordeaux paste was pasted on the cut portion of the trunk. The land was ploughed and the basins of 3 x 3 m size were prepared. The recommended dose of manures and fertilizers (50 kg FYM, and 900:300:600 g NPK tree^{-1}) was applied to the plants and immediately irrigation was given. Well-spaced and upright growing sprouts (up to 4) were retained on the tree as future branches. Hema (2008) suggested somewhat the same technique of management that, apply cow dung or copper oxychloride on the cut portion. Basins were prepared around the tree for regular watering and apply of FYM and fertilizer. Apply 50 kg FYM per tree and recommended dose of fertilizers. Apply paste of copper and lime on the larger limbs as well as trunk to prevent pathogens. Ensure irrigation soon after rejuvenation for shoot sprouting.

Before rejuvenation, the average number of fruits plant^{-1} were 42.31 with the yield of 2.65 kg tree^{-1} and the average weight of fruit 62.82 g. Thus the orchard was totally unproductive (Table 1). Astonishingly, the rejuvenated orchard gave fruits within a year (Table 1) with 4.18 kg marketable yield in first year. However, there was gradual improvement in year 2004-2005. The average number of fruits recorded during 2004 and 2005 were 61.60 and 169.06, respectively. The similar trend in average yield tree^{-1} was observed. The average yield tree^{-1} recorded in the second (9.34 kg) and third (26.06 kg) year (2005). Basu *et al.* (2007) reported similar benefical results of pruning on rejuvenation of an old guava orchard (cv. L-49). Further Singh *et al*. (2005) reported that topping and headging the tree height consequently improved the fruiting potential of tree.

The data on pest and disease incidence showed that there was beneficial effect to control pest and disease infestation after rejuvenation (Table 2).

Table 2. Incidence of pests and diseases (%).

Parameters	Before rajuvenation (Average of 7 years)	Three years after rejuvenation
Pests :		
Mealy bugs	67	6
Fruit fly	64	3
White fly	36	4
Disease :		
Canker	68	Free

There were no previous results on rejuvenation of guava orchard. However, twig pruning has been found useful, which was reported by Gorakh Singh (2005).

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Biosafety of Systemic Insecticides Through Seed Treatment and Stem Smearing to Some Predators

Insecticides being an inevitable component of pest management, comparatively safer to bioagents, need to be included in the plant protection programme. As such systemic insecticides in general and systemic seed dressers in particular become the cause of concern (Mizell and Sconyer, 1992). Thiamethoxam 70 WS, imidacloprid 70 WS, acetamiprid 20 SP, thicloprid 21.7 SC and monocrotophos as per treatments were field evaluated for their safety against there predators *viz*., LBB, chrysopa and spiders on cotton.

Field experiment was conducted in a randomized block design with ten treatments and three replications at experimental field of entomology Dr. PDKV, Akola during *kharif* 2006-07. Thiamethoxam 70 WS, imidacloprid 70 WS, acetamiprid 20 SP, thicloprid 21.7 SC and monocrotophos 36 WSC were tested through seed treatment and stem smearing technique for their biosafety to lady bird beetle, chrysopa and spiders on cotton var. PKV - Rajat. The observations on number of LBB, chrysopa and spiders per plant on whole plant were recorded at weekly interval from 21 to 77,42 to 77 DAE, respectively.

Table 1 shows that maximum population of LBBs (2.55 plant^{-1}) was observed in a untreated control and being on par with stem smearing of thicloprid 1:20 dilution (2. 55) and imidacloprid 1:20 dilution (2.24). In remaining treatments significantly lower population of LBBs were recorded than untreated control. In untreated control plot highest population of chrysopa was recorded (1.94 plant^{-1}) and it was significantly superior over all other treatments except thiamethoxam 70 WS, 1:20 dilution (SS) and acetamiprid 20 SP, 1:20 dilution (SS).

The treatment thiamethoxam 70 WS @ 5g kg^{-1} seed was found most safer to spiders (2.01) followed by thiamethoxam 70 WS, 1:20 dilution (1.16). Both these treatments significantly differ from each other and superior over all other treatments including control. The next safer treatments were acetamiprid 20 SP @ 20 g kg^{-1} (ST) followed by acetamiprid 20 SP, 1:20 dilution (SS) and on par with untreated control. Rest of the treatments were least safer to spiders.

Mizell and Sconyer (1992) found that

Table 1. Effect of different treatments on per plant population of predators.

Treatment	Average number of		
	LBB	Chrysopa	Spiders
Thiamethoxam 70 WS @ 5g kg^{-1}	1.24 (1.11)	1.48 (1.22)	2.01 (1.42)
Imidacloprid 70 WS @ 10 g kg^{-1}	1.62 (1.27)	1.13 (1.06)	0.88 (0.94)
Acetamiprid 20 SP @ 20 g kg^{-1}	0.92 (0.96)	1.42 (1.19)	1.29 (1.14)
Thicloprid 21.7 SC @ 10 ml kg^{-1}	2.19 (1.48)	1.02 (1.01)	0.90 (0.95)
Thiamethoxam 70 WS 1:20 dilution	2.15 (1.47)	1.77 (1.33)	1.61 (1.27)
Imidacloprid 70 WS 1:20 dilution	2.24 (1.49)	1.57 (1.25)	0.97 (0.98)
Acetamiprid 20 SP 1:20 dilution	1.87 (1.36)	1.70 (1.30)	1.07 (1.03)
Monocrotophos 36 WSC 1:20 dilution	1.01 (1.01)	1.13 (1.06)	0.93 (0.96)
Thicloprid 21. 7 SC 1:20 dilution	2.55 (1.60)	1.28 (1.13)	0.76 (0.87)
Untreated control	2.55 (1.60)	1.94 (1.39)	1.18 (1.09)
F' Test	Sig.	Sig.	Sig.
SE (m) ±	0.039	0.038	0.030
CD at 5%	0.11	0.11	0.08

Fig. in parenthesis are square root values.

imidacloprid had little impact on benefical insects. Satpute (1999), concluded that, seed treatment with imidacloprid and thiamethoxam were not only conservative to bioagents, but also attracted more population of LBB adults and chrysopa eggs. Seed treatment was safer than foliar sprays. Imidacloprid @ 10 g kg^{-1} seed treatment allowed maximum lady bird beetle adults and thiamethoxam 4 g kg^{-1} allowed maximum oviposition of chrysopa and were at par with untreated control on cotton (Katole and Patil, 2000).

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Screening of Safflower Genotypes Against *Fusarium oxysporum* f. sp. *carthami*

Safflower is severely affected by wilt disease caused by *Fusarium oxysporum* schlecht f. sp. *carthami* and became an endemic disease in all major safflower growing areas in India. (Pedgaonkar *et al*. 1990). The disease is exemplified by typical symptoms of vascular wilt (Klisiewicz and Houston, (1962).

The severity of symptoms varies depending on the time of infection and the genotypes (Sastry and Ramachandram, 1992) and causes yield losses up to 80 per cent (Sastry and Chattopadhyay, 1997). Availability of resistance in crops is important for most of the soil borne diseases as these are difficult to control by use of pesticides. In disease resistance development programme identification of resistance source is prime important step. In present investigation resistance sources against *Fusarium oxysporum* f. sp. *carthami* is identified by using cultural filtrate of the pathogen.

Isolations of the pathogen was made from wilt affected safflower plant parts particularly root and crown region. The infected plant parts were washed thoroughly under running tap water and transferred to blotting paper. They were cut into 0.20 cm pieces and surface sterilized with 0.1 per cent mercuric chloride solution for one minute followed by three washing with sterile distilled water.

The bits were plated on potato dextrose agar medium under aseptic conditions and incubated at 25±1°C in an incubator. The isolated pathogen was identified based on colony characters and spore measurement by using monograph (Booth, 1971) as *Fusarium oxysporum* f. sp. *carthami*. Fungal culture was maintained on PDA plates for further study.

Water culture technique suggested by Nene *et al*. (1981) was used in present study. Mycelium discs of 5mm diameter were cut from the margin of the seven day old culture of pathogen and transferred to conical flask containing the sterilized potato dextrose broth medium under aseptic condition.

The flasks were incubated at 25±1°C in an incubator for 10 days. The culture filtrate was collected and diluted by adding 97.5 ml sterile water and 2.5 ml of filtrate. Only sterile water tubes without culture filtrate were maintained as control. The seedling of 150 safflower genotypes grown in sterile condition on blotter paper using sterile water were transferred after 10 days of emergence to culture filtrate tubes. Ten seedlings of each genotype were placed in cultural filtrate tube and the observations on the number of seedling wilted were recorded after 5 days.

Out of 150 safflower genotypes three genotypes *viz*. GMU-2794, GMU-2828 and GMU-2850 were free from wilt at the end of five days, whereas rest of the genotypes showed various reactions of wilt. The result clearly indicated that water culture technique is most useful, suitable and economic for initial evaluation of large number of genotypes against wilt reaction for breeding material testing in laboratory.

Nirmal (1985) screened 52 safflower genotypes and found that NS-1016, HOO-22, MVI-28, BLY-211 and BLY-1080 were resistant to disease. Similar results were reported by Kulkarni (1987). Pedgaonkar and Mayee (1989) screened 34 safflower genotypes by water culture technique. JSLF 88 and N-248 showed 22 to 44 per cent wilt as against 100 per cent wilt in other genotypes. Dhokne (1993) screened 170 safflower genotypes against *Fusarium oxysporum* f. sp. *carthami* by water culture technique and found that five genotypes *viz*. GMU-849, 850,861,875 and CTV-218 were free from wilt.

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Studies on Seed Borne Nature of *Fusarium oxysporum* f. sp. *carthami* Causing Wilt of Safflower

Safflower (*Carthamus tinctorius* L) is one of the major post rainy season oilseed crop cultivated in medium to heavy deep textured vertisols. *Fusarium oxysporum* f. sp. *carthami* (Klisiewicz and Houston, 1962) was recognised as a disease of safflower in California and India by Singh *et al.* (1975). It spread widely and caused yield losses up to 80 per cent (Sastry and Chattopadhyay, 1997). The disease is reported to be seed transmitted up to 10-40 per cent (Sastry and Jayaraman, 1993) and the fungus perpetuates as mycelium and spores on the seed and seed coat (Zayed *et al*. 1980). The present paper reports on seed borne nature of *Fusarium oxysporum* f. sp. *carthami* by using Blotter paper methods.

Four hundred seeds each of five varieties of safflower *viz*. Bhima, PBNS 12, Manjira, HUS-305 and PBNS-40 were placed on water soaked blotter paper and incubated at 20 $\pm$ 2°C in petri dishes for 7 days in alternating cycles of 12 hr light and darkness. The individual seeds were examined under stero-binocular microscope and fungi were identified based on the basis of their characters as described in monograph by Booth (1971).

The effect of seed treatment with fungicides, $HgCl_2$ and hot water on seed borne mycoflora of safflower was studied. The seeds of safflower cultivar Nira were treated with fungicides *viz.*, carbendazim (0.3 per cent), thiram (0.3 per cent), carbendazim (0.15 per cent) + thiram (0.15 per cent), captan (0.3 per cent), surface sterilization with 0.1 per cent $HgCl_2$ and treatment with hot water at 52°C (before treatment the seeds were soaked in water for over night). Untreated seeds were used for control treatment. After treatments, the seed

Table 1. Per cent mycoflora on seeds of safflower varieties detected by blotter paper method.

Variety	Per cent seed mycoflora		
	Fusarium oxysporum* f. sp. *carthami	***Rhizophus* spp.**	***Aspergillus* spp.**
Bhima	70 (56.99)	10 (18.34)	20 (26.52)
PBNS-12	80 (63.54)	8.75 (17.20)	11.25 (19.58)
Majira	85 (68.08)	5 (12.87)	10 (18.40)
HUS-305	47.5 (43.55)	22.5 (28.29)	30 (33.17)
PBNS-40	60 (50.78)	17.5 (24.71)	22.5 (28.29)
S. E. $\pm$	3.17	0.80	1.05
C. D. at 5%	14.46	3.65	4.79
CV (%)	9.72	6.88	7.26

Figures in parenthesis are angular transformed values.

Table 2. Effect of seed treatment on seed mycoflora of safflower by agar plate method.

Treatments	Per cent seed mycoflora		
	Fusarium oxysporum f. sp. carthami	**Rhizo-phus spp.**	**Asper-gillus spp.**
Carbendazim (0.3%)	53.33 (46.90)	6.00 (14.14)	20.66 (27.03)
Thiram (0.3%)	60.66 (51.15)	11.33 (19.65)	27.66 (31.71)
Carbendazim (0.15%) + Thiram (0.15%)	40.66 (39.61)	20.66 (27.03)	10.66 (19.04)
Captan (0.3%)	70.00 (56.79)	18.00 (28.07)	12.00 (20.22)
Mercuric chloride (0.1%)	76.33 (60.89)	28.33 (32.15)	38.66 (38.44)
Hot water treatment at 52°C	10.33 (18.71)	21.33 (27.50)	11.66 (19.94)
Unsterilized seeds	88.00 (69.76)	10.33 (18.71)	40.66 (39.61)
S. E. $\pm$	0.73	0.65	0.70
C. D. at 1%	3.12	2.78	3.00

Figures in parenthesis are angular transformed values.

were placed in petri plates containing *Fusarium* selective medium (FSM).

It is seen from Table 1 that, highest incidence of *Fusarium oxysporum* f. sp. *carthami* was observed in safflower variety Manjira which was at par with the PBNS-12. Lowest incidence was observed in the variety HUS-305 but at par with PBNS-40. Lowest incidence of *Rhizopus* spp was observed in the variety Manjira followed by PBNS-12 while HUS-305 had highest incidence. Highest incidence of *Aspergillus* spp. was observed in the variety HUS-305 and it was followed by PBNS-40 and Bhima.

In agar plate method (Table 2), incidence of *Fusarium oxysporum* f. sp. *carthami* was maximum in unsterlized seeds followed by seeds sterilized with mercuric chloride and captan treated seeds. Lowest *Fusarium oxysporum* f. sp. *carthami* was observed in seeds treated with hot water at 52°C. Lowest incidence of *Rhizopus* spp was observed in seeds treated with carbendazim followed by unsterilized seeds, while maximum incidence was observed in seeds sterilized with mercuric chloride. Lowest incidence of *Aspergillus* spp. was observed in seeds treated with carbendazim + thirum followed by seeds treated in hot water at 52°C and captan. Nash and Snyder (1962) used peptone quintozene agar media (PQA) for detection of seed borne nature of *Fusarium*. Klisiewicz and Houston (1963) demonstrated for the first time seed borne nature of *Fusarium oxysporum* f. sp. *carthami* through seeds of safflower. He found 42 per cent of the seeds infected by the fungus externally. He further reported that 8 per cent of the seeds showed internal seed transmission. Vaidehi *et al*. (1985) and Awadhiya (1992) reported nature of the pathogen.

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Efficacy of Different Insecticides Against Population of Lady Bird Beetle on Okra

Okra (*Abelmoschus esculentus* (L) Moench) commonly known as lady's finger or Bhendi, belongs to family malvaceae, is an important vegetable crop for its tender fruits. Different pesticides have been used for control of okra pests. But several pesticides have broad spectrum activity and are highly toxic to non-target organisms. Among many predators on okra lady bird beetle and Chrysopa are predominant predators. There are some pesticides which are harmful to the natural enemies like lady bird beetle and Chrysopa in okra crop. Present field studies were undertaken to determine the effects of insecticides on population of lady bird beetle in okra during the year 2007-2008.

The observations on total number of lady bird beetles per observational plant were made at one day before and 1, 3, 7 and 14 days after second spray and the data in respect of bioefficacy of different insecticides against lady bird beetles were statistically analysed. The null hypothesis was tested by 'F' test of significance at 5 per cent level in order to know the effect of different insecticides on population of lady bird beetle.

It is seen from Table 1 that at one day after treatment all the insecticides except spinosad 0.005 per cent were found to be harmful to the population of lady bird beetle significantly over untreated control. The highest population of lady bird beetle to the extent of 1.46, 2.46 and 3.06 plant^{-1} was observed at 3, 7, 14 days after second spray in the plots which were treated with spinosad 0.005 per cent. The significantly lowest population of lady bird beetle was recorded in the plots treated with cypermethrin 0.01 per cent (0.33 lady bird beetle plant^{-1} followed by imidacloprid 0.004 per cent and profenofos 0.08 per cent (0.40 lady bird beetle plant^{-1}), indoxacarb 0.01 per cent (0.46 lady bird beetle plant^{-1}) and endosulfan 0.06 per cent (0.46 lady bird beetle plan^{-1}). However, all these insecticides were at par with each other.

Table 1. Effect of different insecticides on the population of lady bird beetle (mean of three replications).

Treatments	**Lady bird beetle population plant^{-1}**				
	1 day before treatment	**Days after treatment**			
		1	**3**	**7**	**14**
Spinosad 0.005 pe rcent	1.6 (1.37)	1.33 (1.35)	1.46 (1.17)	2.46 (1.72)	3.06 (1.88)
Indoxacarb 0.01 per cent	1.33 (1.35)	0.46 (0.97)	0.46 (1.10)	1.93 (1.56)	2.20 (1.64)
Imidacloprid 0.004 per cent	1.60 (1.45)	0.40 (0.94)	0.66 (1.08)	1.26 (1.33)	1.80 (1.51)
Cypermethrin 0.01 per cent	1.53 (1.42)	0.33 (0.90)	0.60 (1.01)	1.00 (1.22)	1.33 (1.35)
Profenofos 0.08 per cent	1.46 (1.40)	0.40 (0.94)	0.46 (1.10)	1.86 (1.54)	2.40 (1.69)
Endosulfan 0.06 per cent	1.20 (1.30)	0.46 (0.98)	0.86 (1.16)	1.86 (1.53)	2.66 (1.77)
Untreated control	1.53 (1.42)	1.33 (1.35)	1.53 (1.42)	2.60 (1.76)	3.20 (1.92)
S. E. ±	0.05	0.08	0.08	0.07	0.09
C. D. at 5%	NS	0.23	0.23	0.22	0.26
C. V. (%)	6.76	12.41	11.72	8.37	9.00

Figures in parentheses are square root transformed values, N. S. = Non significant

At 3 days after treatment all the insecticides were found to be toxic to reduce the population of lady bird beetle significantly over untreated control. The significantly lowest population of lady bird beetle to the extent of 0.60 per cent was recorded by cypermethrin 0.01 per cent. However, it was at par with all the insecticides.

At 7 and 14 days after treatment the plots treated with cypermethrin 0.01 per cent recorded significantly lowest population of lady bird beetles (1.00 and 1.33 plant^{-1}) over untreated control and rest of the insecticides except imidacloprid 0.004 per cent (1.26 and 1.80 lady bird beetles plant^{-1}).

Many workers reported spinosad as safer insecticide to lady bird beetle (Shinde, 2004; Prabhudesai, 2005; Shinde *et al*. 2007b and Mane, 2007). However, Rathod and Bapodra (2002) and Mane (2007) reported cypermethrin 0.04 per cent and 60 g a.i. per hectare as toxic to coccinellid predators in cotton and okra, respectively.

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Correlation and Path Analysis Studies in Pigeonpea (*Cajanus cajan* (L.) Millsp.)

For improvement of yield, the selection for other contributing traits is essential, since yield is a result of these traits. The association not only between the yield and its components but also the interrelationship between these components plays an important role. The direct and indirect effects of such characters on yield therefore, be considered while selecting the plant ideotype for better productivity. Path coefficient analysis is a useful tool in this regards, which provides better index for selection by separating correlation coefficient of yield and it's components into direct and indirect effects.

Forty genotypes of pigeonpea (*Cajanus cajan* (L.) Millsp.) from different geographic origins and showing phenotypic variability for agronomic and yield characters were collected from Principal Scientist, Pulses Improvement Project, Badnapur and were planted in a randomized block design with three replications

at the Botany Section farm, College of Agriculture, Pune - 5 (Maharashtra), during *kharif* 2006. Each genotype was represented by a single row of 4.0 m. length in each replication with a spacing of 60 cm. between rows and 20 cm. within rows. Observations were recorded on five randomly selected plants of each genotype in each replication for days to 50 per cent flowering, days to maturity, plant height at harvest, plant spread at harvest, number of primary branches plant^{-1}, number of secondary branches plant^{-1}, number of pods plant^{-1}, pod length , number of seeds pod^{-1}, 100 seed weight, protein content (%) and grain yield plant^{-1}. Correlation coefficients were calculated according to Singh and Chaudhary (1977), while path coefficients were obtained by following method given by Dewey and Lu (1959).

The genotypic correlation coefficients between yield and its attributes in all possible comparisons presented in Table 1, revealed highly significant positive relationship of seed yield with number of pods per plant (0.813), number of secondary branches per plant (0.385) and plant spread (0.325). Similar trend was also reported by earlier workers, Joshi (1973), Singh and Malhotra (1973) and Gupta *et al*. (1975).

The attribute days to 50 per cent flowering showed significantly positive correlation with 100 seed weight. Days to maturity showed significantly negative association with seed yield (-0.316), while it was significantly and positively correlated with number of primary branches. Similar results were reported by Salunke *et al*. (1995). Number of primary branches plant^{-1} showed positive significant association with number of secondary branches plant^{-1} (0.968), number of pods plant^{-1} (0.374), which was highest among the characters studied. Number of secondary branches showed significantly positive correlation with number of pods plant^{-1} (0.365) but negative correlation with pod length (-0.414). It revealed highly significant positive relationship of seed yield

Table 1. Genotyupic correlations for 12 characters in 40 genotypes of pigeonpea.

Sr. No.	Days to 50% flowering (No)	Days to maturity (No)	Plant height (cm)	Plant spread (cm)	Primary branches plant^{-1}	Secondary branches plant^{-1}	Pods plant^{-1}	Pod length (cm)	Seeds pod^{-1}	100 seed weight (g)	Protein content (%)	Seed yield plant^{-1} (g)
	1	2	3	4	5	6	7	8	9	10	11	12
1		0.0686	0.2664	0.1627	-0.1080	-0.1737	0.0389	-0.0920	-0.1183	0.3586*	-0.0664	0.0324
2			0.1284	-0.1009	0.3571*	0.2757	-0.0299	-0.3418*	0.2113	-0.3195*	-0.1483	-0.3160*
3				0.4280**	0.2482	0.1655	0.5541**	-0.1275	0.1276	0.0423	-0.0383	0.2143
4					0.1682	0.1073	0.2689	-0.3868*	-0.3014	0.2519*	-0.1081	0.3250*
5						0.9686**	0.3749*	-0.3012	0.1292	-0.3074	0.1401	0.2522
6							0.3651*	-0.4148**	0.1092	-0.1486	0.0339	0.3850*
7								-0.1580	-0.2294	0.0141	-0.0225	0.813**
8									0.5124**	0.2116	0.1671	0.0197
9										-0.4696**	-0.1553	-0.0632
10											0.0080	0.2843
11												0.2196

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

with number of pods plant^{-1}. Similar results were reported by Deshmukh *et al*. (2000). This situation could be exploited to select the genotypes having more number of secondary branches and plant spread. Both these character were significantly associated with seed yield plant^{-1}. Number of pods plant^{-1} had significantly positive association with seed yield (0.813) and plant height (0.554). Pod length showed significantly positive correlation with number seeds pod^{-1} (0.512). However, number of seeds pod^{-1} had significantly negative association with 100 seed weight (-0.469). Protein content showed positive association with seed yield (0.220).

The trait number of pods plant^{-1}, which had highest positive correlation with seed yield, also had highest direct effect on it. It was also observed that number of pods plant^{-1}, number of seeds pod^{-1}, 100 seed weight and plant spread were the major yield contributing characters. This was in conformity with the results obtained by Salunke *et al*. (1995) and Aher *et al*. (1997). The secondary branches plant^{-1}, plant spread, days to 50 per cent flowering, number of seeds pod^{-1} and 100 seed weight showed positive and direct effects. The attributes *viz*., days to 50 per cent flowering, 100 seed weight and protein content showed almost equal values of their direct effect and correlation coefficient with yield, it explains true relationship and direct selection for these traits will be effective.

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A Comperative Study of Men and Women in Farm Activities in Dharwad District of Karnataka

Women play a significant role in farming and farm management activities of a large number of farms where they are engaged in farming operations solely or in tandem with males (Badiger, 1999). Women habitually participate in a wide range of agricultural operation like manuring, land preparation, sowing of seed, weeding, transplanting, applying fertilizers, harvesting, threshing, storage of food grains cattle care, etc. (Das, 2000). Therefore, the survival of a farm depends mainly on the contribution made by farm women (Ingle *et al.* 1990). A major share of increased activity in the field of agriculture is contributed by women folk. In this context the present study throws light on the various activities of farm women and men. Hence the main objective of the study is to know the extent of participation of men and women in agricultural operations.

Dharwad district of Karnataka state was selected for the study since it has one of the highest rural female population. Two taluks of Dharwad district *viz*., Navalgund irrigated and Kundagol dry were selected from the five taluks. The village having highest and lowest women literay percentage were selected. The two villages, Navalli and Ballur from Navalgund and Hirebudhihal and Vithalpur from Kundagol were selected during the year 2000 to 2003.

The total sample size for the study was 480 respondents comprising of 240 farm women and 240 farm men drawn from 240 families 68 from each village and fifteen families from each respondent category, namely agricultural labourers (landless), small farmers (holding less than five acres), medium farmers (holdings greater than five acres but less than 10 acres) and large farmers (holdings more than 10 acres) and from each selected family the woman and man interviewed was a person very much involved in farm and home affairs of the family.

Irrespective of the type of village, generally men appeared to dominate the activities of ploughing, fertilizer application, sowing, marketing and watch and ward. The proportion of men performing ploughing and fertilizer application was 58 and 61 per cent respectively. In the case of sowing the men's participation was 48 per cent; for marketing 52 per cent and for watch and ward it was 63 per cent. Women dominated the activities of weeding, fertilizer application, threshing and storage of grains. The proportion of participation in the case of women for the operation of weeding was 68 per cent; for fertilizer application 56 per cent; for threshing it was 46 per cent while for storage it was 65 per cent. Women abstained themselves from any involvement in ploughing, watch and ward, and limited independent participation in threshing and marketing. Complementarily men had the least involvement in the activities where women dominated.

Men dominated in the activities where physical powers was needed and where dealings with other men, and night time activity. While women dominated in activities which were sedentary, repetitive and monotonous.

Categorywise, irrespective of the gender and the education statuses of the village the proportion of activities done by the farm men or women decreased with the increase in the

holding size, indicating more involvement of hired labourers in larger holdings.

Irrespective of the village, men dominated in assistance of the activities of harvesting, marketing, threshing, weeding and irrigation. The proportion of men assisting farm activities was 49 per cent in the case of harvesting, 38 per cent in the case of marketing, 50 per cent in the case of threshing, 41 per cent in the case of weeding and 21 per cent in the case of irrigation. Women generally dominated the assistance in the operations of sowing, harvesting, marketing, storage and irrigation. In the case of sowing, the proportion of women assistance was 66 per cent, for harvesting it was 69 per cent, for marketing it was 49 per cent, for storage it was 30 per cent and for irrigation it was 15 per cent.

As in the case of actual doing, category wise, the extent of men and women assistance in various operations was inversely related to the holding size in all villages indicating that, hired labour was inducted in increasing proportions for assistance in larger holdings.

The proportion of male supervision in harvesting was 51 per cent, for threshing it was 28 per cent and watch and ward 15 per cent. In case of women proportion of supervision in watch and ward was 1 per cent, 24 per cent, harvesting 31 per cent and for marketing it was 21 per cent. Sowing and harvesting were two critical operations which had to be conducted properly, and in time failing which the farm family would have to face dire consequences and as such the supervision in these activities was high either by the farm men or women. Supervision of watch and ward was undertaken by women especially in daytime. They also kept track of the produce harvested, lent and disposed through sale especially in large holdings.

In the case of larger holdings increased hired manpower led to increased supervision operations by the farm family. The activity of water management i.e. irrigation was found to be participated more by women (7 %) than by men (3 %).

It was observed that large farm owning women do not physically work on the land. They engaged agricultural workers in their fields. Some felt below to their dignity to work in the fields. However, their participation was high in supervising and assisting of labourers in various farm activities. It was found that majority of farm women were participating in storage of grains. The reason might be that the operation does not involve much of the hard work and time and which could be done within the house itself.

Small and medium farm women participated to a greater extent in operations like weeding, threshing, harvesting and storage. Small farm women belonged to low income group were not in a position to engage more number of hired labourers to work in their fields. They supplemented their incomes by sporadically working in the field of other farmers. The participation of landless agricultural labourers was high in weeding, sowing, fertilizer application, threshing and watch and ward in case of both men and women of all the villages. It was observed that the physical participation of large farm women in agricultural operations was very less compared to small and medium farm women. Similar results were also reported by Seema Rani *et al.* (2000).

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