Volume 34 Number 2 May, 2009 ISSN 0378-2395

Journal of Maharashtra Agricultural Universities

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PUBLICATION OF THE
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PHYSICAL SCIENCE

ANIMAL SCIENCE

RESEARCH NOTES

J. Maharashtra agric. Univ., 34 (2) : 125-127 (2009)

Response of Chickpea to Conjoint Application of Inorganic Fertilizers Based on STCR Approach and Vermicompost on Inceptisol

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(Received : 25-05-2008)

ABSTRACT

The fertilizer required for 25 q ha^{-1} yield target along with 5 t ha^{-1} vermicompost recorded significantly higher grain (23.44 q ha^{-1}) and straw (25.18 q ha^{-1}) yield of chickpea. The higher nitrogen (106.71 kg ha^{-1}), phosphorus (15.46 kg ha^{-1}) and potassium (60.38 kg ha^{-1}) uptake by chickpea was obtained in fertilizer application for 25 q ha^{-1} yield target combined with 5 t ha^{-1} vermicompost followed by the conjoint application of vermicompost @ 5 t ha^{-1} with fertilizer required for 20 q ha^{-1} yield target. Significantly higher uptake of iron (1703 g ha^{-1}) by chickpea was noticed with only vermicompost application @ 5 t ha^{-1}. whereas, conjoint application of vermicompost @ 5 t ha^{-1} along with fertilizer nutrient required for 20 q ha^{-1} yield target significantly recorded higher iron (1549 g ha^{-1}), manganese (440 g ha^{-1}) and zinc (101 g ha^{-1}).

Key words : Chickpea, STCR, vermicompost, micronutrient uptake

Balanced fertilization would essentially mean rational use of fertilizers and organic manures for supply of plant nutrients for agricultural production in such a manner that would ensure efficiency of fertilization, harnessing of best possible positive and synergistic interactions among the various other factors of production, least adverse effects on environment, minimum nutrient losses and maintaining high yields commensurate with the biological potential of all the crop varieties under the unique soil-climate-agro-ecological set up (Goswami, 2006).

In view of this the experiment was conducted to study the response of chickpea to fertilizer application based on STCR approach alongwith vermicompost on Inceptisol.

MATERIALS AND METHODS

The field experiment was carried out at Soil Test Crop Response Correlation Project Farm, Mahatma Phule Krushi Vidyapeeth, Rahuri, Dist Ahmednagar in order to study the response of chickpea (cv.Vijay) to inorganic fertilizer application based on STCR approach alongwith vermicompost on Inceptisol during *rabi*- 2006. The soil of the experimental plot was Vertic Haplustepts with pH 8.1, EC 0.55 dSm^{-1}, and organic carbon 5.5 g kg^{-1}. The $KMnO_4$-N, Olsen-P and NH_4OAc-K were 194, 13 and 258 kg ha^{-1} respectively. Analysis of soil was carried out by using standard methods as described by Jackson (1973). The total nitrogen content in vermicompost was determined in H_2SO_4 digestion mixture using micro-Kjeldhal method (A.O.A.C. 1970). Phosphorus and potassium were estimated by digesting 1 g dry vermicompost sample with 10 mL tri-acid mixture (9:3:1 HNO_3:$HClO_4$:H_2SO_4) at 180-200°C and digested materials used for estimation of phosphorus as given by Jackson (1973). The metallic micronutrients were analysed on atomic absorption spectrophotometer using the standard method as described by Lindsay and Norvell (1978). The vermicompost contains total N 1.70 per cent, phosphorus 0.78 per cent, potassium 1.0 per cent, C: N ratio 23.52 and C:P ratio 51.28.

There were nine treatments replicated thrice with randomized block design. The treatments included, Absolute control, STCR target 20q ha^{-1} (13:41:15 kg ha^{-1} N, P_2O_5 and K_2O), STCR target 25q ha^{-1} (39:61:22 kg ha^{-1} N, P_2O_5 and K_2O), STCR target 20q ha^{-1} (13:41:15 kg ha^{-1} N, P_2O_5 and K_2O) + 2.5 t ha^{-1} vermicompost, STCR target 20q ha^{-1} (39:61:22 kg ha-1 N, P_2O_5 and K_2O)+ 5 t ha^{-1} vermicompost, STCR target 25q ha^{-1} (39:61:22 kg ha^{-1} N, P_2O_5 and K_2O) + 2.5 t ha^{-1} vermicompost, STCR target 25q ha^{-1} (39:61:22 kg ha^{-1} N, P_2O_5 and K_2O) + 5 t ha^{-1} vermicompost, Only vermicompost 2.5 t ha^{-1} and only vermicompost 5 t ha^{-1}.

The yield targeting equation developed by All India Coordinated Research Project on Soil Test Crop Response Correlation, centre, MPKV., Rahuri was used for inorganic fertilizer application.

STCR equation :

FN = 5.25 X T - 0.46 X 0.46 SN
FP_2O_5 = 3.87 X T - 2.78 X 0.46 SP
FK_2O = 1.29 X T - 0.04 X 0.46 SK

Where FN, FP_2O_5 and K_2O kg ha^{-1} respectively, T is yield target (q

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Table 1. Yield and nutrient uptake of chickpea as influenced by conjoint application of fertilizer and vermicompost on Inceptisol .

Treatment	Yield (q ha^{-1})		Nutrient uptake (q ha^{-1})		
	Grain	Straw	N	P	K
Absolute control	17.03	18.20	63.40	13.73	42.65
STCR target 20q ha^{-1} (13:41:15 kg ha^{-1} N, P_2O_5 and K_2O)	19.44	20.82	88.33	14.50	51.83
STCR target 25q ha^{-1} (39:61:22 kg ha^{-1} N, P_2O_5 and K_2O)	21.33	22.33	90.99	15.10	60.13
STCR target 20q ha^{-1} (13:41:15 kg ha^{-1} N, P_2O_5 and K_2O) + 2.5 t ha^{-1} VC	20.77	22.27	83.19	14.89	60.23
STCR target 20q ha^{-1} (39:61:22 kg ha^{-1} N, P_2O_5 and K_2O) + 5 t ha^{-1} VC	22.44	24.09	106.11	15.36	58.86
STCR target 25q ha^{-1} (39:61:22 kg ha^{-1} N, P_2O_5 and K_2O) + 2.5 t ha^{-1} VC	20.22	21.68	87.74	15.28	59.40
STCR target 25q ha^{-1} (39:61:22 kg ha^{-1} N, P_2O_5 and K_2O) + 5 t ha^{-1} VC	23.44	25.18	106.71	15.46	60.38
Only vermicompost 2.5 t ha^{-1}	16.99	18.34	78.05	13.75	39.69
Only vermicompost 5 t ha^{-1}	18.74	20.50	93.48	14.35	56.95
SE±	0.422	0.34	1.388	1.118	0.52
CD at 5%	1.153	1.019	4.159	1.354	1.557

ha^{-1}), and SN, SP and SK are soil available N, P and K kg ha^{-1} respectively.

RESULTS AND DISCUSSION

Yield : The results indicated that the grain and straw yield was significantly influenced by all the integrated nutrient application treatments except absolute control. (Table 1). Application of inorganic fertilizers for 25 q ha^{-1} yield target along with vermicompost @ 5 t ha^{-1} recorded higher grain (23.44 q ha^{-1}) and straw (25.18 q ha^{-1}) yield of chickpea followed by the fertilizer application for 20 q ha^{-1} yield target (22.44 and 24.09 q ha^{-1}) along with vermicompost 5 t ha^{-1} which was at par with the fertilizers for 25 q ha^{-1} yield target without vermicompost.

The fertilizer application for 20 q ha^{-1} yield target along with vermicompost @ 2.5 t ha^{-1} (20.77 and 22.27 ha^{-1}) and conjoint application of inorganic fertilizers to achieve 25 q ha^{-1} yield target along with vermicompost @ 2.5 t ha^{-1} (20.22 and 21.68 ha^{-1}) recorded statistically at par results for grain and straw yield of chickpea. The application of only vermicompost @ 5 t ha^{-1} recorded significantly higher grain and straw yield of chickpea (18.74 and 20.52 q ha^{-1}) than the 2.5 t ha^{-1} vermicompost application (16.99 and 18.34 q ha^{-1}). It could be concluded that the yield target equation based on soil test and crop response was found to be valid for achieving targeted yields of chickpea either along with vermicompost or alone. Application of inorganic fertilizers based on targeted yield equation along with vermicompost reported higher grain and straw yield of chickpea which might be due to supplementary nutrient addition through vermicompost and enhanced nutrient availability with balanced fertilization.

The vermicompost application @ 5 t ha^{-1}, fertilizer required for 20 q ha^{-1} yield target and only 2.5 t ha^{-1} vermicompost reported 18.74 and 20.52 q ha^{-1}, 19.44 and 20.82 q ha^{-1} and 18.99 and 20.34 q ha^{-1}

Table 2. Micronutrient uptake of chickpea as influenced by conjoint application of fertilizer and vermicompost on Inceptisol.

Treatment	Micronutrient uptake (g ha^{-1})			
	Fe	Mn	Zn	Cu
Absolute control	873	226	67	19
STCR target 20q ha^{-1} (13:41:15 kg ha^{-1} N, P_2O_5 and K_2O)	987	323	82	22
STCR target 25q ha^{-1} (39:61:22 kg ha^{-1} N, P_2O_5 and K_2O)	1350	363	88	22
STCR target 20q ha^{-1} (13:41:15 kg ha^{-1} N, P_2O_5 and K_2O) + 2.5 t ha^{-1} VC	1295	358	91	28
STCR target 20q ha^{-1} (39:61:22 kg ha^{-1} N, P_2O_5 and K_2O) + 5 t ha^{-1} VC	1549	440	103	26
STCR target 25q ha^{-1} (39:61:22 kg ha^{-1} N, P_2O_5 and K_2O) + 2.5 t ha^{-1} VC	895	278	79	25
STCR target 25q ha^{-1} (39:61:22 kg ha^{-1} N, P_2O_5 and K_2O) + 5 t ha^{-1} VC	1569	386	100	27
Only vermicompost 2.5 t ha^{-1}	1272	300	74	24
Only vermicompost 5 t ha^{-1}	1703	289	84	29
SE±	10.2	4.7	0.8	0.7
CD at 5%	30.6	14.2	2.4	2.0

statistically recorded at par results for grain and straw yield of chickpea respectively. In general yield target equation based on soil test crop response was found to be valid for achieving targeted yields of chickpea either along with vermicompost or alone. Application of inorganic fertilizers along with vermicompost reported higher grain and straw yield which might be due to the balanced fertilization. As the vermicompost is the decomposed material containing 1.70 per cent N 0.78 per cent P and 1.0 per cent K which has the added advantage to the soil. The application of vermicompost might had the beneficial effects on soil microbial population and mycorrhiza leads to the solubalization of nutrients. The C:N ratio of vermicompost had the favourable effects on the process of mineralization of nutrients in soil. Similar results were also reported by Tolanur and Badanur (2003) and Shrivas *et al*. (2007).

Nutrient uptake : The fertilizer application for the yield target of 25 q ha^{-1} combined with 5 t ha^{-1} vermicompost recorded maximum uptake of nitrogen (106.71 kg ha^{-1}), phosphorus (15.46 kg ha^{-1}) and potassium (60.38 kg ha^{-1}) followed by the conjoint application of vermicompost @ 2.5 t ha^{-1} with fertilizer required for 20 q ha^{-1} yield target (106.11, 15.36 and 58.86 kg ha^{-1} N, P and K) respectively (Table 1).

The vermicompost application @ 5 t ha^{-1} and fertilizer application for achieving 25 q ha^{-1} yield target recorded statistically at par results for nitrogen (93.48 and 90.99 kg ha^{-1}), phosphorus (14.35 and 15.10 kg ha^{-1}) and potassium (56.95 and 60.13 kg ha^{-1}) uptake of chickpea. Further, the phosphorus uptake by chickpea was statistically at par in the combine application of vermicompost either 5 t ha^{-1} (15.46 kg ha^{-1}) or 2.5 t ha^{-1} (15.28 kg ha^{-1}) alongwith fertilizer required for yield target of 20 and 25 q ha^{-1}.

The higher uptake of phosphorus by chickpea in vermicompost applied treatment may be attributed to higher total P content (0.78%) and narrow C: P ratio (51.28) of vermicompost that may enhances the net mineralization of orthophosphate. The vermicompost also plays an important role in solubalization of clay occluded or Ca fixed phosphorus. Similar results were also reported by Wandile *et al*., (2005).

Application of only vermicompost @ 5 t ha^{-1} recorded significantly higher iron (1703 g ha^{-1}), manganese (289 g ha^{-1}) and copper (29 g ha^{-1}) uptake whereas conjoint application of fertilizer for 20 q ha^{-1} yield target alongwith 5 t ha^{-1} vermicompost reported higher zinc (103 g ha^{-1}) uptake of chickpea. Significantly higher uptake of iron (1569 g ha^{-1}) was reported with the application of fertilizer to achieve 25 q ha^{-1} yield target alongwith vermicompost @ 5 t ha^{-1} which was at par with inorganic fertilizer application to attain 20 q ha^{-1} yield target alongwith vermicompost @ 5 t ha^{-1} (1549 g ha^{-1}). The vermicompost application either @ 2.5 t ha^{-1} or 5 t ha^{-1} with inorganic fertilizer required for 20 and 25 q ha^{-1} yield targets recorded higher uptake of all the micronutrients than only inorganic fertilizer application for same yield targets. The higher uptake of micronutrients by chickpea in vermicompost applied treatment might be attributed to release of organic acids and humus which act as chelating agents which prevents from precipitation, fixation, leaching and oxidation and the addition of micronutrients directly to the available pool through vermicompost. Similar results were also reported in various crops by Suresh and Prabha (2005) and Malewar (2005).

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J. Maharashtra agric. Univ., 34 (2) : 128-130 (2009)

Sustainability of Rice-Wheat Cropping System Through Integrated Nutrient Supply in Sub-Montane Zone of Maharashtra

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(Received : 02-07-2006)

ABSTRACT

Application of 50 per cent recommended dose of fertilizers and 50 per cent N through green manure to *kharif* rice with 100 per cent recommended dose of fertilizers to *rabi* wheat crop resulted in significantly higher system productivity and benefit soil fertility improvement than that of all those treatments, in which green manure was not used. The application of 50 per cent recommended dose of fertilizers and 50 per cent N through green manure to *kharif* rice gave significantly higher net returns and benefit cost ratio, irrespective of fertilizers level applied to *rabi* wheat which saved 50 per cent NPK dose to *kharif* rice and *rabi* wheat crop without sacrifice in yield and with maximum net returns and benefit cost ratio.

Key words : Basmati rice, wheat, cropping system, net returns.

Basmati rice is one of the important cash crops of the sub-montane zone of western Maharashtra. The crop is mostly grown under irrigated conditions, in the belt of Krishna and Koyna rivers. The existing, system of fertilizer application is based on nutrient requirement of individual crop ignoring the carry-over effect of the manure or fertilizer to preceding crop, Organic sources of nutrient applied to the preceding crop benefit the succeeding crop to a great extent (Singh *et al*. 1996; Hegde, 1998) and the system productivity becomes sustainable through integrated use of organic and inorganic sources of nutrient (Nambiar *et al*. 1992). Hence study was conducted to find out the optimum combination of organic and inorganic sources of nutrients for Basmati rice-wheat system in western Maharashtra region.

MATERIALS AND METHODS

The field experiment was conducted at Agricultural Research Station, Karad from 2000 to 2003. The soil was heavy black with pH 8.4, organic carbon 0.95 per cent, available N-170 kg ha^{-1}, P-14.30 kg ha^{-1}, and K-449 kg ha^{-1}. The experiment was laid out in a randomized block design with 14 treatments replicated thrice *viz*. i) 100% RDF to both rice and wheat. ii) 50% RDF + 50% N through FYM to rice and 100% RDF to wheat. iii) 50% RDF + 50% N through FYM to rice and 75% RDF to wheat. iv) 50% RDF + 50% N through FYM to rice and 50% RDF to wheat. v) 50% RDF + 50% N through green manure to rice and 100% RDF to wheat vi) 50% RDF + 50% N through green manure to rice and 75% RDF to wheat. vii) 50% RDF + 50% N through green manure to rice and 50% RDF to wheat viii) 75% RDF + 25% N through FYM to rice and 100% RDF to wheat. ix) 75% RDF + 25% N through FYM to rice and 75% RDF to wheat. x) 75% RDF + 25% N through FYM to rice and 50% RDF to wheat. xi) 75% RDF + 25% N through green manure to rice and 100% RDF to wheat. xii) 75% RDF + 25% N through green manure to rice and 75% RDF to wheat. xiii) 75% RDF + 25% N through green manure to rice and 50% RDF to wheat, xiv) 100% RDF + 50% N through FYM to rice and 100% RDF to wheat, The seeds of rice variety Basmati 370 were dibbled at spacing of 30 x 10 cm in the flat bed of six lines. The FYM was applied at the time of land preparation on the basis of N content (0.5%) in treatments No. 2, 3, 4, 8, 9, 10 and 14. In the treatment No. 5, 6, 7, 11, 12 and 13 the one line of sunhemp was sown along with rice on the bunds of flat beds of rice after every sixth line of rice. The sunhemp was cut at 45 days after sowing, put in between rows of rice and trampled by human feet to incorporate in soil as a green manure. The quantity of sunhemp green manure was used as per its N content (0.75% N on fresh weight bassis). *Rabi* wheat veriety HD-2189 was grown after harvent of rice with 100, 75 and 50 per cent recommended dose of fertilizers (120:60:40 NPK kg ha^{-1}) without green manure or FYM. The yield data of wheat was recorded and converted into rice grain equivalent.

RESULTS AND DISCUSSION

Yield and yield components : Yield components of rice were influenced significantly with the system of manuring to rice, but

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remained unaffected with levels of fertilizers applied to succeeding wheat crop (Table 2). Treatment No. 5 recorded maximum plant height, panicle length, number of panicles per meter row length, number of grains per panicle and thousand grain weight of rice. The same treatment recorded significantly more number of grains per panicle than all those treatments in which green manure was not used as substitution.

In wheat, the plant height, number of panicles per meter length, number of grains per panicle and thousand grain weight was influenced significantly due to system of manuring. Treatment No. 14 recorded maximum and significantly more number of panicles per meter length number of grains per panicle and thousand grain weight than that of treatment No. 10. Substitution of N through green manure to rice along with fertilizer also recorded identical yield components.

System productivity : System of manuring to the rice but not the level of fertilizer to wheat significantly influenced the grain yield of rice (Table 3). Application of 50 per cent RDF to rice with 50 per cent N through green manure recorded maximum grain yield of rice irrespective of levels of fertilizer to wheat, followed by 75 per cent RDF and 25 per cent N through green manure. The treatment with 100 per cent RDF and 50 per cent N through FYM was equally good. All other manurial treatments reduced rice yield significantly.

Both the levels of fertilizer to wheat and system of manuring to preceding rice crop significantly influenced yield of the wheat. Application of 75 per cent RDF and 25 per cent N through green manure to rice and 100 per cent RDF to wheat recorded maximum grain yield of wheat. Irrespective of system of manuring to rice, 100 per cent RDF to wheat reorded

Table 1. Change in nutrient status and nutrients uptake of soil under rice-wheat cropping system over 3 years.

Treat-ments	Change in nutrient status and nutrients uptake of soil kg ha^{-1}									
	Orga-nic C (%)	Available nutrient (kg ha^{-1})			Total N uptake		Total P uptake		Total K uptake	
		N	P	K	Rice	Wheat	Rice	Wheat	Rice	Wheat
T_1	0.93	169.0	14.14	435.0	73.0	124.3	49.3	17.3	97.7	125.0
T_2	0.95	175.0	14.53	446.7	82.0	134.3	55.3	21.0	110.0	154.3
T_3	0.94	172.7	14.72	445.7	74.0	125.3	53.0	22.0	123.3	146.3
T_4	0.94	172.7	14.29	438.0	73.3	105.0	54.3	22.0	96.7	136.7
T_5	0.99	178.0	15.22	468.3	93.7	127.0	73.3	25.3	136.7	136.7
T_6	0.98	175.7	14.97	453.7	88.0	105.7	68.3	24.3	109.3	136.0
T_7	0.96	176.0	14.72	449.0	83.3	110.3	71.3	20.0	117.3	128.0
T_8	0.95	174.0	14.55	446.0	77.7	124.0	54.0	22.0	80.3	146.3
T_9	0.93	168.3	13.97	432.7	70.7	111.3	51.0	22.3	101.3	134.3
T_{10}	0.92	165.0	13.69	430.3	69.7	101.3	50.0	20.7	89.7	130.3
T_{11}	0.96	177.7	15.02	455.0	93.0	117.3	65.7	21.3	110.0	147.7
T_{12}	0.96	176.3	14.85	449.3	85.7	112.0	63.7	21.0	94.7	153.7
T_{13}	0.96	175.7	14.58	447.7	81.3	104.0	63.7	22.3	99.3	126.0
T_{14}	0.98	176.3	14.95	453.0	87.0	120.3	61.3	23.3	104.0	151.0
Initial	0.63	181.7	21.05	537.6	-	-	-	-	-	-
SE ±	-	-	-	-	3.9	2.2	2.9	0.4	5.5	4.6
CD 5%	-	-	-	-	11.8	6.5	8.9	1.3	16.7	13.9

Table 2. Yield component of rice and wheat as influenced by different treatments (Average of 3 year).

Treat-ments	Rice				Wheat			
	Plant height (cm)	Length of panicle (cm)	Grains per panicle	Test weight of grain (g)	Plant height (cm)	Panicles per mt. row	Grains per panicle	Test weight of grain (g)
T_1	85.9	19.8	72	20.67	99.9	95	51	33.17
T_2	91.3	20.5	80	22.00	102.7	103	53	33.70
T_3	90.9	20.9	78	21.30	99.6	95	50	33.60
T_4	91.1	20.5	79	21.07	96.5	84	49	33.60
T_5	93.5	22.2	94	23.00	102.4	102	52	34.77
T_6	93.4	21.5	84	22.60	98.9	94	50	34.43
T_7	93.2	21.3	86	22.73	95.8	76	49	34.03
T_8	87.5	20.1	77	22.70	100.0	96	51	33.77
T_9	86.9	20.1	73	20.73	98.3	90	50	33.40
T_{10}	87.3	20.1	76	19.73	88.7	76	46	33.07
T_{11}	92.7	21.2	82	22.73	100.7	97	51	34.27
T_{12}	91.5	21.1	81	22.67	101.3	99	52	34.40
T_{13}	92.3	21.1	82	22.57	96.0	82	49	33.73
T_{14}	91.5	20.9	80	22.93	102.9	107	53	34.43
SE ±	2.36	0.6	4.3	0.14	3.55	8.03	2	0.09
CD at 5%	7.1	1.8	13	0.41	10.7	24	6	0.29

Table 3. Effect of integrated nutrient management on yield and economics of rice-wheat cropping system (Average of 3 years).

Treatments	Grain (kg ha^{-1})			Straw (kg ha^{-1})			Net returns (Rs. ha^{-1})	Benefit cost ratio
	Rice	Wheat	Total*	Rice	Wheat	Total		
T_1	2700	4766	5819	7119	4752	11871	38368	1.98
T_2	2936	4902	6141	7510	4958	12468	40675	1.99
T_3	2901	4679	5960	7860	4630	12490	38971	1.96
T_4	2919	4458	5834	7325	4485	11810	37755	1.94
T_5	3639	4855	6813	8992	4938	13930	52212	2.36
T_6	3624	4683	6685	8786	4588	13374	51062	2.34
T_7	3578	4429	6474	8766	4177	12943	48868	2.30
T_8	2845	4867	6027	7078	4773	11851	40093	2.00
T_9	2821	4593	5824	7366	4403	11769	38088	1.96
T_{10}	2844	4369	5700	6893	4115	11008	36920	1.95
T_{11}	3510	4891	6708	8107	4835	12942	50912	2.33
T_{12}	3461	4702	6536	7963	4917	12880	49191	2.30
T_{13}	3475	4449	6385	8128	4279	12407	47828	2.29
T_{14}	3325	5010	6601	6842	4979	13621	45957	2.10
SE±	172	86	148	417	138	-	2474	0.06
CD at 5%	510	259	551	1243	546	-	7374	0.19

* Rice equivalent.

significantly higher grain yield of wheat.

The total productivity of system was maximum with application of 50 per cent RDF and 50 per cent N through green manure, irrespective of fertilizer applied to succeeding wheat crop. The next best treatment was 100 per cent RDF + 50 per cent N through FYM to rice and 100 per cent fertilizer dose to wheat. Application of 75 per cent RDF and 25 per cent N through green manure to rice, irrespective of fertilizer levels applied to wheat also recorded identical yields. Similar type of results were reported by Grewal *et al*. (1992). It can be concluded from the data that 50 per cent NPK dose to rice and wheat can be saved, without sacrifice in yield, when one line of sunhemp is grown on bunds of flat beds, after every sixth row of rice and incorporated as green manure in between rows of rice at 45 days after sowing.

Straw production followed the same trend of grain. Maximum straw yield of the component crops and the system were recorded with incorporation of green manure in rice irrespective of fertilizers applied to both the crop. The 100 per cent RDF to rice and wheat with 50 per cent N through FYM to rice gave identical straw yield

Economics : Application of either 50 or 75 per cent N through green manure to rice, irrespective of fertilizers applied to both the crops, gave significantly more net returns and benefit:cost ratio of the system than all other manurial combinations (Table 3). The next best treatment was 100 per cent NPK to rice and wheat + 50 per cent N through FYM to rice,

Soil fertility : The treatment those included green manure showed slight improvement in nutrient status of soil (Table-1). It clearly indicates that inclusion of green manure helps in maintaining the soil fertility. Gill *et al*. 1994 also suggested that the multiple cropping system with legume offer special advantage to farmers in term of productivity and fertility.

Nutrients uptake : Application of organic material in rice-wheat system contributed to significant increase in nutrient uptake (Table-1), Higher uptake of NPK with organic material indicated that mineralized nutrient from these sources could sufficiently meet the nutritional requirement of the crops. Thus higher fertilizer dose favorably influenced the plant growth and developmental characters which ultimately resulted in higher yields.

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J. Maharashtra agric. Univ., 34 (2) : 131-134 (2009)

Genetic Variability, Correlation and Path Analysis in Finger Millet (*Eleusine coracana* Gaertn)

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ABSTRACT

Wide range of variability was present in the elite lines of Finger Millet under study. PCV and GCV were high for plant height, days to 50 per cent flowering, flag leaf blade length, inflorescence length and yield. Heritability and genetic advance was high for leaf blade length, basal tillers and plant height. There were highly significant positive association with yield and almost all the growth and yield contributing characters except flag leaf blade width and exertion. Path analysis showed that indirect effect of yield had masked the direct or indirect effect in almost all the characters except inflorescence width. The traits like yield, flag leaf blade length, flag leaf sheath length, inflorescence length, inflorescence width and 1000 grain weight be given due emphasis in selection programme of genotypes for substantial high yield improvement of finger millet.

Key words : *Eleusine coracana*, variability, correlation and path analysis.

Finger millet is self pollinated crop and possess problem for the breeders for exploiting the available genetic variability for selecting the promising genotypes. Contact crossing method and pure line selection is the main method for finger millet improvement and development of new varieties. For this a better understanding of the characters showing variability along with their genetic advance and heritability and their interactions for obtaining a high yielding genotypes is most important. Besides this, the knowledge of association of yield and yield contributing characters, directly as well as indirectly helps in achieving success in a plant breeding programme. Therefore, an experiment was conducted to determine the variability present, interrelationship among the yield traits and direct and indirect association among them through path coefficient analysis in finger millet.

MATERIALS AND METHODS

Sixty five genotypes received from ICRISAT, Hydrabad with five checks were grown in a randomized block design with three replications at All India co-ordinated Small Millets Improvement Project, Zonal Agril. Research Station, Shenda Park, Kolhapur. Each entry was grown in one meter length row with spacing of 22.5 cm between the rows and 10 cm within plants. All the recommended package of practices were followed. Five plants randomly selected from each genotype in each replication were used to record observation on days to 50 per cent flowering [FLG], plant height [PLHT] (cm), basal tillers [BT], flag leaf blade length (cm) [FLBL], flag leaf blade width (cm) [FLBW], flag leaf sheath length (cm) [FLSL], peduncle length (cm) [PEDELEN], exertion (cm) |EXER], inflorescence length (cm) [INFLL], Inflorescence width (cm) [INFLW], length of longest finger (cm) [LLF], width of longest finger (cm) [WLF], panicle branch number [PBN], 1000

Table 1. Mean, range, variance, coefficient, heritability and genetic advance for different characters in finger millet.

Characters	Mean	Range	GCV	PCV	Heritability (%)	Genetic advance	Genetic advance as percentage of mean
FLG	80.16	70-96	83.40	94.67	77.60	12.44	15.13
PLHT	80.91	91-106	45.64	52.76	90.88	23.14	28.59
BT	4.57	2-6	72.68	40.65	81.95	23.69	18.61
FLBL	33.15	15-41	75.36	20.02	76.73	30.44	31.65
FLBW	0.84	0.53-1.26	51.02	19.75	58.55	0.20	23.81
FLSL	10.95	7.0-25.33	25.44	27.32	86.69	5.34	48.79
PEDELEN	21.47	6.0-28.60	20.52	24.43	72.91	7.75	36.11
EXER	10.98	5.0-14.66	13.63	31.35	8.10	5.75	52.36
INFLL	6.50	4.53-5.33	21.59	25.93	69.30	2.43	14.37
INFLW	4.43	2.36-7.00	15.81	23.67	44.62	0.96	21.76
LLF	5.89	3.66-16.33	72.52	35.54	83.76	3.61	61.52
WLF	0.77	0.57-1.03	17.39	26.22	43.99	0.18	23.76
PBN	1.22	1.00-3.00	25.01	40.03	39.04	0.39	32.19
1000 grain weight	2.20	1.21-2.81	87.14	83.16	78.10	0.60	27.07
YIELD	190.48	26.0-542.7	88.59	89.19	98.00	97.59	94.8

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grain weight (g) and grain yield plot^{-1} , (YIELD). The mean of five plants was subjected to statistical analysis to estimate phenotypic and genotypic coefficient of variation as suggested by Burton (1952); phenotypic and genotypic co rrelation by Panse and Sukhatme (1961) and heritability by Allard (1960) along with path coefficient as suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Analysis of variance showed that genotypes differed significantly among themselves for all traits studied indicating presence of wide range of variability in the genotypes. Days to 50 per cent flowering ranged from 70 to 96 days, plant height ranged from 61 to 106 cm, basal tillers ranged form 2-6. There was also wide range in yield and yield contributing characters. Phenotypic and genotypic coefficient of variation indicated that, there were no much differences among themselves indicating little effect of environment on their expression. GCV and PCV were high for 1000 grain weight and yield. Heritability was also very high for yield (98%). plant height (91%), flag leaf sheath length (87%), longest finger (84%), basal tiller (82%) and exertion (80%). There was fairly high heritability for other traits which ranged between 69 to 77 per cent except exertion and panicle branch number (Table 1). These results are in conformity with the studies of Chaudhari and Acharya (1969) and Dhagat *et al.* (1972). High heritability was associated with high genetic gain in characters like plant height. flag leaf sheath length and yield indicating that additive effects were important in determining these characters. These results are in agreement with studies of Kempana and Thirumalchar (1968). Genetic advance was high in longest finger, days to 50 per cent flowering, exertion, inflorescence width, length of longest finger, width of longest finger, panicle number and 1000 grain weight, were quite less though high amount of heritability was present which attributed to lesser amount of variation also reflected by PCV and GCV for these characters. Characters having high GCV also had high genetic advance. Genetic advance was highest in case of yield, plant height, flag leaf blade length, flag leaf sheath length and days to 50 per cent flowering. Thus, selection for such characters will be useful for vartetal improvement in finger millet. These results are in conformity with Goud and Laxmi (1977). A wide range of variability for all the characters associated with yield and high heritabilrty which is predominantly due to additive genes reported in the studies made so far suggests greater scope for developing varieties superior to presently studied genotypes through hybridization followed by selection. Selection for 1000 grain weight will be more efficient as it is based on

Table 2. Phenotypic (above diagonal) and genotypic (below diagonal) correlation coefficient for different pair of characteristics in finger millet.

Chara-cter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
FLG		0.230**	0.051**	0.251**	-0.012	0.063**	0.0250**	0.042**	0.231**	0.358**	0.308**	0.077**	0.092**	0.116**	0.454**
PLHT	0.221		0.039	0.274**	0.122*	0.147**	0.056	-0.012	0.111*	0.098**	0.218**	0.166**	-0.230**	0.083*	0.418**
Basal tillers	-0.725	-0.873		0.036**	-0.037	0.185**	0.055**	-0.058*	0.073**	0.197**	0.058**	0.282**	0.061**	-0.162	0.603**
FLBL	11.89	22.455	-0.442		0.243**	0.025**	-0.092*	-0.127*	0.156*	0.236*	0.218**	0.225**	0.149**	-0.010	0.603**
FLBW	-0.015	0.251	-0.011	0.268		0.088**	0.066**	-0.010	0.067**	0.111**	0.105**	0.215**	-0.045	0.307**	0.503**
FLSL	1.469	5.411	1.013	0.486	-0.043		-0.006	0.063**	0.098*	0.005	0.054**	-0.018	0.069**	-0.99**	0.547**
PEDLEN	-1.005	-3.597	0.511	3.164	0.0567	-0.099		0.508*	-0.98**	0.005	0.054**	-0.008	0.069**	0.100**	0.410**
Exer	-1.118	0.903	0.363	-2.896	0.0190	-0.690	-9.030		0.056**	0.116**	-0.016	-0.123*	-0.008	0.124**	0.050
INFLL	3.063	7.334	-0.228	1.763	0.019	-0.496	-1.132	0.329		0.300**	0.563*	0.049*	0.097**	0.042	0.091**
INFLW	2.918	1.262	-0.377	1.641	0.019	0.015	-0.580	-0.411	0.535		0.417*	0.195**	0.115**	0.069*	0.323**
LLF	5.023	5.646	-0.222	3.043	0.035	0.340	-1.194	-0.117	2.007	0.915		0.032**	0.081**	0.104**	0.415**
WLF	0.121	0.414	0.010	0.296	0.007	-0.005	-0.019	-0.186	-0.098	-0.083	-0.012		0.123**	0.177**	0.385**
PBN	-0.349	-1.388	0.655	0.481	-0.004	0.100	0.271	-0.113	-0.080	-0.059	-0.083	0.012		-0.044*	0.575**
1000 Gr. wt.	0.334	0.239	-0.110	-0.025	0.002	-0.115	-0.333	-0.158	0.026	0.027	0.080	0.013	0.080		0.785**
Grain yield (g) plot^{-1}	11.33	-25.463	13.291	-19.858	1.926	-49.524	66.300	19.459	-17.573	-14.530	-30.179	2.106	4.793	15.14	

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

Table 3. Genotypic path coefficient analysis for 14 characters in finger millet.

Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Correlation
FLG	46.945	0.291	-0.449	0.292	0.008	0.066	-0.312	-0.075	0.313	0.526	0.361	0.102	-0.197	0.105	-0.449**
PLHT	23.553	138.840	-0.064	0.335	0.158	0.258	-0.086	-0.033	0.145	0.179	0.261	0.285	-0.336	-0.067	-0.150**
BT	-0.510	-1.243	2.748	-0.375	-0.106	0.261	-0.086	-0.055	-0.110	-0.314	-0.060	-0.050	0.119	-0.185	-0.203**
FLBL	11.630	22.976	-0.361	33.791	0.332	0.024	-0.171	-0.197	0.154	0.323	0.264	0.317	-0.327	-0.070	-0.443**
FLBW	0.006	0.237	-0.022	0.245	0.016	-0.174	0.091	0.058	0.044	0.137	0.118	0.365	-0.176	0.037	0.547**
FLSL	1.263	5.200	0.948	0.391	-0.061	7.745	-0.046	-0.104	-0.119	-0.043	0.063	0.005	0.075	-0.126	-0.210**
PEDLEN	-9.422	-4.486	0.647	-4.386	-0.051	-0.565	19.430	0.558	-0.164	-237.00	-0.126	0.024	0.211	-0.213	0.060
EXER	-1.609	-1.210	-0.281	-3.550	-0.023	-0.898	7.583	9.620	0.632	-0.232	-0.028	-0.129	0.034	-0.167	0.130**
INFLL	3.039	2.421	-0.259	1.266	-0.008	-0.472	-1.026	0.276	2.033	0.424	0.640	0.080	-0.005	0.070	-0.345**
INFLW	2.522	1.479	-0.365	1.317	0.012	-0.084	-0.734	-0.503	0.420	0.489	0.542	0.293	-0.322	0.141	-0.321**
LLF	4.447	5.908	-0.189	2.946	0.286	0.333	-1.067	-0.165	1.733	0.777	3.673	-0.023	-0.076	0.109	-0.385**
WLF	0.093	0.450	-0.110	0.247	0.006	0.002	0.014	-0.054	0.015	0.028	-0.006	0.018	-0.305	0.334	0.384**
PBN	-0.411	-1.206	0.066	0.579	-0.007	0.063	0.284	0.032	-0.002	-0.069	-0.044	-0.013	-0.093	-0.073	0.182**
YIELD	113.951	-32.005	11.6676	20.128	2.147	48.612	60.234	15.452	-19.077	-14.600	31.564	2.299	6.204	14.994	0.785**

Residual effect = 0.3394, Bold latters denote direct effect, ** Significant at 1% level probability, * Correlation with 1000 grain weight

one or more highly heritable characters correlated with each other, which can be studied with the help of genotypic and phenotypic correlations. The genotypic correlation was lower than phenotypic ones, which indicated that environment played role in the inherent relationship between these characters which was similar to Johnson *et al*. (1955). Thousand, grain weight and total yield was highly significantly correlated with all the characters under study in positive direction except for the exertion (Table 2). These results are also in agreement with Chaudhari and Acharya (1969). The major variables of yield seems to be number of productive tiller and 1000 grain weight with inflorescence length.

Studies made by Dhagat *et al*. (1978) are in line for various characters who observed positive and significant correlation of plant height with peduncle length, inflorescence width, flag leaf sheath length and exertion with plant height was reported. Similarly, path coefficient under study analysis of selected characters indicated that yield is having direct correlation with number basal tillers, 1000 grain weight, flag leaf length, flag leaf width, inflorescence length and width. The major variables of yield seems to be basal tillers, inflorescence length, inflorescence width and days to 50 per cent flowering.

Selection based on correlation may be misleading. Hence, path analysis was studied (Table 3). The direct effects of panicle branch number was negative though the correlation was significant and in positive direction. Though direct effect of plant height, basal tiller, 1000 grain weight, inflorescence length, inflorescence width and yield had high positive direct effect on 1000 grain weight. Indirect effect of yield with plant height, flag leaf length flag leaf width, flag leaf sheath length, flag leaf sheath width and 1000 grain weight and exertion was very high resulting in positive significant correlation in these characters. Indirect effect on yield had masked the direct or indirect effect in almost all the characters except plant height where the indirect effect were in negative direction via flag leaf sheath length, flag leaf sheath width, exertion, panicle branch number resulted in non significant correlations. Though the direct effect was high and in positive direction. These finding are similar to Dhagat *et al*. (1972). The direct effect of inflorescence width yield was positive with low magnitude also reported by Kempana and Thirumalchar (1968). Direct effect of 1000 grain weight on yield was fairly high and positive, which was in agreement with the studies of Dhagat *et al*. (1972). Thus, the results indicate that one should emphasize on yield, basal tiller, inflorescence length and width, and 1000 grain weight while making selection for improvement in the yield of finger millet.

ACKNOWLEDGEMENT

The authors express their gratitude to the University, ICAR and ICRISAT authority for their encouragement and providing the necessary facilities to carry out the present research work. This study was supported by an All India Co-ordinated Small Millet Improvement Project, Zonal Agriculture Research Station, Kolhapur 416012 (Maharashtra).

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J. Maharashtra agric. Univ., 34 (2) : 134-137 (2009)

Character Association, Path Coefficient Analysis and Genetic Diversity in Pigeonpea*

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ABSTRACT

The correlation , path coefficients analysis and genetic diversity were worked out for fiftysix genotypes of pigeonpea for 11 characters. The correlation studies revealed that the genotypic correlation coefficients were higher than corresponding phenotypic correlations. Grain yield showed significant positive correlation with plant spread, number of secondary branches plant^{-1}, number of pods plant^{-1} and days to maturity. Path coefficient analysis revealed that the pods plant^{-1} had the highest positive direct effect on grain yield, followed by plant spread and 1000 grain weight. Considering correlation coefficients and path coefficients the character *viz*., plant spread and number of pods plant^{-1} emerged out as important components of grain yield in pigeonpea in the present studies.The D^2 statistic showed that there was considerable divergence among the genotypes with D^2 values ranging from 6.82 to 311.69. On the basis of D^2 values the fiftysix genotypes were grouped into thirteen gene clusters. Clustering pattern of these genotypes did not necessarily follow the geographical distribution. Tentative crossing programme is suggested on the basis of genetic divergence, cluster means and *per se* performance of genotypes to secure yield improvement in pigeonpea.

Key words : Correlation, path analysis, genetic diversity, pigeonpea.

Grain yield is determined by the combined action of various components, hence selection for yield *per se* is likely to be unfruitful. It is therefore, important to identify the components of grain yield for its indirect improvement. The present investigation was therefore, undertaken to derive information on correlation, direct and indirect effects of various traits on grain yield and to estimate the genetic divergence between different genotypes of pigeonpea and to group them into suitable gene clusters.

MATERIALS AND METHODS

Fiftysix genotypes of pigeonpea were obtained from the International Crop Research Institute for Semi Arid Tropics, Patancheru, Hyderabad (A.P) and All India Co-ordinated Pulses Improvement Project, Mahatma

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Phule Krishi Vidyapeeth, Rahuri. The experiment was conducted in a randomized block design with three replications at Instructional farm of Post Graduate institute, MPKV, Rahuri during *kharif* 2000.

Each genotype was represented by two rows of 5 meter length in each replication. Spacing of 45 cm between rows and 20 cm between the plants within a row was maintained. One guard row of standard variety ICPL-87 was grown to avoid the border effect. Recommended package of practices were followed to raise a good crop. Observations were recorded on the five randomly selected plants of each genotype in each replication for eleven different characters. Genotypic and phenotypic covariances were calculated according to Singh and Chaudhari (1977) and these covariances were used for calculating correlation coefficients according to Johnson *et al*. (1955), path-coefficient analysis was done as suggested by Dewey and Lu (1959). The genotypes were further grouped into clusters on the basis of Mahalanobis's (1936) D^2 as described by Rao (1952).

RESULTS AND DISCUSSION

Phenotypic and genotypic correlation coefficients of fiftysix genotypes of pigeonpea for grain yield with its component characters were studied. The results indicated that genotypic correlation coefficients were higher than phenotypic correlation coefficients between most of the characters (Table-1). This indicated that there was strong inherent association between the various characters studied and the same was less influenced by environmental variations. A strong significant and positive correlation was observed between grain yield plant^{-1} with plant spread, number of secondary branches and number of pods plan^{-1} and days to maturity. Similar results were also reported by Awatade *et al*. (1980), Khapre and Nerkar (1992), Salunke *et al*. (1995) and Srinivas *et al*. (1999). However, number of primary branches plant^{-1}, 100 grain weight and plant height at maturity had low positive association with grain yield. Similar results were reported by Khapre and Nerkar (1992). Grain yield had significant negative

Table 1. Genotypic and phenotypic correlation coefficients between grain yield and its component characters in pigeonpea.

Character		Days to 50% flowering	Days to maturity	Plant height at maturity (cm)	Plant spread (cm)	Primary branches plant^{-1}	Secondary branches plant^{-1}	Pods plant^{-1}	Seeds pod^{-1}	100-grain weight (g)	Protein content (%)	Grain yield plant^{-1} (g)
Days to 50% flowering	P	1.000	0.3627**	0.0985	0.0048	0.0024	-0.0075	0.0220	-0.1131	0.0134	-0.0514	0.0397
	G	1.000	0.7250**	0.2356	0.0927	0.1453	-0.0190	0.0000	-0.3457**	0.0956	-0.0733	-0.0104
Days to maturity	P		1.000	0.3566**	0.1400	0.2239	-0.0141	0.2632*	-0.1315	0.3316*	-0.1373	0.2524
	G		1.000	0.4855**	0.2910*	0.2885*	0.0582	0.3418**	-0.2183	0.3471**	-0.1616	0.3252*
Plant height at maturity (cm)	P			1.000	0.2946*	0.3895**	-0.0654	0.1748	0.0470	0.1528	0.0767	0.1007
	G			1.000	0.3505**	0.5092**	-0.2167	0.1838	0.0753	0.1988	0.1161	0.0609
Plant spread (cm)	P				1.000	0.4719**	0.5578**	0.4500**	-0.1331	-0.0392	-0.1091	0.4515**
	G				1.000	0.6494**	0.7827**	0.7907**	-0.3062*	-0.0891	-0.1514	0.7941**
Primary branches plant^{-1}	P					1.000	0.2924*	0.3956**	-0.1412	-0.1742	-0.0447	0.1935
	G					1.000	0.2690*	0.5874**	-0.3343*	-0.2228	-0.0457	0.2055
Secondary branches plant^{-1}	P						1.000	0.5372**	-0.2142	-0.1404	-0.0748	0.5216**
	G						1.000	0.7876**	-0.3532**	-0.1312	-0.1049	0.7741**
Pods plant^{-1}	P							1.000	-0.1745	-0.2283	-0.1039	0.6280**
	G							1.000	-0.2767*	-0.2827*	-0.1262	0.7588**
Seeds pod^{-1}	P								1.000	0.2246	0.0768	-0.0571
	G								1.000	0.3102*	0.0946	-0.1160
100-grain weight (g)	P									1.000	0.1061	0.1057
	G									1.000	0.1059	0.1499
Protein content (%)	P										1.000	-0.2229
	G										1.000	-0.2619*
Grain yield plant-1 (g)	P											1.000
	G											1.000

*,** Significant at 5 and 1% level respectively, P = Phenotypic correlation, G = Genotypic correlation.

Table 2. Direct and indirect effects of component characters on grain yield in pigeonpea.

Character	Days to 50% flowering	Days to maturity	Plant height at maturity (cm)	Plant spread (cm)	Primary branches plant^{-1}	Secondary branches plant^{-1}	Pods plant^{-1}	Seeds pod^{-1}	100-grain weight (g)	Protein content (%)	Genotypic correlation with grain yield
Days to 50% flowering	**0.9997**	-1.9121	-0.7123	0.5498	-0.3986	0.7839	0.0001	0.4586	0.2413	-0.0189	-0.0104
Days to maturity	0.7235	**-2.6372**	-1.4772	1.7305	-0.7915	-0.5009	2.1539	0.2897	0.8760	-0.0417	0.3252**
Plant height at maturity (cm)	0.2351	-1.2883	**-3.0239**	2.0784	-1.3969	1.8667	1.1581	-0.0999	0.5017	0.0300	0.0609
Plant spread (cm)	0.0925	-0.7697	-1.0600	**5.9292**	-1.7816	-6.7409	4.9825	0.4062	-0.2250	-0.0391	0.7941**
Primary branches plant^{-1}	0.1450	-0.7608	-1.5397	3.8504	**-2.7435**	-2.3169	3.7015	0.4435	-0.5623	-0.0118	0.2055
Secondary branches plant^{-1}	-0.0908	-0.1534	0.6554	4.6406	-0.7380	**-8.6126**	4.9624	0.4686	-0.3310	-0.0271	0.7741**
Pods plant^{-1}	0.000	-0.9015	-0.5558	4.6884	-1.6116	-6.7829	**6.3010**	0.3671	-0.7134	-0.0326	0.7588**
Seeds pod^{-1}	-0.3449	0.5738	-0.2278	-1.8157	0.9172	3.0421	-1.7435	**-1.3266**	0.7830	0.0244	-0.1160
100-grain weight (g)	0.0954	-0.9154	-0.6011	-0.5285	0.6112	1.1296	-1.7810	-0.4116	**2.5238**	0.0273	0.1499
Protein content (%)	-0.0732	0.4261	-0.3510	-0.8980	0.1255	0.9038	-0.7950	-0.1255	0.2673	**0.2581**	-0.2619*

Bold figures denote direct effects., *,** Significant at 5 and 1% level respectively, Residual effect = 0.57.

Table 3. Inter and intra cluster D values in pigeonpea.

Cluster	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
I	7.704	10.348	10.001	10.822	10.506	10.609	10.691	12.293	10.198	14.891	10.969	11.793	13.027
II		0.000	9.603	13.792	12.514	11.005	15.531	10.508	9.620	14.192	13.748	17.409	11.829
III			0.000	7.748	8.556	10.195	13.772	5.605	9.499	11.445	9.549	15.604	16.821
IV				0.000	5.112	8.345	15.464	7.238	13.667	8.940	11.375	12.854	16.404
V					0.000	7.354	16.008	7.845	14.309	7.801	11.277	12.965	15.559
VI						0.000	15.211	8.755	14.733	6.452	10.472	13.237	11.031
VII							0.000	17.413	12.293	20.333	9.324	11.500	17.655
VIII								0.000	13.268	7.654	11.356	17.809	16.586
IX									0.000	18.548	13.805	15.052	15.601
X										0.000	13.624	17.952	15.959
XI											0.000	14.388	17.223
XII												0.000	16.506
XIII													0.000

correlation with protein content. Similar results were reported by Salunke *et al.* (1995).

Days to 50 per cent flowering had highly significant positive correlation with days to maturity both at genotypic and phenotypic level indicating that there was certain inherent relationship between these characters. Days to maturity showed significant positive association with plant height at maturity, 100 grain weight and number of pods plant^{-1} at both the levels. Plant height had positive correlation with plant spread and number of primary branches plant^{-1}. Plant spread, number of primary and secondary branches plant^{-1} and number of pods plant^{-1} had significant positive association between them at both the genotypic and phenotypic levels. Non significant negative correlation was found between protein content and all other characters except plant height, number of seeds pod^{-1} and 100 grain weight. The number of seeds pod^{-1} had significant negative association with number of secondary branches plant^{-1}, days to 50 per cent flowering, number of primary branches plant^{-1}, plant spread and number of pods plant^{-1} at genotypic level indicating reverse relationship among these characters.

Path coefficient analysis (Table 2) revealed that number of pods plant^{-1} and plant spread had positive and high direct effects on grain yield and also showed significant and positive association with grain yield. The direct effect of 100 grain weight was higher but its correlation with grain yield was non significant which was due to negative indirect effect via number of pods plant^{-1}, days to maturity, plant height at maturity, plant spread and number of seeds pod^{-1}. The character number of secondary branches plant^{-1} and days to maturity had negative direct effect but their correlation with grain yield was significantly positive which was due to high positive indirect effects via number of pods plant^{-1}, plant spread and number of seeds pod^{-1}. Protein content had positive direct effect but its association with grain yield was negative which might be due to negative indirect effects via plant spread, number of pods plant^{-1} and plant height. These results were in agreement with those of Awatade *et al.* (1980), Malik, *et al*. (1981), Dumbre and Deshmukh (1985), Dahat *et al.* (1995) and Shrinivas *et al.* (1999). Considering correlation and path coefficient analysis together, it could be concluded that plant spread and pods plant^{-1} were the important yield components in the present studies.

The D^2 values ranged from 6.82 (between ICP-9713 and ICP-3347) to 311.69 (between ICP-9810 and ICP-3379). The fiftysix pigeonpea genotypes were grouped into thirteen clusters. Cluster I was the largest comprising of fortyfour genotypes while remaining twelve clusters were solitary clusters. The clustering pattern obtained in the present study confirmed that the genetic diversity is not necessarily parallel to the geographic diversity. These results are similar to those reported by Asawa *et al*. (1981), Patel *et al*. (1988), Henry and Krishna (1992) and Sandhu *et al.* (1993).

The maximum inter-cluster distance (Table 3) was observed between clusters VII and X (D=20.33), followed by IX and X (D-18.54), X and XII (D=17.95) and VIII and XII (D=17.81). The cluster means for plant spread, number of secondary branches plant^{-1} number of pods plant^{-1} and grain yield plant^{-1} were the highest in case of cluster XI and differed very much from other clusters suggesting quite different genetic make up of the genotype included in this cluster.

On the basis of inter cluster distance, cluster mean and *per se* performance hybridization programme involving the genotypes ICP-10019, ICP-9513, ICP-9808, ICP-9810, ICP-9830, ICP-7379, ICP-8754,BSMR-736,AKT-88-11 and C-11 is suggested for yield improvement in pigeonpea.

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J. Maharashtra agric. Univ., 34 (2) : 138-140 (2009)

Parental Lines Improvement for Morphophysiological Characters in *Rabi* Sorghum

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ABSTRACT

Genetic variability was estimated in sorghum genotypes (mostly *rabi*) representing tropical landraces, parental lines, (B and R lines), hybrids and varieties. The phenotypic coefficient of variance and genotypic coefficient of variance were high for fodder yield per plant and moderate for green leaves at maturity and dry weight of stem. Low variability (less than 10%) was noticed for days to 50 per cent flowering, No. of leaves per plant and relative water content. Comparison of group means indicated distinct superiority of parents over other groups for leaf area index, number of leaves per plant and per cent green leaves at maturity.

Key words : Genetic variability, morpho physiological characters, *rabi* sorghum.

Post rainy (*rabi*) sorghum is unique to southern states (North west Andhra Pradesh, North Karnataka and Mid west Maharashtra) of India, where it is mostly grown on residual soil moisture. Productivity of *rabi* sorghum (640 kg ha^{-1}) is much less compared to *kharif* sorghum (1060 kg ha^{-1}) (Rana *et al.* 1998). Though important for food and fodder security in drought prone area, low yield in *rabi* is attributed to lack of suitable high yielding hybrids and varieties and to some degree of susceptibility to drought, cold, shoot fly and charcoal rot Besides, the crop is grown in vertisols of varied soil depths i.e deep (> 90 cm), medium (45-90 cm) and shallow (< 45 cm).

Knowledge of the nature and magnitude of genotypic and phenotypic variability present in the crop species plays a vital role in formulating a successful breeding programme to evolve superior cultivars. Progress in any breeding programme depends upon the magnitude of useful variability present in the population and the extent to which the desirable characters are heritable. The present study was aimed at estimation of genetic variability for morpho physiological characters important and determine drought adaptation in *rabi* sorghum.

MATERIALS AND METHODS

Forty one sorghum genotypes representing genetic stocks, parental lines of hybrids (B and R lines), released varieties and hybrids were grown in a randomized block design, with three replications during *rabi* 2001-02, at National Research Centre for Sorghum, Hyderabad. Each entry was sown in two rows of each three-meter length with a spacing of 45 x 15 cm. Observations were recorded on five random plants in each entry and each replication.

The data were collected on nine morpho-physiological traits *viz.*, days to 50 per cent flowering, plant height, leaf area index (LAI), number of leaves per plant, green leaves at maturity, relative water content (RWC), harvest index, dry weight of stem and fodder yield per plant. The observations on LAI, number of leaves per plant and dry weight of stem were recorded at flowering and RWC of leaves was estimated at physiological maturity. The LAI was estimated as per the procedure of Stickler and Pauli (1961), whereas RWC of leaves was estimated as suggested by Smart (1974).

The phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were computed as per formula given by Burton and Devane (1953).

RESULTS AND DISCUSSION

The analysis of variance revealed highly significant differences among the genotypes for all the characters studied, which indicated existence of considerable genetic variability. The differences among genetic stocks and hybrids, varieties and hybrids vs. genetic stocks and hybrids vs. varieties were highly significant for all characters except for leaf area index and number of leaves per plant (Table 1).

When group means were compared for different characters, it was found that the genetic stocks were significantly late in flowering compared to B lines, R lines, varieties and hybrids by five, six, two

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Table 1. Analysis of variance for morpho physiological characters of *rabi* sorghum.

Source	d.f	Days to 50% flowering	Plant height (cm)	LAI	Leaves plant^{-1}	Green leaves at maturity (%)	Dry weight of stem at flowering (g)	RWC (%)	Fodder yield plant^{-1} (g)
Replications	2	0.62	34.14	0.04	0.14	31.86	0.58	2.28	0.44
Treatments	40	110.92**	2659.10**	1.08**	2.68**	502.10**	381.27**	188.87**	372.28**
B lines	8	28.00**	1062.37**	1.25**	4.35*	750.47**	134.52**	249.59**	214.78**
R lines	13	115.30**	1493.64**	1.15**	3.17**	269.87**	256.83**	189.81**	246.52**
Varieties	6	125.54	512.02**	0.72**	1.22**	1144.18**	89.18**	184.66**	263.04**
Hybrids	2	101.33**	934.54**	0.25**	0.03**	45.86**	163.17**	146.92**	104.09**
Genetic stocks	7	71.40**	1056.84**	0.94**	1.09*	117.22**	146.22	80.71**	164.87**
B line vs. R line	1	6.79*	10341.85**	1.66**	13.84**	169.47**	566.52**	18.02	6.61**
B line + R line vs. rest	1	391.50**	9908.69**	0.01	1.05	1587.78**	6454.19**	49.92*	1575.51**
Var + Hyb vs. Genetic stocks	1	211.55**	3.09	0.05	0.03	400.64**	30.10	201.67**	2308.85**
Hybrid vs. var	1	804.04**	2847.73**	0.03	0.82	601.49**	742.98	948.88**	5421.21**
Error	80	1.10	16.80	1.04	0.49	6.45	5.24	9.04	4.27
Means									
B lines		79.00	125.88	1.38	8.37	57.67	37.67	66.71	69.82
R lines		78.35	156.88	1.66	9.29	57.67	41.50	65.70	69.20
Varieties		82.67	172.26	1.54	9.21	62.21	47.93	65.60	61.37
Hybrids		73.83	202.67	1.53	8.78	56.33	65.80	77.30	83.70
Genetic stocks		83.78	180.64	1.60	9.13	64.66	54.65	65.11	54.63
CD(0.05)		1.72	6.60	0.28	1.08	4.13	3.71	4.88	3.36
CD(0.01)		2.26	8.83	0.37	1.44	5.47	4.93	6.48	4.45
C.V (%)		1.36	2.57	11.08	9.08	4.93	5.01	4.51	3.12

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

and 11 days respectively. The genetic stocks were significantly taller than all other groups except hybrids.

The comparison between varieties and hybrids was significant for days to 50 per cent flowering, plant height, green leaves at maturity, dry weight of stem, relative water content and fodder yield per plant and it was non significant for rest of the characters. In general hybrids were nine days early having higher dry weight at flowering and higher RWC. Varieties were almost similar in performance to that of genetic stocks. Comparison of B and R lines represented distinct variation pattern for some characters, B lines were short in height and low in leaf area index. There was considerable improvement in R lines over B lines with respect to plant height, leaf area index, number of leaves per plant, dry weight of stem. But B lines were as productive as R lines (Table 2). The parental superiority to hybrids in respect of LAI, number of leaves per plant and per cent green leaves at maturity may however be translated for further genetic enhancement of parental lines.

As genetic improvement of parental lines is essential for breeding high yielding hybrids, Rana and Kaul (1997) predicted the F_1 yield (kg ha^{-1}) as $Y_1 = 1969 + 0.71 X_1$ and $Y_2 = 1808 + 0.74 X_2$ where X_1 and X_2 are given yields of B and R lines. They concluded that

Table 2. Percentage improvement in different groups for morpho physiological characters.

Comparison	Days to 50% flowe-ring	Plant height	LAI	Leaves plant^{-1}	Green leaves at matu-rity	Dry weight of stem at flowe-ring	RWC	Fodder yield plant^{-1}
Hybrid vs. parents	-6.07	40.01	-1.31	-1.67	-1.80	64.49	16.95	20.53
Hybrid vs. varieties	-10.69	17.63	-0.64	-4.73	-9.45	37.28	17.83	36.38
Varieties vs. genetic stocks	-1.87	-16.06	-3.75	0.94	-3.78	-12.29	0.75	12.33
R lines vs. B lines	-0.82	24.62	20.28	10.99	-0.86	10.16	-1.51	-0.88
R line vs. varieties	-5.22	8.93	7.79	-0.75	-8.01	-13.41	-0.15	12.75

Table 3. Genetic parameters for morpho physiological characters in *rabi* sorghum.

Characters	Mean	SE ±	Pheno-typic variance	Geno-typic variance	PCV %	GCV %
Plant height(cm)	158.97	2.33	886.36	880.72	18.72	18.66
Days to 50% flowering	80.15	0.60	36.97	36.60	7.58	7.54
LAI	1.54	0.09	0.28	0.279	34.57	33.92
No. of leaves plant^{-1}	9.00	0.38	0.89	0.74	10.49	9.52
Green leaves at maturity (%)	58.76	1.44	167.36	165.21	22.01	21.82
Dry weight of stem at flowering (g)	45.62	1.30	127.09	125.34	24.71	24.53
RWC (%)	66.64	1.71	62.95	59.94	11.90	11.61
Fodder yield plant^{-1} (g)	66.27	1.17	123.83	122.75	29.52	29.39

PCV = Phenotypic coefficient of variance, GCV =Genotypic coefficient of variance

if F_1 hybrids with yield potential of 5.0 t ha^{-1} are to be developed B and R lines with yield potential of 2.4 t ha^{-1} grain yield need to be bred. The importance of parental line improvement in hybrid breeding was also mentioned by Swarnalata Kaul *et al*. (1996) and Madhusudhana (2002).

Thus, it is evident from the results of the present findings, that much improvement has been achieved with respect to various traits under the process of selection and breeding from genetic stocks to varieties, varieties to B and R lines and thus the improved parental lines contributed to heterosis in commercial hybrids.

High phenotypic and genotypic variability (>25%) were observed with respect to characters such as LAI, dry weight of stem and fodder yield per plant and moderate variability for plant height and green leaves at maturity indicating that selection may be effective for these traits (Table 3).

The characters days to 50 per cent flowering, number of leaves per plant, RWC and harvest index which are important for drought adaptation exhibited low PCV and GCV indicating low level of variability for these traits in the *rabi* germplasm, on overall basis. These results are bound to be different with the earlier reports of Phul and Allahrang (1986), Gururaja Rao and Patil (1996), Can and Yoshida (1999) as they dealt with fodder and grain types of kharif origin and different range of material. However present findings are in conformity with those of Prabhakar (2001) who reported similar pattern in varieties and genetic stocks. The present study analysed the genetic variation in specific traits and identified the genotypes useful in the breeding programme of *rabi* sorghum where yields have been stagnated over years.

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J. Maharashtra agric. Univ., 34 (2) : 141-143 (2009)

Effect of Integrated Weed Management on Yield and Economics of Soybean (*Glycine max* L. Merrill)

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ABSTRACT

The yield components like pods, seeds plant^{-1} and their weights and seed and straw yields were found to be significantly superior under two hand weedings at 30 and 45 DAS over rest of the weed control treatments. Among the integrated weed control methods, the application of pursuit (EPOE) @ 100 g a.i. ha^{-1} + one hand weeding at 30 DAS was found to be superior *vis-a-vis* other integrated weed control methods. Among the chemical weed control treatments pre planting incorporation of fluchioralin @ 1.0 kg a.i ha^{-1} recorded the lowest seed and straw yields (24.23 and 35.94 q ha^{-1}, respectively).

Key words : Integrated weed management, yield, quality, soybean, economics.

The highest gross income (Rs. 62,500 ha^{-1}) and net monetary returns (Rs. 25635 ha^{-1}) was observed in hand weedings at 15 and 30 DAS which was followed by treatment pursuit (EPOE) @ 100 g a.i. ha^{-1} + one hand weeding at 30 DAS (Rs. 55,114 ha^{-1} and Rs. 18,609 ha^{-1}, respectively). The highest B:C ratio of 5.10 was observed under two hand weedings at 30 and 45 DAS followed by pursuit (EPOE) @ 100 g a.i. ha^{-1}.

The traditional method of weed control i.e. hand weeding is expensive, tedious and time consuming. Weeding also becomes difficult due to unfavourable weather, wet soil and unavailability of labour. Under such circumstances, use of effective herbicides in suitable dose remains the pertinent choice for controlling the weeds. Herbicides in isolation, however, are unable to obtain complete weed control because of their selective kill. Their use can be made more effective if supplemented with hand weeding or hoeing etc. are available for weed control in soybean. A judicious combination of chemicals and cultural methods of weed control would not only reduce the expenditure on herbicides but would benefit the crop timely by providing proper aeration and conservation of moisture. A judicious combination of chemical and cultural weed control would certainly prove to be effective for controlling weeds in soybean.

MATERIALS AND METHODS

The present investigation was carried out at Agronomy Farm, College of Agriculture, Pune (M.S.) during *kharif* season of 2006 . The experiment was laid out in a randomized block design with eleven treatments replicated thrice. The different treatments comprised of unweeded control (T_1), while among the mechanical methods the treatments comprised weed free check (T_2) , two hand weedings 15 and 30 DAS (T_3), hand weeding at 15 DAS followed by one hoeing at 30 DAS (T_4) and two hoeings 15 and 30 DAS (T_5). The chemical methods of weed control comprised the application of Imazethapyr @ 0.075 kg. a. i. ha^{-1} at 15 DAS (T6), Chlorimuron ethyl @ 0.009 kg a. i. ha^{-1} at 15 DAS (T8) and Quizalofop ethyl @ 0.05 kg a. i. ha^{-1} at 15 DAS (T_{10}). The integrated methods of weed control comprised the application of Imazethapyr @ 0.075 kg. a. i. ha^{-1} at 15 DAS + one hoeing at 30 DAS (T_7) , Chlorimuron ethyl @ 0.009 kg a. i. ha^{-1} at 15 DAS + one hoeing at 30 DAS (T_9) and Quizalofop ethyl @ 0.05 kg a. i. ha^{-1} at 15 DAS + one hoeing at 30 DAS (T_{11}). The gross and net plot sizes were 4.2 x 3.6 m and 3.6 x 3.0 m, respectively. The soil of the experimental field was clay in texture, with low in available nitrogen and available phosphorus and rich in available potassium. The soil was slightly alkaline in reaction with pH of 7.6. The experimental crop was sown by dibbling at 30 x 10 cm spacing on 23rd June 2006.

RESULTS AND DISCUSSION

Yield characters : Two hand weedings at 30 and 45 DAS (T_2) was significantly superior over rest of the weed control treatmenrs (Table 1) as regards number of pods per plant (59.00), number of seeds per plant (141.60), weight of seeds per plant (23.29 g) and hundred seed weight (16.40 g) revealing the beneficial effect of weed free environment resulting in no

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Table 1. Mean number of pods, number of seeds and weight of seeds (g) per plant and hundred seed weight (g) as influenced by different treatments.

Treatments	Pods plant^{-1}	Seeds pod^{-1}	Weight of seeds (g)	Hundred seed weight (g)
T_1 - Weedy check	29.26	73.60	10.30	14.00
T_2 - Two hand weedings (30 and 45 DAS)	59.00	141.60	23.29	16.40
T_3 - Two hoeings (30 and 45 DAS)	50.80	119.80	19.16	15.90
T4 - hand weeding at 30 DAS + 1 hoeing at 45 DAS	53.93	128.80	20.66	16.00
T_5 - Fluchloralin @ 1.0 kg a. i. ha^{-1} (PPI)	41.40	96.60	13.95	14.40
T_6 - Fluchloralin @ 1.0 kg a. i. ha^{-1} (PPI) + 1 hand weeding at 30 DAS	45.86	107.70	16.37	15.20
T_7 - Pendimethalin @ 1.0 kg a. i. ha^{-1} (PE)	44.33	106.40	15.94	14.90
T_8 - Pendimethalin @ 1.0 kg a. i. ha^{-1} (PE) + 1 hand weeding at 30 DAS	48.46	116.30	17.95	15.40
T_9 - Pursuit @ 100 g a. i. ha^{-1} (EPOE)	47.26	113.40	17.89	15.70
T_{10} - Pursuit @ 100 g a. i. ha^{-1} (EPOE) + 1 hand weeding at 30 DAS				
Mean	47.49	113.58	17.69	15.42
S. E.±	0.66	0.52	0.43	0.16
C. D. at 5%	1.97	1.56	1.29	0.47

DAS - Days after sowing, PE - Pre-emergence, PPI - Pre-plant incorporation, EPOE - Early post - emergence

competition between weed and crop plants.

Among the integrated weed control measures, treatment T_{10} (Pursuit (EPOE) @ 100 g a.i. ha^{-1} + one hand weeding at 45 DAS) was found to be the best in IWM treatments for the characters under consideration revealing the efficiency of chemical along with manual weeding in weed control, thereby resulting in better yield parameters. These results corroborate the findings of Marold and Krausse (1987) and Arya *et al.*, (1994).

Seed yield : The results of the study indicated that the maximum seed yield (32.73 q ha^{-1}) was obtained with two hand weedings (30 and 45 DAS) and was significantly superior over rest of the treatments. Among the IWM treatments for weed control, treatment T_{10} (Pursuit (EPOE) @ 100 g a.i. ha^{-1} + one hand weeding at 45 DAS) recorded the highest seed yield. Fluchloralin @ 1kg a.i. ha^{-1} (24.23 q ha^{-1}) recorded the lowest seed yield among the chemical weed control treatments which was followed by treatment Pendimethalin @ 1 kg a.i. ha^{-1} (26.47 q ha^{-1}).

These results revealed the comparative inefficiency of the chemical methods of weed control in isolation in reducing the crop weed competition resulting in comparatively lower yields as compared to their use in combination of two hand weedings at 15 and 30 DAS. This results corroborates the results of Porwal *et al.* (1991) and Dubey *et al.* (1996).

Table 2. Economics of different weed control treatments.

Treat-ment	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})	Gross incom (Rs.)	Additional income over control (Rs.)	Additional expenditure over control (Rs.)	Net profit over control	B:C ratio
T_1	20.44	29.35	34465	-	-	-	-
T_2	37.23	48.86	62500	28035	2400	25635	5.10
T_3	30.90	40.09	51845	17380	2200	15180	4.17
T_4	32.51	42.40	54560	20095	2500	17595	4.31
T_5	24.23	35.94	40924	6459	1119	5340	3.49
T_6	28.56	41.20	48168	13709	2319	11384	3.78
T_7	26.47	40.87	44804	10339	1652	8687	3.69
T_8	29.17	43.11	49259	14794	2852	11942	3.70
T_9	30.00	42.97	50578	16113	870	15243	4.65
T_{10}	32.76	45.47	55144	20679	2070	18609	4.55

1. Total expenditure is same for all the treatments except items of weed control in idfferent treatments.
2. Total cost of cultivation except weed control : Rs. 8235/- ha^{-1}
3. Net income from weedy check : Rs. 26230/- ha^{-1}
4. For one hand weeding 20 labours per hectare. Application of herbicide for one time 2 labours are required.
5. Rates of different inputs prevailing during crop season were considered.

Elimination of weeds during early stages of crop growth would enable the plant to grow better and consequently yield better. These results corroborate the findings of Muniyappa *et al*. (1986), and Singh and Kolar (1994).

The increase in seed yield with integrated methods can be attributed to the fact that the crop was kept free of competition at the early critical stage of growth resulting in the crop using the land and climatic resources more efficiently. These results are in confirmation with the earlier findings of Chandrakar and Urkurkar (1993), Rao *et al.* (1995) and Velu and Sankaran (1996).

Straw yield : The straw yield in soybean crop was found to be significantly influenced by different weed control treatments. The data regarding this aspect revealed that two hand weedings (30 and 45 DAS) significantly recorded the maximum straw yield (48.86 q ha^{-1}) *vis-a-vis* all the other weed control methods which can be attributed to the fact that the treatment resulted in least crop weed competition for nutrients, water, light and space, thereby resulting in highest straw yield. Similar results were obtained by Satao and Chandurkar (1994).

Among the IWM treatments, T_{10} i.e. Pursuit (EPOE) @ 100 g a.i. ha^{-1} + one hand weeding at 45 DAS reported the maximum straw yield (45.47 q ha^{-1}). This result is similar to that obtained by Natrajan *et al.* (1997).

Economics : The net monetary returns were found to be influenced by the different weed control treatments. The data from Table 2 revealed that two hand weedings (30 and 45 DAS) produced the highest gross income (Rs. 62,500 ha^{-1}) and net monetary returns (Rs. 25635 ha^{-1}) indicating superiority of this treatment over rest of the treatments.

The B:C ratio was the highest (5.10) under two hand weeding (30 and 45 DAS) followed by Pursuit (EPOE) @ 100 g a.i. ha^{-1} (T_9) and treatment (T_{10}) i.e. Pursuit (EPOE) @ 100 g a.i. ha^{-1} + one hand weeding at 45 DAS would be the most economical proposition in soybean. These results are in close confernity with the earlier findings of Singh and Sharma (1990), Chandrakar and Urkurkar (1993), Singh and Bajpai (1994), Chandel *et al*. (1995), and Jain *et al*. (2000).

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J. Maharashtra agric. Univ., 34 (2) : 144-146 (2009)

Genetic Variability and Correlation Studies in Pigeonpea under Sub-montane Zone of Maharashtra

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ABSTRACT

A study was undertaken to determine the genotypic and phenotypic variation in twenty one pigeonpea genotypes. The wide range of variability was observed in all the characters studied. The GCV, PCV, heritabihty estimates and the expected genetic gain revealed that the variability in plant spread, 100 grain weight, days to 50 per cent flowering, days to maturity and seed yield plant^{-1} were heritable and additive type of gene action was operative for these characters. The grain yield was positively and significantly correlated with days to 50 per cent flowering, plant spread and number of pods plant^{-1}.

Key words : Genetic variability, correlation, pigeonpea.

Pigeonpea (*Cajanus cajan* (L.) Millsp.) is widely grown throughout tropical and subtropical region of the world. It is an important pulse crop in India, Africa, South-East Asia and Caribbean. India is reported as primary centre of origin of pigeonpea. The information on genetic parameters of variability for different characters of economic significance are important for pigeonpea, such variation can be utilised by plant breeder for further genetic improvement of any crop. The present investigation was therefore, undertaken to study the extent of genetic variability present in the population and estimates of heritability and genetic advance for various economic characters which would be useful for designing an effective breeding programme for improvement of pigeonpea crop.

MATERIALS AND METHODS

Twenty one genotypes of pigeonpea were grown in a randomized block design with three replications during *kharif* 2004 at Agricultural Research Station, Gadhinglaj, Dist. Kolhapur under rainfed condition. The spacing was 45 x 20 cm in plots of 4.00 x 3.60 m. A recommended package of practices and plant protection measures were followed to raise a good crop. Observations were recorded on five randomly selected plants in each plot for nine characters *viz.*, days to 50 per cent flowering, days to maturity, plant height, plant spread, number of primary branches plant^{-1}, number of pods plant^{-1}, number of grains pod^{-1}, 100 grain weight and grain yield plant^{-1}. The variability parameters were estimated as per the methods suggested by Johnson *et al*. (1955) and Hanson et al. (1955). The correlation coefficient was worked out as per the procedure given by Singh and Choudhari (1985).

RESULTS AND DISCUSSION

Variability and genetic parameters : A wide range of variability (Table 1) was observed almost for all the characters. Earlier workers, Chandra *et al*. (1975), Shoran (1983) and Thombare (1997) also observed wide range of veriability for all the characters. Thus variation for important yield contributing characters indicated great scope to make selection for desirable types.

The genotypic coefficient of variation (GCV) was highest for

Table 1. Genetic varibility parameters in pigeonpea.

Character	Mean	Range	C. D. at 5%	GCV	PCV	Herita-bility (%)	GA	GAM
Days to 50% flowering	108.62	101.0-115.0	1.84	3.56	3.71	92.29	7.66	7.05
Days to maturity	181.30	174.0-189.0	2.25	2.10	2.23	88.67	7.40	4.08
Plant height (cm)	218.41	169.4-244.0	16.22	5.59	7.18	60.56	19.56	8.95
Plant spread (cm)	65.38	38.7-82.3	0.63	20.60	20.61	99.92	27.74	42.43
Primaryy branches plant^{-1}	6.95	4.0-12.0	1.46	14.44	19.26	56.20	1.55	22.30
Pods plant^{-1}	69.01	39.0-127.0	20.39	18.71	25.91	52.12	19.20	27.82
Grains pod^{-1}	4.25	4.0-5.0	0.54	8.81	11.74	56.37	0.58	13.63
100 grain weight (g)	10.71	7.90-14.50	0.15	17.23	17.26	99.74	3.80	35.46
Grain yield plant^{-1} (g)	19.08	10.00-33.14	4.58	18.08	23.21	60.64	5.53	29.00

GCV = Genotypic coefficient of variation, GA = Genetic advance, PCV = Phenotypic coefficient of variation, GAM = Genetic advance as percentage of mean

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plant spread followed by number of pods plant^{-1}, 100 grain weight and grain yield per plant^{-1}. The phenotypic coefficient of variation (PCV) was highest for number of pods plant^{-1} followed by grain yield plant^{-1}, plant spread and number of primary branches plant^{-1}. The lowest value for GCV and PCV were observed for days to 50 per cent flowering. The least difference between the GCV and PCV was observed for plant spread and 100 grain weight indicating the maximum reflection of genotype into phenotype. As evidence, from differences in GCV and PCV, number of pods plant^{-1} grain yield plant^{-1} and number of primary branches plant^{-1} were slightly influenced by environment. The estimates of GCV and PCV for all the characters studied showed little difference, thus indicating that the variability existing in these characters was mainly due to genetic factores. Rathnaswamy *et al*. (1973) observed high estimates of GCV for the characters, clusters plant^{-1}, number of pods plant^{-1}, branches plant^{-1} and plant height, while it was lowest for days to maturity. Singh *et al*. (1981 a) observed high GCV for pods plant^{-1}. Khapre *et al.* (1993) observed high values of GCV and PCV for plant height, pods plant^{-1}, grain yield plant^{-1}, and harvest index. Thombare (1997) observed high estimates of GCV and PCV for plant height and number of pods plant^{-1}.

The heritability (bs) was highest for plant spread (99.92 %) and it was followed by 100 grain weight (99.74 %), days to 50 per cent flowering (92.29 %) and days to maturity (88.67 %). However, the heritability for number of pods plant^{-1} was lowest. Very high estimates of heritability were obtained for almost all characters studied. Rathnaswamy *et al*. (1973) and Thombare (1997) also reported high estimates of heritability in almost all the characters confirming the present results.

Table 2. Correlation (r) between grain yield and its component characters in pigeonpea.

Characters		Days to maturity	Plant height (cm)	Plant spread (cm)	Primary branches	Pods plant^{-1}	Grains pod^{-1}	100 grain weight (g)	Grain yield plant^{-1} (g)
Days to 50% flowering	P	0.176	-0.062	-0.023	-0.069	0.113	-0.436*	0.487*	0.761**
	G	0.214	-0.075	-0.025	-0.049	0.179	-0.543*	0.506*	0.856**
Days to maturity	P		-0.100	-0.219	-0.209	-0.364	0.037	-0.434*	-0.272
	G		-0.132	-0.231	-0.260	-0.438*	-0.029	-0.454*	-0.362
Plant height (cm)	P			-0.041	0.119	0.026	-0.135	-0.145	-0.048
	G			-0.054	0.138	0.067	-0.445*	-0.182	0.045
Plant spread (cm)	P				0.105	0.565**	0.109	-0.085	0.550**
	G				0.136	0.791**	0.141	-0.085	0.703**
Primary branches	P					0.225	0.213	-0.030	0.059
	G					0.322	0.328	-0.040	0.236
Pods plant^{-1}	P						0.024	0.007	0.613**
	G						0.031	0.014	0.982**
Grains pod^{-1}	P							-0.222	0.003
	G							-0.295	-0.036
100 grain weight (g)	P								0.044
	G								0.067

*,** Significant at 5 and 1 per cent of probability levels respectivel, P = Phenotypic and G = Genotypic

The high genetic advance was observed for plant spread (27.74), whereas it was lowest for number of grains pods^{-1} (0.58). However, genetic advance as percentage of mean was high for plant spread (42.43 %) followed by 100 grain weight (35.46%) and grain yield plant^{-1} (29.00 %). Similar results were reported by Singh *et al.* (1981) and Thombare (1997). Days to 50 per cent flowering, days to maturity and plant height exhibited high heritability accompanied by lower genetic advance as percentage of mean. Thombare (1997) reported high heritability and low genetic advance for number of pods plant^{-1}, 100 grain weight days to maturity and number of pods plant^{-1}. High heritability coupled with high to moderate genetic advance for plant height, plant spread number of pods plant^{-1} and grain yield would be useful for selection of these charaders in breeding programme for improvement of grain yield.

Correlation : The value of genotypic correlation (Table 2) were higher than phenotypic correlation except for days to 50 per cent flowering, days to maturity and plant height. A strong significant positive correlation was observed between grain yield plant^{-1} with plant spread and number of pods plant^{-1} at phenotypic as well as genotypic levels. Similar results have also been observed by Khapre and Nerkar (1992), Salunke et al. (1995), Singh *et al*. (1999), Srinivas *et al*. (1999) and Sawant (2001).

A strong significant association

was observed between grain yield plant^{-1} with days to 50 per cent flowering at phenotypic and genotypic levels. Similar results were also reported by Srinivas et al. (1999). Non significant positive correlation was found between number of primary branches and 100 grain weight at both the genotypic and phenotypic levels.

Days to 50 per cent flowering had significant negative correlation with number of grains pod^{-1} and positive correlation with 100 grain weight both at phenotypic and genotypic levels indicating that there was certain inherent relationship between these characters. Days to maturity had shown significant and negative association with number of pods plant^{-1} and 100 grain weight. This results have also been confirmed with the results of Singh *et al*. (1995) and Salunke *et al*. (1995). Plant spread had shown highly significant and positive correlation with number of pods plant^{-1}. The characters plant spread, number of primary branches plant^{-1}, number of pods plant^{-1} and 100 grain weight had positive correlation with each other. Grain yield exhibited strong association with days to 50 per cent flowering, plant spread and number of pods plant^{-1}, and positive correlation with other yield contributing characters. It is therefore, suggested that the selection for these characters would be more effective in improving the yield in pigeonpea.

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J. Maharashtra agric. Univ., 34 (2) : 147-148 (2009)

Variability, Heritability and Genetic Advance in Sesame (*Sesamum indicum* L.)*

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ABSTRACT

Genetic variability, heritability and genetic advance were studied in 30 F_4 progenies of sesame. High phenotypic and genotypic coefficient of variation were observed in the characters, number of branches plant^{-1}, seed yield plant^{-1}, number of capsules plant^{-1} and number of capsules bearing nodes which indicated large variability among the progenies for these traits. The capsule length, number of capsules plant^{-1} showed high heritability estimates accompanied with high genetic advance as a per cent of mean. It suggests that most likely the heritability is due to additive gene effects and selection may be effective.

Key words : Variability, heritability, genetic advance, sesame.

Sesame (*Sesamum indicum* L.) is one of the most ancient oilseed crops in India. The crop is cultivated in almost all parts of the country in all seasons of the year. Sesame is called 'Queen' of oilseeds in view of its oil and protein is of very high quality, and it has tremendous potential for export. The variability available in the segregating material is important for the selection programme of any crop. So breeder has to make constant search for few and diverse genetic stocks for stabilizing yield and quality of produce. In the present study the extent of variability available in the F_4 generation of cross JLSV-4 x Hawari of sesame and the scope of selection through heritability and genetic advance were attempted.

MATERIALS AND METHODS

The experimental materials consisting of thirty F_4 progenies of cross JLSV 4 x Hawari of sesame along with parents and standard check. The experiment was carried out during *kharif* 2005 in randomized block design with three replications. Each entry was represented by a single row of 4.5 m length with a spacing of 30 cm between the rows and 15 cm between the plants. Five plants in each treatment were randomly selected for recording observations on days to 50 per cent flowering, days to maturity, plant height at harvest (cm), number of branches plant^{-1}, number of capsules bearing nodes, number of capsules plant^{-1}, capsule length (cm), number of seeds capsule^{-1}, seed oil content (%) and seed yield plant^{-1} (g). Different genetic components were calculated according to the method suggested by Singh and Chaudhary (1977).

RESULTS AND DISCUSSION

The analysis of variance for different characters showed significant differences indicating presence of wide genetic variability among progenies studied. The range, mean, coefficient of variation, heritability, genetic advance and genetic advance as a per cent of mean values for all the characters are presented in Table 2. The values of phenotypic coefficient of variation (PCV) were higher than genotypic coefficient of variation (GCV) indicating the role of environment in the total variance.

Table 1. Analysis of variance for ten characters in F_4 generation of a cross (JLSV 4 x Hawari) in sesame.

Characters	Mean sum of squares		
	Replication (2)	Treatment (32)	Error (64)
Days to 50% flowering	6.257	10.040**	4.30
Days to maturity	4.031	11.408**	1.728
Plant height at harvest (cm)	69.906*	99.298**	6.85
Number of branches plant^{-1}	0.201	0.234**	0.115
Number of capsules bearing nodes	14.160	7.176**	2.831
Number of capsules plant^{-1}	9.312	49.634**	5.856
Capsule length (cm)	0.017	0.155**	0.0003
Number of seeds capsule^{-1}	250.312*	20.098**	9.823
Seed oil content (%)	13.632*	6.359**	0.692
Seed yield plant^{-1} (g)	0.444	4.320**	1.656

*,** Significant at 5 and 1 per cent probability, respectively. Values in parenthesis indicate degrees of freedom.

* Part of M. Sc. (Agri.) thesis submitted by senior author to M.P.K.V., Rahuri.

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Table 2. Components of genetic variability in F_4 generation of cross (JLSV 4 x Hawari) in sesame.

Characters	Range	General mean	PCV	GCV	Heritability % (b.s)	Genetic advance (GA)	GA as % of mean
Days to 50% flowering	34.33-39.33	37.87	6.58	3.65	30	1.57	4.15
Days to maturity	86.33-91.00	88.89	2.50	2.02	65	2.98	3.35
Plant height at harvest (cm)	80.27-99.50	88.07	6.96	6.30	81	10.34	11.74
Number of branches plant^{-1}	1.93-3.00	2.41	16.33	8.24	25	0.20	8.30
Number of capsules bearing nodes	20.37-25.87	22.70	9.11	5.30	33	1.44	6.34
Number of capsules plant^{-1}	36.47-52.90	44.91	10.06	8.50	71	6.64	14.78
Capsule length (cm)	2.86-3.98	3.14	7.26	7.23	99	0.46	14.65
Number of seeds capsule^{-1}	60.67-69.00	65.07	5.59	2.84	25	1.93	2.97
Seed oil content (%)	46.51-53.36	50.12	3.20	2.74	73	2.42	4.83
Seed yield plant^{-1} (g)	12.23-17.03	14.93	10.68	6.31	34	1.14	7.64

PCV = Phenotypic coefficient of variation, GCV = Genotypic coefficient of variation
h^2 (b.s) = Broad sense heritability, GA = Genetic advance

The phenotypic and genotypic coefficient of variation estimates were of high magnitude for number of branches plant^{-1} followed by seed yield plant^{-1}, number of capsules plant^{-1} and number of capsules bearing nodes suggesting the presence of good amount of variability for these traits. The characters days to maturity and seed oil content had low PCV and GCV estimates indicating narrow range of variation for these characters and provides very least scope for selection. In general magnitudinal differences between PCV and GCV were minimum for all these characters studied indicating less influence of environment on this character expression. Similar results obtained by Godawat and Gupta (1986), Baruah and Goud (1993), Krishnaiah *et al*. (2002) and Kumar and Sundaram (2002).

The heritability (bs) estimates ranged from 25 to 99 per cent. The capsule length (99.0) recorded the highest heritability followed by plant height at harvest (81.0), seed oil content (73.0), number of capsules plant^{-1} (71.0) and days to maturity (65.0). The high heritability exhibited in these traits indicating the role of additive gene effects and selection based on these traits would be more convenient in segregating generations. Selection based on heritability alone may mislead the selection process. Therefore, genetic advance and heritability were taken into consideration during the selection programme (Johnson *et al*. 1955).

Number of capsules plant^{-1} had highest genetic advance as per cent of mean (14.78) followed by capsule length (14.65) and plant height (11.74). The results showed that the characters capsule length, number of capsules plant^{-1} and plant height with high heritability coupled high values of genetic advance as a per cent of mean and GCV indicated the preponderance of higher order additive gene effects. Thus mass selection would be effective to improve these traits. Number of capsules plant^{-1} (6.64) indicates the prevalence of additive gene action for these traits. These results are in agreement with those recorded by Godawat and Gupta (1986) and Backiyarani *et al*. (1997a).

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J. Maharashtra agric. Univ., 34 (2) : 149-151 (2009)

Weed Management in Wheat

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ABSTRACT

Beneficial effect due to the integrated weed management treatment *viz.*, pendimethalin pre emergence @ 1.0 kg ha^{-1} + hand weeding was observed on growth and yield attributes of wheat. The grain and straw yield (42.50 and 52.54 q ha^{-1} respectively) of wheat was maximum in weed free treatment followed by pendimethalin pre emergence @ 1.0 kg ha^{-1} + and weeding (41.70 and 51.07 q ha^{-1} respectively). Weed intensity and dry matter of weeds at harvest were significantly lower in weed free, pendimethalin pre emergence @ 1.0 kg ha^{-1} + hand weeding treatment and was higher in weedy check. This is attributed to efficient and prolonged weed control by herbicide, supplemented with hand weeding for the control of late emerging weeds. Maximum net monetary returns were obtained due to pendimethalin pre emergence @ 1.0 kg ha^{-1} + hand weeding (Rs. 22284 ha^{-1}) with benefit cost ratio of 2.32, followed by pendimethalin pre emergence 0.75 kg ha^{-1} + hand weeding.

Key words: Weed management, weed intensity, wheat yield.

An increased cropping intensity due to availability of irrigation water, modern farm technology, short duration varieties and increased use of fertilizers are some of the reasons that lead to greater weed infestation in recent years. The weed free condition during early period can be maintained either by cultural practices or by means of pre-planting or pre-emergence application of herbicides or combination of chemical and mechanical methods. It is also necessary to develop cheaper method of weed control with herbicides alone or in combination with other mechanical methods. The objective of this experiment was to study the efficacy of different weed control methods and to evaluate most suitable and economical treatment combinations for controlling weeds in wheat.

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MATERIALS AND METHODS

The field experiment was carried out during *rabi* 2004 at Instructional Farm of Post Graduate Institute, Central Campus, Mahatma Phule Krishi Vidyapeeth, Rahuri. The soil of the experimental field was sandy clay loam in texture, low in available N and P and high in available K and slightly alkaline in reaction. The experiment was laid out in a randomized block design with three replications. There were eleven treatment combinations comprised of herbicidal, mechanical and both along with control. The gross and net plot size were 6.0 x 3.6 m and 5.1 x 3.7 m, respectively. The sowing of wheat was carried out on 10th December, 2004. The crop was fertilized with 120 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1}.

The herbicides were applied as pre-emergence on 3rd day and post emergence on 40th day after sowing. Hand weedings were done

Table 1. Weed intensity, weed control efficiency, dry matter of weeds and different growth characters of wheat as influenced by different treatments.

Treatments	Weed intensity m^{-2} at harvest	Weed control efficiency (%)	Dry matter of weeds (q ha^{-1})	Plant height (cm)	Number of functional leaves	Number of tillers $plant^{-1}$
WC	32.00	-	5.15	73.00	14.40	4.20
WF	3.00	90.62	0.42	88.40	19.00	5.20
Pendi PE @ 1.0 kg ha^{-1}	12.00	62.50	2.65	81.70	15.80	4.40
Pendi PE @ 1.0 kg ha^{-1} + HW	4.00	87.50	0.68	87.90	18.60	5.20
Pendi PE @ 0.75 kg ha^{-1} + HW	5.00	84.50	0.83	86.10	18.00	5.00
2-4-D POE @ 1.0 kg ha^{-1} + HW	10.00	68.75	2.31	79.10	15.00	4.40
HW + 2-4-D POE @ 1.0 kg ha^{-1}	6.00	81.25	1.05	83.50	16.60	4.80
HW + 2-4-D POE @ 0.75 kg ha^{-1}	7.00	78.12	1.16	81.80	16.40	4.60
MSM POE @ 4.0 g a.i. ha^{-1}	8.00	75.00	1.66	79.80	15.20	4.40
HW + MSM POE @ 4.0 g a.i. ha^{-1}	4.00	87.50	0.83	85.40	17.20	4.80
HW + MSM POE @ 3.0 g a.i. ha^{-1}	5.00	84.37	0.96	85.00	16.80	4.60
SE $\pm$	0.85	-	0.10	1.81	0.21	0.13
C. D. at 5%	2.51	-	0.31	5.34	0.63	0.39
Mean	8.72	79.99	1.61	82.43	16.55	4.69

WC = Weedy check, HW = Hand weeding, WF = Weed free upto 60 DAS on 20 and 40 days after sowing as per the treatments. Plant protection was also carried out by spraying Dithane Z-78. In all five irrigations were given during the crop period including pre-sowing irrigation.

RESULTS AND DISCUSSION

Highest weed intensity (Table 1) was observed in weedy check (32 weeds m^{-2}). Lowest weed intensity was observed in weed free treatment and it was followed by pendimethalin pre emergence @ 1.0 kg ha^{-1} + hand weeding. Because of lower weed intensity competition was minimum there by crop growth was enhanced and obtained good yield. These results are in conformity with Pandey *et. al*. (1996) and Jat *et al.* (2004).

The highest weed control efficiency was observed in weed free treatment (90 %) followed by pendimethalin pre emergence @ 1.0 kg ha^{-1} + hand weeding. Lowest dry matter of weeds was observed in weed free treatment (0.42 q ha^{-1}) and it was at par with pendimethalin pre emergence @ 1.0 kg ha^{-1} + hand weeding (0.68 q ha^{-1}). These results are in conformity with Jat *et al*. (2004). Because of effective control of weeds lowest dry matter of weeds was observed in weed free treatment and it was at par with pendimethalin pre emergence @ 1.0 kg ha^{-1} + hand weeding. These results are in conformity with Jat *et al*. (2004).

There was also significant effect of weed management practices on growth characters like plant height, number of functional leaves and number of tillers $plant^{-1}$. Highest plant height (88.40 cm) and maximum number of functional leaves (19.00) were observed in weed free treatment it was followed by pendimethalin pre emergence @ 1 kg ha^{-1} + hand weeding (87.90 cm) and (18.60). Numbers of tillers $plant^{-1}$ (5.20) were similar in both above treatments. These results are in conformity with Kumar and Singh (1994) and Singh and Singh (2005).

Table 2. Yield attributes of wheat, gross and net monetary returns, B:C ratio as influenced by different treatments.

Treatments	**Length of ear (cm)**	**Number of spikelets ear^{-1}**	**Grain yield (q ha^{-1})**	**Straw yield (q ha^{-1})**	**Gross monetary return (Rs. ha^{-1})**	**Net monetary return (Rs. ha^{-1})**	**B:C ratio**
WC	7.20	14.00	25.20	28.50	23477	10551	1.82
WF	9.00	17.00	42.50	52.54	39801	20875	2.10
Pendi PE @ 1.0 kg ha^{-1}	7.90	15.00	32.80	37.94	30582	15825	2.07
Pendi PE @ 1.0 kg ha^{-1} + HW	8.90	16.73	41.70	51.07	39041	22284	2.32
Pendi PE @ 0.75 kg ha^{-1} + HW	8.70	16.60	40.00	47.31	37366	20990	2.28
2-4-D POE @ 1.0 kg ha^{-1} + HW	7.50	14.60	30.40	34.85	28343	14867	2.10
HW + 2-4-D POE @ 1.0 kg ha^{-1}	8.40	16.00	36.90	45.49	34562	19086	2.23
HW + 2-4-D POE @ 0.75 kg ha^{-1}	8.10	15.40	35.20	41.79	33764	18351	2.19
MSM POE @ 4.0 g a.i. ha^{-1}	7.80	14.80	31.70	34.01	29438	15812	2.16
HW + MSM POE @ 4.0 g a.i. ha^{-1}	8.40	16.20	38.47	48.07	36062	20436	2.30
HW + MSM POE @ 3.0 g a.i. ha^{-1}	8.20	15.60	37.10	45.63	34744	19218	2.23
SE $\pm$	0.19	0.35	0.77	1.02			
C. D. at 5%	0.58	1.05	2.22	3.01			
Mean	8.17	15.63	35.63	42.45			

There was beneficial effect of different treatments on yield characters like length of ear, number of spiklets ear^{-1}, grain and straw yield. The length of ear was highest in weed free treatment and it was followed by pendimethalin pre emergence @ 1.0 kg ha^{-1} + hand weeding and lowest was observed in weedy check (Table 2). Similar results were obtained by Kumar and Singh (1994) and Singh and Singh (2005). Similar trend like length of ear was also observed in case of number of spikelets ear^{-1}.

Grain and straw yield (Table 2) was also significantly influenced by different treatments. Maximum grain (42.50 q ha^{-1}) and straw yield (52.54 q ha^{-1}) was obtained in weed free treatment and it was followed by pendimethalin pre emergence @ 1 kg ha^{-1} + hand weeding (41.70 q ha^{-1} grain) and (51.07 q ha^{-1} straw). Lowest grain (25.20 q ha^{-1}) and straw (28.50 q ha^{-1}) yield was recorded in weedy check. These results are in conformity with Jat *et al*. (2004).

Highest net monetary returns and B:C ratio were observed in pendimethalin pre emergence @ 1.0 kg ha^{-1} + hand weeding treatment (Rs. 22284 ha^{-1} and 2.32, respectively) and it was followed by pendimethalin pre emergence @ 0.75 kg ha^{-1} + hand weeding (Rs. 20990 ha^{-1} and 2.28, respectively). These results are in conformity with Singh and

Singh (2004).

The findings of the present investigation revealed that the improvement in grain and straw yield of wheat was observed when weeds are controlled either with mechanical or herbicidal use. From economic point of view pendimethalin pre emergence @ 1 kg ha^{-1} + hand weeding gave highest returns.

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J. Maharashtra agric. Univ., 34 (2) : 151-153 (2009)

'Phule Samruddhi' a New High Yielding Variety of Rice, for Western Maharashtra

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ABSTRACT

The culture VDN-99-29 'Phule Samruddhi' was developed by crossing Indrayani, a long slender, scented variety with Sonsali, a long slender and high yielding variety of Rice. In station trials it gave 31.93 per cent more yield over the check RP-4-14. In state multilocation trials it had produced 4012 kg ha^{-1} of grain yield which was 16.39 per cent more over the national check RP-4-14 (3447 kg ha^{-1}). In station trial it had recorded highest grain (4929 kg ha^{-1}) and straw yield (5555 kg ha^{-1}). It was found to be resistant to the pest like brown plant hopper and moderately resistant to stem borer. It was also resistant to the disease like bacterial blight and moderately resistant to the leaf blast and neck blast. In adaptive trials it had recorded 30.07 per cent more yield over the check RP-4-14. Besides having, high grain yield potential due to more number of tillers per sq. m., panicle length and number of spikelets per panicle, It had more milling and head rice recovery with long slender grains and optimum amylase content. Hence, it was released in State Variety Release Committee held on 11th July 2007.

Key words : Rice, yield, variety.

The average rice productivity of the state is stable around 1.7 tones per ha. which is low as compared to national productivity of 1.93 t ha^{-1}. (Anonymous, 2007). It is necessary to increase the productivity level of rice up to 2500 to 3000 kg ha^{-1} to meet the requirements of increasing population. Therefore, the area of rice, under local types which are low yielding and susceptible for various diseases and pests must be brought under high yielding improved verities (D. Cruz and Patil, 1966). The area under midlate duration rice varieties is about 50%. The liking of the consumers/cultivators is towards high yielding, fine-grained, rice varieties having midlate duration for maturity. It indicated the need, for suitable high yielding, fine grained, midlate, quality rice variety (Katare, *et al.* 2004).

MATERIALS AND METHODS

The culture, VDN-99-29 was evolved by crossing scented, high yielding, midlate Indrayani variety with non sticky, non scented, high yielding variety Sonsali. The segregating population from F_2 to F_6 was screened at A.R.S. Vadgaon Maval for isolating the culture of midlate duration and high yield potential having more number of panicles per sq. m., long panicle length with more number of spikelets per panicle. The promising progenies including culture VDN-99-29 were tested in Initial Varietal Trial (IET) and Uniform Varietal Trial (UVT) during *kharif*-1999 and 2000 respectively. This culture was also tested in state multilocation trial (2001-2003) i.e. Initial Variety Trial

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Table 1. Pooled grain yield (kg ha^{-1}) performance of the genotype VDN-99-29 in various trials.

Genotype	Grain yield (kg ha^{-1})		Mean (kg ha^{-1})	Increase over check (%)	Grain yield (kg ha^{-1})			Mean (kg ha^{-1})	Increase over check (%)
	IET-Midlate (Kh-1999)	UVT-Midlate (Kh-2000)			IVT-Midlate (Kh-2001)	AVT-Midlate (Kh-2002)	AVT-Midlate (Kh-2003)		
VDN-99-29	2391	2546	2468	31.93	4006	3785	4245	4012	16.39
RP-4-14 (Ch)	1780	1914	1847	-	3553	3264	3524	3447	-
S. E. $\pm$	137.3	200.59	-	-	160.1	174.3	54.3	-	-
C. D. at 5%	396.6	576.98	-	-	516	516	163	-	-

and Advance Variety Trial in ten locations of Maharashtra. All the trials were conducted in a randomized block design with 3 replications by adopting plot size 4.5 x 3.0 m. with spacing of 20 x 15 cm. The recommended dose of fertilizer was applied i.e. 100:50:50 N.P.K kg ha^{-1}. At maturity, yield and yield contributing characters were studied over locations. Adaptive trials were conducted at different locations on farmers field during *kharif* 2006 in Pune, Satara, Kolhapur and Nashik districts of Western Maharashtra.

RESULTS AND DISCUSSION

In station trials, conducted during *kharif*-1999 and 2000, VDN-99-29 gave average grain yield of 2468 kg ha^{-1} while check RP-4-14 gave 1847 kg ha^{-1} (Table 4). Yield of VDN-99-29 was 31.93 per cent more than RP-4-14.

State multilocation trials of promising cultures including high yielding national check RP-4-14 were conducted during 2001-2003 at different locations. VDN-99-29 was found superior over RP-4-14. On an average of all ten locations during the period of 2001-2003, it gave 4012 kg ha^{-1} of grain yield which was 16.39 per cent more over RP-4-14.

Table 2. Mean grain and straw yield of paddy (q ha^{-1}) as affected by different treatments.

Treatments	Yield (q ha^{-1})	
	Grain	Straw
Varieties :		
V_1 - VDN-99-29	49.60*	56.04*
V_2 - Indrayani	42.13*	47.21
V_3 - RP-4-14	38.98	44.57
SE$\pm$	1.03	1.19
C. D. at 5%	2.92	3.49
Fertilizer levels :		
F_1 - 75% RDF through straight fertilizers	38.16	42.15
F_2 - 100% RDF (100:50:50) through straight fertilizers	43.04	47.87
F_3 - 125% RDF through straight fertilizers	44.20	49.55
F_4 - 75% RDF in urea- DAP briquette form + 37.5 kg K_2O	40.18	45.86
F_5 - 100% RDF in urea- DAP briquette form (56:30:0) + 50 kg K_2O	48.53*	54.64
F_6 - 125% RDF in urea- DAP briquette form + 62.5 kg K_2O	49.29*	55.55
SE$\pm$	1.46	1.68
C. D. at 5%	4.13	4.93
C. Interaction (A x B)		
SE$\pm$	2.52	2.91
C. D. at 5%	N. S.	N. S.
C. V. %	9.96	10.24

Table 3. Disease and pest reactions of VDN-99-29.

Genotype	Karjat		Lonavala				Sindewahi		Population/hill	
	W. E.	B. B.	Leaf Blast		Neck blast	Leaf scald	Blast	BLB	30 DAT	
			GH	Field					BPH	WBPH Gr.
Kh-2001 :										
VDN-99-29	3MR	1R	3MR	3MR	-	3MR	4MS	4MS	-	-
RP-4-14 (Ch)	3MR	2R	2MR	2R	-	3MR	4MR	3MR	-	-
Kh-2002 :										
VDN-99-29	3MR	2R	3MR	3MR	3MR			6S	T	2R
RP-4-14 (Ch)	3MR	3MR	1R	2R	0HR			6S	T	2R
Kh-2003 :										
VDN-99-29	NG	3MR	1R	1R	1R		3MR	1R	1R	1R
RP-4-14 (Ch)	NG	3MR	NG	1R	3MR		2R	2R	2R	2R

Table 4. Performance of VDN-99-29 in adaptive trials conducted at various locations.

District	Trials	Grain yield (q ha^{-1})	
		VDN-99-29	RP-4-14
Pune	6	75.66	45.50
Satara	5	76.75	60.50
Kolhapur	5	61.49	54.59
Nashik	6	93.50	75.75
Mean		76.85	59.08

Average increase over the check RP-4-14 = 30.07%

Table 5. Mean ancillary data and grain quality characteristics of VDN-99-29.

Characteristics	Genotype	
	VDN-99-29	RP-4-14
Ancillary characteristics :		
Days to 50% flowering	128	135
Plant height (cm)	72	68
Tillers per sq. m	270	260
Panicle length (cm)	22	21
Spikelets per panicle	165	152
Grain qualities :		
Grain type	**Long slender**	**Long slender**
L:B ratio	3.58	2.48
Test weight (g)	22.00	22.00
Amylase content (%)	21.17	24.80
Milling %	69.60	68.60
Head rice recovery	61.00	60.20

An agronomical trial was conducted at Vadgaon, to observe the response of VDN-99-29 to different fertilizer levels and green manures, the highest grain yield (49.29 q ha^{-1}) and straw yield (55.55 q ha^{-1}) were recorded by treatment 125 per cent RDF in UB form + 62.5 kg K_2O (Table. 2).

It was screened for different diseases and pest at hot spot locations like Karjat, Lonavala and Sindewahi during 2001-2003 and found to be moderately resistant to pests like stem borer and resistant to the brown plant hopper and moderately resistant to the diseases like leaf blast, neck blast and resistant to bacterial blight (Table 3).

In adaptive trials, conducted at different locations on farmers field during 2006 in Pune, Satara, Kolhapur and Nashik districts of Maharashtra, the culture VDN-99-29 gave 30.07 per cent more yield over the check RP-4-14 (Table 4).

With sequential trials and research, it was found that, VDN-99-29 is a semi dwarf (72.0 cm.), non lodging with profuse tillering and more panicle length (22 cm) and matures in about 125-130 days (Table 5). It was having long slender good quality grains with optimum amylase content (21.17 per cent). It was also having good milling (69.6 per cent) and head rice recovery (61.00 per cent). Therefore, the culture VDN-99-29 was recommended for release in the name of 'Phule Samruddhi' by the State Variety Release Committee meeting held on 11th July, 2007.

ACKNOWLEDGEMENT

The authors are thankful to Associate Director of Research, Igatpuri (Nashik), Kolhapur and Karjat and Officer Incharge, A.R.S. Radhanagari for conducting the trials at their respective centers under collaborative programme of multi-location testing of genotypes.

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J. Maharashtra agric. Univ., 34 (2) : 154-157 (2009)

Productivity and Weed Dynamics as Influenced by Fish in Rice-Fish-Poultry Integrated Farming Systems

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ABSTRACT

A field experiment was conducted, during the wet and dry seasons of 2004-05 and 2005-06, consisting of five rice-fish-poultry models compared with conventional rice -rice system. Among the different rice-fish-poultry models, the total productivity was highest in the model where the fish pits dugged at the center of the rice field and poultry was maintained separately (17502 kg ha^{-1} $year^{-1}$). This model showed the highest yield (riec equivalent yield) of rice-rice (9118 kg ha^{-1}), fish (1488 kg ha^{-1}) and poultry (6896 kg ha^{-1}). Intensity of weeds was less in the fields where fishes were maintained as compared to rice-rice system alone. The weed intensity was less near the fish pit and middle of the rice field. Among different models, fish pits dugged at the center of the rice field and poultry was maintained separately recorded lower weed count and dry weight followed by fish pits dug on one side of the rice field and poultry shed on the fish pit and -fish pits dug on one side of the rice field and connected by small trenches and poultry shed on the fish pit.

Key works : Fish, Integrated farming system, poultry, productivity, rice-rice, weed dynamics.

In the irrigated eco-system of Tungabhadra project area of Karnataka; canals are one of the major source of irrigation. The productivity of low laying fields in Tungabhadra command areas are very low due to excess moisture and occasional water logging through seepage from adjacent canals. Added to this, indiscriminate use of inorganic fertilizers and plant protection chemicals has aggravated the ill effects. Rice-fish culture may be one suitable intervention to improve the productivity of such lands. Introduction of fish in the rice fields having flooded condition not only provided economic benefits, but also nutritional security by production of protein from the rice fields (Bhatnagar *et al.* 2005). The benefits of rice-fish under flooded conditions as a low-investment technology of resource poor farmers had been demonstrated at several locations in the world (Prein, 2002). A good *in-situ* synergism exists between the fish and rice crop improving the productivity of each other. Rice yields were reported to be improved by 35 per cent as fish controls a wide range of weeds and insect pests (Ayyappan, *et al.*, 2004). Further integration of poultry in rice -fish would improve the productivity and sustainability. Therefore, five rice-fish-poultry models with one conventional rice -rice system were evaluated for their productivity and feasibility of maintaining fish and its effect on weed dynamics.

MATERIALS AND METHODS

A field experiment was conducted at Agricultural Research Station, Siruguppa, Karnataka, under canal irrigation of Tungabhadra project during 2004-05 and 2005-06. The soil of the experiment site was deep black with pH 8.1. The available N, P_2O_5 and K_2O of the soil were 195, 30, and 500 kg ha^{-1}, respectively. The field size under each IFS (Integrated farming systems) was 1666.5 m^2 to 2704 m^2 (Table 1). The treatments consisted of five models of IFS (Table 1) compared with conventional system of rice-rice. Rice genotype BPT 5204 and IR - 64 were used during wet and dry seasons, respectively. A common dose of NPK (150:75:75 NPK kg ha^{-1}) was applied. Fifty per cent of N and full dose of recommended P and K were applied at the time of sowing. The remaining 50 per cent N was top dressed in two equal splits at tillering and panicle initiation stage. Fish fingcrlings *viz.*, rohu (20%), catla (30 %) and mrigal (50%) were released 15 days after transplanting and harvested after dry season rice. For rearing fish, one tenth of the area in each plot was allotted. Only poultry droppings was served as the source of fish feed. Poultry breed Giriraj @ 500 ha^{-1} was reared in cages constructed on the fish pit (T_1 and T_2) or reared separately (T_3, T_4 and T_5) as per the treatment . The birds were provided with starter feed up to 20 days and later farm waste (broken grains, fish meal, sunflower cake) were used as the source of feed. The droppings were allowed directly into the fish pit in models (T_1 and T_2) where the cage was constructed on the fish pit while when poultry was reared

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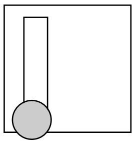
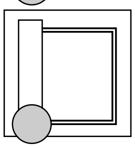
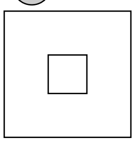
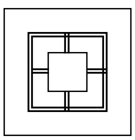
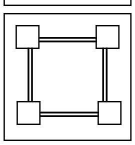
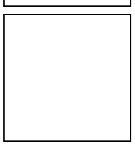
Table 1. Field layout, treatments details and area allocation for rice and fish in rice-fish-poultry integrated farming system

T. No.	Design	Treatment details	Pit area	Trench area	Total field area
T_1		Fish pits dug on one side of the rice field and poultry shed on the fish pit	28.3 x 5.9 m	-	1666.5m^2
T_2		Fish pits dug on one side of the rice field and connected by small trenches. Poultry shed on the fish pit.	25.8 x 3.7 m (95.72 m2)	25.0 + 58.7 + 58.7 m length x 1m width (142.4 m2)	2384.2 m^2
T_3		Fish pits dug at center of the rice field Poulry was maintained separately	13.4 x 13.4 m (179.3 m2)	-	1793.0 m^2
T_4		Fish pits at the center of the rice field and connected by small trenches. Poultry was maintaned separately.	5 x 4 m (20 m2)	31.6 + 30 + 65.7 + 65.7 m length x 1m width (193 m2)	2220.6 m^2
T_5		Fish pits dug at the corners of the rice field and connected by small trenches. Poultry was maintaned separately.	(4.4 x 4.4 m length) x 4 Nos. x 1m width (77.31 m2)	84 + 25.6 m length x 1m width (109.6 m2)	1869.1 m^2
T_6		Conventional rice field	-	-	2704.0 m^2

separately (T_3, T_4 and T_5) the droppings were collected once in 15 to 30 days and added to respective treatments. After the harvest of fish, the fish pit silt was recycled to respective plots. Since, the study includes diversified enterprises like fish and poultry, the yield was converted into rice equivalent yield as suggested by Singh *et al*. (2005). The growth, survival rate and yield of fish was taken at release and at harvest. Weed count and dry weight per m^2 area was recorded at near, middle and end from the fish pit.

Table 2. Component productivity (rice grain equivalent), growth and productivity of fish in rice-fish-poultry system (pooled over years).

Treat. No.	Component productivity (kg ha^{-1} year^{-1})				Weight of fish (g)			Survival rate (%)	Yield (kg ha^{-1})
	Rice-rice	Fish	Poultry	Total	At realease	At harvest	Growth		
A. Integrated farming systems :									
T-1	8533	1171	5586	15290	6.1	364.0	357.9	21.4	289.4
T-2	8697	961	5493	15151	6.1	376.2	370.1	20.5	237.6
T-3	9118	1488	6896	17502	6.1	345.7	339.6	35.8	264.5
T-4	7750	76	6778	14604	6.1	101.3	95.2	5.5	18.7
T-5	8291	130	6808	15229	6.1	114.2	108.1	7.5	31.8
Mean	8478	765	6312	15556	6.1	260.3	254.2	18.1	168.4
B. Conventional cropping systems :									
T-6	6667	-	-	6667	-	-	-	-	-

RESULTS AND DISCUSSION

Component productivity : The data on the productivity was pooled over the years (Table 2). The results of the integrated farming system was compared with the conventional rice-rice system. The rice-fish-poultry integrated farming system resulted in the highest system productivity of 15556 kg

Table 3. Weed dynamics (Dicot and monocot weeds) during wet season as influenced by different rice-fish-poultry IFS (Pooled over 2004-05 and 2005-06).

Treat. No.	Dicot weed						Monocot weeds					
	Number of weeds m^{-2}			Weed dry weight (g m^{-2})			Number of weeds m^{-2}			Weed dry weight (g m^{-2})		
	Head	Middle	End	Head	Middle	End	Head	Middle	End	Head	Middle	End
T-1	9.0	12.5	38.5	2.0	8.7	16.0	1.9	11.4	13.0	1.0	5.2	8.7
T-2	2.4	16.4	31.5	1.2	11.0	11.0	3.2	22.5	18.7	1.7	14.6	7.5
T-3	5.5	12.6	17.5	2.6	6.0	9.2	3.0	16.5	9.2	1.4	21.6	2.7
T-4	12.5	19.8	19.7	6.1	10.4	9.0	5.2	16.0	6.0	2.5	20.4	6.5
T-5	10.0	22.0	32.5	5.8	10.5	10.4	7.6	12.2	14.1	3.7	5.4	8.5
T-6	46.0	40.7	38.5	15.6	14.7	15.4	12.0	14.7	18.6	7.1	8.7	9.1

Table 4. Weed dynamics (Dicot and monocot weeds) during wet season as influenced by different rice-fish-poultry IFS (Pooled over 2004-05 and 2005-06).

Treat. No.	Dicot weed						Monocot weeds					
	Number of weeds m^{-2}			Weed dry weight (g m^{-2})			Number of weeds m^{-2}			Weed dry weight (g m^{-2})		
	Head	Middle	End	Head	Middle	End	Head	Middle	End	Head	Middle	End
T-1	3.1	13.6	23.7	3.1	6.4	27.6	8.6	17.0	38.9	1.2	16.7	26.7
T-2	10.1	30.5	33.5	4.5	13.0	20.1	10.1	43.0	34.6	6.6	40.1	39.0
T-3	8.0	19.2	29.9	3.3	7.5	49.0	10.5	22.1	24.0	15.7	27.0	29.1
T-4	10.2	14.2	32.1	7.6	11.5	47.9	10.2	22.6	20.2	14.6	35.0	24.0
T-5	8.0	16.0	38.2	5.3	17.1	30.4	17.1	18.1	20.4	8.9	18.2	14.9
T-6	29.7	39.0	42.1	24.4	32.0	26.0	32.2	38.5	40.5	25.7	39.0	30.2

ha^{-1} $year^{-1}$, which was 133 per cent higher than the conventional rice-rice system (6667 kg ha^{-1} $year^{-1}$). Thus IFS provided an opportunity to increase the yield per unit area per unit time due to intensification and integration of allied enterprises and thereby efficient use of resources. The productivity of rice-rice in IFS was 8478 kg ha^{-1} $year^{-1}$, which was 27 per cent higher than the conventional rice-rice system. This may be attributed to better weed control by fish and enhanced nutrient availability due to recycling of poultry droppings. Ayyappan *et al.* (2004) reported that rice yield were improved by 33 per cent as fish controlled wide variety of insect attack and weeds. Bhatnagar *et. al.* (2005) also reported an increase of rice yields by 17 to 21 per cent with the inclusion of fish with the rice. Of the productivity obtained from the IFS, 54.5 per cent was from cropping, 40.6 per cent from poultry and 4.8 per cent from fisheries.

Among the different rice-fish-poultry models, the total productivity was highest (17502 kg ha^{-1} $year^{-1}$) in T_3 (Rice-fish (pit at the center of the field) - poultry (reared separately). The maximum system productivity may be attributed to the relatively higher rice equivalent of rice, fish and poultry under this system as compared to others. Channabasavanna (2000) also reported the highest productivity (11133 kg ha^{-1}) and sustainability with rice-fish-poultry system.

Growth, survival rate and yield of fish : The growth, survival rate and yield of fish was directly proportional to the size of the fish pit (Table 2). The pit design varied depending on the models (Table 1). In T_1, T_2 and T_3 much of the area was devoted for fish pit while in T_4 and T_5, pit area was reduced as a result of much area has gone for making trench (T_4) and / or spitting of fish pits into four (T_5). The data in fable 2 clearly indicated that in T_1, T_2 and T_3, growth, survival rate and yield was higher over T_4 and T_5. This may be attributed to more area devoted for fish pit in T_1, T_2 and T_3. Gupta *et al*. (1998) harvested 180 -

190 kg ha^{-1} of fish without any management while, Bhatnagar *et al*. (2004) reported that fish yield could be increased to 500 kg ha^{-1} with little management.

Weed dynamics : The weed count and weed dry weight was recorded in each field at three spots *viz*., near the fish pit, middle and end or away from the fish pit to study the movement of fish and its impact on weeds. In general, intensity of weeds (*Echinocloa crossgalli*, *Digitaria* sp., *Panicum* sp. and *Jussiara repens*) was less in the field where fish was maintained as compared to control. Generally fishes fed on the weeds that are germinated from seeds. Similar results were reported by Yang Guang Li. *et al*. (1990) and Ghosh *et al*. (1994). With respect to different locations, weed intensity was less near the fish pit followed by middle of the rice field. No much control was notice at far end or away from the fish pit. This clearly indicated the movement of fish when rice-fish culture was practiced in inland canal irrigated rice.

Among the models, in T_3 low weed count and dry weight was recorded followed by T_1 and T_2 (Table 3 and 4). This may be attributed to higher growth and survival rate of fish in these treatments.

With respect to seasons, the control of weeds by fish was better during wet season compared to dry season. This may be due to the fact that, during wet season, the fish size was smaller, high in number and no limitation of water, thus helped the fish for better movement in the field. While, during dry season, the fishes were grown up, less number (survival rate) and water level was limiting for its efficient movement. The control in weeds was noticed only near the fish pit.

Conclusion : Integrate farming system attained higher productivity as compared to conventional rice-rice system. Among the various models, T_3 (Rice-fish pit at the center of the field) - poultry (reared separately) was the best, which recorded the highest rice equivalent yield of crop (rice), fish and poultry. The weed control was also efficient in this model as a result of better growth and survival rate of fish.

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Physiology of Water Use Efficient Genotypes of Groundnut (*Arachis hypogaea* L.) in *Kharif* Season

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(Received : 25-03-2008)

ABSTRACT

A field trial with ten genotypes of groundnut was carried out. The results revealed that the genotypes T-18, J-30 and I-13 had higher yields coupled with high photosynthetic rate. However, genotypes I-23 and I-09 had lower photosynthetic rate resulted in lower yield. As regards to transpiration rate, the genotypes T-18, I-10 and J-17 had the highest transpiration rate, while the high yielding genotypes J-30, I-43 and I-13 had lowest transpiration rate. From the study, it was revealed that the higher water use efficiency (WUE) was exhibited by genotypes T-18 and J-30 had higher economic yield as compared to other genotypes having less WUE.

Key words: WUE, photosynthetic rate, transpiration, *kharif* groundnut.

Water use efficiency (WUE) is important physiological parameter for water relation studies in field crops. WUE is defined as the ratio of total dry matter produced to the total amount of water-transpired in the plant. Rainfed groundnut cultivation faces intermittent dry spells and thus there is a need to have drought tolerant genotypes. WUE is one of the traits, which can contribute to higher productivity when water availability is limited. The development of high yield drought tolerant genotype is, therefore a priority research issue in the state, so the study of WUE in groundnut genotype is very important. Considering all these aspects, the present investigation was planned and conducted.

MATERIALS AND METHODS

A field experiment was conducted during *kharif*, 2002 at the Mahatma Phule Krishi Vidyapeeth, Rahuri., The experiment was conducted in a randomized block design with ten genotypes [*viz*. J-17 (T_1), I-09 (T_2), T-18 (T_3), I-13 (T_4), J-30 (T_5), I-43 (T_6), ICGS-76 (T_7), I- 10 (T_8), T-41 (T_9) and I-23 (T_{10})] of groundnut and replicated three times in rainfed condition. The gross plot size was 3.0 x 2.10 m^2 crop sown on July, 2002 with 30 x 10 cm spacing. For measuring the rate of photosynthesis and transpiration in the field conditions a portable IRGA (Infra Red Gas Analyzer) has been developed in the recent years. The portable IRGA was used for measuring the rate of photosynthesis i.e. CO_2 fixation (mol CO_2 m^{-2} s^{-1}) and transpiration i.e. H_2O lost (mol H_2O m^{-2} s^{-1}) of crop plants. These measurements were recorded at flowering stage of groundnut crop. The water use efficiency (WUE) was calculated by using SPAD Chlorophyll meter (SPAD-502 Minolta i.e. Silicon Photo Amplified Diode) by calculating specific leaf area (SLA) after 35 to 55 days after sowing (DAS). Passioura (1977) considered pod yield (Yp) under limited conditions is given as Pod yield =T x WUE x HI

Where, T = the amount of water transpired by the crop (mm), WUE = the efficiency of water use in dry matter production, HI = the proportion of total biomass partitioning into pods.

Other formulae required for calculating WUE are

i) Adjusted SPAD = Average SPAD x (Radiation/VPD)

Where, VPD = Vapour pressure deficit

ii) Calculated SLA = (0.475 x Adjusted SPAD) + 333.2

iii) K = 6.72 - 3.14 x SLA index

Where, K = Transpiration efficiency

iv) SLA index = SLA/mean SLA of the treatment

v) VPD = 0.7 x (Vp maximum - Vp minimum) (in milli bars)

vi) Radiation = 1.813 x Sunshine + 1.4633

The data was analyzed as per the standard method of analysis of variance (Panse and Sukhatme, 1985).

RESULTS AND DISCUSSION

The data on mean rate of photosynthesis and transpiration are presented in Table 1. The data revealed that the genotypic differences were statistically significant. The genotype T-18

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(22.480 p mol m^{-2} s^{-1}) recorded significantly the higher mean rate of photosynthesis over rest of the genotypes except J-30 (18.797 mol m^{-2} s^{-1}), which was at par with T-18. The genotype I-09 (12.253 M mol m^{-2} s^{-1}) recorded significantly the lower mean rate of photosynthesis than other genotypes. The genotype T-18 recorded maximum photosynthetic rate while I-09 was lowest photosynthetic rate that was lowered at water stress at flowering stage. High temperature, humidity and water stress affected the photosynthetic rate adversely. These findings are in agreement with results reported by Subramanian and Maheswari (1990) who stated that decrease rate of photosynthesis under prolonged water stress in groundnut.

The genotype T-18 (0.541 mol m^{-2} s^{-1}) recorded significantly the higher mean rate of transpiration over rest of the genotypes except J-17 (0.526 mol m^{-2} s^{-1}) and I-10 (0.325 mol m^{-2} s^{-1}), which were at par with T-18. The genotype I-13 (0.325 mol m^{-2} s^{-1}) recorded significantly the lowest mean rate of transpiration among all the genotypes. Due to the high temperature, transpiration rate was increased greatly during the season. These findings are in accordance with findings of Reddy *et al.* (1993) who stated that transpiration at high temperature was 400 per cent higher than under a moderate temperature and under dry land conditions transpiration rate decreased by only 9 per cent. Light had also played an important role in transpiration.

The data of various characters

Table 1. Rate of photosynthesis and transpiration at the flowering stage of groundnut genotypes and WUE.

Genotypes	Photo synthesis rate (μ mol CO_2 m^{-2} s^{-1})	Transpiration rate (mol H_2O m^{-2} s^{-1})	Average SPAD value	Adjusted SPAD value (cm^2)	Specific leaf area (g^{-1})	Water use efficiency (g kg^{-1})
J-17	15.597	0.526	33.47	254.40	216.60	3.217
I-09	12.253	0.434	34.57	262.90	223.97	3.097
T-18	22.480	0.541	38.50	292.77	208.80	3.337
I-13	18.127	0.325	34.20	260.17	249.00	2.690
J-30	18.797	0.472	35.87	272.70	213.17	3.273
I-43	14.653	0.373	33.30	253.03	226.50	3.053
ICGS-76	14.790	0.456	36.17	275.00	239.90	2.837
I-10	13.340	0.521	32.33	245.83	236.23	2.897
T-41	15.803	0.475	34.03	258.93	227.27	3.043
I-23	14.080	0.490	31.10	236.60	253.90	2.610
Mean	15.992	0.461	34.353	261.233	229.533	3.005
S. E. ±	1.372	0.015	0.859	6.553	8.837	0.143
C. D. at 5%	4.074	0.045	2.550	19.461	26.245	0.425

Maximum temperature : 31.4°C, Sunshine hours : 6.2, VPD : 1.71, SPAD date : 28.8.2002
Minimum temperature : 18.7°C, Radiation : 13.00

Table 2. Yield contributing characters in groundnut genotypes.

Genotypes	Mature pods $plants^{-1}$	Kernel plant-1	Kernel yield (g) $plant^{-1}$	100 pod weight (g)	100 kernel weight (g)	Dry pod yield (g) $plant^{-1}$	Dry pod yield (kg) per net $plot^{-1}$	Dry pod yield (q ha^{-1})	Shelling per centage (%)	Total dry matter (kg) net $plot^{-1}$	Total dry matter (q ha^{-1})	Harvest index (%)
J-17	14.26	24.29	08.44	80.20	31.24	18.59	0.88	20.95	45.49	2.08	49.60	42.24
I-09	13.39	21.16	08.37	102.46	39.40	18.43	0.84	19.92	45.28	2.03	48.41	41.17
T-18	12.98	20.33	08.28	82.02	34.04	18.27	0.81	19.37	45.73	1.91	45.48	42.74
I-13	14.82	24.32	8.78	101.46	41.76	19.03	0.88	20.87	46.21	2.01	47.86	43.77
J-30	16.95	29.70	09.24	97.50	30.60	21.50	1.02	24.36	42.97	2.31	54.92	44.54
I-43	13.66	22.64	08.60	108.52	47.36	18.83	0.76	18.09	45.53	2.19	52.06	35.00
ICGS-76	10.74	18.26	08.05	102.86	44.24	17.25	0.82	19.60	46.54	1.95	46.51	42.34
I-10	10.51	15.87	07.74	93.98	41.26	15.88	0.71	16.90	48.57	1.81	43.09	39.22
T-41	12.20	18.85	08.13	98.78	43.64	18.01	0.80	18.97	45.37	1.61	38.42	49.38
I-23	09.43	15.06	07.48	96.65	38.80	15.44	0.74	17.22	48.70	1.77	42.06	40.94
Mean	12.894	21.048	8.311	96.45	39.234	18.120	0.826	19.627	46.008	1.967	46.841	42.147
S. E.±	0.35	0.60	0.46	1.58	0.96	0.75	0.02	0.54	2.28	0.08	1.97	1.88
C. D. at 5%	1.05	1.78	NS	4.71	2.87	2.23	0.06	1.61	N.S.	0.24	5.87	5.59

for calculating water use efficiency were collected, statistically analyzed and presented in Table 1. The statistical analysis of the data collected from all characters revealed that the genotypic differences were significant for crop growth. The genotype T-18 (3.337) recorded significantly the highest WUE over rest of the genotypes except J-30 (3.273), J-17 (3.217), I-09 (3.097), I-43 (3.053) and T-41 (3.043), which were at par with T-18. The genotype I-23 (2.610) recorded significantly the lowest WUE among all the genotypes except MO (2.897), ICGS-76 (2.837) and I-13 (2.690), which were at par with I-23.

Water use efficiency (WUE) or Transpiration efficiency (TE) improves productivity when available moisture levels are low. The use of specific leaf area (SLA) as simple and easily measurable trait that has strong relationship with WUE. These findings are in agreement with the findings of Wright *et al.*, (1994) who stated that low soil water status increased water use efficiency by decreasing transpiration in rainfed conditions. Craufurd *et al.* (1999) also stated that water deficit increases the WUE, while high temperature decreases the WUE.

It was evident from yield data (Table 2) that the differences due to genotypes were statistically significant indicating genetic variation in yield potential. The performance of different genotypes in respect of dry pod yield per hectare was statistically significant.

The genotype J-30 (24.36 q ha^{-1}) recorded significantly highest dry pod yield per hectare, over all genotypes. The genotypes J-17 (20.95 q ha^{-1}), I-13 (20.87 q ha^{-1}), I-09 (19.92 q ha^{-1}), ICGS-76 (19.60 q ha^{-1}) and T-18 (19.37 q ha^{-1}) were at par in per hectare yield with each other. The genotype I-10 (16.90 q ha^{-1}) recorded the significantly lowest dry pod yield per hectare over rest of the genotypes. The higher pod yield of the genotypes, *viz.*, T_5, T_1, T_4, T_2, T_7 and T_3 was mainly due to higher photosynthetic rate and lower transpiration. Water use efficiency (WUE) of these genotypes was also better. The present investigation had similar trend as seen by Jayalakshmi *et al.* (2000).

From the present investigation, it is revealed that the genotypes J-30 and T-18 had higher photosynthetic rate coupled with higher pod yield. These genotypes had lower transpiration rate than other genotypes. Among several drought adaptive mechanisms, WUE is the most important physiological trait. The genotypes T-18 and J-30 exhibited higher WUE and ultimately resulted in higher yield. The genotype I-23 recorded the lowest WUE with lowest yield.

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J. Maharashtra agric. Univ., 34 (2) : 161-163 (2009)

Evaluation of Different Mulches for *Rabi* Onion

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(Received : 28-04-2008)

ABSTRACT

The marketable yield of onion was maximum (31.24 t ha^{-1}) with the adoption of the sugarcane trash mulch, followed by black and white polyethylene and wheat straw mulches, while the lowest marketable bulb yield (21.45 t ha^{-1}) was found in the treatment of non-mulch. The bulb yield of the onion was in proportion with the growth performance of the crop. The study revealed that there is a potential for adopting the sugarcane trash as mulch in onion cultivation to increase yield by 45.6 per cent over non-mulch.

Key words : Onion, mulches, growth parameters, yield.

Onion is one of the most important vegetable crops grown in India. India's share in the world production is about 12.3 per cent and ranks second in the production of dry onion bulbs in the world (Anonymous, 2003). In India, onion is grown on an area of over 0.53 M ha, producing about 5.5 M tonnes of bulbs (Anonymous, 2006). The increasing need for crop production for the growing population is causing the rapid expansion of irrigation throughout the world. Therefore, it is necessary to have a careful management of water resource for maximizing the production.

The use of mulching as a soil moisture conservation technique is an accepted practice in the crop cultivation. Benefits of plastic mulch are probably associated with better diurnal pattern of soil temperature and wider canopy-air temperature (Pandey and Singh, 1998). Therefore, this study was undertaken to find out the relative efficiency of the selected mulches with the *rabi* onion.

MATERIALS AND METHODS

The investigation was carried out at the Research Farm of Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri during *rabi* season, 2005-06. The experiment consisted of seven treatments, replicated three times in a randomized block design. The treatments included l. No mulch (control), 2. Black polyethylene strip (50 μ), 3. Black polyethylene sheet (50 μ), 4. White polyethylene strip (37.5 μ), 5. White polyethylene sheet (37.5 μ), 6. Wheat straw and 7. Sugarcane trash.

The gross plot size was 3.0 x 2.0 m with 1 m gap in between adjacent treatment plots. Graded and vigorous seedlings were transplanted at the spacing of 12.5 x 7.5 cm on 19th January, 2006. The irrigations were given to each plot as per the respective treatment. The irrigation water was applied on the day on which soil moisture content reached 29.04 per cent, which was decided according to the MAD value for onion (0.25), field capacity (33.25%) and permanent wilting point (16.45%). The soil sampling was done frequently in order to determine the day of irrigation in each irrigation cycle. Data on yield and crop growth parameters were recorded and analysed. All the treatment means were separated at $P < 0.05$.

RESULTS AND DISCUSSION

Growth attributes : The growth attributes of onion are shown in Table 1. The plant height

Table 1. Growth attributes of onion as influenced by different treatments.

Treatments	Plant height (cm)	Functional leaves plant^{-1}	Diameter of bulb (cm)	Neck thickness of bulb (cm)	Dry matter content (g)
Control	54.00	7.67	4.74	0.95	12.17
BP strip	61.97	8.33	5.83	1.29	14.18
BP sheet	64.10	8.90	6.22	1.37	14.23
WP strip	58.13	8.47	5.56	1.20	13.19
WP sheet	60.47	8.87	5.68	1.33	13.27
Wheat straw	57.53	7.80	5.28	0.98	13.39
Sugarcane trash	67.60	9.47	6.73	1.36	15.21
LSD at 5%	2.47	0.99	0.28	0.14	0.76

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was significantly increased by the mulched treatment. The maximum plant height of 67.60 cm was observed in the sugarcane trash mulch, followed by the black and white polyethylene and the wheat straw mulch. The lowest height of 54.00 cm was observed in the non-mulched treatment. The positive response of mulches on plant height was might be due to improved micro-environment developed in the rhizosphere of the crop and also due to the trend of soil moisture reservation under the different mulches.

The maximum and significantly superior number of functional leaves per plant was observed in the sugarcane trash mulch (9.47) than in WP strip (8.47), BP strip (8.33), wheat straw (7.80) and non-mulch (7.67) treatments and it was at par with BP sheet (8.90) and WP sheet (8.87). The neck thickness was maximum and significantly higher (1.37 cm) in the BP sheet than WP strip (1.20 cm), wheat straw (0.98 cm) and non-mulch (0.95 cm) and it was at par with sugarcane trash (1.36 cm), BP strip (1.29 cm) and WP sheet (1.33 cm) mulches.

The diameter of bulb in the sugarcane trash mulch was 6.73 cm, which was the maximum, and significantly greater than all the other treatments followed by BP sheet (6.22 cm). The least bulb diameter (4.74 cm) was found in the non-mulch treatment. It was found that the BP strip (5.83 cm) was significantly better than wheat straw (5.28 cm) and it was at par with WP sheet (5.68 cm) and WP strip (5.56 cm). Increased equatorial bulb diameter in the various mulched treatments might be due to the enhancement of early vegetative growth that resulted in better bulb development.

Table 2. Yield and quality of onion as influenced by different treatments.

Treatments	Marketable yield (t ha^{-1})	Unmarketable yield (t ha^{-1})	Twin bulbs (t ha^{-1})	Bolted bulbs (%)	TSS (%)
Control	21.45	4.67	0.40	0.4	10.3
BP strip	28.00	4.94	0.54	0.8	11.5
BP sheet	28.87	4.41	0.60	0.5	11.7
WP strip	24.72	5.05	0.54	0.6	11.6
WP sheet	25.74	4.34	0.59	0.5	11.2
Wheat straw	24.29	4.92	0.66	0.9	11.0
Sugarcane trash	31.24	5.09	0.51	1.6	11.4
LSD at 5%	2.34	NS	0.12	0.05	1.22

The sugarcane trash mulch recorded significantly superior dry matter content per plant (15.21 g) over all the other treatments. The black polyethylene sheet and strips were significantly superior to the white polyethylene sheet and strips, wheat straw and non-mulch treatments. The dry matter contents in BP sheet (14.23 g) and BP strip (14.18 g) were at par each other. WP sheet (13.27 g) was better than non-mulch (12.17 g) and it was at par with WP strip (13.19 g) and wheat straw (13.39 g) mulches. The dry matter increment due to mulches might be attributed to the presence of sufficient soil moisture content and provision of micro-environment.

Yield and quality of onion : The highest marketable bulb yield (31.24 t ha^{-1}) was observed in the sugarcane trash mulch, followed by black polyethylene (BP), white polyethylene (WP) and wheat straw (WS) mulches. The yield of onion in BP sheet (28.87 t ha^{-1}) was at par with BP strip (28.00 t ha^{-1}) and that of WP sheet (25.74 t ha^{-1}) was at par with WP strip (24.72 t ha^{-1}) and wheat straw (24.29 t ha^{-1}), while the lowest marketable bulb yield (21.45 t ha^{-1}) was found in the treatment of non-mulch (Table 2). The conservation of soil moisture and presence of favorable micro-environment due to the different mulches resulted in promoting the better yield performance in onion cultivation. The marketable bulb yield of the onion was in line with the growth performance of the crop. Similar results were reported by Rekowska (1997) and Rekowska and Fiedorow(1998).

In quality parameters, the yield of twin and bolted bulbs was significantly influenced by the different mulching treatments. The yield of twin bulbs was found to be maximum (0.66 t ha^{-1}) and significantly more in wheat straw than sugarcane trash (0.51 t ha^{-1}) and non-mulch (0.40 t ha^{-1}) and it was at par with all the remaining polyethylene treatments.

The highest bolting percentage (1.6%) was observed in the sugarcane trash mulch treatment, followed by wheat straw (0.9%), BP strip (0.8%), WP strip (0.6%) and black and white sheet. The sugarcane trash mulch was significantly superior to all the treatments. The BP sheet (0.5%) was at par with WP sheet (0.5%) and significantly better than the non-mulch (0.4%), which bring into being the lowest bolting percentage. The observed high bolting percentage in mulched treatments might be attributed to the early maturity and it is established fact that mulches encourage early maturity (Singh and Sethi, 1966).

The highest TSS (11.7%) was observed in the BP sheet mulch. BP sheet (11.7%) and WP strip (11.6%) were found to be significantly more than that of non-mulch (10.3%) and these were at par with all the other remaining treatments. The lowest TSS was found in the treatment of non-mulch (Table 2). These findings are in accordance with the results of Vani *et al.* (1989) and Kolhe (2003) who reported increased T.S.S. in muskmelon due to various mulches as compared to control.

The mulched treatments showed better performance in plant growth, yield and quality parameters of onion. Amongst the mulches, the sugarcane trash showed highest marketable yield (31.24 t ha^{-1}), which was 45.6 per cent greater than the non-mulch, followed by black and white polyethylene, and wheat straw mulch. Amongst polyethylene mulches, the black polyethylene sheet mulch was found to be better.

ACKNOWLEDGEMENT

Authors are thankful to the Council for Agricultural Research Policy (CARP), Sri Lanka for providing financial assistance for the study.

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J. Maharashtra agric. Univ., 34 (2) : 164-167 (2009)

Physiological Basis of Yield Variation in Oat in Relation to Nitrogen Levels under Different Cutting Management

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ABSTRACT

The mean crop growth rate, relative growth rate and net assimilation rate were improved significantly at single cut (50 % flowering) over double cut system (C_2 and C_3) at all the stages, while maximum leaf area ratio was recorded at double cut system. Among cutting managements, crop harvested once at 50 per cent flowering (C_1) significantly improved leaf area index, specific leaf weight and also the dry matter yield. The CGR, RGR and LAR increased significantly with increase in nitrogen levels however, reverse trend was noticed for NAR. Leaf area index significantly increased with increase in nitrogen levels up to 160 kg ha^{-1} and dry matter yield up to 120 kg N ha^{-1}.

Key words : Oat, cutting management, nitrogen, growth parameters and yield.

Oat (*Avena sativa* L.) is an important winter feed and forage crop of gramineae family. Owing to its excellent growth habit, better regeneration capacity and good quality forage, it has become a promising forage crop for the livestock production. Forage plants especially the multicuts are heavy feeders of plant nutrients and remove large amount of nutrients from the soil. Nitrogen is an essential primary nutrient for plant growth that improves the productivity of the crop by increasing the meristematic activities of plant. Besides nitrogen, growth and yield of crop is also affected by improved agronomic practices in which cutting management is one of the important practices. Yield is the manifestation of various physiological processes occurring in the plant and these processes are usually modified by management practices. Among various inputs, nutrient management plays an important role in productivity of crops. Nitrogen fertilization is one of the key factors in determining growth and yield of oat. Nitrogen application up to 150 kg ha^{-1} resulted in an increase in leaf area, leaf pigments, photosynthetic productivity (NAR) and photosynthetic potential (LAD) in wheat (Zaigraev, 1977). Thus, variation in productivity of crop may be related to growth parameters like CGR, RGR, NAR, LAR and LAI. Most of the work on growth parameters in the past has been on grain crops. Keeping above points in view, the present study was undertaken.

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MATERIALS AND METHODS

A field experiment was conducted at Instructional Dairy Farm, G. B. Pant University of Agriculture and Technology, Pantnagar during the rabi seasons of 2003-04 and 2004-05. The treatments comprised of three cutting management (C_1 - single cut at 50% flowering, C_2 - first cut at 50 DAS and second cut at 50% flowering and C_3 - first cut at 60 DAS and second cut at 50% flowering) and five nitrogen levels (0, 40, 80, 120 and 160 kg ha^{-1}). The experiment was laid out in a factorial randomized block design with four replications. The soil of experimental field was silty loam in texture with 1.23 per cent organic carbon, 0.14 per cent total nitrogen, 46.25 kg ha^{-1} available P and 279.8 kg ha^{-1} available K and neutral in reaction (pH -7.1). The crop was fertilized with 60 kg P_2O_5 ha^{-1} and nitrogen as per the treatments. The variety UPO-212 was sown at 25 cm apart @ 100 kg ha^{-1}. The half quantity of nitrogen and full dose of phosphorus were applied as basal in each plot. The remaining half dose of nitrogen in C_2 was top dressed just after first cut (50 DAS) and in C_3 and C1 at 60 DAS. The crop was harvested as per the treatments. Five hundred gram fresh sample at each cut from each plot was taken and dried in oven at 70°C ± 2 for 48 hours for calculating dry matter yield. At each sampling, plant samples from 0.5 m. row length were cut from ground level and green leaves were separated and leaf area of separated leaves was measured by using leaf area meter. The mean crop growth rate (CGR), relative growth rate (RGR), net assimilation rate (NAR) and leaf area ratio (LAR) were calculated by using the formula of Radford (1967) at different growth stages.

RESULTS AND DISCUSSION

Cutting management : Pooled data presented in Table 1 revealed that in general, CGR increased with crop age up to final harvest except 20 days after first cut as it decreased owing to first cut taken at 50 and 60 days after sowing in C_2 and C_3 treatment, respectively. At 30 DAS - I cut, the delay in first cutting from 50-60 days after sowing (C_2 and C_3) significantly increased CGR, while reverse trend was noticed in case of RGR and NAR. Single cut at 50 per cent flowering (C_1) noticed significantly higher CGR and NAR at first onward at all growth stages than double cut system (C_2 and C_3) except at 20-40 DAFC, where, C_2 i.e. first cut at 50 days after sowing and second cut at 50 per cent flowering recorded significantly higher NAR than single cut system (C_1). The same treatment (C_2) also recorded significantly higher RGR at 20-40 DAFC and LAR at I cut - 20 DAFC growth period. Single cut system also recorded maximum RGR at 40 DAFC - harvest period. At 20-40 DAFC, C_3 i.e. first cut at 60 days after sowing and second cut at 50 per cent flowering registered significantly higher LAR than C_1 however, at 40 DAFC - harvest, C_3 was found significantly superior over C_1 and C_2. The increased CGR with progress of plant growth can be explained on the basis of dry matter accumulation and is probably one of the factors contributing maximum dry matter during 40 DAFC - harvest. The LAR increased up to first cut and thereafter declined. This might be due to the fact that leaves became thicker and thicker due to more accumulation of dry matter up to first cut and thereafter this capacity was reduced. The results are in conformity with the findings of Rao and Bharduaj (1982).

Table 1. Crop growth rate (CGR) and relative growth rate (RGR) of oat as influenced by cutting management and levels of nitrogen (Pooled over 2 years).

Treatment	Crop growth rate ($g\ dm\ day^{-1}\ 0.5\ m^{-2}$)				Relative growth rate ($mg\ g^{-1}\ day^{-1}$)			
	30 DAS-I cut	I cut-20 DAFC	20-40 DAFC	40 DAFC-harvest	30 DAS-I cut	I cut-20 DAFC	20-40 DAFC	40 DAFC-harvest
Cutting management :								
C_1	-	0.499	1.795	3.905	-	24.223	43.814	39.889
C_2	0.660	-0.346	1.248	1.709	91.085	-28.823	62.913	37.442
C3	0.735	-0.851	0.965	1.280	75.837	-59.112	59.377	36.117
S. Em.±	0.012	0.015	0.034	0.095	0.848	1.033	1.076	1.525
C. D. at 5 %	0.033	0.042	0.095	0.268	2.405	2.908	3.027	NS
N levels ($kg\ ha^{-1}$) :								
0	0.454	-0.174	0.680	1.192	82.210	-22.807	48.381	38.140
40	0.637	-0.255	1.032	1.680	84.511	-23.533	52.755	36.837
80	0.725	-0.255	1.375	2.406	84.592	-21.003	56.353	37.939
120	0.778	-0.216	1.746	2.935	81.502	-19.057	60.506	37.974
160	0.892	-0.262	1.849	3.277	84.491	-19.786	58.846	38.190
S. Em.±	0.018	0.019	0.043	0.123	1.341	1.335	1.390	1.969
C. D. at 5 %	0.052	0.054	0.122	0.346	NS	NS	3.908	NS

DAS = Days after sowing, DAFC = Days after first cut.

Table 2. Net assimilation rate (NAR) and leaf area ratio (LAR) of oat as influenced by cutting management and levels of nitrogen (Pooled over 2 years).

Treatment	Net assimilation rate ($mg\ cm^{-2}\ day^{-1}$)				Leaf area ratio ($cm^{-2}\ g^{-1}$)			
	30 DAS-I cut	I cut-20 DAFC	20-40 DAFC	40 DAFC-harvest	30 DAS-I cut	I cut-20 DAFC	20-40 DAFC	40 DAFC-harvest
Cutting management :								
C_1	-	0.137	0.322	0.483	-	184.385	136.740	82.795
C_2	0.391	-0.130	0.381	0.334	238.071	228.686	166.090	114.777
C_3	0.329	-0.330	0.361	0.290	239.403	189.445	167.195	125.403
S. Em.±	0.007	0.006	0.011	0.016	3.502	3.201	2.522	2.393
C. D. at 5 %	0.021	0.018	0.030	0.045	NS	9.056	7.093	6.731
N levels ($kg\ ha^{-1}$) :								
0	0.397	-0.118	0.357	0.386	210.971	182.492	140.420	100.742
40	0.399	-0.126	0.366	0.378	214.149	181.477	147.614	100.162
80	0.378	-0.111	0.365	0.381	227.198	187.218	154.737	106.207
120	0.324	-0.093	0.349	0.355	258.081	218.585	168.035	111.034
160	0.302	-0.092	0.334	0.343	283.285	234.419	172.571	120.147
S. Em.±	0.012	0.008	0.014	0.021	5.538	4.157	3.256	3.090
C. D. at 5 %	0.033	NS	NS	NS	15.702	11.691	9.158	8.690

Among the cutting management single cut at 50 per cent flowering (C_1) noticed significantly higher LAI (7.11), SLW (3.72 $mg\ cm^{-2}$) and also the dry matter yield (80.46 q ha^{-1}) than double cut system (C_2 and

Table 3. Leaf area index (LAI), specific leaf weight (SLW) and dry matter yield of oat as influenced by cutting management and levels of nitrogen (Pooled over 2 years).

Treatment	LAI	SLW (mg cm^{-2})	Dry matter yield (q ha^{-1})
Cutting management :			
C_1	7.11	3.72	80.46
C_2	5.40	3.10	63.08
C_3	4.76	2.59	56.33
S. Em.±	0.07	0.06	0.91
C. D. at 5 %	0.20	0.18	2.57
N levels (kg ha^{-1}) :			
0	3.13	3.56	41.07
40	4.11	3.46	57.18
80	5.63	3.20	70.07
120	7.24	2.89	81.14
160	8.68	2.60	83.56
S. Em.±	0.09	0.08	1.18
C. D. at 5 %	0.26	0.24	3.32

C_3). The delay in first cutting from 50-60 days after sowing (C_2 to C_3) significantly reduced LAI, SLW and dry matter yield. Higher LAI with single cut system might be due to higher number of leaves per unit area. Increased tillers and more functioning leaves gave more canopies which ultimately increased the leaf area index. Higher dry matter yield in single cut system might be due to more biomass synthesis due to photosynthetic activity continuing uninterrupted beyond 50-60 days of growth. Also higher dry matter yield could be attributed to more CGR, RGR, NAR, LAI and SLW under single cut system (Table 1, 2 and 3). These results are in conformity with findings of Joshi *et al*. (1997) and Singh (2004).

Nitrogen levels : The CGR, RGR and LAR increased with increase in level of nitrogen at all the stages of observation. Application of 160 kg N ha^{-1} significantly enhanced the CGR and LAR over rest of the nitrogen levels, however, 120 and 160 kg N ha^{-1} were at par for CGR at 20-40 DAFC and 40 DAFC- harvest and 20-40 DAFC for LAR. Increased CGR with increase in nitrogen level might be due to more foliage growth and metabolic activities occurred in plant. The enhanced photosynthetic activity in plant leads to more production and accumulation of photosynthates in plant (Reddy, 1984). The LAR decreased with advancement of crop growth stages (Table 2). It might be due to the fact that dry matter accumulation was more rapid in non-leaf area than leaf tissue. The RGR did not influenced significantly by nitrogen levels at all stages except at 20-40 DAFC, where 120 kg N ha^{-1} significantly increased the RGR over 0, 40 and 80 N kg ha^{-1}. Singh and Agarwal (2001) reported that application of 180 kg N ha^{-1} significantly enhanced CGR and RGR over preceding nitrogen levels. The enhancement in growth parameters with increase in nitrogen was due to rapid conversion of synthesized carbohydrates into protein and thus increases the number and size of cell which might caused increase in dry matter accumulation. The NAR did not differ significantly due to nitrogen levels at all stages and showed decreasing trend with increase in level of nitrogen, however, at 30 DAS - I cut, 40 kg N ha^{-1} was at par with 0 and 80 kg recorded significantly more NAR than 120 and 160 kg N ha^{-1}. Morgan (1988) and Potiraj and Srinivasan (1992) reported that NAR was unaffected by nitrogen and reduced with application of nitrogen. The growth parameters *viz*., CGR, RGR and NAR during I cut - 20 DAFC owing to first cut taken at 50 and 60 days after sowing in C_2 and C_3 treatment, respectively were adversely affected due to low temperature immediately after first cut.

Leaf area index increased significantly upto 160 kg N ha^{-1} and dry matter yield up to 120 kg N ha^{-1}, while decreasing trend was noticed in case of specific leaf weight. Increase in nitrogen level increased the LAI due to enhanced synthesis of enzymes, coenzymes, chlorophyll and other nitrogen containing compounds (Russell, 1973). The higher LAI attained through nitrogen led to high photosynthetic efficiency, which contributed to higher CGR and RGR. The SLW decreased with increase of nitrogen level might be due to leaf area increased at much faster rate than the amount of dry matter being accumulated in the leaf. Miyagi (1983) and Singh and Agarwal (2001) also reported similar results. The dry matter increased with increase in nitrogen levels mainly due to higher magnitude of CGR, RGR, LAR and LAI at higher level of nitrogen (Table 1, 2 and 3). Aklilu (2005) also reported that dry matter yield increased significantly up to 120 kg N ha^{-1} and increased yield might be due to beneficial effect of nitrogen on tillers, plant height, leaf length, leaf width and dry matter accumulation. On the physiological basis, it can be concluded that single cut at 50 per cent flowering along with application of 120 kg N ha^{-1} showed better response for achieving higher yield of oat.

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J. Maharashtra agric. Univ., 34 (2) : 167-170 (2009)

Phosphorus Management in Safflower Based Cropping System under Dryland Conditions

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(Received : 20-05-2008)

ABSTRACT

An application of 100 per cent recommended P to chickpea preceding with safflower receiving 100 per cent P recorded the highest chickpea yield, oil yield, gross monetary returns, net monetary returns and B:C ratio. The same treatment also recorded significantly high safflower equivalent yield, highest system gross returns, system net monetary returns and combine B:C ratio. However, application of 100 per cent recommended P to safflower preceding with chickpea receiving 5 t FYM ha^{-1} produced statistically at par yield. While, application of 50 per cent P + PSB to both safflower and chickpea produced comparatively low yield but almost equal B:C ratio due to the reduction in cost of phoshpatic fertilizers.

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

Continuous cropping with rabi safflower has led to depletion of soil fertility of particular zone. Improvement in soil fertility is possible by inclusion of short duration leguminous crop (Clegg, 1982). Leguminous crops in a cropping system also helps in meritorious availability of phosphorus (Chandrashekharan, 1969). The high density of cropping with application of adequate fertilizer did not deplete the soil nitrogen (Gosh, 1981). Phosphorus is most important nutrient which affects the yield and quality of oilseed. In recent years there has been renewed emphasis on integrated use of fertilizers and organic manures particularly in a cropping system taking in to account residual and cumulative effect to sustain soil fertility and crop productivity but also brings an economy and efficiently in fertilizer use and favorable influence on physio-chemical and biological properties of soils.

Thus, the present investigation, phosphorus management in safflower-chickpea year to year crop rotation was carried out to find out the better method of P management under dryland condition.

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MATERIALS AND METHODS

Field experiment was conducted for seven successive years at Agriculture Research Station, Mohol during *rabi* 1999-2000 to *rabi* 2006-07 on fixed site of vertisol under rainfed condition. The soil was low in available N (129 kg ha^{-1}), medium in available P_2O_5 (11.75 kg ha^{-1}) and high in available K_2O (548 kg ha^{-1}) with a pH of 8.0. Twelve treatments consisted of various nutrient management as shown in Table-1 were tested in randomized block design with two replications. Nitrogen was given through the urea, while phosphorus through single super phosphate as per the treatments. PSB was inoculated with seed just before sowing. All the dose of fertilizers, and biofertilizer were given as basal dose as per the treatments. Well decomposed FYM @ 5 ton ha^{-1} was incorporated in the soil 21 days before sowing as per the treatment. The experimental plots were kept fallow during *kharif* season and *insitu* moisture conservation practices were followed. The chickpea and safflower rotation was followed. The recommended safflower variety Bhima and chickpea variety Vishal was used. The sowing was completed in first week of October. The pooled analysis for seed yield and its economics was worked out. Safflower equivalent yield was calculated based upon market price of chickpea every year and statistically analyzed. Safflower oil content from each treatment was estimated on NMR and safflower oil yield and safflower equivalent seed yield was calculated for each treatment.

RESULTS AND DISCUSSION

The pooled data of seven years revealed that, the seed yield of chickpea, safflower, safflower equivalent yield and economics were significantly influenced by the various treatments of P application under dryland conditions.

Safflower : The treatment differences were observed to be statistically significant (Table 1). The application of 100 per cent recommended P to safflower preceding with chickpea receiving 100 per cent recommended P recorded highest seed yield and oil yield (1316 kg ha^{-1} and 390.9 kg ha^{-1} respectively) followed by application of 100 per cent recommended P to safflower preceding with chickpea receiving 5 t FYM ha^{-1} (1302 kg ha^{-1} and 382.8 kg ha^{-1} respectively). Similar results were reported by Khandse *et al.* (1991), Sudhakar and Sudharani (2007) and Ulemale *et al.* (2007) reported that application of 100 per cent recommended dose of phosphorus to safflower increased the seed yield by 25 per cent over the control.

The treatment of application of

Table 1. Seed yield, oil content, oil yield and economics of phosphorus management in safflower based cropping system (Pooled data of seven years).

Treatments		Seed yield (kg ha^{-1})		Safflower oil content (%)	Safflower oil yield (kg ha^{-1})	Gross returns (Rs ha^{-1})		Cost of culti (Rs ha^{-1})		Net returns (Rs ha^{-1})		B:C ratio	
Safflower (Bhima)	Chickpea (Vishal)	Safflower	Chickpea			Safflower	Chickpea	Safflower	Chickpea	Safflower	Chickpea	Safflower	Chickpea
Control	Control (No P)	898	902	28.9	259.5	11740	13997	6995	8959	4745	5038	1.21	1.56
100 % rec. P	100 % rec. P	1316	1545	29.7	390.9	17755	24619	8303	11438	9452	13181	2.13	2.15
100 % rec. P	50 % rec. P	1247	1184	28.9	360.4	16731	18702	8056	10165	8675	8537	2.07	1.83
50 % rec. P	50 % rec. P	1047	1185	29.7	311.0	14256	18785	8147	10115	6109	8670	1.75	1.95
50 % P + PSB	50 % P + PSB	1113	1339	29.5	328.3	15248	21659	7664	10670	7584	10989	1.99	2.02
100 % rec. P	Control (No P)	1263	935	29.0	366.3	17334	14638	8206	9022	9128	5616	2.11	1.62
100 % rec. P	5 t FYM ha-1	1302	1337	29.4	382.8	17667	20991	8269	11791	9398	9200	2.10	1.77
100 % rec. P	PSB+5 t FYM ha^{-1}	1270	1444	28.8	365.8	17291	22708	8178	12137	9113	10571	2.11	1.81
50 % rec. P	100 % rec. P	1046	1437	28.7	300.2	13859	22867	7490	11031	6369	11536	1.84	2.07
Control (No P)	100 % rec. P	923	1377	28.10	259.3	12375	22519	7820	10966	4555	11553	1.58	2.05
5 t FYM ha^{-1}	100 % rec. P	1167	1479	30.0	350.1	15747	23525	9224	11062	6523	12463	1.72	2.13
PSB+5 t FYM ha^{-1}	100 % rec. P	1244	1440	28.70	357.0	16705	22737	9390	10964	7315	11773	1.78	2.07
S. E. ±		27	24	-	-	-	-	-	-	-	-	-	-
C. D. at 5 %		79	66	-	-	-	-	-	-	-	-	-	-
CV %		10	9	-	-	-	-	-	-	-	-	-	-

Table 2. Pooled data of safflower equivalent yield (kg ha^{-1}) , economics of saffflower-chickpea year to year crop rotation system.

Treatment details		Safflower equivalent yield (kg ha^{-1})	System gross returns (Rs ha^{-1}) safflower-chickpea	System cost of cultivation (Rs ha^{-1}) safflower-chickpea	System net retrns (Rs ha^{-1}) safflower-chickpea	System B:C ratio
Safflower (Bhima)	Chickpea (Vishal)					
Control	Control (No P)	1963	25737	15954	9783	1.61
100 % rec. P	100 % rec. P	3132	42374	19741	22633	2.14
100 % rec. P	50 % rec. P	2655	35433	18221	17212	1.94
50 % rec. P	50 % rec. P	2462	33041	18262	14779	1.85
50 % P + PSB	50 % P + PSB	2741	36907	18334	18573	2.01
100 % rec. P	Control (No P)	2398	31972	17228	14744	1.86
100 % rec. P	5 t FYM ha-1	2899	38658	20060	18598	1.93
100 % rec. P	PSB + 5 t FYM ha-1	2992	39999	20315	19684	1.96
50 % rec. P	100 % rec. P	2752	36726	18521	18205	1.97
Control (No P)	100 % rec. P	2551	34894	18786	16108	1.85
5 t FYM ha-1	100 % rec. P	2924	39272	20286	18986	1.93
PSB + 5 t FYM ha-1	100 % rec. P	2952	39442	20354	19088	1.93
S. E. +		37	-	-	-	-
C. D. at 5 %		104	-	-	-	-
CV %		10	Market price of safflower-Rs. 1300 q^{-1}		Market price of chickpea-Rs. 1550 q^{-1}	

100 per cent recommended P to safflower preceding with chickpea receiving 100 per cent recommended P also recorded highest gross returns (Rs.17755 ha^{-1}), net monetary returns (Rs. 9452 ha^{-1}) and B:C ratio (2.13) followed by application 100 per cent recommended P to safflower preceding with chickpea receiving 5 t FYM ha^{-1} having Rs 23525 ha^{-1} gross monetary returns, Rs. 12463 ha^{-1} net monetary returns and 2.13 B:C ratio respectively. The treatment of application of 100 per cent recommended P to safflower preceding with chickpea without P and 100 per cent recommended P to safflower preceding with chickpea receiving PSB + 5 t FYM ha^{-1} also exhibited high B:C ratio (2.11).

Chickpea : The treatment differences were found to be statically significant (Table-1). The application of 100 per cent recommended P to chickpea preceding with safflower receiving 100 per cent P recorded the highest seed yield of chickpea (1545 kg ha^{-1}) and it was at par with application of 100 per cent recommended P to chickpea preceding with safflower receiving 5 t FYM ha^{-1} (1479 kg ha^{-1}). However, it was statistically significant over the rest of the treatments. The application of 100 per cent recommended P to chickpea preceding with safflower receiving 100 per cent P also recorded highest gross monetary returns (Rs. 24619 ha^{-1}), net monetary returns (Rs. 13181 ha^{-1}) and B:C ratio (2.15) followed by application of 100 per cent recommended P to chickpea preceding with safflower receiving 5 t FYM ha^{-1} (Rs. 23525 ha^{-1} Rs. 12463 ha^{-1} and 2.1) gross monetary yield, net monetary returns and B:C ratio respectively.

Safflower equivalent yield : The safflower equivalent yield in safflower- chickpea year to year crop rotation cropping system was significantly influenced by the different INM treatments (Table-2). The application of 100 per cent recommended P to safflower preceding with chickpea receiving 100 per cent recommended P recorded significantly high safflower equivalent yield (3132 kg ha^{-1}) and it was statistically significant over all other treatments. The same treatment also exhibited highest system gross returns (Rs. 42374 ha^{-1}), system net monetary returns (Rs 22633 ha^{-1}) and combine B:C ratio (2.14) followed by application of 100 per cent recommended P to safflower preceding with chickpea receiving PSB +5 t FYM ha^{-1} (Rs. 42374 ha^{-1}, Rs 22633 ha^{-1} and 2.14 system gross monetary returns, system net monetary returns and combine B:C ratio respectively.

Thus, in phosphorus management, the safflower-chickpea year to year crop rotation cropping system, highest seed yield was obtained by applying the recommended dose of Phosphorus. However, application 100 per cent recommended P to safflower preceding with chickpea receiving 5 t FYM ha^{-1} also produced statistically same yield. While, application of 50 per cent P + PSB to both safflower and chickpea produced comparatively low yield than application of 100 per cent P but almost equal B:C ratio due to the reduction in cost of phoshpatic fertilizers.

ACKNOWLEDGEMENT

The authors are acknowledging with thanks to the Director of Oilseeds Research, Hyderabad for making availability of funds and to the Officer in charge, Agriculture Research Station, Mohol for making availability of permanent land and other resources to conduct the experiment.

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J. Maharashtra agric. Univ., 34 (2) : 170-172 (2009)

Performance of Different Varieties of Chrysanthemum on Flower Yield Under North Gujarat Condition

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(Received : 20-05-2008)

ABSTRACT

Study revealed that the seven varieties of chrysanthemum showed significant difference in plant growth, flowering and flower yield. The highest plant height (24.58 cm and 36.69 cm) was recorded in variety Nilima at 30 and 60 days after planting respectively and 42.50 cm at 90 days after planting was recorded in variety Red Gold. The maximum number of branches (4.33, 5.41 and 6.41) were observed in variety Mayur at 30, 60 and 90 days after planting respectively. The maximum plant stem girth (3.95 cm) was found in variety Nilima. The variety Mayur recorded minimum days for first bud initiation (24.91 days) and days taken for initiation of first flower (31.25 days). The maximum size of flower (7.32 cm) and average weight of flower (2.33 g) were recorded in variety Nilima. The maximum shelf life of cut flower at room temperature (6.58 days) was recorded in variety Shyamal. The maximum number of flowers per plant (96.25) was found in variety Red Gold. Variety Nilima was recorded maximum weight of flower per plant (214.04 g) and flower yield (158.54 q ha-1).

Key words: Crysanthimum, varieties, growth characters, yield.

The present varieties of crysanthimum in the world are above 2000. In India, there are about 1000 varieties which include exotic as well as indigenously developed. The species *Chrysanthemum morifolium* Ram is a perennial type, has considerable number of varieties which differ in the size of the plant, shapes, size and colour of flower, weight and number of flowers, plant girth and flowering season. These types of varieties are preferred by the growers to get continuous demand in market and earn more profits. Thus, it is necessary to identify the most suitable cultivars for the particular region.

MATERIALS AND METHODS

Seven varieties of chrysanthemum were used for investigation during the year 2005-

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2006 under field condition at Sardarkrushinagar where falls under the category of sub-tropical zone and characterized by semi-arid and arid condition. The rainfall of the area is restricted within the rainy season mostly with average rainfall of 500 mm per annum. The experiment was carried out in well drained and sandy loam soil. The experiment was laid in a randomized block design with four replication. Plant spacing between two rows is 45 cm and within plant 30 cm. Seven varieties of chrysanthemum were selected for experimentation *viz.*, IIHR-6, Shyamal, Mayur, Red Gold, Honey Comb, Panchon and Nilima.

Five tones FYM, 50 kg N (half doses); 100 kg P_2O_5 and 50 kg K_2O per hectare was applied at the time of soil preparation and half dose of nitrogen was applied in two splits, 30 and 45 days after planting. Irrigation was given at 10 days interval.

RESULTS AND DISCUSSION

The data (Table 1) showed that the different varieties significantly differed from each other in all the parameters. The highest plant height was recorded in the variety Nilima at 30 (24.58 cm) and 60 days (36.69 cm) after planting respectively and at 90 days after planting the highest plant height was observed in variety Red Gold (42.55 cm). It might be due to the erect growth habit of plant. While, the minimum plant height was noted by variety Mayur at 30 (14.92 cm), 60 (15.87 cm) and 90 days (16.67 cm) after planting respectively. Significantly more number of branches were recorded by variety Red Gold at 30 (4.33), 60 (5.41) and 90 days (6.41) after planting. It might be due to vigorous growth habit. Whereas, significantly minimum number of branches were recorded in varieties IIHR-6 (3.08) and Shyamal (3.08) at 30 days after planting while, minimum number of branches at 60 (4.0) and 90 days (4.42) after planting was recorded by variety Mayur. The plant stem girth was significantly influenced by various varieties of chrysanthemum. The variety Nilima recorded maximum plant stem girth (3.95 cm) and it was minimum in variety Mayur (3.07 cm). It might be due to differences in morphological growth characters (Table 1). The findings are in accordance with the findings of Bhati and Chitkara (1988) who reported that the differences in vegetative growth in all the varieties of marigold can be attributed to differences in their genetic

Table 1. Performance of different chrysanthemum varieties for different growth parameters.

Varieties	Plant height (cm)			Branches per plant			Girth of main stem (cm)
	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP	
IIHR-6	15.43	15.59	22.72	3.08	4.00	4.92	3.10
Shyamal	20.45	27.60	33.45	3.08	4.17	4.83	3.67
Mayur	14.92	15.87	16.67	3.16	4.00	4.42	3.07
Red Gold	22.44	35.37	42.55	4.33	5.41	6.41	3.47
Honey Comb	17.31	25.89	30.48	3.91	5.17	6.33	3.54
Panchon	21.60	35.25	41.67	4.08	5.33	6.17	3.43
Nilima	24.58	36.69	42.5	3.92	4.83	5.58	3.95
S. Em. ±	0.95	1.25	1.26	0.34	0.35	0.48	0.16
C. D. at 5 %	2.81	3.70	3.75	0.95	1.00	1.44	0.46
C. V. %	9.70	8.89	7.68	17.62	14.29	17.55	9.00

DAP – Days after planting

Table 2. Flowering, quality and yield of different chrysanthemum varieties.

Varieties	Days for first bud initiation	Days for initiation of first flower	Size of flower (cm)	Weight of flower (g)	Shelf life of cut flowers at room temperature (days)	Number of flowers per plant	Weight of flowers per plant (g)	Flower yield (q ha^{-1})
IIHR-6	54.75	62.31	5.91	1.258	4.42	40.00	50.09	37.09
Shyamal	41.41	57.16	6.82	2.28	6.58	79.92	183.03	135.57
Mayur	24.91	31.25	3.7	0.67	4.83	41.58	27.98	20.72
Red Gold	38.75	52.00	6.81	1.49	4.33	96.25	143.69	106.43
Honey Comb	35.58	44.46	6.44	1.23	5.66	75.00	92.56	68.19
Panchon	49.58	57.66	6.51	1.4	5.16	83.67	116.86	86.56
Nilima	38.66	48.41	7.32	2.33	5.41	82.58	214.04	158.54
S. Em.±	2.497	2.205	0.168	0.128	0.314	4.249	7.116	5.347
C. D. at 5 %	7.42	6.55	0.50	0.38	0.93	12.62	21.28	15.88
C. V. %	12.33	8.73	5.42	16.86	12.09	11.92	12.11	12.21

composition.

The variety Mayur recorded significantly minimum number of days (Table 2) for initiation of first flower bud (24.91 days). While, IIHR-6 recorded maximum number of days for initiation of first flower bud (54.75 days). The chrysanthemum variety Mayur was found earlier than rest of the varieties in respect of initiation of first flower (31.25 days after planting) and maximum days were recorded by variety IIHR-6 (62.31 days). The variety Nilima was significantly superior in terms of size of flower (7.32 cm) and weight of flower (2.33 g) as compared to other varieties of chrysanthemum. Whereas, lowest size of flower (3.70 cm) and weight of flower (0.67 g) were recorded in variety Mayur.

The maximum shelf life of cut flower at room temperature (6.58 days) was recorded in variety Shyamal, while minimum (4.33 days) was observed in variety Red Gold (4.33 days). Red Gold variety produced significantly maximum number of flowers per plant (96.25) and least number of flowers (40.00) was noted in variety IIHR-6. The weight of flowers per plant (214.04 g^{-1}) and total yield of flower per hectare (158.54 q^{-1}) were found significantly higher in variety Nilima due to large flower size.

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J. Maharashtra agric. Univ., 34 (2) : 172-174 (2009)

Genetic Divergence in Rice (*Oryza sativa* L.)

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(Received : 12-07-2008)

ABSTRACT

The 40 rice genotypes were grouped into 3 clusters following Mahalanobiss D^2 statistic. Cluster I emerged as the largest with 36 genotypes. Cluster II had 3 genotypes while cluster III was monogenotypic. Investigation revealed the independence of the genetic diversity from the eco geographic distribution of the genotypes. Length to breadth ratio of grain (33.33%) followed by number of grains per panicle, length of grain and seed yield per plant exhibited the greater contribution to the genetic divergence among genotypes. Wide range of variability was recorded for characters days to 50 per cent flowering, plant height, effective tillers per plant, panicle length, grains per panicle and length of grain.

Key words : Genetic divergence, intra and inter-cluster, rice.

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

MATERIALS AND METHODS

Forty diverse genotypes of rice collected from Agricultural Research Station, Radhanagari were evaluated in a randomized block design with three replications during *kharif*, 2006. Each entry was represented by a single row of 3 m length with spacing of 22.5 cm between rows and 10 cm between plants. Observations were recorded on five randomly selected plants of each genotype in each replication for 13 yield and yield contributing characters. Recommanded agronomic practices were followed to grow the crop successfully.

The genetic divergence was estimated by using D^2 statistics of

* Part of the M. Sc. (Agri.) thesis, submitted to M.P.K.V., Rahuri by 1st author.

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Mahalanobis (1936) as described by Rao (1952). The D^2 values were used to have clustering pattern by Tocher's method. The divergence classes were formed following Arunachalam and Bandyopadhyay (1984).

RESULTS AND DISCUSSION

The analysis of variance revealed highly significant differences among genotypes for all the characters. The D^2 values in the genotypes ranged from 23.82 (RDN 13 and RDN 27) to 12905.85 (RDN 42 and RDN 57) indicating that the material was diverse.

Based on genetic distances, the 40 genotypes were grouped into 3 clusters. The cluster I included 36 genotypes and was the largest. The genotypes belonging to the cluster I were originated from 10 different eco geographical regions *viz*. Orissa, Chhattisgarh, U.P., Maharashtra, Bihar, Uttarakhand, Pakistan, Hyderabad, Haryana and New Delhi. Cluster II constituted 3 genotypes each belonging to different eco geographical region as U.P., Maharashtra, Phillipines while cluster III had only one genotype from Bihar. In the present study, the genotypes belonging to the same geographical region or same location fell into different clusters, separated by high genetical distances. It confirmed the non existence of any relationship of genetic diversity with geographical diversity. Similar findings were reported earlier by Hanmaratti *et al.,* (1998), Kandhola and Panwar (1999) and Rather *et al.* (2001).

The intra and inter cluster D^2 and D values were worked from divergence analysis (Table 1). Maximum intra cluster distance was observed in cluster I (D^2 = 767.648) followed by cluster II (D^2 = 294.569) indicating that genotypes present in these clusters might have different genetic architecture. The D^2 value equal to 0.00 of cluster III is being due to it's monogenotypic nature.

Table 1. Average intra and inter cluster D^2 and D (in parenthesis) values of 3 clusters formed from 40 genotypes of rice.

Cluster	I	II	III
I	767.648 (D = 27.706)	2526.216 (D = 50.261)	4456.125 (D = 66.762)
II		294.569 (D = 17.163)	11574.290 (D = 107.584)
III			0.000 (D = 0.000)

Table 2. Per cent contribution of 13 characters for divergence in rice.

Character	No. of times appearing I in ranking	Per cent contribution
Days to 50% flowering (No.)	1	0.128
Days to maturity (No.)	1	0.128
Plant height (cm)	1	0.128
Effective tillers per plant (No.)	1	0.128
Panicle length (cm)	2	0.256
Secondary branches per panicle (No.)	3	0.385
Grains per panicle (No.)	250	32.051
Length of grain (mm)	87	11.154
Breadth of grain (mm)	24	3.077
Length : breadth ratio of grain	260	33.333
1000 grain weight (g)	10	1.282
Protein content (%)	59	7.564
Seed yield per plant (g)	81	10.385
Total	780	100.000

Genotypes in cluster II and III had the maximum inter cluster distance (D = 107.584) followed by cluster I and III (D = 66.762) indicating wide range of divergence among these clusters. Genotypes of distinct clusters separated by high genetic distances would be utilized in breeding programme for obtaining a wide spread range of variability in the segregating generations. Results of present investigation suggested a possibility for obtaining greater variation in the segregating generations derived from hybridization between genotypes of cluster II and III. The inter cluster distance between cluster I and II (D = 50.261) was minimum suggesting genetic closeness among the

Table 3. Distribution of different cluster combinations into four divergence classes based on D values between them.

Y (107.584) (II, III)

DC 1

m + s (85.821) (I, II)

DC 2

m (53.895) (I, II), (I, I)

DC 3

m - s (21.969) (II, II)

DC 4

X (17.163

DC = Divergence class

genotypes of the concerned clusters.

The relative contribution of different characters towards total divergence (Table 2) indicated that the L : B ratio of grain had the maximum contribution (33.333 %) towards divergence, followed by number of grains per panicle (32.051 %), length of grain (11.154 %) and seed yield per plant (10.385 %). This suggested that L : B ratio of grain, number of grains per panicle, length of grain and seed yield per plant should deserve the consideration while choosing parents for breeding programme.

Cluster mean for 13 characters, revealed wide range of variability among the clusters for the characters, days to 50 per cent flowering, plant height, effective tillers per plant, panicle length, grains per panicle, length of grain, 1000 grain weight and seed yield per plant.

Based on the delineation of parental divergence into four divergence classes, the combinations, (I, III) and (I, II) would result in more heterotic as these combinations fall into DC 1 and DC 2 (Table 3).

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J. Maharashtra agric. Univ., 34 (2) : 174-178 (2009)

Genetic Variability and Character Association in Rice (*Oryza sativa* L.)

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(Received : 12-07-2008)

ABSTRACT

Seed yield per plant exhibited highest GCV and PCV followed by 1000 grain weight, grains per panicle and effective tillers per plant among 40 genotypes of rice. High heritability coupled with high genetic advance was observed for grains per panicle, plant height, days to maturity and 1000 grain weight suggesting the additive genetic control in the inheritance of these characters. Seed yield exhibited positive and significant correlation with days to 50 per cent flowering, plant height, effective tillers per plant, panicle length, secondary branches per panicle and 1000 grain weight indicating that these characters are major yield contributing characters. There is a better chance for improvement of seed yield through direct selection of these three characters in rice.

Key words : Genetic variability, correlation, path analysis, rice.

The systematic breeding programme involves the steps like creating genetic variability, practicing selection and utilization of selected genotypes to evolve promising varieties. The large spectrum of genetic variability among combining genotypes offers a better scope for selection. Estimates of heritability and genetic advance will play an important role in exploiting future research projections of rice improvement. Seed yield is a polygenic character. A knowledge of the association between yield and it's component characters themselves can improve the efficiency of selection, because in a complex situation, selection for an optimum feature should be based on judiciously computed index. In such a situation, studies on path analysis prove to be an effective tool

* Part of the M. Sc. (Agri.) thesis, submitted to M.P.K.V., Rahuri by 1st author.

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for partitioning the correlation coefficient into direct and indirect effects of component characters. The present study was therefore, undertaken to assess the genetic variability for important quantitative characters and protein content and to know the association among them in order to develop high yielding desirable genotypes in rice.

MATERIALS AND METHODS

Forty rice genotypes which represent a wide spectrum of variation for various agronomic and morphological characters were grown in a randomized block design with three replications at Botany farm, College of Agriculture, Pune during *kharif* 2006. Each genotype was sown in a row of 3 m length. The spacing between rows was 22.5 cm and 10 cm between plants. Data were recorded on 5 randomly selected plants in each replication for number of days to 50 per cent flowering, number of days to maturity, plant height, effective tillers per plant, panicle length, secondary branches per panicle, grains per panicle, length of grain, breadth of grain, length to breadth ratio (L : B) of grain, 1000 seed weight and protein content. Analysis of variance was done by method suggested by Panse and Sukhatme (1967). GCV, PCV, heritability and genetic advance was estimated as per procedure advocated by Burton (1952), Burton and DeVane (1953) and Johnson *et al.* (1955), respectively. Genotypic and phenotypic correlation coefficient and path coefficients were obtained using standard method suggested by Singh and Choudhary (1977) and Dewey and Lu (1959) respectively.

RESULTS AND DISCUSSION

Analysis of variance revealed highly significant differences for all characters studied indicating the wide range of variability among genotypes. The present material therefore could serve a pool for selection of suitable material in breeding programmes. This was in conformation with the findings of Naik *et al.* (2002).

Seed yield per plant exhibited highest GCV and PCV followed by 1000 grain weight, grains per panicle and effective tillers per plant, indicating the presence of variability among the genotypes for these traits which would be exploited by selecting these traits in rice improvement (Table 1). Similar results were recorded by Singh and Choudhary (1996). The magnitudes of PCV were higher than GCV for all corresponding characters. This revealed the importance of environmental variance in expression of different traits in rice. Kumar *et al.*, (2001) also observed higher PCV than GCV.

The proportion of genetic variability which is transmitted from parents to progeny is reflected by heritability (Lush, 1949). In the present investigation, all characters showed high heritability (b.s.) ranging from 74.67 (panicle length) to 98.48 per cent (grains per panicle), indicating the scope for selection of these traits. Naik *et al.* (2002) also recorded high heritability for all the traits under study. As heritability in broad sense includes both additive and non additive gene effects, heritability

Table 1. Variability parameters for different characters in rice.

Character	Range	Mean	G. C. V.	P. C. V.	Heritability % (B. S.)	Genetic advance	G. A. as % of mean
Days to 50% flowering (No.)	69.00-116.00	104.28	10.819	12.033	80.83	20.894	20.037
Days to maturity (No.)	99.67-145.67	132.83	7.944	9.085	76.46	19.007	14.309
Plant height (cm)	70.13-148.07	116.26	16.158	18.616	75.34	33.589	28.891
Effective tillers per plant (No.)	2.00-10.07	5.22	26.165	29.231	80.12	2.517	48.247
Panicle length (cm)	15.47-26.23	19.23	11.190	12.950	74.67	3.830	19.920
Secondary branches per panicle (No.)	5.13-11.33	8.77	17.905	19.414	85.06	2.984	34.017
Grains per panicle (No.)	28.47-197.67	109.82	40.967	41.282	98.48	91.973	83.750
Length of grain (mm)	4.00-7.94	5.78	20.663	21.003	96.79	2.420	41.876
Breadth of grain (mm)	1.75-2.74	2.20	10.570	10.994	92.45	0.461	20.945
Length : breadth ratio of grain	1.74-4.40	2.67	25.671	26.123	96.57	1.386	51.967
1000 grain weight (g)	3.33-28.13	16.10	44.537	45.969	93.86	14.308	88.887
Protein content (%)	5.27-13.05	7.85	29.535	30.016	96.82	4.699	59.868
Seed yield per plant (g)	4.74-25.84	10.38	49.703	50.887	95.40	10.382	100.000

G.C.V. = Genotypic coefficient of variation, P.C.V. = Phenotypic coefficient of variation.

estimates should be considered in conjunction with genetic advance (Johnson *et al.*, 1955). Based on this consideration, in the present investigation, high heritability coupled with high genetic advance were observed for grains per panicle followed by plant height, days to maturity and 1000 grain weight. Selection based on these traits would be effective for increasing the yield as variability in the characters with high heritability and genetic advance might be due to additive gene interaction. Genetic advance for yield was low but when expressed as percentage of mean, it was fairly high.

The phenotypic and genotypic correlations among different characters were mostly comparable in magnitude (Table 2). However, genotypic correlations, in general, were higher than corresponding phenotypic correlations excepting for the characters, L : B ratio of grain and seed yield per plant. Earlier workers, Shivani and Reddy (2000) recorded higher genotypic correlation coefficients than corresponding phenotypic ones. In the present study the characters, days to 50 per cent flowering, plant height, effective tillers per plant, panicle length, secondary branches per panicle and 1000 grain weight exhibited significant positive association with seed yield at both phenotypic and genotypic levels indicating their importance in the selection. Whereas, days to maturity showed significant positive association with seed yield only at genotypic level. These results were similar to those of Cristo *et al.*, (2000). Two traits, *viz.*, L : B ratio of grain and protein content were negatively correlated with seed yield in the present investigation.

Table 2. Estimates of genotypic (rg) and phenotypic (rp) correlation coefficient for 13 characters in 40 genotypes of rice.

Characters	**Correlation coefficients**	**Days to 50% flowering (No.)**	**Days to maturity (No.)**	**Plant height (cm)**	**Effective tillers per plant (No.)**	**Panicle length (cm)**	**Secondary branches per panicle (No.)**	**Grains per panicle (No.)**	**Length of grain (mm)**	**Breadth of grain (mm)**	**Length : breadth ratio of grain**	**1000 grain weight (g)**	**Protein content (%)**	**Seed yield per plant (g)**
Days to 50% flowering (No.)	rg		0.967**	0.611**	0.197	0.464**	0.683**	0.548**	-0.089	0.264	-0.213	0.337*	-0.068	0.567**
	rp		0.759**	0.517**	0.144	0.353*	0.556**	0.492**	-0.075	0.234	-0.188	0.286	-0.067	0.497**
Days to maturity (No.)	rg			0.686**	0.203	0.416**	0.620**	-0.600**	-0.172	-0.290	-0.291	0.205	0.001	0.332*
	rp			0.491**	0.171	0.278	0.508**	0.513**	-0.147	0.278	-0.265	0.178	-0.010	0.279
Plant height (cm)	rg				0.359*	0.802**	0.565**	0.500**	-0.117	0.342*	-0.271	0.183	0.095	0.436*
	rp				0.263	0.623**	0.446**	0.431**	-0.094	0.281	-0.223	0.149	0.075	0.364*
Effective tillers per plant (No.)	rg					0.269	0.306	0.060	-0.088	-0.089	-0.037	-0.101	0.012	0.390*
	rp					0.183	0.243	0.048	-0.083	-0.074	-0.038	-0.073	0.005	0.324*
Panicle length (cm)	rg						0.401**	0.499**	-0.134	0.336*	-0.265	0.182	-0.096	0.428**
	rp						0.393*	0.426**	-0.119	0.284	-0.231	0.143	-0.072	0.382*
Secondary branches per panicle (No.)	rg							0.670**	-0.018	0.365*	-0.213	0.440**	-0.189	0.684**
	rp							0.609**	-0.018	0.343*	-0.202	0.387*	0.166	0.632**
Grains per panicle (No.)	rg								-0.499**	0.301	-0.578**	0.139	-0.422**	0.491**
	rp								-0.487**	0.289	-0.564**	0.138	-0.414**	0.471**
Length of grain (mm)	rg									-0.157	0.895	0.377*	0.278	0.101
	rp									-0.146	0.887**	0.361*	0.271	0.106
Breadth of grain (mm)	rg										-0.570**	0.56**	-0.174	0.154
	rp										-0.573**	0.530**	-0.162	0.139
Length : breadth ratio of grain	rg											0.051	0.330*	-0.020
	rp											0.046	0.321*	-0.010
1000 grain weight (g)	rg												-0.207	0.444**
	rp												-0.196	0.418**
Protein content (%)	rg													-0.297
	rp													-0.282

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

Table 3. Direct (diagonal) and indirect effects using genotypic correlation of different characters towards yield in rice.

Characters	Days to 50% flowering (No.)	Days to maturity (No.)	Plant height (cm)	Effective tillers per plant (No.)	Panicle length (cm)	Secondary branches per panicle (No.)	Grains per panicle (No.)	Length of grain (mm)	Breadth of grain (mm)	Length : breadth ratio	1000 grain weight (g)	Protein content (%)	Seed yield per plant (g)
Days to 50% flowering (No.)	-2.385	2.589	-0.874	0.011	0.711	0.853	-0.522	-0.184	-0.529	0.636	0.251	0.008	0.567**
Days to maturity (No.)	-2.307	2.678	-0.981	0.012	0.638	0.773	-0.571	-0.352	-0.580	0.869	0.153	0.000	0.332**
Plant height (cm)	-1.458	1.837	-1.429	0.021	1.228	0.704	-0.476	-0.240	-0.684	0.807	0.137	-0.011	0.436**
Effective tillers per plant (No.)	-0.469	0.545	-0.514	0.058	0.412	0.381	-0.057	-0.180	0.179	0.111	-0.075	-0.001	0.390*
Panicle length (cm)	-1.106	1.114	-1.149	0.016	1.532	0.501	-0.475	-0.273	-0.671	0.789	0.136	0.011	0.428**
Secondary branches per panicle (No.)	-1.630	1.660	-0.807	0.018	0.614	1.248	-0.638	-0.038	-0.729	0.635	0.328	0.022	0.684**
Grains per panicle (No.)	-1.307	1.607	-0.714	0.004	0.764	0.835	-0.952	-1.019	-0.602	1.724	0.104	0.049	0.491**
Length of grain (mm)	0.213	-0.461	0.168	-0.005	-0.205	-0.023	0.475	2.045	0.313	-2.668	0.282	-0.033	0.101
Breadth of grain (mm)	-0.631	0.777	-0.489	-0.005	0.514	0.455	-0.287	-0.320	-1.999	1.700	0.418	0.021	0.154
Length : breadth ratio of grain	0.509	-0.781	0.387	-0.002	-0.406	-0.266	0.551	1.830	1.140	-2.981	0.038	-0.039	-0.020
1000 grain weight (g)	-0.803	0.548	-0.261	-0.006	0.279	0.549	-0.132	0.771	-1.120	-0.152	0.747	0.024	0.444**
Protein content (%)	-0.161	-0.002	-0.135	0.001	-0.147	-0.236	0.402	0.568	0.347	-0.984	-0.154	-0.118	-0.297

Residual effect = 0.1836213

The information derived from correlation studies indicates only mutual association among characters whereas, path coefficient analysis provides an effective measure of direct and indirect influence of association and depicts the relative importance of each factor involved in contributing to the final product i.e. seed yield per plant. The characters, days to maturity, grain length, panicle length, secondary branches per panicle and 1000 grain weight influenced the seed yield per plant by their positive direct effect on it (Table 3).

The traits, *viz*., days to 50 per cent flowering, plant height, grains per panicle and grain breadth though had significant positive correlations (except the latter) with seed yield, their direct effects were negative. However, these traits influenced the yield through the positive indirect effects mainly via L : B ratio of grain. The L : B ratio and protein content of grain showed the negative effect on seed yield with a non significant negative correlation.

From present study, it could be concluded that considerable amount of variation exists in the germplasm studied for all 13 characters. The characters, secondary branches per panicle, days to 50 per cent flowering, grains per panicle and 1000 grain weight are major yield contributing characters and will help in improving seed yield. Therefore, the emphasis should be given on these characters in selection programme to develop desirable genotypes in rice.

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J. Maharashtra agric. Univ., 34 (2) : 178-180 (2009)

Variability Among Isolates of *Fusarium oxysporum* f. sp. *carthami*

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ABSTRACT

Microconidia of 21 isolates of *Fusarium oxysporum* f. sp. *carthami* ranged from 2.86 to 26.64 µm in length, whereas macroconidia ranged from 36 to 50 µm in length with 1 -4 septa. The isolates also exhibited variation in colony growth and nature of mycelium. Most of the isolates showed moderately resistant (1-10% wilting) and tolerant (10-20% wilting) reaction on safflower variety NARI-6 as well as on hybrids *viz*., NARI-NH-1 and DSH-129. However, all the *Fusarium oxysporum* f. sp. *carthami* isolates were pathogenic (>50% wilting) to safflower variety Nira and Bhima. Similarly, fourteen *Fusarium oxysporum* f. sp. *carthami* isolates showed tolerant reaction (10-20% wilting) on safflower variety A-1. The results indicated the existence of morphological, cultural and pathogenic variability among the *Fusarium oxysporum* f. sp. *carthami* isolates.

Key words : Variability, *Fusarium oxysporum* f. sp. *carthami*, safflower wilt.

Safflower (*Carthamus tinctorius* L.) is cultivated as an important rabi oilseed crop in Madhya Pradesh. The wilt caused by *Fusarium oxysporum* f. sp. *carthami* is one of the major diseases on safflower grown in Madhya Pradesh, Maharashtra, Karnataka and Andhra Pradesh. The disease was recorded for the first time in India by Singh *et al*. (1975). Now it has become a serious disease in all safflower growing areas of India. The disease causes yield loss up to 93 per cent in susceptible varieties (Sastry and Ramchandram, 1994). A variety which exhibits resistance in one area may show susceptibility in another area indicating variability in the pathogen (Murumkar et al. 2007). Studies were therefore, initiated as cultural, morphological and pathogenic variability among the *Fusarium oxysporum* f. sp. *carthami* isolates from Madhya Pradesh.

MATERIALS AND METHODS

The survey was undertaken during February 2006 for collection of wilt affected plant samples from major safflower growing areas of Madhya Pradesh. 250 farmers fields from major safflower growing areas of Guna, Shivpuri, Betul, Indore, Ujjain, Dhar, Harda, Dewas and Shajapur districts of Madhya Pradesh state were surveyed and about 127 wilt affected plant samples were collected. On subjecting the root samples for isolation, 21 pure *Fusarium oxysporum* f. sp. *carthami* isolates were obtained. The pathogenicity of all isolates was confirmed by Koch's postulates. The isolates showed wilting symptoms within 30 days. For morphological characterization, the size and septation of macro and microconidia was measured. The presence of chlamydospores was

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also recorded. For cultural study, the growth rate and type of mycelium were recorded on PDA medium.

The field soil was autoclaved at 30 lbs pressure for 15 min. for two successive days. The pots were disinfected with 0.3 per cent mercuric chloride. For preparation of mass culture, the sorghum grains were presoaked in water for 24 hrs. The 300 g presoaked sorghum grains were taken in 1000 ml conical flask and sterilized in autoclave at 15 lbs pressure for 15 min. for two successive days. The flasks were inoculated with 1 to 21 isolates and incubated at room temperature for seven days to get profuse fungus growth. The contents of the flasks were mixed with the sterilized soil (1:9) and the earthen pots were filled with the mixture of inoculum and kept for three days. Ten seeds of susceptible variety (cv. Nira) were sown in each pot. The wilt incidence was monitored and reisolations were made from the infected plants to confirm the pathogenicity.

The pathogenic variation has been detected based on pathogenicity test on six selected differentials. These standard differentials were used at national level. For studies on pathogenic variability, ten seeds of four safflower varieties *viz*., Nira (susceptible), Bhima (local), A-1 (national check) and NARI-6 (non-spiny tolerant) and two safflower hybrids *viz*., NARI-NH-1 and DSH-129 (tolerant hybrids) were sown in earthen pots containing inoculum with three replications. The number of wilted plants was recorded. The differential reaction was assessed as per scale given in Anonymous (2005) i.e. immune/wilt free (I) no wilting, resistant (R) <1% wilting, moderately resistant (MR) 1-10% wilting, tolerant (T) 11-20% wilting, susceptible (S) 21-50% wilting and highly susceptible (HS) >50% wilting.

RESULTS AND DISCUSSION

Twenty one pure isolates of *Fusarium oxysporum* f. sp. *carthami* obtained from Madhya Pradesh were studied for colony growth, nature of mycelium, size and septation of macroconidia and microconidia. Based on these characters, the 21 isolates were categorized in 11 groups comprising microconidia and other 2 groups comprising macroconidia (Table 1). The growth rate on PDA indicated that thirteen isolates showed slow growth rate (< 50 mm colony diameter), two showed medium growth rate (51-70 mm) and six were fast growing isolates (71-90 mm). Two types of mycelial growth *viz*., appressed and fluffy were recorded; 10 isolates had appressed growth and 11 isolates had fluffy type growth.

The results of the morphological study revealed variation in size of micro and macroconidia among the 21 isolates. The size of microconidia ranged from 2.86 to 26.64 μm in length, whereas that of macroconidia ranged from 36 to 50 μm in length. Out of 21 isolates, two isolates produced large sized macroconidia (36-50 μm) with 1-4 septations and showed chlamydospores. Nineteen isolates produced microconidia and on the basis of size, they were grouped into three. Thirteen isolates produced small sized microconidia (1-10 μm), two produced medium (11-20 μm) while four had large sized microconidia measuring 21-50 μm length. The grouping of the *Fusarium oxysporum* f. sp. *carthami* isolates on the basis of size of macro and microconidia was done as per the Anonymous (2006).

All these characters observed in the present investigation are in agreement with those reported by Paulkar and Raut (2004) while working with variability in chickpea

Table 1. Grouping of *Fusarium oxysporum* f. sp. *carthami* isolates on the basis of morphological and cultural characters.

Growth and colony diameter (mm)	Conidia		Nature of mycelium (Growth pattern)	Isolate number (Madhya Pradesh)
	Category	Size (μm)		
a) Microconidia				
Slow (<50 mm)	Small	1-10 μm	Appressed	01, 25*, 32, 39
	Small	1-10 μm	Fluffy	15, 18, 83, 84
	Medium	11-20 μm	Fluffy	115
	Large	21-50 μm	Appressed	30, 31
	Large	21-50 μm	Fluffy	23
Medium (51-70 mm)	Small	1-10 μm	Appressed	47
	Small	1-10 μm	Fluffy	49
Fast (71-90 mm)	Small	1-10 μm	Appressed	41
	Small	1-10 μm	Fluffy	64, 75*
	Medium	11-20 μm	Appressed	53
	Large	21-50 μm	Appressed	27
b) Macroconidia				
Slow (<50 mm)	Large	36-50 μm	Fluffy	101*
Fast (71-90 mm)	Large	36-50 μm	Fluffy	03*

* These pure isolates showed chlamydospores

Table 2. Reaction of safflower cultivars to isolates of *Fusarium oxysporum* f. sp. *carthami*.

Isolate number	Reaction to differentials					
	Nira	Bhima	A-1	NARI-6	NARI-NH-1	DSH-129
01	HS	HS	S	MR	T	T
03	HS	S	T	MR	T	T
15	HS	S	T	MR	T	T
18	HS	HS	T	T	T	T
23	HS	HS	T	T	T	T
25	HS	S	S	MR	T	T
27	HS	S	S	MR	T	T
30	HS	S	S	MR	T	T
31	HS	S	S	MR	T	T
32	HS	HS	T	MR	T	T
39	S	S	T	T	T	T
41	S	S	T	T	T	T
47	S	S	T	T	T	T
49	S	S	T	T	T	T
53	S	S	T	T	T	T
64	S	S	T	T	T	T
75	S	S	T	T	T	T
83	S	S	T	T	T	T
84	HS	HS	S	MR	T	T
101	HS	HS	S	MR	T	T
115	HS	S	T	MR	T	T

wilt pathogen. There was variation in all 21 isolates of *Fusarium oxysporum* f. sp. *carthami* in respect of cultural characters, colony diameter and size and septation of macro and microconidia. These results also support the observations of Ingole (1995), Raghuwanshi (1995) and Murumkar *et al.* (2007), who reported the variability in pigeonpea, sesame and safflower wilt isolates, respectively.

The observations on varietal reaction are presented in Table 2. The isolates of *Fusarium oxysporum* f. sp. *carthami* from different geographical areas showed a wide range in their pathogenichy. All the 21 isolates were found pathogenic to the safflower varieties *viz*., Nira, Bhima, A-1 and NARI-6 and hybrids *viz*., NARI-NH-1 and DSH-129 tested. The varieties Nira and Bhima were susceptible (21-50% wilting) to highly susceptible (> 50% wilting) to all the isolates tested. Out of 21 isolates, 14 isolates showed tolerant reaction to the variety A-1 recording wilt (11-20%), rest of the isolates recorded susceptible (21-50% wilting) to highly susceptible (> 50% wilting) reaction to A-1. The non-spiny variety NARI-6 recorded moderately resistant (1-10% wilting) to tolerant (11-20% wilting) reaction while the hybrids *viz*., NARI-NH-1 and DSH-129 exhibited tolerant reaction (11-20% wilting) against all the isolates.

The results indicated morphological, cultural and pathogenic variation among the *Fusarium oxysporum* f. sp. *carthami* isolates. The present study is supported by the findings of Jimenez *et al*. (1992) and Reddy and Raju (1993).

ACKNOWLEDGEMENT

Authors are thankful to the Indian Council of Agricultural Research, New Delhi for providing funds under the 'Network Project on Wilt of Crops' to undertake the research.

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J. Maharashtra agric. Univ., 34 (2) : 181-182 (2009)

Shelf Life Study of *Trichoderma* spp in Different Carrier Materials

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ABSTRACT

Shelf life study of *Trichoderma* spp. (*T. harzianum*, *T. viride*, *T. hamatum* and *T. virens*) in four different carrir materials (talc, lignite, charcoal and fly ash) was undertaken for a period of 180 days. The population of individual *Trichoderma* spp was assessed at monthly interval from 30 days onwards. After 180 days of storage talc (*T. harziamum* - 29.7 x 10^6 cfu g^{-1}, T. *viride* - 37.0 x 10^6 cfu g^{-1}. *T. hamatum* - 27.2 x 10^6 cfu g^{-1} and *T. virens* - 16.3 x 10^6 cfu g^{-1}) was found best to retain maximum number of viable propagules. Minimum propagules were recorded in fly ash (*T. harzianum* - 803 x 10^6 cfu g^{-1}, *T. viride* - 11.2 x 10^6 cfu g^{-1}, *T. hamatum* - 6.2 x 10^6 cfu g^{-1} and *T. virens* - 3.2 x 10^6 cfu g^{-1}) at 180 days after storage. However, it could retain sufficient number of propagules upto 120 days in all *Trichoderma* spp.

Key words : *Trichoderma* spp, carriers, shelf life.

Trichoderma spp. are most common soil inhabitants and are effective in providing biological control of soil borne pathogens due to antagonistic behaviors (Papavizas, 1985). The major aspects of successful biological control technologies include the establishment of production, formulation and delivery system for micro-organisms. With the increasing interest in developing alternative to chemical fungicides, production of *Trichoderma* as bioprotectant has become the focus point for research and development. Biomass of *Trichoderma* must be produced in a timely and cost effective way and to survive each processing step such as harvesting, formulation, storage and delivery. *Trichoderma* spp. are produced by different firms, traders, research workers under different names, hence mass production of such potent bioagent has gained importance. The present study was performed to evaluate the suitability of various carriers for the growth of *Trichoderma* spp.

MATERIALS AND METHODS

The carriers evaluated were talc, lignite, fly ash and charcoal powder. The carriers were dried in sun, powdered and sieved through a sieve of pore size 1 mm and sterilized at 1.05 kg square cm^{-1} pressure for 30 min. The substrate was mixed with culture of respective *Trichoderma* spp. Previously grown on potato dextrose broth 2 : 1 proportion (2 parts carrier + 1 part liquid cultures). Such 50 g mixture was filled in polypropylene bag (25 x 30 cm), tied and stored at 27 $\pm$ 2°C. Observation on cfu g-1 carrier were recorded at monthly interval upto 6 months for shelf life study. Shelf life of four selected *Trichoderma* spp. *viz*., *T.*

Table 1. Effect of different carriers on the population of *Trichoderma* spp. (x 10^6 cfu g^{-1}).

Carriers	Initial	30 days	60 days	90 days	120 days	150 days	180 days
***T. harzianum* :**							
Talc	170.7	142.0	107.4	96.1	65.4	45.9	29.7
Lignite	170.1	144.5	103.1	83.4	58.7	33.6	18.2
Charcoal	169.5	130.6	102.2	82.8	52.8	28.0	16.0
Fly ash	169.0	126.9	97.9	79.4	46.4	27.2	8.3
CD (P = 0.01)	-	9.47	3.49	6.50	2.47	4.35	1.94
***T. viride* :**							
Talc	171.8	154.2	114.6	97.8	70.2	51.7	37.0
Lignite	171.5	148.8	108.2	88.7	62.7	42.7	25.2
Charcoal	170.2	139.2	106.5	88.4	59.6	33.2	18.2
Fly ash	169.2	130.7	98.2	87.8	54.8	31.2	11.2
CD (P = 0.01)	-	2.06	5.49	5.19	2.70	2.52	2.78
***T. hamatum* :**							
Talc	169.4	141.9	102.6	86.7	62.2	39.6	27.2
Lignite	169.1	139.9	98.4	78.6	44.3	30.2	16.6
Charcoal	168.6	127.3	96.6	70.6	41.6	21.7	11.8
Fly ash	168.4	119.4	92.9	69.3	39.0	19.4	6.2
CD (P = 0.01)	-	3.40	2.90	2.07	5.07	2.26	2.39
***T. virens* :**							
Talc	168.9	140.2	100.2	78.0	56.2	35.8	16.3
Lignite	168.7	130.5	94.8	70.3	35.6	28.4	12.2
Charcoal	168.2	106.6	91.6	64.0	29.6	17.2	9.6
Fly ash	168.4	102.0	86.7	62.0	26.4	13.6	3.2
CD (P = 0.01)	-	3.22	6.06	4.79	6.43	2.78	1.28

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harzianum, T. viride, T. virens and *T. hamatum* were undertaken. Carrier based cultures were stored at room temperature (27 $\pm$ 2°C) and shelf life study was carried out at monthly interval.

RESULTS AND DISCUSSION

The data in respect of shelf life study of *Trichoderma* spp is presented in Table 1. The fluctuations in population of *Trichoderma* spp in four different carrier within 180 days has been described. Talc was found best carrier material among all carrier materials under study to retain maximum number (*T. harzianum* - 29.7 x 10^6 cfu g^{-1}, *T. viride* - 37.0 x 10^6 cfu g^{-1}, *T. hamatum* - 27.2 10^6 cfu g^{-1} and *T. virens* - 16.3 x 10^6 cfu g^{-1}) of propagules upto 180 days. Though there was reduction in cfu when stored for 180 days, still there was sufficient viable population. The results clearly indicated that the formulation can be safely stored for 180 days. Minimum number of propagules were recorded in fly ash (*T. harzianum* - 8.3 x 10^6 cfu g^{-1}, *T. viride* - 11.12 x 10^6 cfu g^{-1}, *T. hamatum* - 6.2 x 10^6 cfu g^{-1} and *T. virens* - 3.2 x 10^6 cfu g^{-1}) at 180 days after storage as compared to the other carriers in all the *Trichoderma* spp. But the population of all the *Trichoderma* spp was well maintained upto 120 days in all carriers. The results may differ due to environmental conditions and quality of material procured. Viability of propagules may be less in fly ash because of low level of N (Deshmukh *et al.*, 1999). Nakkeran *et al.*, (1997) standardized the packing and storage conditions to increase shelf life to talc and vermiculite based formulations in milky white (LDPE) bags at room temperature upto 75 days. Prasad *et al*. (2002) also reported that conidial formulation retained optimum amount of viable propagules (>10^6 cfu g^{-1}) even after 180 days of storage at room temperature. The results of the present findings are comparative with that of Das *et al*. (2006) who reported that talc based formulation hold spores well even after 30 days onwards. Hence talc is the best carrier to retain maximum number of viable propagules at 180 days after storage and hence can be used safely. Flyash also retained propagules upto 120 days.

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J. Maharashtra agric. Univ., 34 (2) : 183-185 (2009)

Effect of *VAM* Fungi and *Azospirillum* on Growth and Development of Kagzilime (*Citrus aurantifolia* L.) Seedlings

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ABSTRACT

The seed inoculation of kagzilime with *A. brasilense* alone and soil inoculation with cither of the VAM fungi resulted in significant improvement in all the growth parameters, dry matter production and N and P by the seedlings, as compared to their corresponding uninoculated controls. These bioinoculants showed synergistic effects when *A. brasilense* inoculation was done in conjunction with soil treatment with either of the VAM fungi. The treatment with *A. brasilense* + *G. fasciculatum* recorded the highest values for all the growth parameters, fresh and dry matter production and uptake of N (150.99 mg plant^{-1}) and P (31.24 mg plant^{-1}) by the seedings. This was followed by *A. brasilense* + *G. mosseae*.

Key words : Kagzilime, *A. brasilense*, *G. fasciculatum*, *G. mosseae*.

Kagzilime (*Citrus aurantifolia* L.) is one of the major fruit crops widely cultivated in India. Being a high yielding perennial crop, the nutritional requirements of lime are quite high. Morever, the prices of inorganic nitrogenous and phosphatic fertilizers are ever increasing. This fact has forced the mankind to look for the alternative low input technology of using the biofertilizers like *Azospirillum* and VAM fungi for supplying adequate amount of nutrients to crop so as to boost the growth and development and thereby production. Recently there have been many reports on the synergistic effect of diazotrophic *Azospirillum* and VAM fungi leading to improved growth, yield and nutrition. However, the effect of dual inoculation of *Azospirillum* and VAM fungi on the growth and development of kagzilime seedlings is not available and hence the present study was undertaken to study the effect of seed inoculation of kagzilime with *Azospirillum brasilense* and effect of different VAM fungi *viz.*, *Glomus fasciculatum* and *Glomus mosseae* on the growth of kagzilime seedlings.

MATERIALS AND METHODS

A pot culture experiment using unsterile P deficient soil was conducted in the glasshouse of the Department of Plant Pathology and Agril. Microbiology, MPKV, Rahuri. The experiment was conducted in a factorial completely randomized block design with four replications. The two factors studied were (1) uninoculated control and seed treatment with *A. brasilense* and (2) uninoculated control, soil inoculation with *Glomus fasciculatum* and soil inoculation with *Glomus mosseae*. The seeds of kagzilime were extracted from the freshly harvested mature fruits. *A. brasilense* treatment was given to seeds @ 250 g inoculant for 8-10 kg seed. For VAM inoculation, 150 g culture of the respective VAM fungus was placed 2 cm below the surface soil and was covered with the soil after seeding. Fifty seeds were dibbled equidistantly in each pot (30 cm top diameter).

The growth observations like plant height, number of leaves, stem thickness, root length, total fresh and total dry weights were recorded at 180 days. The N and P content of whole plant samples (shoot+ root) was determined at 180 days after sowing by Micro-kjeldahl digestion and distillation method and by vanadomolybdate yellow colour method measuring the colour intensity at 470 um wavelength on Spectronic 20 D (Jackson, 1971). The uptake of N and P by kagzilime seedlings was also calculated with the help of nutrient concentrations and plant dry weights at 180 days of sowing. The nutrient uptake was calculated by multiplying the dry matter yield with respective nutrient concentration and dividing with 100. The data were analyzed statistically by following standard methods for analysis of variance. The standard errors for the treatment means and least significant differences at 5 per cent level of significance were worked out following Panse and Sukhatme (1957).

RESULTS AND DISCUSSION

The data in respect of various parameters like plant height, number of leaves, stem thickness, root length, total fresh weight and total dry matter production of

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kagzilime seedlings at 180 days are presented in Table 1. *Azospirillum* inoculated plants had significantly higher plant height (42.87 cm), number of leaves (42.67 plant^{-1}), stem thickness (3.95 mm), root length (23.94 cm), total fresh weight (23.77 g plant^{-1}) and total dry matter production (4.94 g plant^{-1}) as compared to uninoculated control. The VAM fungal inoculation treatments also had a significant influence on the plant height. The treatment with *G. fasciculatum* recorded significantly highest plant height (43.10 cm), number of leaves (43.62 plant^{-1}), stem thickness (4.03 mm), root length (24.21 cm), total fresh weight (24.12 g plant^{-1}) and higher total dry matter production (5.01 g plant^{-1}) as compared to uninoculated control.

Table 1. Effect of diazotrophic bacterial and VAM fungal inoculation treatments on different parameters of kagzilime seedling at 180 days.

Parameters	Diazotrophic treatment	VAM inoculation treatment			
		Control	G. fascic-ulatum	G. mos-seae	Mean
A. Plant Height (cm)	Control	32.08	40.57	36.17	36.27
	A. brasilense	40.06	45.63	42.93	42.87
	Mean	36.07	43.10	39.55	-
B. No. of leaves plant^{-1}	Control	32.50	41.50	38.25	37.42
	A. brasilense	39.50	45.75	42.75	42.67
	Mean	36.00	43.62	40.50	-
C. Stem thickness (mm plant^{-1})	Control	2.92	3.86	3.65	3.48
	A. brasilense	3.71	4.21	3.94	3.95
	Mean	3.31	4.03	3.79	-
D. Root length (cm plant^{-1})	Control	17.77	23.16	20.28	20.41
	A. brasilense	21.83	25.25	24.74	23.94
	Mean	19.80	24.21	22.51	-
E. Total fresh wt. (g plant^{-1})	Control	19.19	23.16	21.06	21.14
	A. brasilense	22.57	25.07	23.68	23.77
	Mean	20.88	24.12	22.37	-
F. Total dry matter (g plant^{-1})	Control	3.99	4.82	4.39	4.40
	A. brasilense	4.71	5.21	4.92	4.94
	Mean	4.35	5.01	4.65	-

S. E.$\pm$	A	B	C	D	E	F
Diazotrophis	0.21	0.33	0.03	0.15	0.16	0.03
VAM	0.25	0.40	0.04	0.19	0.19	0.04
Interaction	0.36	0.57	0.05	0.26	0.27	0.05
L.S.D. P = 0.05						
Diazotrophs	0.61	0.97	0.09	0.45	0.47	0.09
VAM	0.75	1.19	0.11	0.55	0.57	0.11
Interaction	1.06	1.69	0.16	0.78	0.81	0.15

The interactions between VAM and diazotrophic inoculation treatments in respect of various parameters were also significant. The treatment with *A. brasilense* + *G. fasciculatum* (45.63 cm) was significantly superior to the rest of the treatments in respect of plant height. It was followed by *A. brasilense* + *G. mosseae* (42.93 cm), *G. fasciculatum* (40.57 cm) and *A. brasilense* (40.06 cm). The diazotrophic and VAM inoculation treatments had a significant effect on the number of leaves. The combined inoculation with *A. brasilense* and *G. fasciculatum* recorded the highest number of leaves (45,75 plant^{-1}) and was significantly superior to the rest of the combinations. Amongst the different interactions, the dual inoculation with *A. brasilense* + *G. fasciculatum* recorded significantly highest stem thickness (4.21 mm). It was followed by *A. brasilense* + *G. mosseae* (3.94 mm) and *G. fasciculatum* (3.86 mm) which were at par with each other. The treatment with *A. brasilense* + *G. fasciculatum* recorded the highest root length (25.25 cm). However, it was at par with *A. brasilense* + *G. mosseae* (16.90 cm). The interactions between diazotrophic and VAM inoculation treatments in case of total fresh weight were non-significant. However, the treatment with *A. brasilense* + *G. fasciculatum* recorded the highest total fresh weight (2.03 g plant^{-1}) and total dry weight (5.21 g plant^{-1}).

Data presented in Table 2 revealed that nitrogen and phosphorus content and its uptake differed significantly for the diazotrophic and VAM inoculation treatments. The seed treatment with *A. brasilense* recorded significant improvement in N concentration (2.78%) and its uptake (137.80 mg plant^{-1}) as well as P content (0.51%) and its uptake (25.30 mg plant^{-1}) over uninoculated control. Amongst the VAM inoculation treatments *G. fasciculatum* resulted in significant improvement in N and P concentration of whole plants. The interaction between diazotrophic and VAM inoculation treatments were non significant both for N

Table 2. Effect of *Azospirillum* and VAM treatments on nitrogen and phosphorus content of kagzilime seedlings and its uptake.

Parameters	Diazotrophic treatment	VAM inoculation treatment			
		Control	*G. fasciculatum*	*G. mosseae*	Mean
(A) N content of whole plant sample (%)	Control	2.20	2.32	2.25	2.26
	A. brasilense	2.67	2.90	2.77	2.78
	Mean	2.44	2.61	2.51	-
(B) N uptake by plant (mg $plant^{-1}$)	Control	87.77	111.92	98.77	99.49
	A. brasilense	125.97	150.99	136.43	137.80
	Mean	106.87	131.46	117.60	-
(C) P content of whole plant sample (%)	Control	0.34	0.51	0.49	0.45
	A. brasilense	0.40	0.60	0.52	0.51
	Mean	0.37	0.56	0.51	0.48
(D) P uptake by plant (mg $plant^{-1}$)	Control	13.66	24.80	21.51	19.99
	A. brasilense	18.84	31.24	25.83	25.30
	Mean	16.25	28.02	23.67	22.65
S. E.±	A	B	C	D	
Diazotrophis	0.03	1.32	0.004	0.29	
VAM	0.03	1.62	0.005	0.36	
Interaction	0.05	2.29	0.008	0.50	
L.S.D. P = 0.05					
Diazotrophis	0.08	3.92	0.01	0.86	
VAM	0.10	4.80	0.02	1.06	
Interaction	N.S.	N.S.	0.02	N.S.	

content of whole plants and N uptake by the plants. The factor interactions were significant only for the P content of plants. *A. brasilense* + *G. fasciculatum* registered the highest P content (0.60 %) in plants followed by *A. brasilense* + *G. mosseae* (0.52 %). Although the interactions between the factors were non significant for P uptake by plants, the treatement with *A. brasilense* + *G. fasciculatum* recorded the highest P uptake (31 .24 mg $plant^{-1}$).

The above results are in conformity with Ghogare (1991) who reported that the shoot, root, total dry matter production, N and P content and its uptake in tomato were significantly higher in the treatments with bioinoculants like *A. brasilense* and VAM fungi either alone or in combination. An improvement in dry matter production of citrus plants by use of VAM inoculants have also been reported (Vinayak and Bagyaraj, 1990 and Guidice, 1993). However, the synergistic effect leading to improved dry matter production has been reported in chilli (Patil, 1989, Subba Rao *et al.*, 1985). The results of the present investigation are, therefore, in agreement with these reports. The overall results, therefore indicated that it is possible to obtain vigorous seedlings of kagzilimc by following the practice of seed inoculation with *A. brasilense* and soil inoculation with VAM fungi *viz.*, *G. fasciculatum* or *G. mosseae*.

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J. Maharashtra agric. Univ., 34 (2) : 186-188 (2009)

Associative Effect of *Rhizobium*, PSB and Fertilizers on Nodulation and Yield of Black Gram (*Vigna mungo*) in Vertisol

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ABSTRACT

The dual inoculation of *Rhizobium* and PSB with recommended dose of chemical fertilizer found beneficial in field experiment of blackgram over single use of bio-fertilizer. The dual inoculation of bio-fertilizer increased the grain yield either with or without chemical fertilizer. The highest grain yield of 856.36 kg ha-1 was recorded in 100 per cent RDF with dual inoculation. The fresh weight and dry weight of nodules per plant showed significant result in dual inoculation with or without chemical fertilizer. Highest number of nodules (30.35) per plant, fresh and dry weight of nodules 85.47 and 27.39 mg per plant was recorded in dual inoculation without chemical fertilizers, respectively.

Key words : Bio fertilizers, *Rhizobium* , PSB, nodulation, black gram.

Bio-fertilizers have capacity to fix atmospheric nitrogen and convert insoluble phosphate into soluble form. *Rhizobium* legume symbiosis has attracted attention, as it accounts for a major part of biological nitrogen fixation of pulses (More *et al.* 2002). PSB are micro-organisms which solubilize native phosphorus in the soil and improve its availability to crops. Single inoculation of either *Rhizobium* or PSB is an established practice. However, the dual inoculation of *Rhizobium* and PSB are yet to be established in Black gram under Marathwada region. Thus, the present investigation was conducted with an objective to study the feasibility and adaptability of dual inoculation of *Rhizobium* and PSB for Black gram production.

MATERIALS AND METHODS

A field experiment was conducted at the Cotton Research Scheme of the Marathwada Agricultural University, Parbhani during *kharif* season of 2002-2003, 2003-2004, 2004-2005, 2005-2006 and 2006-2007 with variety TAU-1 in vertisol. The soil of the experimental plot as per rating limits of Muhr *et al.* (1963) was categorized as low in available nitrogen, medium in phosphorus with high content of potassium. The experiment was laid in randomized block design (factorial experiment) with twelve treatments consisting of *Rhizobium*, PSB, *Rhizobium* + PSB with and without chemical fertilizers and replicated thrice. There were three main and four sub treatments in each replication. The main treatment consisted of T_1 = 100 per cent RDF, T_2 = 75 per cent RDF and T_3 = No RDF. The four sub treatments consisted of single and dual inoculation of bio-fertilizer i.e. S_1 = *Rhizobium* inoculation, S_2 = PSB inoculation, S_3 = *Rhizobium* + PSB inoculation and S_4 = No bio-fertilizer. Seed inoculation was done with *Rhizobium japonicum* and PSB @ 250 g each /10 kg seed as seed treatment before sowing. The mixtures of 250 g *Rhizobium japonicum* and PSB culture each with 150 ml starch was added to 10 kg seed and mixed thoroughly. After mixing uniformly coated seeds were dried under shade and sown at 30 x 10 cm spacing. The recommended dose of chemical fertilizer was

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Table 1. Effect of bio-fertilizers in presence and absence of chemical fertilizers on nodulation and yield of black gram (Pooled mean of five years.)

Treatments	Nodule $plant^{-1}$	Dry wt. of nodules (mg $plant^{-1}$)	Grain yield (kg ha^{-1})
Chemical fertilizers (% RDF) :			
T_1 = 100	19.48	17.71	771.35
T_2 = 75	18.26	15.05	720.75
T_3 = Zero	22.86	21.28	671.35
SE. ±	0.427	0.295	10.97
C. D. at 5%	1.183	0.817	30.37
Bio-fertilizers :			
S_1 = *Rhizobium*	21.56	19.60	715.22
S_2 = PSB	18.86	16.80	750.72
S_3 = *Rhiz.*+PSB	26.27	23.56	803.89
S_4 = Control	14.90	12.21	614.78
SE ±	0.493	0.341	12.67
C. D. at 5%	1.367	0.944	35.07
Intractions :			
T_1S_1	20.94	18.72	756.32
T_1S_2	17.67	16.78	788.48
T_1S_3	25.25	24.09	856.36
T_1S_4	14.05	11.25	675.25
T_2S_1	19.87	16.41	713.73
T_2S_2	17.13	14.98	767.88
T_2S_3	23.21	19.21	807.85
T_2S_4	12.82	10.29	593.35
T_3S_1	23.87	23.67	666.60
T_3S_2	20.88	19.23	695.79
T_3S_3	30.35	27.39	747.47
T_3S_4	16.32	14.83	575.55
SE ±	0.86	0.59	21.95
C. D. at 5%	NS	1.63	60.74

applied @ 25:50:00 N and P_2O_5 through urea and SSP respectively. A basal dose of fertilizer was applied as per treatment at the time of sowing. For recording observations, three plants were randomly selected from the plot and were marked. The grain yield was recorded from net plot area at physiological maturity. The economics of fertilizer use computed and reported.

Tabel 2. Economics of fertilizer use for black gram.

Treat-ments	Seed yield (kg ha^{-1})	Gross income (Rs. ha^{-1})	Benefit over control	Fertilizer cost (Rs. ha^{-1})	B:C ratio
T_1S_1	765	22499	5559	1430	3.89
T_1S_2	788	23175	6235	1430	4.36
T_1S_3	856	25175	8235	1460	5.64
T_1S_4	675	19852	2921	1400	2.08
T_2S_1	714	20999	4059	1080	3.76
T_2S_2	768	22587	5647	1080	5.23
T_2S_3	808	23763	6823	1110	6.15
T_2S_4	594	17470	530	1050	0.50
T_3S_1	667	19616	1276	30	42.56
T_3S_2	696	20469	3529	30	117.63
T_3S_3	747	21969	5029	60	83.80
T_3S_4	576	16940	-	-	-

Commodity cost considered : Urea = Rs. 5 kg^{-1}, SSP = Rs. 3.6 kg^{-1}, *Rhizobium* = Rs. 15 $packet^{-1}$, PSB = Rs. 15 $packet^{-1}$ and Blackgram = Rs. 2941 q^{-1}.

RESULTS AND DISCUSSION

The bio-fertilizers both *Rhizobium* and PSB exhibited spectacular performance in improving nodulation and yield (Table 1) of black gram. The use of bio-fertilizers stimulated the development of nodules resulted in increased weight of nodules in black gram. While chemical fertilizer partially suppressed the nodule development. Hence, the highest nodules per plant of 26.27 and 22.86 was recorded in S_3 and T_3 treatment, respectively, in sub as well as main treatments. The interaction effects between chemical and bio -fertilizer treatments were non significant in case of number of nodules per plant.

The fresh and dry weight of nodules showed highly significant differences within chemical and bio-fertilizer treatment and also between chemical and bio-fertilizer treatments of black gram. The highest fresh and dry weight of nodules of 85.47 and 27.39 mg per $plant^{-1}$ was recorded in T_3S_3 treatment and the lowest of 27.81 and 10.29 mg $plant^{-1}$ was recorded in T_2S_4 treatment respectively. Bishoni and Dutta (1980) reported that inoculation of seed significantly influenced the fresh weight of nodules and biomass of nodules. Iswaran (1970) reported that *Rhizobium* spp. encouraged early initiation of nodules with more fresh weight. Lanje *et al.* (2005) reported highest nodules per plant in *Rhizohium* + PSB treatment. Similar results were also observed by Singh and Pareek (2003), Jain and Trivedi (2005).

The dual inoculation of *Rhizobium* + PSB recorded the highest yield either in presence or absence of chemical fertilizers. The highest grain yield (856.36 kg ha^{-1}) was recorded in T_1S_3 i. e. 100 per cent RDF with dual inoculation of *Rhizobium* + PSB followed by T_2S_3 treatment (807.85 kg ha^{-1}). In case of bio-fertilizer treatment, the highest grain yield of 803.89 kg ha^{-1} recorded in dual inoculation over single inoculation. Namdeo and Gupta (1999) recorded highest yield with co-inoculation of *Rhizobium* + PSB along with 100 per cent RDF. Similar findings were recorded by Prabhakaran *et al.* (1999), Shrivastava and Rajput (2000).

In case of economics and B:C ratio of black gram (Table 2), it was conclusively proved that dual inoculation of *Rhizobium* and PSB is highly remunerative at both the levels of fertilizer application. The highest B:C ratio (6.15) was recorded in T_2S_3 treatment over T_1S_3 treatment, though this treatment had highest benefit over control. Gautam and Pant (2002) noticed highest net returns with dual inoculation and rock phosphate. Ramamoorthy *et al.* (1997) obtained highest net returns under 12.5 kg N + 37.5 kg P_2O_5 ha^{-1} with seed inoculation of *Rhizobium* and PSB.

The interaction of *Rhizobium* and PSB inoculation in black gram exhibited positive effect of these beneficial micro-organisms. The yield response of bio-fertilizers was better when used along with chemical fertilizer. Dual inoculation of *Rhizobium* + PSB is highly remunerative at all the levels of fertilizer application. Hence. for profitable black gram production dual inoculation of *Rhizobium* and PSB with 75 per cent RDF (25:50:00 NPK kg ha^{-1}) is recommended, there by 25 per cent saving on expenditure of chemical fertilizer is achieved.

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J. Maharashtra agric. Univ., 34 (2) : 188-190 (2009)

Control of Thrips Vector Transmitting Bud Necrosis in Sunflower under Dry Land Condition

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ABSTRACT

Two years pooled data of field experiment revealed the significant differences among the treatments studied. Methyl demeton 0.05 per cent was found significantly superior over the untreated control in reducing thrips population and thereby necrosis disease and produced higher seed yield (1081.9 kg ha^{-1}) of sunflower. It was closely followed by malathion 0.05 per cent which produced the seed yield of 820.2 kg ha^{-1}. The other treatments *viz*., quinalphos 0.05 per cent (759.9 kg ha^{-1}) and dimethoate 0.05 per cent (739.8 kg ha^{-1}) were also found comparatively good for controlling necrosis disease caused due to vector (thrips) and produced good seed yields of sunflower.

Key words : Control, thrips, bud necrosis, sunflower.

The cultivation of sunflower has been hampered by necrosis disease (SND) caused due to thrips. The intensity of disease ranges from 2 to 100 per cent. The seed yield losses are as high as 89 per cent under severe condition (Anonymous, 2001). The disease was noted for the first time by Singh *et al.* (1997) at Bagepally near Bangalore in Karnataka. Subsequently, the disease has been reported in other states like Tamil Nadu, Andhra Pradesh, Maharashtra etc.

The causal organism of the disease has been identified as tobacco streak ilar virus which is transmitted by thrips (Rao *et al.*, 2000 and Ravi *et al.* 2001). The virus transmission through insect vector (thrips) was further confirmed (Anonymous, 2003 and Singh, 2005). Upendhar *et al.* (2007) reported five different thrips species survived on sunflower and *Parthenium hyseterophorus* weed *viz*., *Thrips palmi* (Karny), *Frankliniella schultzei* (Trybom), *Scirtothrips dorsalis* (Hood), *Megalurothrips usitatus* (Bagnall)

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and *Haplothrips gowdeyi* (Franklin). In view of this, the present investigation was carried out for the effective control of thrips causing sunflower necrosis virus disease.

MATERIALS AND METHODS

The field experiments were conducted during *kharif* seasons of 2006-07 and 2007-08 at the Mulegaon Research Farm, ZARS, Solapur. The experiment was laid out in a randomized block design with three replications and gross and net plot size of 4.5 x 5.0 m^2 and 3.60 x 4.60 m^2, respectively. The sunflower variety SS-56 was used for study during both the years. A total of twelve treatments (Table 1) were evaluated against thrips (SND). Two sprayings of pesticides were given at 15 and 30 DAS. However, the treatment number eleven *viz*., uproot and burn was a non pesticidal one which comprised the simple rouging and destruction of affected plants commencing from seedling stage upto the flowering. The observations on thrips count were taken before first spray (pre count) and after first and second sprays (post count) whereas, per cent bud necrosis was worked out 45 DAS. The seed yield of each treatment was recorded at harvest.

RESULTS AND DISCUSSION

The two years pooled data in respect of thrips count before and after spray and necrosis disease incidence at 45 DAS and seed yield at harvest are presented in Table 1. The pooled data results revealed that thrips count after both the sprays, per cent disease incidence and seed yield were significantly influenced due to different treatments studied. However,

Table 1. Effect of different pesticides on incidence of thrips on sunflower (pooled data 2006-07 and 2007-08).

Treatment	Average thrips plant^{-1}			Necrosis incidence (%)	Seed yield (kg ha^{-1})
	Pre count before Ist spray	Post count after Ist spray	Post count after IInd spray		
NSE 5%	13.75	6.70	5.22	9.24	603.8
Dimethoate 30 EC 0.05%	13.33	4.97	3.60	6.42	739.8
Malathion 50 EC 0.05%	14.00	3.70	2.63	5.91	820.2
Methyl demeton 25 EC 0.05 %	1308	2.43	1.95	4.92	1081.9
Triazofos 40 EC 0.05%	13.28	7.20	6.08	7.44	558.5
Endosulfan 35 EC 0.05%	13.42	4.70	5.03	9.16	623.9
Spinosad 45 EC 0.0018%	13.55	5.97	4.20	8.88	593.6
Profenophos 50 EC 0.05%	12.98	6.43	6.25	8.38	659.0
Quinalphos 25 EC 0.05%	13.62	6.53	6.07	7.41	759.9
Carbaryl 50 WP 0.2%	13.83	8.27	7.78	8.44	598.7
Uproot and burn	13.68	9.47	13.11	10.96	648.9
Control	14.08	13.67	20.41	15.05	352.3
S. E.±	0.31	0.60	0.67	0.76	62.25
C. D. 5%	NS	1.70	1.92	2.17	177.40

NSE = Neem seed extract

average thrips pre count before first spray during both the seasons and pooled mean were nonsignificant indicating the uniformity of insect population in all the treatments.

The pooled results also revealed that all the treatments were found to be significantly superior over untreated control in respect of post count after both the sprays, per cent bud necrosis and seed yield. The mean thrips population varied from 2.43 to 13.67 and 1.95 to 20.41 plant-1 after first and second sprays, respectively (Table 1). Methyl demeton 0.05 per cent recorded significantly less thrips population (2.43 and 1.95 number plant^{-1}) than all other treatments. It was followed by malathion 0.05 per cent which recorded mean thrips population of 3.70 and 2.63 plant^{-1} after first and second spray, respectively. However, these two treatments were at par with each other. The maximum thrips survival of 13.67 and 20.41 plant^{-1} was recorded in untreated control followed by treatment number eleven i.e. uproot and burn (9.47 and 13.11 thrips plant^{-1}).

As regards disease incidence, significantly lowest per cent necrosis (4.92) was observed in the treatment methyl demeton 0.05 per cent followed by malathion 0.05 per cent (5.91) and dimethoate 0.05 per cent (6.42) over untreated control (15.05). These three treatments were statistically at par with each other. The pooled mean seed yield of sunflower varied from 352.3 to 1081.9 kg ha^{-1}. All the treatments recorded significantly higher seed yield than untreated control. However, methyl demeton 0.05 per cent recorded significantly highest seed yield (1081.9 kg ha^{-1}) than all other treatments and proved effective in controlling thrips causing necrosis disease as well as for increasing the seed yield under dryland condition. The findings of present investigation are more or less similar as that of earlier workers (Basappa and Sriharan, 1999; Singh *et al.* 2000 and Nagaraju *et al.* 2000).

Based on the above overall results, it is concluded that for the effective control of thrips causing necrosis disease and increasing the seed yield of sunflower, two sprayings of 0.05 per cent methyl demeton at 15 and 30 DAS are certainly beneficial under rainfed condition, particularly in the scarcity zone of Maharashtra.

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J. Maharashtra agric. Univ., 34 (2) : 190-193 (2009)

Use of AMMI in Simultaneous Selection of French bean (*Phaseolus vulgaris* L.) Genotypes for Yield and Stability

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ABSTRACT

Multi-location trials (MLT), generally, have significant main effect and significant multiplicative genotype x environment interaction effect. Additive main effect and multiplicative interaction model (AMMI) offers a more appropriate statistical analysis to deal with such situation, compared to traditional methods of ANOVA, principal component analysis and linear regression. In this paper, a family of simultaneous indices was estimated which selects genotypes for both high yield and stability in MLT using AMMI model. A comparison between proposed indices and existing simultaneous selection indices with reference to french bean MLT is also made.

Key words : French bean, simultaneous selection indices, stability, MLT.

Genotype x environment interaction (GEI) is the challenging issue to the plant breeders, geneticists and agronomist who conduct crop performance trials across diverse environments. GEI can reduce the progress from selection. The method of partitioning GEI into components attributable to each genotype measures the contribution of each genotype to GEI. An universally acceptable selection criterion that takes GEI into consideration does not exit. Whenever an interaction is significant, the use of main effects, for example overall genotypes means across environments, is questionable. Hence, stability of performance should be considered

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as an important aspect of yield trials. Researchers need a statistic that provides a reliable measure of stability or consistency of performance across a range of environments, particularly one that reflects the contribution of each genotype to the total GEI. In literature large number of stability measure are available (Prabhakaran and Jain, 1994). However, the stability measure alone is of limited use. For successful breeding or cultivar testing programme, both stability and yield (or any other trait) must be considered simultaneously. Also integration of stability of performance with yield through suitable measures will help in selecting cultivars in a more refined manner. One approach would be to integrate measures of performance and stability as a most informative index.

Rao and Prabhakaran (2005) proposed a family of simultaneous selection indices using Additive Main Effects and Multiplicative Interaction (AMMI). Nachit *et al*. (1992) showed that AMMI model was more effective in partitioning the GEI sum of squares than the linear regression model. Yan *et al*. (2000) advocated a graphical presentation of main effect of genotype (G) and genotype x environment interaction (GEI) as a 'GGE' biplot. However, the inferences drawn from biplots will be valid only when first PCA or first two PCAs explain a large proportion of interaction variation. Whenever more than two axes are retained in the AMMI model, the biplot formulation of interaction becomes complex. Consequently, the conclusions drawn on stability of varieties may not be precise. However, the plant breeders would like to identify varieties which are stable and high yielding when the PCA axes retained in AMMI model will be more than two, if the axes together accumulate considerable portion of interaction variation. Thus, to cater the need to develop selection indices under such circumstances Rao and Prabhakaran (2005) proposed new yield stability indices.

MATERIALS AND METHODS

Simultaneous selection indices based on AMMI model : It is evident from the earlier section that the scope of the biplots is very much limited. The inferences drawn from biplots will be valid only when first two PCAs explain a large portion of interaction variation. In situations, where more than two PCA axes are needed to accumulate considerable portion of GEI variation, what should be the approach for identifying varieties which are high yielding as well as stable. Rao and Prabhakaran (2005) proposed a new family of simultaneous selection indices which can select varieties for both yield and stability.

Let $\alpha^*_n = \alpha_n \tau_n$ be a T x 1 vector of modified genotypic scores corresponding to the n^{th} PCA axis of ZZ', where λ_n is the eigen value and α_n is corresponding eigen vector of ZZ'. Suppose that n' of the N axes are retained in the AMMI model to explain genotype x environment interaction, then the stability measure of i^{th} variety can be determined as the end point of its vector (α^*_{1i}, α^*_{2i}, ... $\alpha^*_{n'i}$) from the origin $O'_{1 \times n'}$. This can be taken as squared Euclidean distance between the vector $\delta' = (\alpha^*_{1i}, \alpha^*_{2i}, \ldots, \alpha^*_{n'i})$ from the origin, in the n'-dimentonal Euclidean space. They considered a stability measure, ASTABi as

$$ASTABi = di\ (\delta, 0) = \alpha^{2*}_{1i},\ \alpha^{2*}_{2i}, \ldots\ \alpha^{2*}_{n'i},$$

$$= \sum_{n=1}^{n'} \alpha^{2*}_{ni} = \sum_{n=1}^{n'} \lambda_n \alpha^2_{ni} \qquad (1)$$

The algebraic expression of the above said stability measure can also be derived from the spectral decomposition of ZZ' matrix. As we know that

$$ZZ' = \lambda_1\alpha_1\alpha'_1 + \lambda_2\alpha_2\alpha'_2 + \ldots\ldots + \lambda_n\alpha_n\alpha'_n + \ldots\ldots + \lambda_N\alpha_N\alpha'_N +$$

The diagonal element of ZZ' i.e.

Table 1. AMMI ANOVA for seed yield (13 french bean genotypes and 3 checks tested at 16 environments).

Source	df	MSS	% SS
Treat combinations	255	175204.70588**	100.0
Genotypes	15	393058.6667**	13.2
Environments	15	1537980**	51.6
G x E Interacton	225	69829.3333**	35.2
PCA 1	29	204766.5517**	#37.8
PCA 2	27	154161.8519**	#26.5
PCA 3	25	60088.4**	#9.6
PCA 4	23	57443.4783**	#8.4
Residual	121	23038.4298	#17.7
Error	512		

*,** : Significant at 5 and 1 per cent levels, respectively. # : as a per cent of GEI SS

$$\sum_{j=1}^{s} Z^2_y$$

is nothing but the interaction effect of i^{th} genotype over S environments.

Therefore,

$$\sum_{j=1}^{s} Z^2_{ij} = \lambda_1\alpha^2_{1i}+\lambda_2\alpha^2_{2i}+\ldots+\lambda_n\alpha^2_{ni} = \sum_{j=1}^{s} \lambda_n\alpha^2_{ni} \quad (2)$$

The stability measure mentioned in (1) is also equal to the expression given in (2) when N=n', n' being the number of PCA axes retained in AMMI model. A variety is considered more stable when the value of ASTABi is lower. The proposed selection indices (I_j) consists of (i) yield component, measured as the ratio of the average performance of j^{th} genotype to the overall mean performance of the genotypes under test, and (ii) a stability component, measured as the reciprocal of stability information (1/ASTABi) of j^{th} genotype to the mean stability information of all the genotypes under test. The simultaneous selection index can be given as

$$I_j = \frac{\bar{Y}_{j.}}{\bar{Y}_{..}} + \alpha \frac{(1 / ASTAB_j)}{1/T \sum_{j=1}^{T} ASTAB_j}$$

where, α is the ratio of the weights given to the stability components (w_2) and yield (w1) with restriction that $w_1 + w_2 = 1$. The weights considered in the index are, in general, as per the plant breeders' requirement. By considering values of α as 1.0 ($w_1 = w_2 = 0.5$), 0.66 ($w_1 = 0.6$, $w_2 = 0.4$), 0.43 ($w_1 = 0.7$, $w_2 = 0.3$) and 0.25 ($w_1 = 0.8$, $w2 = 0.2$), a new family of indices consists of four indices I_1, I_2, I_3 and I_4.

Comparison of the simultaneous selection indices : The data used for comparing various simultaneous selection indices are collected from University multilocation trials of sixteen french bean (*Phaseotus vulgaris* L.) genotypes including three checks *viz*., 'ACPR-5', 'ACPR-9', 'ACPR-11', 'ACPR-94034', 'ACPR-94035', 'ACPR-94036', 'ACPR-94037', 'ACPR-94038', 'ACPR-94039', 'ACPR-94040', 'Red Cloud', 'PDR-5', 'EC-40844', 'HPR-35 (C)', 'Vaghya (C)' and 'HUR-137 (C)', grown in 1.8 x 4.0 m^2 plot with 30 and 10 cm spacing between and within rows, respectively in a randomized block with three replications during *kharif* 1996-2001 at five different locations, *viz*., Ganeshkhind, Pune, Karad, Borgaon and Kolhapur, in the rajmash growing region of plain zone. All the treatments received uniform recommended dose of fertilizers, timely inter-culturing and plant protection measures. The data generated on seed yield of rajmash were analysed as per Zobel *et al.* (1988) and Gauch and Zobel (1989), using IRRISTAT software developed by International Rice

Table 2. Effect of variation of weight on the rank orders of french bean varieties in the simultaneous selection indices.

Genotypes	Yield (kg ha^{-1})	Yield based rank	Stability (x 10^6)	Stability based rank	α = 1.00		α = 0.67		α = 0.43		α = 0.25	
					Index	Rank	Index	Rank	Index	Rank	Index	Rank
ACPR 5	1183	12	1.68	10	1.84	9	1.53	9	1.31	12	1.14	12
ACPR 9	1315	9	2.49	14	1.64	14	1.43	14	1.28	14	1.16	11
ACPR 11	1159	13	2.83	15	1.44	16	1.26	16	1.12	16	1.03	15
ACPR 94034	1335	8	2.31	13	1.70	13	1.48	12	1.31	9	1.19	9
ACPR 94035	1505	1	0.96	2	2.79	1	2.25	1	1.85	1	1.56	1
ACPR 94036	1482	4	1.35	4	2.30	4	1.91	4	1.63	4	1.42	4
ACPR 94037	1448	5	1.00	3	2.68	3	2.16	3	1.78	2	1.50	2
ACPR 94038	1306	10	2.18	12	1.72	12	1.48	11	1.31	11	1.18	10
ACPR 94039	1505	2	2.01	11	1.93	7	1.67	7	1.49	5	1.35	5
ACPR 94040	1492	3	3.19	16	1.63	1	1.47	13	1.35	8	1.26	7
Red cloud	1338	7	1.51	6	2.07	6	1.72	5	1.47	6	1.28	6
PDR 5	1356	6	0.94	1	2.72	2	2.16	2	1.76	3	1.46	3
EC 40844	1208	11	1.35	5	2.09	5	1.70	6	1.42	7	1.21	8
Vaghya (LC)	1150	15	1.65	9	1.83	10	1.52	10	1.29	13	1.12	14
HPR 35 (SC)	1155	14	1.59	8	1.87	8	1.55	8	1.31	10	1.13	13
HUR 137 (NC)	982	16	1.55	7	1.76	11	1.43	15	1.19	15	1.00	16

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RESULTS AND DISCUSSION

From the ANOVA based on AMMI model (Table 1) it is evident that the use of biplots to explain efficiently the interaction is very much limited, since the first two PCA axes explain 64 per cent of the total interaction variation. Hence, it may not be advisable to conclude regarding stability or simultaneous selection based on these two axes. It is evident that at least four axes must be retained for explaining stability or using the Rao and Prabhakaran (2005) simultaneous selection indices. Hence, the index and stability values are calculated by retaining four PCA axes in the model. Accordingly, the rank orders based on yield, stability (ASTABi), Indices for each genotype and for different α values presented in Table 2 revealed that the high yielding genotype 'ACPR-94035' was found to be stable followed by the genotypes 'ACPR-94036' and 'ACPR-94039'. These results are in accordance with the findings of Nimbalkar *et al.* (2004, 2005).

The researchers may identify the genotypes as per their desired levels of stability and yield indices.

ACKNOWLEDGEMENT

Authors greatly acknowledge the help rendered by Dr. A. P. Baviskar, Associate Professor of Plant Breeding and Dr. M. T. Patil, Associate Director of Research, NARP (PZ), Ganeshkhind, Pune for their encouragement and permitting to use Multilocation Trial's data for this investigation.

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J. Maharashtra agric. Univ., 34 (2) : 194-196 (2009)

Training Need of Tribal Leaders in Agriculture and Allied Enterprises and Constraints Faced by them in Their Role Performance

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ABSTRACT

The study was conducted in Junnar, Ambegaon and Rajgurunagar tahsils of Pune district. Total 80 tribal leaders were selected for the study. Animal husbandry (81.25 per cent), poultry (63.75 per cent) and horticulture (46.25 per cent) were the major areas identified by the tribal leaders for training. Regarding constraints, three fourth (76.75 per cent) of tribal leaders had experienced the constraint of low economic status, followed by drug addiction among the tribal farmers.

Key words : Training needs, constraint, agricultural development.

India is one among the few nations of the world noted for its tribal concentration. Tribal leaders play an important role in agricultural development. Their role is diversified; like communicator, advisor, helper, planner etc. The leadership qualities can be developed in an individual by creating opportunities and training. Thus, the individuals who are identified as leaders can be helped to perform their role efficiently by providing knowledge and skill through training. It is always better to design and organize the training programmes considering the training needs of the people concerned. In view of this, the present study was conducted in tribal areas of Pune district to assess the training needs of the tribal leaders regarding agriculture and allied enterprises and the constraints faced by them in role performance.

MATERIALS AND METHODS

On the basis of maximum tribal population, sixteen villages from Junnar, Ambegaon and Rajgurunagar tahsils of Pune district were selected for this study. Eighty tribal leaders were selected with the help of Gramsevak, Talathi, Village Extension Worker and Head Master of primary schools in respective villages by using socio-metry method. The structured interview schedule was developed, pre-tested and finalized to elicit the general and specific information. The data was collected by personal interview.

RESULTS AND DISCUSSION

It was observed that 100 per cent of the tribal leaders had expressed the desire to have training about agriculture and allied enterprises. The data from Table 1 revealed that, the intensity of training needs of tribal leaders with respect to animal husbandry and poultry was very high (81.25 and 63.75 per cent, respectively). Similarly, the response of the tribal leaders to the training area of horticulture was moderate (46.25 per cent). The bee keeping and sericulture seemed to be important, while the area like mushroom cultivation was considered comparatively less important by the tribal leaders. The findings are similar to the findings of Bagle *et al.* (2003).

It was observed that (Table 2) majority of the leaders had high intensity of training needs. In case of horticulture, layout and planting of orchard, method of preparing grafts and seedlings, and post harvest technology were the important sub areas of training as reported by 51.35, 94.59 and 67.56 per cent respondents, respectively.

In the area of animal husbandry, the sub areas namely care and management of pregnant animal, milch .animals and calves, and cattle feeds had higher intensity of training needs (87.69 per cent for each). In the area of poultry, selection of pure breeds, poultry feeds and diseases and their control measures were the sub areas of training reported by respondents to the extent of 60.78, 64.70 and 86.27 per cent respectiveiy. In the area of

Table 1. Intensity of training needs with respect to agriculture and allied enterprises as expressed by the tribal leaders.

Major areas of training	Percentage (N = 80)
Horticulture	46.25
Animal Husbandry	81.25
Poultry	63.75
Mushroom cultivation	7.50
Bee keeping	22.50
Sericulture	20.00
Vermicompost	10.00

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mushroom cultivation, scientific mushroom cultivation and mushroom harvesting method were the sub areas of training need stated by 83.33 and 50.00 per cent respondents respectively. Regarding bee keeping, 88.88 per cent respondents mentioned the sub-areas, of training requirement namely, installation of honey bee boxes in field and technique of honey extraction. In sericulture, feed required for silkworm and processing of ready cocoons were the sub areas of training need reported by 56.25 and 87.50 per cent respondents respectively. The results are consistent with that of Tarde and Nirban (2001).

It is seen from Table 3 that majority (76.25 per cent) of the tribal leaders faced constraints of low economic status of tribal farmer followed by drug addiction among the tribal farmers (73.75 per cent), illiteracy of tribal farmers (48.75 per cent), high cost of improved seeds, implements, fertilizers and insecticides (47.50 per cent) and insufficient visits of extension workers (38.75 per cent). More than one-third (35.00 per cent) of the tribal leaders expressed orthodox nature of tribal farmers as one of the important constraints.

Lack of co-operation from tribal farmers (21.25 per cent), Government agricultural programmes, are not effectively implemented in tribal areas (21.25 per cent), lack of proper guidance from related departments (20.00 per cent), factions in the village (12.50 per cent), no proper information about new technology (11.25 pre cent) and reluctance of extension workers for working in tribal areas (6.25 per cent) were the other problems faced by the tribal leaders in agricultural development. The results are in accordance with the findings of Mankar *et al.* (2000)

It was evident from the investigation that the tribal leaders were eager to have detailed information on different areas related to agricultural development. The agricultural university, the concerned departments and local

Table 2. Intensity of training needs with respect to sub-areas of agriculture and allied enterprise as experssed by tribal leaders.

Areas and sub-areas of training needs	Percentage
Horticulture (N = 37)	
Layout and planting of orchard	51.35
Methods of presaring grafts and seedlings	94.59
Post harvest technology	67.56
Animal husbandry (N = 65)	
Care and management of pregnant animal, mulch animal and calves	87.69
Information about cattle feed	87.69
Preparation of milk products	38.46
Poultry (N = 51)	
Selection of pure breeds	60.78
Poultry feeds	64.70
Diseases and their control measures	86.27
Mushroom cultivation (N = 6)	
High yielding mushroom varieties	100.00
Scientific mushroom cultivation	83.33
Mushroom harvesting method	50.00
Bee keeping (N = 18)	
Information about installation of honey bee boxes in field	88.88
Technique of honey extraction	88.88
Training for identification of pure honey	16.66
Sericulture (N = 16)	
Rearing of silkworm	100.00
Feed required for silkworm	56.25
Processing of ready cocoons	87.50

Table 3. Constraints faced by the tribal leaders in agricultural development.

Constraints	Percentage
Low economic status of tribal farmers	76.25
Drug addiction among the tribal farmers	73.75
Illiteracy of tribal farmers	48.75
High cost of improved seeds, implements, fertilizers and insecticides	47.50
Insufficient visits of extension workders	38.75
Orthodox nature of tribal farmers	35.00
Lack of co-operation from tribal farmers	21.25
Government agricultural programme are not effectively implemented in tribal areas	21.25
Lack of proper guidance from related departments	20.00
Factions in the village	12.50
Insufficient information about new agricultural technology	11.25
Reluctance of extension workers for working in tribal areas	6.25

bodies should plan the training programmes jointly for imparting training to the tribal leaders as suggested by Parvathy *et al.* (2000). Emphasis should be given in the training programmes on the sub-areas identified by the tribal leaders, so that the training will become need based. It was indicated that most of the problems were related to the social aspects. All efforts therefore, need to be diverted towards developing the sense of oneness among the villagers and awareness about self development. The concerned organizations should make efforts in this regard.

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J. Maharashtra agric. Univ., 34 (2) : 196-200 (2009)

Suitable Gear Throttle Combination for Tillage Implements

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ABSTRACT

The study indicated that all the tractor implement systems can be operated fairly well in IV-L gear at 1/3rd load setting to be a fuel efficient gear throttle combination and for higher rate of work the III-L gear in 2/3rd load setting appeared to be a better selection for the operation.

Key words : Part load and tractor implement system.

It would be useful to the tractor manufacturers and users to know the tractive performance behavior of the tractor with implement and to evaluate methods and operational practice to optimize their performance in the field. An implements manufacturer must be aware of the power requirement of the various tillage implements, which could be designed and manufactured in accordance with the size of the tractor available in the country. Type of an implement, depth of cut, width of implement, tool shape, tool arrangement, soil type, soil moisture content, shape of field condition, travel speed and part load on engine i. e. the ratio of engine speed during work to the maximum speed (at which maximum power is developed) of an engine are the factors that are considered for testing and evaluation of tractor implement systems (Janabi and Shaibani 1998).

It is known that tractor operator makes minor adjustments to the engine to match field conditions at a given instant can improve output of the tractor considerably. To accomplish this tractor operator must know the engine load speed, torque level and slip for the fuel economy and high tractive efficiency. As very less work has been done on the part load concept and very less information is available to the tractor operators in this regard. Hence, this should be widely understood and brought to the attention of the owners and operators of the tractor. This information would enable the manufactures and users in selection of correct implement, their adjustments and instructional settings of the tractor for better different efficiencies improving the tractor implement combination performance in the field. Keeping theses points in view a study was undertaken to select suitable gear throttle combination based on power and energy requirement, field, tractive, fuel and power

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delivery efficiency for tillage implements.

MATERIALS AND METHODS

Suitable gear throttle combination was selected by evaluating the drawbar power per unit volume of soil tilled and energy requirement, field capacity, field efficiency, tractive efficiency and fuel consumption for three tractor implement systems *viz*. tractor-rotavator, tractor-cultivator and tractor-disc plough at 1/3rd (650 - 700 rpm), 2/3rd (1350 -1400 rpm) and full load (2000 rpm) settings. The measurement of selected parameters is discussed as given below:

Speed of travel : The speed of operation was measured in the field by using standard procedure as per RNAM test code.

Fuel consumption : Fuel consumed by the tractor during field operation was measured using an auxiliary fuel system. The fuel system consisted of auxiliary fuel M. S. tank that was fixed on the tractor. To find out the consumption of fuel, the top up method in the auxiliary tank was used and calculated as:

Fuel consumption (*l*/ha). F,

$$F = \frac{\text{Fuel consumed } (l)}{\text{A Covered plot area, ha.}} \quad (1)$$

Measurement of rolling resistance : The rolling resistance was measured by towing a dummy tractor to test tractor through load cell connected with digital load indicator.

Measurement of draft : Load cell was placed in between two tractors for the draft measurement and the implement was hitched to the rear tractor. The gear of the rear tractor was kept in neutral and implement hitched behind the tractor given a desired depth. Front tractor pulled the rear tractor with implement. The reading of load indicator was recorded from digital load indicator. The draft was calculated using the calibration curve. The difference of calculated draft and rolling resistance was taken as a draft for further calculations of power requirement per unit volume of soil tilled, which is calculated as:

Drawbar power (DBHP),

$$DBHP = \frac{D \times S}{W \times d \times 75} \quad (2)$$

Where,

D=draft, kg;

S=forward speed of operation, m/s;

W=width of implement, m and

d=depth of operation, m.

Energy requirement : Energy requirement was calculated from fuel consumption, calorific value (10500 kcal kg^{-1}) and specific gravity (0.84) of diesel as:

$$E = \frac{F \times 0.84 \times 10500}{EFC \times 860} \quad (3)$$

Where,

E = energy requirement, kWh ha^{-1},

F = fuel consumption per unit time, liter and

EFC = effective field capacity, ha h^{-1}.

Field efficiency (FE) : It gives an indication of time lost in the field and the failure to utilize the working width of the implement. It is expressed in percentage and was calculated as:

$$FE = (EFC/TFC) \times 100 \quad (4)$$

The actual area covered by the implement, based on its time consumed and it's width was taken as effective field capacity (EFC) and the rate of field coverage of the implement, based on its 100 per cent of the time at the rated speed and covering 100 per cent of its rated width was taken as theoretical field capacity (TFC)

Tractive efficiency (TE) : It is defined as the ratio of output power to input power for a traction device. It is the measure of efficiency with which the traction device transforms the torque acting on the axle into linear drawbar pull. It was calculated using following expression:

$$TE = \frac{P}{F} \times (1 - s) \quad (5)$$

Where,

P = pull, kg;

F = gross thrust force acting on the wheel (P + R), kg;

S = slip and

R = rolling resistance, kg.

Power delivery efficiency : It is the measure of efficiency with which the engine power is utilized by the tractor -implement system (Zoz, *et al.* 1999).

Soil pulverization : Soil pulverization indicated the general fragmentation of soil mass resulting from the action of tillage forces, and it was evaluated by using a set of sieves as per RNAM test code.

RESULTS AND DISCUSSION

Selection of gear-throttle combinations for tractor rotavator system : At 1/3rd load setting, performance was found better in IV-L gear than III-L gear. It reduced the fuel consumption and tractive efficiency by 22 per cent and 18.36 per cent respectively with 31.28 per cent and 2.7 per cent increase in effective field capacity, power delivery efficiency and mean soil clod diameter respectively when compared with III-L gear.

At 2/3rd load setting, III-L gear was found better gear than I-L and II-L gear. When gear was shifted from I-L to II-L the fuel consumption and tractive efficiency reduced by 14.24 per cent and 25.47 per cent respectively and effective field capacity, power delivery efficiency and mean soil clod diameter were increased by 51.23 per cent, 71.6 per cent and 2,8 per cent respectively. Whereas, when gear was shifted from II-L to III-L the fuel consumption and tractive efficiency reduced by 18.89 per cent and 10.3 per cent respectively and effective field capacity, power delivery efficiency and mean soil clod diameter were increased by 72.13 per cent, 2.31 per cent times and 5.5 per cent respectively. The increase in work rate and reduction in fuel consumption at the selection of next higher gear was also reported by Hasen *et al.* (1986) and Mani and Panwar (1992).

At full load setting, II-L gear was observed to be a better gear than I-L gear. The percentage reduction in fuel consumption was 19.38 per cent and increase in effective field capacity, mean soil clod diameter and power delivery efficiency were 43.34 per cent, 3.84 per cent and 81 per cent was found in II-L gear when compared with I-L gear.

Table 1. Performance of different tractor implements systems at different gear throttle combinations.

Load condition	Gear selected	Effective field capacity (ha h^{-1})	DBHP per unit volume of soil tilled	Energy requirment (KW h ha^{-1})	Field effciency (%)	Tractive efficiency (%)	Fuel consumption (Lit ha^{-1})
For rotavator :							
1/3rd	III-L	0.157	0.337	98.62	79.13	25.76	9.616
1/3rd	IV-L	0.217	0.467	76.84	88.48	21.03	7.493
2/3rd	I-L	0.121	0.167	178.55	83.25	24.12	17.410
2/3rd	II-L	0.183	0.289	156.19	87.42	21.63	15.230
2/3rd	III-L	0.315	0.670	131.37	82.81	16.11	12.810
Full	I-L	0.198	0.199	197.29	88.24	13.36	19.238
Full	II-L	0.284	0.362	188.46	85.29	13.00	18.377
For disc plough :							
1/3rd	III-L	0.090	2.416	133.192	73.30	63.35	12.987
1/3rd	IV-L	0.114	3.217	107.481	74.40	57.90	10.480
2/3rd	I-L	0.067	1.474	135.889	73.31	65.18	13.250
2/3rd	II-L	0.102	2.550	130.430	75.52	62.75	12.718
2/3rd	III-L	0.185	5.790	108.002	77.72	55.18	10.531
Full	I-L	0.106	2.757	187.694	77.71	60.35	18.301
Full	II-L	0.161	4.989	164.196	76.60	59.21	16.010
For cultivator :							
1/3rd	III-L	0.295	2.36	49.455	88.85	63.50	4.882
1/3rd	IV-L	0.358	3.10	45.828	87.90	57.66	4.469
2/3rd	I-L	0.206	1.44	80.916	89.24	65.66	7.890
2/3rd	II-L	0.306	2.47	83.470	89.82	63.19	8.139
2/3rd	III-L	0.538	5.48	64.688	90.40	54.23	6.307
Full	I-L	0.319	2.62	104.660	90.40	59.78	10.205
Full	II-L	0.457	4.40	95.679	89.89	57.20	9.329

Among all the gear throttle combinations, IV-L gear at 1/3rd load setting was found to be fuel-efficient. It required 45.16 per cent and 52 per cent less fuel but 45.17 per cent and 30.88 per cent more time to cover one hectare plot area than at III-L gear at 2/3rd load setting and II-L gear at full load setting (normal practice of operation followed by the farmers in the region). Reason for less fuel consumption though tractor implement systems were operated for more time at IV-L gear may be the power developed, which is enough to operate the implement, in IV-L gear at 1/3rd load setting was lower than the power developed at 2/3rd load setting in III-L gear and in II-L gear at full load setting, which reduces fuel consumption. The use of III-L gear at 2/3rd load setting showed 9.85 per cent less time requirement and 30.3 per cent less fuel consumption than at II-L gear in full throttle position (normal practice of operation followed by the farmers in the region).

Selection of gear throttle combinations for tractor disc plough system : At 1/3rd load setting IV-L gear was found to be better than III-L gear at which, fuel consumption, tractive efficiency and mean soil clod diameter reduced by 19.3 per cent, 8.44 per cent and 5.36 per cent respectively and effective field capacity and power delivery efficiency increased by 26.33 per cent and 33.2 per cent respectively.

At 2/3rd load setting, III-L gear was found to be better than I-L and II-L gear. When gear was shifted from I-L to II-L the fuel consumption, tractive efficiency and mean soil clod diameter reduced by 4.0 per cent, 3.7 per cent and 3.88 per cent respectively and effective field capacity and power delivery efficiency increased by 50.6 per cent and 73.0 per cent respectively. When gear was shifted from II-L to III-L the fuel consumption, tractive efficiency and mean soil clod diameter reduced by 4.0 per cent, 3.7 per cent and 3.88 per cent respectively and effective field capacity and power delivery efficiency increased by 50.6 per cent and 73.0 per cent respectively.

At full load setting II-L gear was observed to be suitable gear than I-L gear. At II-L gear the percentage reduction in the fuel consumption, tractive efficiency and mean soil clod diameter was observed to be 12.51 per cent, 1.9 per cent and 5.25 per cent respectively and increase in effective field capacity and power delivery efficiency was 51.88 per cent and 81 per cent when compared with I-L gear.

Among the better gear throttle combination selected, IV-L gear at 1/3rd load was found to be fuel-efficient. It required 10 per cent and 34.5 per cent less fuel and 62 per cent and 41 per cent more time to cover one hectare plot area than at III-L gear at 2/3rd load setting and II-L gear at full load setting (normal practice of operation followed by the farmers in the region) respectively. The reason may be the same as in case of rotavator. The use of III-L gear at 2/3rd load setting showed the 12.8 per cent less time to cover one hectare of field area and 34.1 per cent less fuel consumption than at II-L gear in full throttle position (normal practice of operation followed by the farmers in the region). Similar results were also reported by Tanihuhi *et al*. (1999) and Dahab *et al*. (2002).

Selection of gear throttle combinations for tractor-cultivator system : At 1/3rd load setting IV-L gear was found to be a better gear than III-L gear. In IV-L gear the fuel consumption, tractive efficiency and mean soil clod diameter reduced by 7.32 per cent, 9.19 per cent and 6.06 per cent respectively. And effective field capacity and power delivery efficiency increased by 21.35 per cent and 31.17 per cent respectively when compared with III-L gear.

At 2/3rd load setting III-L gear was found to be better than I-L and II-L gear. When gear was shifted from I-L to II-L, the fuel consumption, tractive efficiency and mean soil clod diameter reduced by 3.15 per cent, 3.76 per cent and 0.1 per cent and effective field capacity and power delivery efficiency increased by 48.58 per cent and 71.6 per cent respectively. When gear was shifted from II-L to III-L, the fuel consumption, tractive efficiency and mean soil clod diameter reduced by 20.15 per cent, 14.17 per cent and 4.43 per cent and effective field capacity and power delivery efficiency increased by 48.54 per cent and 2.21 times respectively.

At full load setting II-L gear was observed to be a better gear than I-L gear. In II-L gear the reduction in fuel consumption, tractive efficiency and mean soil clod diameter was 8.58 per cent 4.31 per cent and 4.43 per cent respectively and increase in effective field capacity and power delivery efficiency was 43.26 per cent and 67.8 per cent respectively when compared with I-L gear.

Among the suitable throttle combinations selected, IV-L gear at 1/3rd load setting was found to be fuel efficient. It required 29 and 52 per cent less fuel but 50.8 and 28 per cent more time to cover one hectare plot area than at III-L gear at 2/3rd and II-L gear at full load setting (normal practice of operation followed by the farmers in the region). The reason may be the same as in case of rotavator. The use of III-L gear at 2/3rd load setting showed the 15.13 per cent less time to cover one hectare of field area 34.1 per cent less fuel consumption than at II-L gear in full throttle position (normal practice of operation followed by the farmers in the region).

The performance of different tractor implements systems at different gear throttle combinations inTable-1 showed that all the tractor implement systems studied can be operated fairly well in IV-L gear at 1/3 load setting to be fuel efficient and if the time is the limitation the III-L gear at 2/3rd load setting appears to be a better selection for operation.

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J. Maharashtra agric. Univ., 34 (2) : 200-204 (2009)

Biodiesel Production from Castor and Palm Oil and its Utilization in Diesel Engine Coupled Electrical Generator

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ABSTRACT

Biodiesel is produced from vegetable oils by adopting transesterification process. In the present study transesterification of vegetable oils of caster and palm was carried out with methanol in the presence of a basic catalyst. The efficiency in the process for the production of caster and palm biodiesel was in the range of 80-82 per cent and above 90 per cent respectively. The kinematic viscosity of caster biodiesel was not comparable with petrodiesel however, palm biodiesel showed very excellent flow properties and its kinematic viscosity was observed very close to the petrodiesel in normal ambient conditions. On the contrary, palm biodiesel was not found suitable alternative in cold conditions. The 7.5 kVA electrical generator was tested on B20, B40, B60, B80 and B100 palm and castor biodiesel blends on 4500 watt and 6000 watt loading conditions. The overall efficiency of electrical generator on B20 and B40 blends were found more than petrodiesel and efficiency improved on 6000 watt load. The engine performance was observed satisfactory and engine was run very smoothly and without breakdown on biodiesel blends.

Key words : Biodiesel, palm, castor, overall efficiency, electrical generator.

Biodiesel is defined as a fuel comprising mono-alkyl esters of long chain fatty acids derived from vegetable oils,animal fats and waste oils. Biodiesel fuel has the benefit of being non toxic, biodegradable and essentially free of sulphur and carcinogenic ring components. Biodiesel is produced from vegetable oils by adopting transesterification process (Shay, 1993 and Agrawal, 2004). The biodiesel hold good promise as an alternate fuel for diesel engines especially, during the periods of diesel shortage. Power cutoff on the peak irrigation scheduling period becomes more panaceas in rural sector. Hence most of the farmers are using diesel engine to meet out their requirements. Newly developed biodiesel processor was used to prepare biodiesel from castor and palm oil which was then tested for operating electric generator for power generation. The biodiesel processor was developed and fabricated at College of Agricultural Engineering and Technology, Marathwada Agriculture University, Parbhani.

MATERIALS AND METHODS

In biodiesel production process, the main reaction is transesterification of vegetable oil (Shay, 1993 and Agrawal, 2004). Product of the reaction is biodiesel and glycerol. They are separated by gravity. Biodiesel was then purified by washing gently with water or by using bubble wash arrangement (Chitra, 2005, Demirbas, 2003 and Ma, 1998). In present work transesterification of vegetable oils of castor and palm with methanol in the presence of a basic catalyst (NaOH) was carried out. The

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biodiesel fuel was processed in a batch type reactor. The catalyst was dissolved into the alcohol by vigorous stirring in a small reactor. The oil was transferred into the reactor and then the catalyst / alcohol mixture was poured into the oil and the final mix stirred vigorously for two hours. Two phases were obtained at the end of reaction, ester and crude glycerol. Biodiesel was observed in the top and glycerin, a sub product of the process was observed in the lower part, Since the castor oil used as a raw material presented some humidity (0.2%) soaps formed were removed by washing process. It is important to note that these impurities may cause problem in the operation of the engine because of the formation of coal dust. Properties of biodiesel were tested according to ASTM D675I standard. Electricity generator used for this study was Kirloskar make with 7.5 kVA, 415 + 2.5 % (volt), 10.5 Amp. With 50 Hz frequency single phase or three phase.

Biodiesel prepared from castor and palm oil and its blends as B20, B40, B60, B80 and B100 by volume were used as a fuel to run electricity generator. Experimental setup was arranged to measure exact fuel consumption, time required, output voltage, output current for each phase and total wattage for each blend of fuel. Generator was running on the constant load of 4500 and 6000 watt. On this constant load, output wattage, voltage and time required to consume specified volume of fuel was measured, for each blend of biodiesel.

Initially electricity generator was run on petrodiesel and time required to consume specific amount of diesel for constant loading of 4500 watt and 6000 watt was measured. Efficiency of the generator running on petrodiesel fuel was considered as a bench mark and 100 per cent on the same basis generator was run on specified blend of castor and palm biodiesel and corresponding efficiency with respect to diesel were determined. Overall efficiency of electric generator was calculated as ratio of energy output to energy input.

$$\text{Overall efficiency} = \frac{\text{Energy output (kW-h)}}{\text{Energy input (kW-h)}} \times 100$$

Energy output was considered as load given to the generator. However, energy input is the calorific value of measured quantity of specified blend of fuel.

RESULTS AND DISCUSSION

Biodiesel production : The efficiency in the process for the production of biodiesel was in the range of 80-82 per cent for castor oil and above 90 per cent for palm oil. Table 1 shows the yield of biodiesel and glycerin during transesterification process. The comparison between the properties of petroleum diesel and the biodiesel obtained in the laboratory is given in Table 2.

Castor oil properties indicate a very low pour and cloud points which make this biodiesel a good alternative in winter condition. Also, mixture of B20, BIO biodiesel, and petroleum diesel showed similar flow properties. It indicates that castor oil biodiesel could be used as petroleum diesel additive improving both environmental and flow

Table 1. Biodiesel and glycerin recovery in transesterification process.

Particular	Castor oil		Plam oil	
	Biodiesel (ml)	Glycerin and soap (ml)	Biodiesel (ml)	Glycerin (ml)
Batch-I	810	220	972	80
Batch-II	805	230	975	76
Batch-III	807	230	980	75
Mean	807	227	976	77

Table 2. Properties of castor and palm biodiesel.

Properties	Units	Petro-leum diesel	Caster oil			Palm oil	
			B10	B20	B100	Petro leum diesel	Bio diesel
Sp. Gravity		0.8610	0.8643	0.8703	0.9268	0.8610	0.875
Density	kg/m3	861.0	864.3	870.3	926.8	861.0	875
Kinematic viscosity	mm^2/s	3.81	4.54	4.97	15.98		4.5
Flash point	°C	68.3	85.3	88.7	190.7	68.3	174
Heating value	kj/kg	47216.4	44427.6	44780.4	37900.8	47216.4	39.16
Carbon residue	per cent	0	0.009	0.007	0.037	0	0.02
Cloud point	°C	-	-5	-7	-23	-6	15
Pour point	°C	-6	-26	-30	-45		

behavior of the mineral fuel (Oilveria, 2004). The transesterification process of castor oil is carried out with a base catalyst and a single reaction step is required because of its favorable acidity level. Therefore, in large scale process it would be less costly than chemical processes with other oils with a higher acidity level.

The properties of the B100 combustible and its B10 and B20 mixtures are comparable to those of petroleum diesel and acceptable within standard limit. The kinematic viscosity of raw castor oil is 100 times more than petroleum diesel and is changed to 15.98 mm^2/s after transesterification process. Thus, kinematic viscosity of petroleum diesel and castor biodiesel is incomparable and not acceptable to be used 100 per cent as a fuel in diesel engine. However, kinematic viscosity of B10 and B20 are 4.54 and 4.97 mm^2/s which is within the standard limit. It was found that viscosity was higher as the proportion of biodiesel in the mixture increased. However, this event does not affect the atomization characteristics. B100 has the highest flash and ignition points. Increasing the proportion of biodiesel in the mixture elevates its flash and ignition temperatures. A higher flash point translates into a higher level of safety in combustible transport and storage.

It is important to highlight that both cloud and pour point decline as more biodiesel is added to petroleum diesei. This implies a higher level of stability at low temperatures, making B100 an ideal combustible for cold region.

The production cost of palm and castor biodiesel will be Rs. 45 to 50 per liter. The specific gravity and density of palm oil biodiesel is very close to petroleum diesel. The high viscosity of palm oil was reduced to 4.5 mm^2/s in the process of transesterification, thus the viscosity was found nearer to the petroleum diesel. Fuel atomization is affected by fuel viscosity. Fuels with high viscosity tend to form larger droplets on injection which can use poor combustion, increased exhaust smoke and emissions. Since the viscosity of palm biodiesel was found within acceptable range fuel line choking and combustion problems will be minimized. Palm oil biodiesel is classified as a non flammable liquid due to higher flash point than it is for petrodiesel. Heating value of palm and castor biodiesel was found to be 39.16 and 37.9 MJ kg^{-1} respectively. Thus, palm and castor biodiesel has heating values 10 per cent lower than that of petrodiesel. The heating value of petrodiesel is approximately 45 MJ kg^{-1}.

The temperature at which oil starts to solidify is known as the cloud point. The cloud point for palm biodiesel was found to be 15°C. On the contrary, the cloud point for castor biodiesel was -23°C showed good flow properties in winter conditions (Kalam, 2002 and Srichirawat, 2002).

Overall efficiency of electrical generator was determined on 4500 and 6000 watt load conditions for specified blends of palm biodiesel. It was then compared with the generator running on petrodiesel fuel. The overall efficiency of electrical generator run by using blends of palm biodiesel on 4500 and 6000 watt load are presented in Table 3.

Table 3. Performance of electric generator using spacified blends of palm biodiesel for 4500 and 6000 watt loads.

Fuel blends	Calorific value kj kg^{-1}	Specific gravity	4500 watt load			6000 watt load		
			Fuel energy input		Overall efficiency (%)	Fuel energy input		Overall efficiency (%)
			kg hr^{-1}	kWh		kg hr^{-1}	kWh	
B20	41541.63	0.8492	1.544	17.84	25.22	1.552	17.93	33.46
B40	40932.19	0.8574	1.582	18.01	24.98	1.659	18.89	31.76
B60	40322.75	0.8635	1.727	19.37	23.23	1.717	19.26	31.15
B80	39713.30	0.8717	1.820	19.58	22.98	1.678	18.54	32.36
B100	39103.86	0.8750	1.656	19.88	22.72	1.675	18.22	32.93
D0	41961.35	0.8610	17.84	19.42	23.18	1.490	17.46	33.78

The calorific values of the blends were found decreasing as the increase in proportion of biodiesel in the blend. Further, the specific gravity of the blends was found increasing as the proportion of biodiesel increased in the blend.

When the generator was run purely on petrodiesel, overall efficiency was found to be 23.18 and 33.78 per cent on 4500 and 6000 watt load, respectively. The corresponding fuel consumption was 1.656 and 1.490 kg hr^{-1} 4500 and 6000 watt load, respectively.

The overall efficiency of the generator for 4500 watt load were 25.22, 24-98, and 23.23 per cent for B20, B40 and B60 palm biodiesel blends, respectively. Thus overall efficiencies on B20 and B40 blends were found more than the generator run on pure petrodiesel. The fuel consumption of B20 and B40 blends were found to be 1.544 and 1.582 kg h^{-1} which are less than the generator fueled with diesel (1.656 kg hr^{-1}). The fuel consumption increased for B60, B80 and B100 blends as compared to DO, B20 and B40 blends. The increase in fuel consumption tends to decrease the overall efficiency of the generator on B60, B80 and B100 blends. The overall efficiency of the generator for B80 and B100 blends were found to be 22.98 and 22.72 per cent, respectively. The difference in the efficiencies for all the blends of fuel was found to be marginal. Thus the overall efficiency of the electrical generator for 4500 watt load and specified blends of palm biodiesel was found in the range of 22 to 25 per cent. The increase in fuel consumption was found in the range of 8 to 9 per cent for B60, B80 and B100 blends.

The performance of electrical generator fueled with palm biodiesel blends for 6000 watt load is presented in Table 3. The overall efficiency of the generator run purely on petrodiesel was found to be 33.78 per cent and the corresponding fuel consumption was 1.490 kg hr^{-1} for 6000 watt load. The overall efficiency of the electrical generator improved on 6000 watt load and ranged in between 31 to 33.5 per cent. Thus the performance of electrical generator was found better on 6000 watt load when fueled with specified palm biodiesel blends. The overall efficiency of electrical generator for B20 blends (33.46 %) was found same with diesel fueled generator (33.78 %). However, the overall efficiency were found less on B40, B60, B80 and B100 fuel blends than D0 and B20 proportion. The fuel consumption for all the blends were found more than the diesel fueled generator.

Table 4. Performance of electric generator using spacified blends of castor biodiesel for 4500 and 6000 watt loads.

Fuel blends	Calorific value kj kg^{-1}	Specific gravity	4500 watt load			6000 watt load		
			Fuel energy input		Overall efficiency (%)	Fuel energy input		Overall efficiency (%)
			kg hr^{-1}	kWh		kg hr^{-1}	kWh	
B20	41290.16	0.8703	1.856	21.32	21.10	1.716	19.71	30.44
B40	40429.25	0.8829	1.815	20.41	22.04	1.672	18.80	31.91
B60	39567.29	0.8970	1.806	19.88	22.63	1.688	18.58	32.29
B80	38707.38	0.9123	1.799	19.37	23.23	1.799	19.37	30.97
B100	37846.47	0.9268	1.866	19.64	22.91	1.866	19.65	30.53
D0	42149.45	0.861	1.656	19.42	23.18	1.496	17.46	33.78

The overall efficiencies for B20, B40, B60, B80, and B100 palm biodiesel blends for 6000 watt load conditions were found to be 33.6, 31.76, 31.15, 32.36 and 32.93 per cent, respectively. The increase in fuel consumption than the diesel on biodiesel blends were found in the range of 4 to 15 per cent.

Overall efficiency of the electrical generator was determined on 4500 and 6000 watt load for specified blends of castor biodiesel (Table 4)

The overall efficiencies for B20, B40, B60, B80 and B100 pastor biodiesel blends were found to be 21.10, 22.04, 22.63, 23.23 and 22.91 per cent, respectively. The overall efficiency of the generator for 4500 watt load fueled with specified biodiesel blends were found less than the diesel fueled generator (23.18%) except for B80 blend (23.23%). Although, the efficiency of biodiesel was found less than the diesel, the difference was found negligible (Table 4). However, the fuel consumption on all the blends was found more than the diesel. The increase in fuel consumption compared to diesel was found in the range of 8.5 to 12 per cent. Thus the overall efficiency was found in the range of 21-23 per cent for 4500 watt load.

The calorific value of the castor biodiesel blends were found decreasing on addition of biodiesel proportion in the blend. On the contrary, the specific gravity of the blends increased on addition of biodiesel in the petrodiesel.

The performance of the generator for 6000 watt loading condition and fueled with specified blends of castor biodiesel is presented in Table 4. The performance of the generator was found better and improved on 6000 watt load. The overall efficiency was found in the range of 30 to 32 per cent. The overall efficiency was found less on biodiesel blends than the generator run on diesel fuel

(33.78 %). On the contrary the fuel consumption on biodiesel blends were found more as compared to diesel and found in the range of 13-25 per cent for 6000 watt load. The difference in overall efficiency on biodiesel blends and petrodiesel were found negligible and marginal.

In all the cases of biodiesel blends, the fuel consumption on 4500 and 6000 watt load were found more than the diesel. However, on the contrary the overall efficiency did not show any prominent difference in the performance of electrical generator on biodiesel blends. Since, the overall efficiency is related with the calorific value of the input fuel and corresponding output. The calorific value of the petrodiesel is 42.15 MJ kg^{-1}. The calorific value of palm and castor biodiesel was 39.16 and 37.9 MJ kg^{-1} respectively. Thus the biodiesel is low calorie or energy fuel than the petrodiesel. Therefore, though the fuel consumption was increased it did not show any significant effect on the value of overall efficiency. The engine performance was observed very satisfactory on biodiesel blends. The engine was run very smoothly without any breakdown and knocking. Choking of fuel supply line, improper fuel spray pattern are some of the problems associated with the use of viscous and straight vegetable oil. The fuel supply line was critically observed on biodiesel blends. However, no chocking was observed. The fuel was supplied in a very normal manner without any trouble. Reduction in viscosity during transesterification process reduced the problem associated with using thick oil in engine.

In general it is concluded that the efficiency in the process for the production of biodiesel was in tl range of 80-82 per cent for castor oil and above 90 per cent for palm oil. The kinematic iscosity of castor biodiesel and petrodiesel are incomparable. However, castor biodiesel will be ideal combustible for cold region and stable due to less cloud and pour point. The specific gravity and kinematic viscosity of palm biodiesel is very close to petrodiesel. The heating value of castor and palm biodiesel was found to be 37.9 and 39.16 MJ kg^{-1} respectively which is 10 per cent less than the petrodiesel.

During the biodiesel test in electrical generator it was observed that the overall efficiency of B20 and B40 palm biodiesel blends was more than the petrodiesel fueled generator for 4500 watt loading condition. The overall efficiency of the electrical generator improved on 6000 watt load and ranged in between 31-33.5 per cent for palm biodiesel blends.

The overall efficiency of the electrical generator was found in the range of 21-23 per cent for 4500 watt load when generator was fueled with castor biodiesel blends. The overall efficiency was found in the range of 30-32 per cent and improved on 6000 watt load when generator run on castor biodiesel blends.

The engine performance was observed very satisfactory on biodiesel 'blends. The engine was run smoothly without any breakdown and knocking. The reduction in viscosity during transesterification process reduced the problem associated using thick vegetable oil in the engine.

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J. Maharashtra agric. Univ., 34 (2) : 205-207 (2009)

Physical Properties of *Bael* (*Aegle marcelos corr.*) Fruit and Extraction of Pulp

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ABSTRACT

Around 72 to 73 per cent *bael* pulp could be extracted and utilized in beverage preparation. Fruit shape varied from flat, spherical, pear and near cylindrical. Fruit weight ranged from 455 to 2010 g. The fruit colour varied from greenish to yellowish with yellow colour pulp. The relative density varied from 1.221 to 0.402 g cm^{-3}. The average specific gravity and sphericity was 0.97 and 0.965 respectively. It was observed that pulp to water ratio of 1:1 gave homogeneous and acceptable quality pulp

Key words : *Bael*, pulp, properties, ratio.

Bael (*Aegle marcelos corr.*) is most important but under exploited indigenous edible wild fruit. This nutritionally and medicinally valuable fruit with hard shell, sticky texture and numerous seed makes it difficult to eat by hand and most of the fruits are wasted. However, it has potential to provide an excellent source of employment and has income generation activities if properly utilized (Gopalan *et al.*, 1971). A number of acceptable products could be developed, preservation methods could be standardized and storage requirement could be formulated to enable its commercial exploitation, which in turn will add to the rural economy (Rayaguru *et al.* 2000). Riped *bael* fruit has a demand for therapeutic use. *Bael* fruit, is not popular as a fresh fruit (Shresthra, 2000). The study was undertaken to explore the possibility of extraction of *bael* fruit pulp.

MATERIALS AND METHODS

The present experiment was conducted at Department of Agricultural Process Engineering, Mahatma Phule Krishi Vidyapeeth, Rahuri in February 2006. The *bael* fruits were purchased from local growers and from the Instructional farm of the University.

Physical properties : Vernier caliper and flexible measuring tape was used to measure physical properties. The volume was calculated by using standard formula (Chakraberty 1997). The water displacement method was used to determine the volume for cross checking and the density was calculated. The weights were taken by using an electronic balance having least count of 0.001 g. The size and sphericity was calculated by usual formulae given by Sahay and Singh *et al.* (2001) and AOAC (1970). Different components *viz.*, rind, seed, fibre, pulp, pulp to peel ratio and seed to pulp ratio was calculated using the method followed by Srivastav *et al.* (2003).

Extraction of pulp : Riped *bael* fruits were used for extraction of pulp. The important factor considered for ideal extraction of pulp was incorporation of water into the pulp and inactivation of enzymes by application of heat and pH adjustment. The pulp alongwith the seed and fibre was removed with the help of a stainless steel spoon and the peels were rejected. To the extracted pulp (with seed and fibre) water was added while adjusting the ratio of 1:0, 1:0.25, 1:0.75, 1:1, 1:1.25 and 1:1.50 to the weight of the pulp. The pulp was heated to 80°C for 1 minute before passing through 20 mesh stainless steel sieve and two layered muslin cloth. The pulp obtained was homogenous and free from seed and fibre. The procedure developed is as given in Fig.1

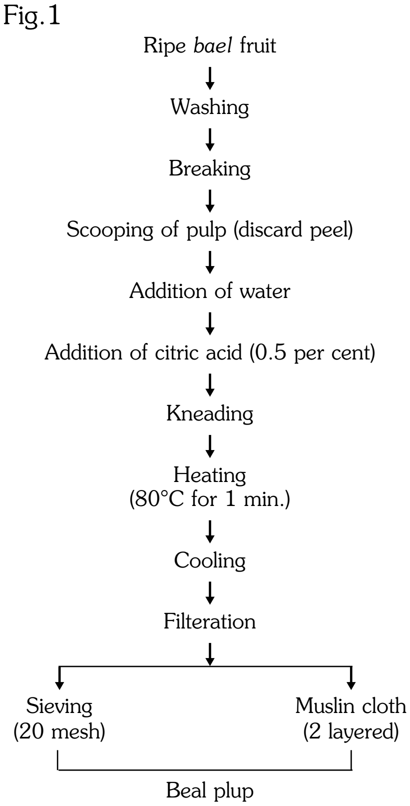

Fig. 1. Flow sheet for extration of *bael* fruit pulp.

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RESULTS AND DISCUSSION

Physical properties : It was observed (Table 1) that there is great variation in the shape, size and weight of *bael* fruit. The weight of *bael* fruit was varied from 455 g to 2010 g. The average weight was found to be 1189.7 g. The radius of *bael* fruit varied from 4.58 to 8.05 cm. The average volume was found 1535.61 cm^3. The average relative density and specific gravity was found 0.93 g cm^{-3} and 0.97, respectively. The size and sphericity was varied from 9.32 to 16.11 and 0.94 to 0.99, respectively. It was observed that fruit greatly varied in shape and size and are found spherical, pear shaped, near cylindrical shaped. In present study the variety of *bael* fruit could not maintained. These results are in conformity with Srivasta and Prasad (2003). The per cent rind, seed, fibre and pulp was 16.89, 4.1, 4.6 and 72.84, respectively. The average peel to pulp ratio was found to be 23:20 and the seed to pulp ratio was found to be 5:63 (Table 2).

Table 1. Physical properties of *bael* fruit.

Fruit No.	Weight (g)	Radius Root $\sqrt[3]{LBH}$	Volume			Relative density (g cm^3)	Specific gravity	Size (abc) 1/3	Sphericity (abc) 1/3/a
			Calculated (cm^3)	Water displaced (ml)	Average (cm^3)				
F_1	2010	7.38	1682.78	2067	1874.89	1.072	0.97	14.76	0.96
F_2	1020	6.45	1123.33	1187	1155.16	0.882	0.86	12.89	0.99
F_3	1840	8.05	2184.19	2395	4581.19	0.402	0.77	16.11	0.94
F_4	1640	7.79	1979.32	1810	1894.66	0.865	0.91	15.59	0.97
F_5	1750	7.76	1956.54	1875	1915.77	0.913	0.93	15.53	0.99
F_6	1482	7.97	2119.72	1865	1992.36	0.743	0.79	15.93	0.99
F_7	450	4.58	402.25	400	401.13	1.121	1.125	9.33	0.98
F_8	635	5.18	581.96	572	576.98	1.100	1.110	10.37	0.99
F_9	615	5.15	571.91	525	548.45	1.121	1.170	10.30	0.98
F_{10}	455	4.65	420.98	410	415.49	1.095	1.110	9.32	0.95
Average	1189.7	6.49	1302.3	1310.6	1535.6	0.93	0.97	13.01	0.97

Table 2. Different components of *bael* fruit.

Bael No	Weight of whole fruit (g)	Rind (%)	Seed (%)	Fibre (%)	Pulp (%)	Peel to pulp ratio	Seed to pulp ratio
F_1	2010	16.85	3.8	4.2	74.00	22.77	5.14
F_2	1020	16.34	3.9	5.2	69.70	23.44	5.59
F_3	1840	17.10	3.5	4.3	72.00	23.75	4.86
F_4	1640	17.30	4.3	4.8	73.6	23.50	5.84
F_5	1750	17.85	3.7	5.2	74.2	24.12	4.99
F_6	1482	16.85	4.2	4.9	69.8	24.14	6.01
F_7	450	17.19	4.6	4.3	71.5	24.04	6.43
F_8	635	16.10	3.9	4.8	75.18	21.42	5.19
F_9	615	16.27	4.8	4.3	72.20	22.53	6.65
F_{10}	455	17.00	4.3	4.1	75.20	22.31	5.64
Average	1189.7	16.89	4.1	4.6	72.84	23.20	5.63

Effect of incorporation of water on recovery of pulp : It was observed from Table 3 that incorporation of water increased the efficiency of pulping. The addition of water upto an amount of the pulp (with seeds and fibre) did not impaired the quality very much but beyond this, deterioration was noticed and the pulp obtained was unacceptable. It was observed that increase in the addition of water upto equal the amount of pulp (with seeds and fibre) there was some increase in the recovery of dry matter, reduction in pomace and the recovered pulp was very convenient for handling; beyond this there was no extra increase in dry matter, the pulp become organoleptically unacceptable and was too diluted to be used for preparation of fruit products other than beverages.

It was also observed that extraction of pulp from *bael* fruit was the main hindrance to the processing. The studies reveled that the *bael* fruit pulp extracted by passing through a sieve without addition of water resulted in a very sticky pulp. The pulp obtained was unfit for handling and nearly ten per cent loss of pulp resulted during extraction, partly left with the pomace and partly sticking to the sieve. This may be due to mucilage content of the pulp. Incorporation of water and application of heat diluted the mucilage considerably and made the pulp possible to extract commercially. Similar results were reported by Srivastava and Kumar (1993), Roy and Singh (1979), Susanta and Singh (1979) and Shresthra (2000) for extraction of bael fruit pulp.

The studies concluded that the

Tabel 3. Effect of incorporation of water on recovery of *bael* fruit, pulp.

Pulp : water	Pulp per kg of fruit (g)	TSS (%)	Organoleptic quality of pulp		Impression
			Score	Rating	
1:0	69.70	28.5	7.7	Liked Moderately	Pulp very sticky, not convenient to handle for processing, difficult to pass through a sieve or pulper
1:0.25	72.50	25.0	7.5	Liked Moderately	Handling of pulp not convenient pulp some how pass through sieve but not passed through pulper
1:0.75	75.18	20.1	7.1	Liked Moderately	Fairly convenient to handle pulp : passed through sieve but not through the pulper easily
1:1	74.00	16.0	8.0	Liked slightly	Very convenient to handle pulp : passed through sieve and pulper very easily
1:1.25	75.20	13.1	7.0	neither liked nordislike	Passed quickly through sieve and pulper
1:1.50	69.80	12.2	6.5	neither liked nordislike	Passed very quickly through sieve and pulper : pulp too diluted to handle for processing excepting for beverages.

bael fruit has lot of potential for processing in rural areas to make the best use of therapeutic characteristics of *bael* fruit.

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J. Maharashtra agric. Univ., 34 (2) : 208-210 (2009)

Reproduction and Production Performance and Breeding Efficiency of Phule Triveni Triple Crossbred Cows

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(Received : 10-03-2008)

ABSTRACT

The data pertaining to 420 Phule Triveni crossbred cows of various generations maintained for a period of 29 years (1977-2005) were utilized to study some reproduction traits, production traits and breeding efficiency. The overall least squares means (days) of lactation length, dry period and calving interval were 332.59 ± 2.93,79.06 ± 1.89 and 421.61 ± 2.93 respectively. The mean breeding efficiency was 92.71 ± 0.66 per cent. The effects of generation and period of calving were significant and season of calving and lactation order were non significant on the traits. The calving interval increased gradually with the advancement of generations. However, breeding efficiency showed contrasting trend. The correlations of LL, DP and CI with breeding efficiency were negative and significant (P<0.01).

Key words : Reproduction, breeding efficiency, Phule Triveni, cows.

The overall production performance of an animal depends on its reproduction performance. Superior reproduction reduces the unproductive period and increases the productive life of an animal. The breeding efficiency indicated the reproduction and production performance of animals. Breeding efficiency is influenced by age at first calving and calving interval. With the view to know the reproduction and production performance and breeding efficiency of Phule Triveni cows the present study was conducted.

MATERIALS AND METHODS

The data of 420 Phule Triveni triple crossbred cows of various generations *viz.* G_1 (113), G_2 (114), G_3 (81), G_4 (51), G_5 (47) and G_6 (14) maintained at Research Cum Development Project on Cattle, Mahatma Phule Krishi Vidyapeeth, Rahuri Dist. Ahmednagar (M.S.) were collected from history / pedigree sheets for a period of 29 years (1977 to 2005). The Phule Triveni is a triple crossbred cow developed at Rahuri which is having 50 per cent HF + 25 per cent Jersey and 25 per cent Gir inheritance. The generation wise least squares means of lactation length (LL), dry period (DP) and calving interval (CI) were estimated (Harvey, 1990). Duncun's Multiple Range Test (DMRT) as modified by, Kramer (1957) was utilized to make pair wise comparison between two mean values. The breeding efficiency (BE) was estimated by using Deshpande and Ingole (1986) formula. The non genetic factors *viz*. season of calving (SOC), period of calving (POC) and lactation order (LO) were considered for estimation of reproduction traits, production traits and breeding efficiency. On the basis of climatic conditions year was divided in to three seasons *viz*. rainy (June - September), winter (October - January) and summer (February -May). The data of 29 years were divided into 6 groups of period of calving *viz*. P_1 (1977-81), P_2 (1982 -86), P_3 (1987-91), P_4 (1992-96), P_5 (1997-2001) and P_6 (2002 and above). Simultaneously, the associations of LL, DP and CI with breeding efficiency were also estimated.

RESULTS AND DISCUSSION

The generation wise overall least squares means of LL, DP, CI and BE observed in Phule Triveni cows are presented in Table 1. The overall means of LL in crossbred cows was 332.59 ± 2.26 days. The effect of generation on LL was significant (P< 0.01). Similar results were reported by Khade (2001) in Gir crossbred cows.

The lactation length of cows of G_2 (320.61 ± 3.07) was significantly shorter than G_1 (327.33 ± 3.30), G_3 (335.31 ± 3.66), G_4 (340.84 ± 5.07), G_5 (335.43 ± 5.53) and G_6 (336.00 ± 9.75) groups. The variations in the LL among the cows of G_3, G_5 and G6 groups did not differed significantly from each other.

The differences due to POC was significant (P<0.01) and SOC and LO were non significant in lactation length, which corroborated with Kamble (2003) observed in Gir crossbreds. The mean LL (days) of cows calved during P_4 (341.44 ± 5.45) and P_6 (338.23 ± 9.24) was

A part of M. Sc. (Agri.) thesis submitted to Mahatma Phule Krishi Vidyapeeth, Rahuri Dist. Ahmednagar (M.S.).

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significantly higher than P_1 (318.31 ± 5.89), P_2 (322.99 ± 4.74), P_3 (322.88 ± 4.50) and P_5 (328.51 ± 6.05) groups. Differences in mean LL among the cows of P_1, P_2 and P_3 and P_4 and P_6 were non significant.

In Phule Triveni cows overall mean dry period was 79.06 ± 1.89 days. The influence of generation on DP was non significant. The difference due to POC was significant (P<0.05) and SOC and LO were non significant in dry period. The dry period of cows calved during P_2 (71.39 ± 4.13), P_3 (72.38 ± 3.92) and P_6 (71.95 ± 7.82) were significantly lower than cows of P_1 (83.17 ± 5.06), P_4 (79.83 ± 4.64) and P_5 (82.42 ± 5.08) groups. The differences in DP among the cows of P_2, P_3 and P_6 and P_1, P_4 and P_5 groups were at par with each other. The dry period during different periods showed erratic trend.

In Phule Triveni cows the mean calving interval was 420.61 days. The effect of generation on CI was significant (PO.05), which was in agreement with Dahiya *et al.* (2003) reported in Hariana crossbred cows. The mean CI (days) of cows of G_5 (428.07 ± 7.01) and G_6 (435.72 ± 12.69) were significantly higher than G_1 (406.53 ± 4.25), G_2 (414.26 ± 4.26), G_3 (415.28 ± 4.70) and G_4 (423.80 ± 6.47) groups. The CI of cows of G_5 and G6 groups were significantly higher than G_1, G_2 and G_3 groups. The results indicated that there was gradual increase in calving interval with the advancement of generations. The increase in CI during later generations might be due to decline in reproduction performance of those cows.

Table 1. Generationwise least squares means for lactation length, dry period, calving interval and breeding efficiency in Phule Triveni crossbred cows.

Effect	LL (days)	DP (days)	CI (days)	B. E. (%)
μ	332.59 ± 2.26 (1311)	79.06 ± 1.89 (1182)	420.61 ± 2.93 (1235)	92.71 ± 0.66 (1281)
G_1	327.33b ± 3.30 (339)	77.70 ± 2.81 (309)	406.53a ± 4.25 (329)	99.73a ± 0.54 (341)
G_2	320.61a ± 3.07 (392)	79.49 ± 2.78 (320)	414.26ab ± 4.20 (337)	94.22b ± 0.54 (343)
G_3	335.31c ± 3.36 (276)	77.39 ± 3.11 (255)	415.28b ± 4.70 (269)	93.22b ± 0.60 (277)
G_4	340.84c ± 5.07 (144)	79.41 ± 4.14 (144)	423.80c ± 6.47 (142)	90.79c ± 0.82 (150)
G_5	335.43c ± 5.53 (121)	81.62 ± 4.60 (117)	428.07cd ± 7.01 (121)	84.46d ± 0.87 (131)
G_6	336.00c ± 9.75 (39)	78.76 ± 8.07 (38)	435.72d ± 12.69 (37)	78.27d ± 1.51 (44)

Means in the same column with different superscript differed significantly

The variation due to POC was significant (P<0.01) and SOC and LO were non significant in calving interval. The CI (days) of cows calved during P_2 (404.56 ±6.17) and P_3 (407.92 ± 5.91) were significantly lower than P_1 (413.95 ± 7.60), P_4 (427.69 ± 7.06), P_5 (436.25 ±7.60) and P_6 (420.58 ± 4.11) groups. The variation in calving interval during different period might be due to change in feeding and management of cows.

In Phule Triveni cows the overall mean breeding efficiency was 92.71 ± 0.66 per cent as reported by Khopade (1996) in Gir crossbreds. The effect of generation on BE was significant (P<0.01). The BE (%) of cows of G_1 (99.73 ± 0.54) was significantly higher than G_2 (94.22 ± 0.54), G_3 (93.22 ± 0.60), G_4 (90.79 ± 0.82), G_5 (84.46 ± 0.87) and G_6 (78.27 ± 1.51) groups. These results indicated that BE was highest in cows of G_1 group, which gradually declined during succeeding generations. The per cent decline in BE from G_1 to G_2, G_3, G_4, G_5 and G_6 generations was 5.52, 1.26, 2.60. 6.97 and 7.35 respectively. The results showed gradual increased rate of decline in BE over the generations in Phule Triveni cows.

The influence of POC on breeding efficiency was significant (P<0.01). The BE (%) of cows calved during P_1 was significantly higher than those calved in later periods. The BE of cows of P_2 and P_3 groups were significantly higher than cows of P_4, P_5 and P_6 groups, which did not differed significantly from each other. The effects of SOC and LO on breeding efficiency were non significant.

In Phule Triveni cows the correlations of LL, DP and CI with BE were negative and significant (P<0.01) and the values were -0.35, -0.31 and -0.49 respectively. Similar negative and significant correlation between lactation length and breeding efficiency was reported by Singh *et al.* (1980) in Sahiwal crossbreds. The results indicated that in Phule Triveni cows BE declined due to increase in lactation length, dry period and calving interval.

ACKNOWLEDGEMENT

The authors duly acknowledge the support and making data available to Senior Scientist, Research Cum Development Project on Cattle, MPKV, Rahuri.

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J. Maharashtra agric. Univ., 34 (2) : 210-213 (2009)

Postnatal Histomorphological Studies of Testis in Bucks*

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(Received : 25-03-2008)

ABSTRACT

Gross morphological measurement of testes, both left and right in buck with histological studies, describing seminiferous tubules, myofibroblast, reticular fibers were carried out. The testis has two surfaces, two borders and two ends. Histologicaly testis shows seminiferous tubules, leydig cells, genoeytes, spermatogonia, primary and secondary spermatocytes, spermatids and sperms were studied using staining methods. Heamatoxylene Eosin stain, Van Gieson's stain and Silver Impregnation stain. The above studies were carried out in post natal developmental stages *viz*, pre pubertal, pubertal and post pubertal.

Key words : Histological, morphological, testes, buck.

Gross anatomy of testis has been studied by Getty (1975), Maurya (1968) in domestic animals and buffalo bulls respectively. Similar studies have been carried out in buck by Mahmood *et. al.* (1988), Gupta *et al*. (1992), Giri *et al.* (1994) and Samarah *et al.* (1997) in different breeds of goats. Histology of testis was studied by Dhingra (1980), Raja and Rao (1982), Sane *et al.* (1982) in different ruminants and Bordoloi and Dhingra (1983), Baishya *et. al.* (1987), Kakde and Singh (1989) in buck, but no work has been reported in different stages of postnatal development in buck *viz.*, pre pubertal, pubertal and post pubertal. This study focused on postnatal developmental changes in testes of bucks.

MATERIALS AND METHODS

The present study was conducted on 18 bucks of different age groups purchased from livestock farm, COVAS, Parbhani and local market. The bucks were grouped into pre pubertal (3 to 7 months), pubertal (8 to 24 months) and post pubertal (above 24 months). The organs were dissected carefully so that the maximum length, maximum width and maximum thickness were recorded by vernier caliper and electronic balance respectively.

For histological studies 5 mm thick samples were collected. Ten per cent formaline, 10 per cent Neutral buffer formaline, Bouine's fluid and Zenkers fluide were used as

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fixative. Ascending grade of alcohol was used for dehydration of tissues while paraffin wax of melting point 58 to 60°C for making the blocks. Section were cut 3 to 5 micron thikness with the help of manually operated micro tome machine and stained with Harries Hematoxyline and Eocine stain (Mukherjee 1990), Wrieger's Van Gieson stain (Mukherjee 1990), and Silver Impregnation stain.

RESULTS AND DISCUSSION

The testis (left and right) were long and elongated shape solid glands present in attached and free borders. Each testis present two surfaces, two borders and two ends. Lateral surface was attached with the body of epididymis. The head of epididymis occupied the upper end, the lower end was slightly thicker and was connected to tail epididymis.

The testis was covered by tunica albugenia and tunica vaginalis. Similar were the findings of Getty (1975), and Frandson (1986) in bucks.

In prepubertal buck length, width, thickness and weight of left testis was 2.67±0.11, 1.79±0.04, 1.21±0.06 and 3.06±0.07 g respectively, while in right testis was 2.67±0.11, 1.74±0.04, 1.19±0.06 and 2.90±0.33 g respectively. In pubertal buck length, width, thickness (cm) and weight (g) of left testis was 5.03± 0.13, 3.17±0.04, 2.63±0.06 and 26.10±0.72 g respectively, while in right testis were 5.00±0.11, 3.15±0.04, 2.62±0.06 and 25.49±0.33 g respectively. In post pubertal buck length, width, thickness (cm) and weight (g) of left testis was 5.57±0.13, 3.71±0.04, 2.84±0.06 and 50.13±0.72 g respectively, while in right testis was 5.57±0.13, 3.69±0.04, 2.72±0.06 and 47.56±0.33 g respectively. The present morphological values were less or more similar to the values reported by Baishya *et al.* (1987), Mahmood *et al.* (1988), Gupta *et al.* (1992), Gir *et al.* (1994), in Ganjam breed, Samrah *et al.* (1997) in buck.

In parenchyma of testis presents seminiferous tubules, which were closely arranged by a thin basement membrane. The basement membrane consisted of myofibroblast, reticular fibers. The leydig cells or interstitial tissues were present in between seminiferous tubules. The epithelium of seminiferous tubule was a stratified containing sertoli cells, based in different cells, genocytes, spermatogonia and primary sperm atocytes, secondary spermatocytes, spermatids and sperms. Sertoli cells or nurse cells were irregularly elongated; pyramidal cells were present at basement membrane with germinal cells. Capsule was the outermost covering of testis also called as tunica albugenia was composed of connective tissue fibers and numerous blood vessels. The dense variety of collage and few elastic fibers were noticed in the connective tissue capsule collagen fibers were wavy in outline. From the tunica albugenia number of connective tissue septae in the form of trabaculae were arised separated the parenchyma of testis to form number of hexagonal shaped compartments. In addition to these interstitial cells, around to those fibroblasts were observed, which were polyhedral in shape. Inside to the capsule various shapes of seminiferous tubules were present, *viz.*, comma, elongated, oval, elliptical, straight, butterfly which were densely packed in the prepubertal testis. The epithelium of the seminiferous tubule was made of germ cells and nourishing cells called sertoli cells. These nuclei were at base showing inactiveness. The following micrometrical observations were noticed in testis. The sustentacular cells were derived from undifferentiated supporting cells of the prepubertal buck. Mitotically these cells were active, the primary spermatocytes were present with myofibroblast. The measured maximum thickness of the capsule (Tunica albugenia) was ranged from 262.2 to 268.9µ with a mean of 264.9 ± 5.6. The maximum diameter of seminiferous tubules ranged from 68.0 to 73.0µ with a mean of 71.00 ± 2.6 having different sizes.

The maximum height of epithelium sertoli cells ranged from 5.7 to 6.9µ with a mean of 6.4 ±0.1. The maximum thickness of leydig cells ranged from 4.1 to 5.3µ with a mean of 4.8 ± 0.1. These cells were polyhedral in shape. Capsule of the testis showed marked increase in the thickness. The presence of blood vessels were also noted in the capsule but the blood vessels were comparatively less in number than in pubertal. Seminiferous tubules showed round convoluted, round, butterfly shape, increase in their size. The interspaces between the seminiferous tubules were found to be increased. The interstitial cells showes increase in their size with eccentric nuclei. The germinal cells also showed presence of primary spermatocytes, secondary spermatocytes in the lumen of seminiferous tubule. The following micrometrical observations were noticed in the testis. The measured maximum thickness of the capsule (Tunica albugenia) was varied in between 373.5 to 419.09µ with a mean of 402.3 ± 5.6 plate. The maximum thickness of leydig cells varied in between 6.5 to 6.9µ with a mean of 6.6 ± 0.1 plate. The maximum diameters of seminiferous tubules were varied in between 172.5 to 185.5µ with a mean of 181.5 ± 2.6.

The height of sertoli cells epithelium varied in between 11.07 to 11.80 with a mean of 11.4 ± 0.1. The capsule of the testis in post pubertal group was thicker than in the pubertal group. The capsule consisted of collagen fibers, few elastic fibers reticular fibers. The presence of blood vessels was also noticed but these were comparatively less in number than in the prepubertal one but almost the same in pubertal group. The interstitial cells presented between the seminiferous tubules, were more in number and larger in size than that of prepubertal group. The epithelium of seminiferous tubule showed increased thickness of the sertoli cells. These cells were active and abundant primary, secondary spermatocytes and sperms were noticed in the seminiferous tubule. The pyramidal shaped sertoli cells showed nucleus at the middle of the cells. The primary spermatocytes were the largest cell present in the germinal cells. Similar histological findings were observed in post-pubertal buck to that of pubertal buck. Marked variations in the increase in size of the tissues were noticed. The increased micrometrical values were as follows. The maximum thickness of the capsule (Tunica albugenia) was ranged from 438.2 to 461.4µ with a mean of 454.1 ± 5.6. The thickness of the sertoli cells ranged from 12.3 to 13.5µ with a mean of 12.9 ± 0.1. The maximum diameter of the seminiferous tubules was ranged from 224.1 to 240.7µ with a mean of 231.7 ± 2.6. The maximum thickness of leydig cells ranged from 6.3 to 7.7µ with a mean of 7.3 ±0.1. Present observation of an investment of seminiferous tubules with a thin basement membrane rich in collagen with scanty reticular fibers, elastic fibers lining the basement membrane were in collaboration with the similar observation of Dellmann and Brown (1987) in different species of animals. The observations of stratified epithelium of a seminiferous tubule were similar with observations of Dellmann (1971). The histoarchitecture of leydig cells in prepubertal buck had resembled with the observation recorded by Baishya *et al.* (1987).

The shape of the intestinal cells was polyhedral void as recorded. The size and shape of the intestinal cells in pubertal buck had similarity to those observations recorded by Bardoloi and Dhingra (1983). The micrometrical observations recorded by Dhingra (1980) and Baishya *et al.* (1987) were similar to present observations. The values were slightly less as compared to Baishya *et al.* (1987) when considered seminiferous tubules luminal diameter. Bordoloi and Dhingra (1983) observed smooth muscle cells in testicular capsule of buck. They observed that muscle component in the shape testicle was least well developed. The micrometrical value had the close relationship in capsule thickness. Smooth muscle cells were also noticed in the present findings. In the present study the maximum diameter of seminiferous tubules were 71.00, 181.5 and 231.7µ in prepubertal, pubertal and post-pubertal testis. These values were related to the values recorded by Dhingra (1980) and Bardoloi and Dhingra (1983).

The values matched to the values measured by Baishya *et al.* (1987) in pre-pubertal buck. Each seminiferous tubule consisted of a basement membrane and multilayered sperm producing epithelium. This epithelium consisted of a basement membrane and multilayered sperm producing epithelium. Sertoli cells and germ cells were present in ruminant testis. These observations were similar to the observations recorded by Dhingra and Barnwal (1977) in bull Raja and Rao (1982) in rabbit, Sane *et al.* (1982) and Kakde and Singh (1989) in goat. The leydig cell pattern was similar to the pattern reported but the micrometrical values in present study were less than the values recorded by Baishya *et al*. (1987).

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RESEARCH NOTES

J. Maharashtra agric. Univ., 34 (2) : 214-215 (2009)

Correlation, Regression and Path Coefficient Analysis in Maize Hybrids

The yield is a complex character controlled by polygenes. The correlation, regression and path analysis studies are important assetts in development of new hybrids, especially in case of crop like maize, wherein both quality and quantity are important. Therefore, selection made on the basis of its phenotypic expression alone is likely to be misleading. Such studies determine the association between yield and its attribute and give an idea of contribution of each attribute towards the yield The present investigation was undertaken to derive information on phenotypic correlation, direct and indirect effects of various traits in maize hybrids.

The field experiment was conducted at Department of Agronomy, Marathwada Agricultural University, Parbhani (India), during kharif season of 2003 and 2004. The experiment was laid out in split plot design with three replications and eighteen treatment combinations consisted of three land configurations as L_1 - flat bed, L_2- opening of furrows in every row at 30 DAS and L_3 - paired row furrow opening at 30 DAS. Two hybrids i.e. H_1 - Parbhani Shakti and H_2 - Kargil, and three fertilizer levels i.e. F_1 - 75 per cent recommended dose of fertilizer (90:40:30 kg. NPK ha^{-1}), F_2 - 100 per cent RDF (120:60:40 kg. NPK ha^{-1}) and F_3 - 125 per cent RDF (150:75:50 kg. NPK ha^{-1}).

The gross and net plot size were 6.00 x 4.8 m. and 4.8 x 3.6 m. respectively. Sowing was done on 4th July 2003 and 3rd July 2004 during first and second year respectively. The sowing was done by dibbling at 60 x 30 cm. spacing as per the treatments. Package of practices were followed as per the treatments. Observations were recorded on the five randomly selected plants from each treatment in each replication for different characters in both the hybrids *viz*. plant height, leaf area, total dry matter, cob weight, cob length, shelling percentage and thousand grain weight. Phenotypic correlations were estimated following Snedecor and Cochran (1967) and path analysis (Dewey and Lu, 1959)

Data revealed that various plant characters of H_1 and H_2 hybrids i.e. plant height, leaf area, total dry matter, cob weight, cob length and thousand grain weight, were found to be highly significant and positively corrected with weight of grain per plant in both the years except total dry matter in H_1 hybrid and plant height and cob length in H_2 hybrid during first year. While shelling percentage showed negative and non-significant correlation during both the years. Simple regression coefficients (b) also showed the similar algebric trends as those were noticed in simple correlation.

The highly significant differences for yield and yield components were observed indicating the presence of high genetic variability. The grain yield was positively and significantly correlated with these characters suggesting that yield is the function of these characters and selection for these characters would be effective to improve the yield. In case of Parbhani Shakti hybrid leaf area and total dry matter showed highest association with grain yield during both the years, which was followed by thousand grain weight, plant height and cob weight. While in case of Kargil hybrid leaf area showed the highest association with yield, during both the years which was followed by total dry matter, cob weight, thousand grain weight and cob length. Similar results were also reported by Umakanth and Khan (2001).

Path coefficient analysis : The correlation and regression coefficients are inadequate to interpret the cause and effect relationship. However, path analysis technique furnishes a method of partitioning the correlation coefficients between various characters into direct and indirect effects and provide the actual contribution of an attribute and its influence through other traits. Direct effect of any character on grain yield gives an idea about effective selection that can be made to bring improvement in the latter. The indirect effect indicates the interrelationship of component charterers towards contribution to yield. Path coefficient analysis revealed that in case of Parbhani Shakti hybrid plant height, leaf area cob weight and total dry matter had strong positive direct impact on grain yield per plant. Pronounced positive indirect impact of leaf area, cob length, thousand grain weight, cob weight and total dry matter were evident through plant height and leaf area. However, in case of Kargil hybrid leaf area and cob weight .had strong positive direct impact on the grain yield per plant. Identical positive indirect effect of total dry matter, thousand grain weight and cob length via. leaf area was also evident in increasing the grain yield. Where as, shelling percentage showed negative direct effect during first year and positive direct effect during second year with yield per plant. These results are in line to those reported by Salunke (1986) and Umakant and Khan (2001).

From the forgoing discussion it could be inferred that, leaf area, cob weight, thousand grain weight and total dry matter per plant showed positive significant correlation with grain yield and also had direct or indirect positive influence on their correlation with grain yield in both the hybrids. Therefore, these characters can be considered as a important components of grain yield and selection of these characters might bring an improvement in grain yield of maize.

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J. Maharashtra agric. Univ., 34 (2) : 215-216 (2009)

Crop Response to Potash Levels and Foliar Spray of Vermiwash on Growth and Yield of Green Gram (*Vigna radiata* L.)

A lot of research has been done on green gram on various aspects, but research information regarding potassium requirement and foliar spray of vermiwash in summer green gram is very meager. In view of this current investigation was planned for study of potassium and vermiwash response during summer 2005 at post graduate farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar.

An experiment was laid out in a factorial randomized block design (FRBD) with eight treatment combinations of four potassium levels (0, 25, 37.5 and 50 kg K_2O ha^{-1}) and foliar spray of vermiwash (@ 50 ml $lit.^{-1}$) and water replicated thrice. Potassium levels along with recommended dose of fertilizer (25 : 50 N, P_2O_5 kg ha^{-1}) was given at the time of sowing. Vermiwash diluted in water was sprayed at 15, 35 and 50 days of crop age and at the same time water spray was given to remaining plots as per treatments.

The experimental soil was clayey in texture with low in available nitrogen, medium on phosphorus and high in available potassium and was slightly alkaline in nature.

The number of branches, number of clusters per plant and grain yield were significantly influenced by different potash levels and foliar spray of vermiwash treatments (Table 1).

The mean number of branches per plant was significantly highest in treatment with 50 kg K_2O ha^{-1} (2.86, 3.02 and 3.41 at 40, 60 DAS and at harvest, respectively) as compared to 0 and 25 kg K_2O ha^{-1} at all the crop growth stages and was statistically at par with 37.5 kg K_2O ha^{-1}. Similar results' were obtained by Malik *et al.*, (1986) and Rawal and Yadav (1986). Foliar

Table 1. The number of branches, number of cluster plant^{-1} and grain yield of green gram as influenced by different treatments.

Treatments	Branches plant^{-1} at harvest	Clusters plant^{-1}	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Gross monetary returns (Rs. ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Net monetary returns (Rs. ha^{-1})	B:C ratio
Potash levels :								
P_1 : 0 kg K_2O ha^{-1}	2.65	3.69	8.66	10.74	17191.20	9531.54	7659.66	1.80
P_2 : 25 kg K_2O ha^{-1}	3.04	4.23	9.93	12.31	19782.78	9688.86	10093.91	2.04
P_3 : 37.5 kg K_2O ha^{-1}	3.26	4.58	10.75	13.34	21356.98	9752.84	11604.14	2.19
P_4 : 50 kg K_2O ha^{-1}	3.41	4.76	10.86	13.83	21622.83	9817.12	11805.72	2.20
C. D. at 5%	0.17	0.22	0.67	0.66	1084.29	5.30	1084.32	0.11
Foliar spray :								
F_1 : Vermiwash	3.23	4.51	10.42	13.11	20870.68	9706.17	11164.50	2.15
F_2 : Water	2.96	4.12	9.68	12.00	19106.21	9689.00	9417.21	1.97
C. D. at 5%	0.15	0.16	0.47	0.47	766.71	3.74	766.73	0.08
Interaction :								
C. D. at 5%	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.

spray of vermiwash was found to be significant for the number of branches over water sprays.

The mean number of clusters per plant were recorded maximum by 50 kg K_2O ha^{-1} (4.76) was statistically at par with 37.5 kg K_2O ha^{-1} (4.58). Similar results were observed by Manjhi *et al*. (1978), Singh *et al*. (1995).

The mean grain yield was significantly highest at 50 kg K_2O ha^{-1} (10.86 q ha^{-1}) as compared to 0 and 25 kg K_2O ha^{-1} and was statistically at par with 37.5 kg K_2O ha^{-1} (10.75 q ha^{-1}) with foliar spray of vermiwash. Similar results' were obtained by Mahboob Akhtar *et al*. (1984), Jamdagni and Birari (1994). Grain yield was significantly higher (10.42 q ha^{-1}) with the application of vermiwash as compared to water spray.

The interaction effect of potash levels and foliar spray was found to be non-significant on number of branches, number of cluster per plant and grain yield.

On the basis of present investigation it can be concluded that for obtaining higher yield (10.75 q ha^{-1}) and gross monetary returns (Rs. 21356.98 ha^{-1}), mungbean crop should be fertilized with 37.5 kg K_2O ha^{-1} along with foliar spray 50 ml lit^{-1} vermiwash (25 lit vermiwash ha^{-1} through 500 lit water) during summer season.

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J. Maharashtra agric. Univ., 34 (2) : 217-218 (2009)

Effect of Non Genetic Factors on Body Weight at Different Ages of Osmanabadi Goats

The goat is an important economic species of livestock in developing countries, specially Asia and Africa. Inspite of unscientific rearing, occurrence of epidemics, natural calamities, increased rate of slaughter of goat for meat, goat population in India which was 47.14 million in 1951 raised to 124.35 million in 2003. India constituted 17.4 per cent of the total gaot population of the world and ranked 2nd in goat population next to China.

Efficiency of meat production is governed by growth rates and stages of faster gain in body weight. The effect of year, season and type of birth, sex, location, color variants and birth weight groups on body weights at different ages were studied.

The data was collected on body weight at various ages of 653 Osmanabadi goats maintained by farmers in its breeding tracts. They were classified into 3 years (1995-96,96-97,97-98), 3 season (winter, summer, rainy), two types of birth (single and multiple), two sex (female and male),3 locations (Osmanabad, Ahmednagar and Solapur), 5 colour variants (CV1 to CV5) and 3 birth weight groups (below 1.5; 1.5 to 2.0 and above2.0 kg). Each new born kid was weighed at birth and thereafter at 3 months interval upto 12 months of age.

The data was analyzed by using the least square technique of fitting constant (Harvey, 1966). Model: Yijklmnop = $(\mu + P_i + S_j + T_k + X_l + L_m + C_n + W_o + e_{ijklmnop}$

The overall least square means of body weight in Osmanabadi kids in field condition at birth, 3, 6 and 12 months of age were 1.84 ±0.01, 7.69 ± 0.06, 14.08 ± 0.10 and 18.62 ± 0.10 kg, respectively. Similar finding in respect of body weight were recorded by Singh and Singh (1999) in Black Bengal x Beetal and Deshmukh (1996) in Osmanabadi goats.

The year of birth had non significant effect on all traits under study in Osmanabadi goat at field condition. Similar results were reported by Saikia *et al.* (1998)

The season of birth had significant influence on body weight at birth and 12 month of age in

Table 1. Least squares means for various body weight (kg) of Osmanabadi goat under field conditions.

Effects	N	Birth		3 months		6 months		12 months	
		Mean	SE±	Mean	SE±	Mean	SE±	Mean	SE±
Overall mean:	653	1.846	0.011	7.695	0.065	14.081	0.106	18.626	0.108
1995-96	320	1.841	0.017	7.646	1.101	14.051	0.164	18.656	0.167
1996-97	172	1.851	0.015	7.821	0.089	14.132	0.145	18.675	0.148
1997-98	161	1.847	0.014	7.618	0.087	14.061	0.141	18.548	0.143
Season of birth :									
Winter	333	1.880^{c}	0.022	7.767	0.137	14.096	0.223	18.889^{b}	0.227
Summer	155	1.804^{a}	0.018	7.557	0.107	13.826	0.174	17.798^{a}	0.177
Rainy	165	1.855^{b}	0.016	7.762	0.098	14.322	0.160	19.192^{c}	0.163
Type of birth :									
Single	189	1.896b	0.019	7.876^{b}	0.114	14.082	0.185	18.706	0.189
Multiple	464	1.796a	0.013	7.515$_{a}$	0.077	14.081	0.125	18.546	0.127
Sex :									
Male	193	1.858	0.029	7.902^{b}	0.176	14.406^{b}	0.287	19.365^{b}	0.292
Female	460	1.834	0.011	7.489^{b}	0.067	13.757^{a}	0.111	17.888^{a}	0.113
Location :									
Ahmednagar	250	1.819a	0.019	8.080^{b}	0.117	13.032^{a}	0.190	19.797^{b}	0.194
Osmanabad	201	1.818a	0.015	7.573^{a}	0.093	14.556^{b}	0.152	16.933^{a}	0.154
Solapur	202	1.901b	0.014	7.433^{a}	0.085	14.655^{a}	0.139	19.149^{b}	0.141
Colour variants :									
CV1	405	1.832	0.021	7.741	0.126	14.214	0.205	18.688	0.208
CV2	113	1.834	0.015	7.595	0.911	13.997	0.148	18.412	0.151
CV3	76	1.840	0.018	7.694	0.110	13.767	0.179	18.593	0.182
CV4	22	1.857	0.032	7.606	0.192	14.004	0.313	18.835	0.318
CV5	37	1.868	0.025	7.842	0.150	14.423	0.245	18.603	0.249
Birth weight group (kg) :									
Below 1.5	140	-	-	7.151^{a}	0.173	13.618^{a}	0.281	18.339^{a}	0.286
1.5 to 2.0	398	-	-	7.679^{a}	0.075	13.981^{a}	0.122	18.528^{a}	0.124
Above 2.0	115	-	-	8.256^{a}	0.116	14.644^{b}	0.190	19.012^{b}	0.193

The means under each class in the same column with different superscript differed significantly from each other.

Osmanabadi goats. Kids born during summer season showed significantly lower body weight at birth and 12 months age than the kids born during winter and rainy season. Similarly, kids born during winter season showed significantly higher body weight at birth and 12 months than the kids born during rainy season. Similar results were reported by Deshmukh (1996) in Osmanabadi goats, and Singh and Singh (1999) in Beetal x Black Bengal.

Types of birth had highly significant effect on body weight at birth and 3 months of age of Osmanabadi goat whereas, type of birth had non significant effect on 6 and 12 months of age of Osmanabadi goats. Single birth showed highly significant body weight at birth and 3 months of age than twin birth. Single born kids get sufficient intrauterine environment in foetus of the doe than the kids born as twin. Similar findings were also reported by Hafez (1968), Deshmukh (1996) in Osmanabadi goat and Singh and Singh (1998) in Beetal x Black Bengal goats.

Difference due to sex of birth in body weights at 3 months and 6 months of age was significant. The body weight at 3, 6 and 12 month of age of Osmanabadi male kids were significantly higher than the body weight of Osmanabadi male kids. Birth weight of male were heavier than male. Similar results were reported by Hafez (1968), Anonymous (1995) in Osmanabadi kids, Sharma *et.al.* (1984) in Assam local cross Beetal kids.

Location showed highly significant difference for all traits under study. Differences for different location were in erratic way. Similar results were quoted by Anonymous (1999) in Osmanabadi goat and Hussain *et al*. (1997) in Black Bengal.

Colour variants had non significant effect on body weight at birth, 3 months, 6 months and 12 months of age in Osmanabadi goat. Similar results were reported by Anonymous (1999).

Birth weight groups had significant effect on body weight at 3 months, 6 months and 12 months of age. The kids born with below 1.5 to 2.0 kg birth weight as well as 1.5-2.0 kg group showed significantly lower body weight at 3 months , 6 months and 12 months of age than the kids born with above 2.0 kg birth weight group. Similar results were quoted by Deshmukh (1996), Anonymous (1999) in Osmanabadi goat.

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J. Maharashtra agric. Univ., 34 (2) : 219-220 (2009)

Response of Oat (*Avena sativa* L.) to Potassium Levels Under Different Cutting Management

Oat (*Avena sativa* L.) is one of the major *rabi* fodder crops, rich in energy, protein and vitamins. Due to its excellent growth habit, better regeneration capacity and good quality fodder, it has become a promising forage crop for the livestock production. Forage plants especially the multicuts are heavy feeders of nutrients and remove large amount of nutrients from the soil. Potassium is an essential primary nutrient for plant growth that helps to produce stiff straw in cereals and reduce lodging. It is an activator for enzymes involved in protein synthesis. Besides potassium, yield of crop is also affected by improved agronomic practices such as cutting management. However, not much information is available on effect of potassium on the yield of oat at different cutting management. Therefore, present experiment was carried out to know the effect of K application on yield of oat at different cutting management.

The present experiment was conducted at Forage Crops Research Project, MPKV, Rahuri during *rabi* 2005-06. The experiment was laid out in factorial randomized block design with three replications. Treatments comprised of four potassium levels (0, 40, 60, and 80 kg ha^{-1}) and three cutting management (50, 60 and 70 DAS). The experimental soil was clayey, low in available nitrogen (208 kg ha^{-1}), medium in phosphorus (10.14 kg ha^{-1}) and high in available potash (432 kg ha^{-1}). The crop was fertilized with 100 kg N and 50 kg P per hectare. The half quantity of N and full dose of P and K were applied as basal dressing. The remaining half dose of N was top dressed at 30 days after sowing as per the treatments. The second cut in all treatments was taken at 50 per cent flowering stage.

Potassium levels : The data presented in Table 1 revealed that increase in potassium level from 0 to 40 kg ha^{-1}, significantly increased green forage yield, dry matter yield and crude protein yield.

However, further increase in potassium level from 40 to 80 kg ha^{-1} resulted in significant decrease in yields. An increase of green forage, dry matter and crude protein yields by 9.89, 3.66 and 21.59 per cent were observed with an application of 40 kg K ha^{-1} over control. The application of 40 kg K ha^{-1} recorded significantly higher green forage (512.47 q ha^{-1}), dry matter (113.97 q ha^{-1}) and crude protein yield (9.46 q ha^{-1}) than all other potassium levels, however, dry matter and crude protein yield were at par with 60 kg K ha^{-1}. However, Thakuria (1993) reported that application of potash did not give any significant response on fodder and crude protein yield of teosinte fodder crop.

Cutting management : Among the cutting management, first cut at 50 days after sowing and second cut at 50 per cent flowering produced significantly higher green forage yield of 514.37 q ha^{-1}, dry matter yield of 122.18 q ha^{-1} and crude protein yield of 9.58 q ha^{-1} than other cutting management. The delay in cutting of first cut from 50 to 70 days after sowing decreased green forage, dry matter and crude protein yield. Prasad *et al*. (1988) reported maximum green and dry forage yields with first cut at 50 days after sowing followed by second cut at 50 per cent flowering. This may be attributed to sufficient time available to the crop for additional yield from the regrowth and further delay in first cut resulted in reduction in forage yields. Singh *et al.* (2005) also reported similar results.

Thus, it could be concluded that first cut of multicut oat should be taken at 50 days after sowing and second cut at 50 per cent flowering along with application of 40 kg K ha^{-1} for obtaining higher forage production.

Table 1. Green forage yield, dry matter yield and crude protein yield of multicut oat as influenced by different treatments (total of two cuts).

Treat-ments	Green forage yield (q ha^{-1})	Dry matter yield (q ha^{-1})	Crude protein yield (q ha^{-1})
K levels (kg ha^{-1}) :			
0	466.82	109.95	7.78
40	512.47	113.97	9.46
60	500.90	113.57	9.01
80	492.93	109.18	8.46
S. E.±	3.25	0.74	0.30
C. D. at 5%	9.52	2.17	0.88
Cutting management (DAS) :			
50	514.37	122.18	9.58
60	479.36	108.29	8.38
70	486.11	104.53	8.07
S. E.±	2.81	0.64	0.26
C. D. at 5%	8.25	1.88	0.76

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J. Maharashtra agric. Univ., 34 (2) : 220-222 (2009)

Heterosis and Inbreeding Depression in Sesame

Sesame (*Sasamun indicum* L.) is an ancient oil crop grown throughout India having tremendous potential for export. However, it has not contributed enormously to the total oilseed production mainly because of average low yield level (323 kg ha^{-1}). The exploitation of hybrid vigour is one of the important breeding techniques to have a quantum jump in yield. Commercial exploitation of hybrid vigour in F_1 for any crop depends on the extent/ magnitude of heterosis for yield and yield attributing traits as well as economical method for producing such hybrids. In sesame, several reports indicated presence of high heterosis for yield and yield components. In absence of male sterile lines, the hybrid development by hand emasculation and pollination for seed production is highly expensive leading to the high cost of seed production. The present investigation was undertaken to study the extent of residual heterosis in second and third generation of hybrids (i.e. F_2 and F_3) so that F_2 or F_3 seed can be utilized in place of costly F_1 seeds.

Hybridization was effected between five lines *viz*. JLT-7, JLT-46, Punjab Til-1, RT-125 and Uma and eight testers *viz*. NIC-7829, NIC-7941, NIC-8316, SI-32, RJS-17, Keriya-7, BDN Local and RT-46 in line x tester model (Kempthorne, 1957). The resultant 40 F_1, along with their F_2, F_3 and parents were raised in a randomized block design with three replications during summer 2005. In each replication the parents and F_1 were raised in single row and F_2 and F_3 in 7 rows (each 5 m length) by adopting 45 x 15 cm spacing.

Table 1. Range of heterosis and inbreeding depression (ID) for five characters in 40 cross combinations in sesame.

Characters	Range of heterosis			Range of ID		Cross showing 25% or more heterosis			Crosses showing less than 10% ID			
	F_1	F_2	F_3	F_2	F_3	F_1	F_2	F_3	F_2		F_3	
									-ve	+ve	-ve	+ve
Branches plant^{-1}	-14.16 to 58.64	-13.03 to 50.14	-13.03 to 52.12	-47.52 to 23.90	-26.36 to 31.32	12	8	9	15	23	25	13
Capsules plant^{-1}	-12.33 to 91.96	-2.83 to 71.09	-4.61 to 59.91	-47.33 to 24.31	-23.84 to 24.31	26	30	26	11	11	4	11
Seeds capsules^{-1}	-0.6 to 44.15	-14.97 to 47.76	-18.58 to 37.53	-24.23 to 27.98	-36.87 to 28.2	18	9	4	3	14	2	12
Harvest index	10.22 to 54.34	11.85 to 43.90	-5.13 to 35.65	-17.45 to 21.43	-7.57 to 22.12	34	23	6	6	28	1	23
Seed yield	-19.19 to 101.31	-9.39 to 71.01	-12.83 to 71.01	-82.30 to 35.00	-30.17 to 29.17	29	31	25	9	29	13	24

Observations on number of branches, number of capsules, number of seeds per capsule, harvest index and seed yield per plant were recorded. Phule Til-1 was used as standard check. The overall mean values for each character were taken to estimate standard heterosis, inbreeding depression, mid residual helerosis.

The analysis of variances revealed significant differences lor yield and yield components indicating the presence of genetic variability in F_1, F_2 and F_3 under study. The range of heterosis in F_1, residual heterosis and inbreeding depression in F_2 and F_3 for five characters is presented in Table 1. Though the maximum limit for the residual heterosis of F_2 and F_3 was lower than that of heterosis in F_1, presence of appreciable amount of heterosis in F_2 and F_3 was recorded. Presence of residual heterosis in sesame has also been reported earlier by Murty (1994) and Kar and Swain (2003).

The heterosis, residual heterosis and inbreeding depression for seed yield per plant of all cross combinations have been presented in Table 2. The data indicated that the crosses exhibited substantial amount of heterosis also had high amount of residual heterosis in F_2 and F_3. This could be possibly due to low inbreeding depression in those cross combinations because of predominance of additive gene action or due to transgrcssive segregation. Similar observation was made by kar and Swain (2003).

The F_2 progenies of crosses. JLT-7 x HDN local, Punjab Til-1 x BDN Local , RT-125 x NIC-8116, Uma x BDN Local and F_3 progenies of crosses. JLT-26 x Keriya-7, Punjab Til-1 x Keriya-7, RT-125 x BDN LocaI exhibited high residual helcrosis coupled with more inbreeding vigour (negative inbreeding depression) for seed yield. Presence of such enhanced vigour could be attributed to epistatic gene action.

Table 2. Heterosis (%) in F_1, residual heterosis (%) in F_2 and F_3 and inbreeding depression (%) in F_2 and F_3 in respect of seed yield for 40 cross combinations.

Crosses	Heterosis	Residual heterosis		Inbreeding depression	
	F_1	F_2	F_3	F_2	F_3
HLT-7 x NIC-7829	48.79**	32.63**	5.05	11.18**	20.79**
JLT-7 x NIC-7941	50.2**	38.38**	41.4**	7.79**	-2.19**
JLT-7 x NIC-8316	66.67**	54.55**	46.16**	16.32**	5.42**
JLT-7 x SI-32	58.89**	46.77**	6.36	-1.45	27.53**
JLT-7 x RJS-17	62.93**	36.67**	29.29**	12.16**	5.40**
JLT-7 x Keriya-7	9.80	4.75	6.77	10.62**	-1.93
JLT-7 x BDN Local	31.3**	66.67**	46.16**	-15.51**	12.30**
JLT-7 x RT-46	76.06**	56.87**	11.11	7.21*	29.17**
JLT-26 x NIC-7829	22.93**	46.77**	43.13**	-9.80**	2.48
JLT-26 x NIC-7941	78.48**	55.86**	64.65**	14.84**	-5.64**
JLT-26 x NIC-8316	65.66**	38.69**	31.62**	8.39**	5.10**
JLT-26 x SI-32	90.61**	51.52**	35.35**	16.49**	10.67**
JLT-26 x RJS-17	86.57**	68.99**	25.25**	7.33**	25.88**
JLT-26 x Keriya-7	32.02**	17.17	52.53**	12.04**	-30.17**
JLT-26 x BDN Local	39.39**	-9.39	-7.78	22.30**	-1.78**
JLT-26 x RT-46	86.57**	77.07**	62.32**	3.88**	8.33**
Punjab Til-1 x NIC-7829	69.7**	49.19**	42.73**	8.24**	4.33**
Punjab Til-1 x NIC-7941	28.59**	26.26**	30.00	3.29*	-2.96**
Punjab Til-1 x NIC-8316	32.02**	26.26**	13.84	6.63**	9.84**
Punjab Til-1 x SI-32	40.1**	33.64**	38.08**	9.88**	-3.33**
Punjab Til-1 x RJS-17	78.79**	59.60**	24.95*	2.85*	21.71**
Punjab Til-1 x Keriya-7	-7.07	6.06	35.66**	-10.56**	-27.90**
Punjab Til-1 x BDN Local	-1.01	60.61**	54.85**	-43.44**	3.58**
Punjab Til-1 x RT-46	101.31**	77.78**	63.33**	13.26**	8.13**
RT-125 x NIC-7829	5.76	-4.34	-12.83	7.55**	8.87**
RT-125 x NIC-7941	-19.19	23.23*	43.13**	-43.90**	-16.15**
RT-125 x NIC-8316	-10.4	63.33**	21.92	-38.59**	25.36**
RT-125 x SI-32	72.02**	58.59**	44.75**	9.17**	8.73**
RT-125 x RJS-17	54.85**	38.08**	18.18	8.81**	14.41**
RT-125 x Keriya-7	2.32	6.36	14.44	3.37**	-7.60**
RT-125 x BDN Local	1.01	7.37	29.60*	-13.4**	-20.70**
RT-125 x RT-46	-4.34	5.76	14.14	-10.45**	-7.93**
Uma x NIC-7829	71.72**	59.29**	61.62*	8.70**	-1.46**
Uma x NIC-7941	57.58**	36.06**	34.34**	10.51**	1.26
Uma x NIC-8316	87.17**	56.26**	35.05**	10.10**	13.57**
Uma x SI-32	47.47**	59.60**	71.01**	6.73**	-7.15**
Uma x RJS-17	57.27**	40.40**	14.44	15.78**	18.49**
Uma x Keriya-7	9.39	35.05**	17.88	-15.17**	12.72**
Uma x BDN Local	54.24**	32.63**	21.92	15.49**	8.07**
Uma x RT-46	84.55**	67.37**	64.95**	9.24**	1.45

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

This study indicated that there was presence of substantial amount of residual heterosis in F_2 and F_3 generations. Crosses, Punjab Til-1 x RT-46, JLT-26 x RT-46 and Uma x RT-46 were having low inbreeding depression. Thus these crosses can be commercially exploited for cultivation in F_2 and F_3 generation hybrids. Singh and Rai (1995) has reported similar result in *Brassica campestris* L.

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J. Maharashtra agric. Univ., 34 (2) : 222-223 (2009)

Effect of Sources of Organic Manures in Integrated Nutrient Management on Yield and Quality of Sweet Corn

The IPNS/INM is an eco-friendly and best way to attain sustainability in agriculture (Dhonde *et al.*, 2005). Looking to the importance of organic manures, biofertilizers and inorganic fertilizers and their integrated effect on crop production both qualitatively and quantitatively, the present investigation was undertaken during *kharif* 2005 at the Agronomy Farm of College of Agriculture, Pune. The soil of the experimental plot was medium black clay loam up to 90 cm depth with pH 7.8, Ec-0.33 dSm^{-1} and organic carbon 0.58 per cent. The available N,P,K, content was 147.50 kg, 17.20 kg, and 280.00 kg ha^{-1}, respectively. The experiment was laid down in a randomized block design with three replications. The gross and the net plot size was 6.00 x 4.80 m^2 and 5.20 x 3.60 m^2 respectivly. The sweet corn hybrid 'Sugar-74' was dibbled on flat beds. There were seven treatments consisting of T_1 : Control (Absolute control), T_2 : Recommended dose of fertilizers (RDF) i.e. 120:60:60 kg N, P_2O_5 and K_2O ha^{-1} + 10 t FYM ha^{-1}, T_3 : 50 per cent RDF + 50 per cent N through FYM, T_4 : 50 per cent RDF + 50 per cent N through vermicompost, T_5 : 50 per cent RDF + 50 per cent N through neem cake, T_6 : 50 per cent RDF + 50 per cent N through compost and T_7 : 50 per cent RDF + 50 per cent N through poultry manure. Before sowing, seeds were treated with *Azotobactor* + *Acetobactor*. Half N through inorganic source (30 kg N ha^{-1}) and full dose of organic N, P and K fertilizers was given as basal dose and remaining half dose of inorganic N (i.e. 30 kg ha^{-1}) was applied in bands as top dressing 35 days after sowing.

The reducing sugars were determined by the method of

Table 1. Effect of integrated nutrient management on cob and fodder weight, protein and sugars content of sweet corn.

Treat-ment	Dry fodder yield (q ha^{-1})	Fresh cob yield (q ha^{-1})	Crude protein (%)		Reducing sugars (%)	Non-reducing sugars (%)	Total reducing sugars (%)
			Fodder	Green cob grain			
T_1	39.17	29.11	4.79	9.60	2.38	3.28	6.75
T_2	125.53	104.14	6.26	12.10	3.90	7.22	11.15
T_3	99.71	78.85	5.08	8.53	3.87	6.98	10.69
T_4	89.91	75.90	4.78	7.27	3.92	6.32	10.17
T_5	122.97	81.78	4.28	9.10	3.54	3.90	7.45
T_6	97.04	72.69	3.58	11.08	3.60	3.92	7.58
T_7	99.71	94.42	4.28	10.35	4.00	4.60	8.56
S. Em.±	4.143	4.112	0.282	2.327	0.052	0.245	0.410
C. D. at 5%	12.769	12.673	0.870	NS	0.160	0.756	1.262

T_1 = Control, T_2 = RDF, T_3 = 50 % each RDF and FYM, T_4 = 50% each RDF and vermicompost, T_5 = 50% each RDF and Neem cake, T_6 = 50% each RDF and compost, T_7 = 50% each RDF and poultry manure.

Nelson (1944). The total N and protein content was determined by Micro-Kjeldhal method.

The weight of cob with and without husk, and dry folder yield of sweet corn were significantly influenced by integrated nutrient management (Table 1). The recommended dose of fertilizer of sweet corn recorded significantly maximum weight of cob with and without husk (189.77 g) and (135.96 g) and dry folder yield (125.53 q ha^{-1}). However, it was at par with 50 per cent N through recommended dose + 50 per cent N through poultry manure. The combined use of bulky and concentrated organic manures in presence of inorganic fertilizers was beneficial for cob yield of sweet corn. Similar findings were also reported by Khanday and Thakur (1990) and Kher and Minhas (1991).

The recommended dose of fertilizers to sweet corn recorded significantly higher crude protein per cent and crude protein yield of fodder (6.26) as well as green cob grain over the rest of the treatments. The remaining treatments were at per with each other in respect of per cent crude protein content. However, the per cent crude protein content in green cob grain was not affected significantly due to various treatments. The increased crude protein per cent of sweet corn due to recommended dose of fertilizers might be due to the fact that the inorganic fertilizers contains the nutrients in available forms which would have been easily taken up by the plant for growth and development as well as formation of organic constituents like amino acid, proteins, carbohydrates etc.

Application of 50 per cent N through RDF + 50 per cent N through poultry manure recorded the highest amount of reducing sugars (4.00%) and was statistically at per with 50 per cent N through RDF + 50 per cent N through vermicompost (3.92%), recommended dose of fertilizers (3.90%),and 50 per cent N through RDF+ 50 per cent N through FYM (3.87%). Higher availability of soil nitrogen may lead to increase in the reducing sugar content of sweet corn. Similar observations were also reported by Hapse (1993).

The integrated nutrient management significantly influenced the non reducing and total reducing sugar content of sweet corn. The treatment of recommended dose, 50 per cent N through RDF + 50 per cent N through FYM and 50 per cent N through recommended dose + 50 per cent N through vermocompost without differing with each other recorded highest both the sugars. Sweet corn grown without fertilization recorded the least amount of non reducing (3.28 %) and total reducing sugars (6.75%).

The results in respect to reducing sugars, non-reducing sugars and total reducing sugars indicated that the supply of nitrogen either through inorganic fertilizers alone or in combination with FYM or vermicompost in the proportion of 50 per cent each enhanced the sugar content in sweet corn. The enhanced sugar content of sweet corn by the inorganic fertilizers or in combination with FYM and vermicompost might be because of more availability of nitrogen in soil and for higher absorption. The results are corroborated with the findings of (Sing and Dubey (1991), Hapse (1993) and Raja (2001).

It can be concluded that application of recommended dose of fertilizers or combined application of recommended dose of fertilizers + FYM or vermicompost in 50 per cent proportion was beneficial for higher sugar content and yield of sweet corn.

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J. Maharashtra agric. Univ., 34 (2) : 224-225 (2009)

Growth and Yield of *Rabi* Onion (*Allium cepa* L.) Influenced by Mulches and Potash Levels

Maharashtra is the largest producer of onion in the country having 20 per cent of total area under this crop with 25 per cent of production. Onion is mostly cultivated in rabi season and there is problem of irrigation water. Under such condition soil moisture conservation benefits the crop. Mulching conserves soil moisture, suppresses weed growth, regulates soil temperature, improves soil structure and checks the soil erosion (Wivutvongvana *et al.* 1991). Potassium is one of the essential nutrient required by plants. It regulates water condition within plant and water loss from plant. It thus reduces tendency to wilt and helps in better utilization of available water (Yawalkar *et al.* 2002). Therefore, the present study was conducted to find out the suitability of mulching and optimum dose of potash for better growth and yield of onion.

The experiment was conducted during *rabi* 2005-06 at Post Graduate Institute Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (M.S.). The experiment was laid out in split plot design with 12 treatment combinations comprising of three main treatments viz., soybean straw mulch, sugarcane trash mulch and no mulch with four sub plot treatments of different potash levels 0, 50, 75, 100 kg ha^{-1} replicated four times. The seeds were treated with thirum @ 3 g kg^{-1} of seed. The seed rate 8 kg ha^{-1} was used and seedlings were raised on raise beds. The flat beds were prepared of gross plot size 4.50 x 3.60 m. The fertilizer were applied as per the treatments. Seedlings were cut to half at top and planted at inter row distance of 15 cm and plant to plant spacing of 10 cm. The onion crop was mulched 10 DAT @ 5 t ha^{-1} with soybean straw and sugarcane trash as per treatments. The weeding and recommended precautionary plant protection measures were taken as per schedule of cultural operations. The time of harvesting was observed on the 50 per cent top fall of the experimental plot irrespective of treatments.

The data in Table 1 indicated that the plant height, number of green leaves $plant^{-1}$ and neck thickness were recorded more in soybean-straw mulch followed by sugarcane trash mulch over no mulch throughout the experimental period. These results are similar to those obtained by Baten *et al.* (1995) and Rahman and Khan (2001) who reported that increase in soil moisture in rhizosphere of the crop improves the plant growth parameters. Mulches significantly influenced the marketable bulb yield. It was significantly increased in soybean straw (22.79 t ha^{-1}) and sugarcane trash (22.28 t ha^{-1}) mulch treatment over no mulch treatment (19.80 t ha^{-1}). Soybean straw mulch and sugarcane trash mulch treatment were found at par. These results are in conformity with those of Khalak and Kumarswami (1992), Rekowska and Fiedorow (1998).

Different levels of potash showed a significant influence on growth parameters. Mean plant height and number of leaves were significantly more in 100 kg K_2O ha^{-1}. As potassium is one of the essential

Table 1. Mean plant height (cm), number of leaves, neck thickness (cm) and marketable bulb yield of onion as influenced by mulches and potash levels.

Treatments	Plant height (cm) at harvest	Number of green leaves at harvest	Neck thickness (cm) at harvest	Marketable bulb yield (t ha^{-1})
Mulches :				
Soybean staw	60.02	4.07 (2.13)	0.95	22.79
Sugarcane trash	57.84	3.95 (2.11)	0.87	22.28
No mulch	53.29	2.99 (1.86)	0.79	19.80
S. E.±	0.68	0.05 (0.01)	0.01	0.33
C. D. at 5%	2.36	0.16 (0.04)	0.02	1.15
Potash levels (kg ha-1) :				
0	53.46	2.87 (1.83)	0.73	19.24
50	56.50	3.62 (2.02)	0.81	21.07
75	58.20	3.89 (2.09)	0.91	22.45
100	60.04	4.31 (2.19)	1.01	23.72
S. E.±	0.47	0.04 (0.01)	0.01	0.15
C. D. at 5%	1.37	0.13 (0.03)	0.04	0.44
Mean	57.05	3.69 (2.03)	0.87	21.62

(Figures in the paranthesis are square root values) nutrient required by the plant for better growth resulted in better utilization of potash and showed good growth of onion. These results are in accordance with those reported by Singh *et al.* (1993) and Yadav *et al*. (2003b). Similarly, neck thickness was greater at highest potash level (100 kg K_2O ha^{-1}) because of proper plant growth due to higher response of potash by plant. These results are similar to those of Janardan Singh *et al*. (1993) and Warade *et al.* (1998). The potash levels from 0 to 100 kg ha^{-1} had increased the marketable bulb yield in the range from 19.42 to 23.72 t ha^{-1}. These results are only due to higher response of potash during the crop growth period of onion. These results are in agreement with those of Yadav et al. (2002) and Yadav *et al*. (2003a).

Conclusively it can be stated that amongst the mulches, soybean straw mulch recorded highest plant height, number of leaves, neck thickness, bulb diameter and marketable bulb yield followed by sugarcane trash mulch. Amongst different potash levels 100 kg ha^{-1} recorded highest plant growth and yield attributes with better quality produce.

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J. Maharashtra agric. Univ., 34 (2) : 225-226 (2009)

Stability and Yield Performance of Chickpea (desi) under Irrigated, Rainfed and Late Sown Conditions

The data generated on seed yield of chickpea (desi) during rabi season of 2006-07, through the conduct of state multilocation trials at six locations were used in present investigation. Fourteen chickpea genotypes *viz*., Phule G-9801-12, Phule G-9802-5, Phule G-9802-6, Phule G-9803-2, Phule G-9807-9, Phule G-97030-1, Phule G-97030, Phule G-9759-10, Phule G-9708-6, Phule G-00108, Phule G-03203, Phule G-05112, Vishal and Digvijay were evaluated. The locations were Rahuri and Mohol under rainfed condition, Rahuri and Kopergaon under Irrigated condition and Rahuri and Pune under late sown condition. The experiment was conducted in a RBD design with three replications adopting net plot size of 4.0 x 1.80 M with spacing of 30 x 10 cm. The recommended packages of practices were adopted for raising the good crop. The data on seed yield was recorded in various test environments and analyzed as per Laxmi (1998).

The mean seed yield of genotypes over all environments indicated that Phule G-03203 ranked first (2025 kg ha^{-1}) followed by Digvijay (2009 kg ha^{-1}) and Phule G-05112 (1918 kg ha^{-1}). It was also revealed that the yield performance of genotypes was differed in all the environments due to significant G x E interaction. Average yield performance of genotypes over all environments was at par. Therefore, it is difficult to identify a stable and significantly high yielding genotype through this multi-location trial. Hence it is essential to classify the environments (favorable, average and unfavorable) and then identify the stable genotype in each environment. The Pune (Late sown) was found to be the favorable environment for chickpea, whereas Rahuri (Irrigated) and Rahuri (Rainfed) were seen to be average environments, while three locations *viz*., Mohol (Rainfed), Kopergaon (Irrigated) and Rahuri (Late Sown) were observed as unfavorable environments for chickpea. Amongst the environments Pune (Late sown) ranked first with an average yield 2604 kg ha^{-1} followed by Rahuri (Rainfed) (1947kg ha^{-1}) and Rahuri (Irrigated) (1808 kg ha^{-1}).

Table 1. Ranking of chickpea genotypes in different environments.

Genotype	Favourable environment			Average environment			Unfavourable environment		
	Yield (kg ha^{-1})	Pheno-typic index	Rank	Yield (kg ha^{-1})	Pheno-typic index	Rank	Yield (kg ha^{-1})	Pheno-typic index	Rank
Phule G-9801-12	2393	-211	10	1943	66	7	1551	10	8
Phule G-9802-5	2234	-370	14	1697	-181	13	1619	78	4
Phule G-9802-6	2351	-253	12	1870	-7	9	1622	81	3
Phule G-9803-2	2518	-86	9	1790	-88	12	1401	-140	13
Phule G-9807-9	2335	-269	13	1884	7	8	1431	-110	12
Phule G-97030-1	2591	-13	6	1963	86	3.5	1522	-19	9
Phule G-97030	2363	-241	11	1952	75	5	1472	-69	11
Phule G-9759-10	2559	-45	8	1989	112	2	1267	-274	14
Phule G-9708-6	2656	52	5	1572	-305	14	1606	65	5
Phule G-00108	2863	259	3	1803	-74	11	1484	-57	10
Phule G-03203	2781	177	4	2107	230	1	1719	178	1
Phule G-05112	2575	-29	7	1949	72	6	1679	138	2
Vishal	2912	308	2	1806	-72	10	1594	53	7
Digvijay	3327	723	1	1963	86	3.5	1599	58	6
Mean	2604	-	-	1877	-	-	1541	-	-

The genotype Digvijay ranked first in favorable condition with seed yield of 3327 kg ha^{-1}, which is nearly five and half times more than the State average yield (560 kg ha^{-1}), 1497 kg ha^{-1} more than average yield over all locations (1830 kg ha^{-1}) and 617 kg ha^{-1} more than favorable environments average yield (2604 kg ha^{-1}).

The genotype Phule-03203 ranked first in average and unfavorable condition with seed yield of 2107 kg ha^{-1} and 1719 kg ha^{-1} respectivly, which is 82 kg ha^{-1} more than average yield over all locations (2025 kg ha^{-1}), 230 kg ha^{-1} more than average environments average yield (1877 kg ha^{-1}) and 178 kg ha^{-1} more than unfavourable environments average yield (1541 kg ha^{-1}).

The average yield of these chickpea genotypes in favourable environments was 2604 kg ha^{-1}, which is more than four times of the State average yield. It was reduced to 1877 kg ha^{-1} i.e. by 27.9 per cent in average environment and to 1541 kg ha^{-1} i.e. by 40.83 per cent in unfavorable environment.

The results revealed that the genotype Digvijay may be adopted for favourable environments and Phule-03203 for average and unfavorable environments for high productivity of chickpea. It is also concluded that instead of recommending genotypes on the basis of average performance of genotypes over all environments, the environments may be classified first and than environmentwise genotypes may be recommended for high productivity.

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J. Maharashtra agric. Univ., 34 (2) : 227-229 (2009)

Effect of Different Sources and Levels of Potassium on Yield of Gerbera under Polyhouse Conditions

Cultivation of gerbera (*Gerbera jamesonii*) a beautiful ornamental flowering plant growing under polyhouse conditions is a fast emerging area in the world. Potassium plays an important role in improving yield and quality of flowers. Therefore, the present investigation was undertaken to study the effect of various sources as well as levels of potassium on yield and quality of gerbera crop. The experiment was planned at Hi-tech Floriculture and Vegetable Project College of Agriculture, Pune during the year 2005-06.

The pot culture experiment under polyhouse condition was laid out in a factorial completely randomized block design with three replications and twelve treatment combinations by using cocopeat as a growth media under polyhouse conditions. Cocopeat having pH-5.80, EC-0.19 dSm^{-1}, organic carbon - 48.75 per cent, water holding capacity 850 per cent, total N, P and K was 0.42, 0.18 and 0.50 per cent respectively. Dong *et al*. (1999) reported that the cocopeat was the most effective for seedling growth of gerbera due to it's suitable porosity, water holding capacity, air permeability, EC and pH.

Three sources of potassic fertilizers i.e. potassium chloride (S_1), potassium sulphate (S_2) and potassium nitrate (S_3) were used in four levels on the basis of NPK dose i.e. 200 : 70 : 75 (L_1), 200 : 70: 100 (L_2), 200 : 70 : 125 (L_3) and 200 : 70 : 150 (L_4) mg $plant^{-1}$ alternate day^{-1} respectively for first 2.5 months and 120 : 60 : 225 (75 per cent RD-K), 120 : 60 : 250, 120 : 60 : 275 and 120 : 60 : 300 (150 per cent RD-K) mg $plant^{-1}$ alternate day^{-1} respectively after flowering were used.

Fifteen days after planting only plain water was given manually as per the water requirement per plant (200 ml day^{-1}). Thereafter fertilizer treatments were given at alternate day upto completion of study.

During the span of study, the morphological observation such as number of leaves per plant, size of flower, number of days required for flowering, flower yield per plant, length of flower stalk were recorded.

Two days after last fertigation i.e. at 240 days after transplanting the pots were allowed to saturate with irrigation water and allowed to collect the lechate (one liter from each pot). This leachate was analyzed for pH, EC, total K, chloride and sulphate by using standard methods. The vase-life of flower was also recorded. Statistical analysis was carried out as per the methods described by Panse and Sukhatme (1973).

The data regarding total number of flowers at 240 days (Table 1) indicated that the sulphate of potash showed highest number of flowers per plant (22.5). This was statistically superior over source muriate of potash (18.7) and nitrate of potash (20.8). The interaction effects of sources and levels of potassium were found to be non significant.

The data regarding mean fresh weight of flower (Table 1) indicated that the source sulphate of potash recorded highest mean fresh weight (30.2 g) from flowering to 240 days of crop age. This source had given

Table 1. Effect of different sources and levels of potassium on various parameters of gerbera from flowering to 240 days crop age.

Treatment	Flowers $plant^{-1}$	Weight of flower (g)	Diameter of head (cm)	Stalk length (cm)	Vase life (days)
Sources :					
S_1 - MOP	18.7	24.7	10.4	41.0	5.2
S_2 - SOP	22.5	30.2	11.3	45.6	7.8
S_3 - NOP	20.8	26.8	10.8	43.3	6.7
S. E.±	0.2	0.8	0.2	1.2	0.07
C. D. at 5%	0.7	2.8	0.6	3.9	0.3
Levels (% K) :					
L_1 - 75	18.6	23.8	10.2	42.0	5.0
L_2 - 100	22.9	28.9	11.6	46.1	7.6
L_3 - 125	20.5	28.2	11.0	43.6	7.4
L_4 - 150	20.4	27.8	10.4	41.0	6.2
S. E.±	0.3	0.5	0.2	1.5	0.2
C. D. at 5%	1.1	1.8	0.7	NS	0.8
Interaction :					
S. E.±	0.3	0.6	0.3	2.7	0.3
C. D. at 5%	NS	NS	NS	NS	NS

significantly higher fresh weight of flowers over all other sources. The level 100 per cent RD of K has recorded higher fresh weight of flowers up to 240 days and it was statistically superior over level 75 per cent K indicating low dose of K showed less weight of fresh flowers. The interaction effect of sources and levels of potassium for mean weight of flowers was non significant.

The mean diameter of flower of treatment sulphate of potash was 11.3 cm, which was statistically superior over muriate of potash (10.4 cm) and at par with nitrate of potash (10.8 cm) indicating that use of muriate of potash showed adverse effect on quality of flower, which might be due to accumulation of salts at 240 days. The treatment 100 per cent K showed more diameter of flower and it was statistically superior over 75 per cent K indicating low dose of K has adverse effect on quality of flower at later stage of harvest. The interaction effects between different sources and levels of potassium were non significant. This is in conformity with result obtained by Kamel *et al*. (1975).

The maximum length of stalk (46.1 cm) was observed in 100 per cent K treatment and it was superior over rest of the levels. Also maximum length of stalk (45.6 cm) was observed in source nitrate of potash and superior over muriate of potash indicating that there was shortening of stalk length due to use of muriate of potash, which might be due to higher accumulation of salts of chloride at 240 days. The interaction effects of sources with levels of potassium were non-significant.

The vase life of flower was improved due to use of source sulphate of potash. It was statistically superior over other two sources. So far as levels of K were concerned, at 240 days there was significant difference on vase life of flowers. Levels 100 and 125 per cent K were on par with each other but superior over 75 and 150 per cent K, indicating higher application of K dose not showed additional beneficial effect on vase life of flower. The effect of interaction between sources and levels was non significant.

Among the potassium sources, sulphate of potash gave significantly higher number of flowers, mean weight of flower, mean diameter of flower head, stalk length, vase life of flower than rest of the sources. Application of 100 per cent potassium gave significantly higher number of flowers, flower head diameter, stalk length and vase life. The interaction effects were found to be non-significant.

Leachate analysis at 240 days (Table 2) indicated that the pH of leachate was in range of 5.72 to 7.00, EC 0.88 to 1.72 dSm^{-1}, K 198 to 392 mg kg^{-1}, sulphate 79 to 142 mg kg^{-1} and chloride 62 to 382 mg kg^{-1}. The chloride content in leachate was more in treatments of KCl, which might be due to addition of chloride through KCl, which in turn showed higher electrical conductivity of leachate in this treatment, while slightly higher sulphur was observed in treatment of sulphate of potash at L_3 and L_4 level.

Table 2. Effect of different sources and levels on leachate characteristics (240^{th} days).

Treat-ment	pH	EC (dS m^{-1})	K (ppm)	SO_4 (mg lit^{-1})	Cl (mg lit^{-1})
MOP :					
L_1	6.71	1.38	216	98	282
L_2	6.88	1.52	249	88	315
L_3	6.92	1.66	336	79	348
L_4	7.00	1.72	392	83	382
SOP :					
L_1	5.92	0.88	188	85	65
L_2	5.88	0.97	198	92	68
L_3	5.81	1.25	210	115	62
L_4	5.72	1.39	258	142	55
NOP :					
L_1	6.35	0.98	196	86	77
L_2	6.15	1.11	215	89	68
L_3	6.08	1.26	271	80	71
L_4	6.00	1.44	315	91	80

The higher chloride content obtained from source muriate of potash had showed bad effects on growth of plant, flowers, nutrient uptake and flower yield.

The application of K sources was found in the order of K_2SO_4> KNO_3 > KCL in respect of growth, yield and quality of gerbera. Application of recommended dose of K gave significantly higher yield and quality of gerbera under polyhouse condition.

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December 31, 2007

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J. Maharashtra agric. Univ., 34 (2) : 229-230 (2009)

Performance of Cotton Based Inter-Cropping System with *In-situ* Water Management

The vagaries of rainfall having maligned even in the assured rainfall area in recent years. Cotton being a long duration crop needs a fairly sufficient soil moisture to sustain the growth at later stages of reproductive phase. In this context efficient utilization of rain water plays an important role which can be achieved by various means like soil management practices, inter-cropping effecting a better build up of water in soil, limiting the loss of soil moisture through weeds. *In situ* moisture conservation practices reduce the runoff thereby store more soil moisture. Cotton is an important commercial fibre crop of Maharashtra grown on rain water as a rainfed crop. With this in view the present study was undertaken on effect of *in situ* rain water conservation in cotton based inter-cropping system.

A field experiment was conducted on deep black soil of Water Management Research, Khamgaon during *kharif* seasons of 2006-07. The experiment was laid out in factorial randomized block design replicated thrice. Twelve treatment combinations of four inter-cropping system *viz*. cotton sole, cotton + green gram (1:1), cotton + soybean (1:1) and cotton + black gram (1:1) and three different land layouts *viz*. flat beds, opening of furrow after alternate row and opening of furrow after every row.

The furrows were opened as per treatment after harvest of intercrops. The fertilizer dose of 80:40:40: NPK kg ha^{-1} was applied. The cotton variety PH-316 (Ganga) was used for sowing. The intercrops varieties green gram (BM-4), soybean (MAUS-47) and black gram (BDU-1) were used for sowing. The rainfall during the crop growing season was 584 mm during 2005 and 534 mm in 2006 respectively. The data on seed cotton yield, intercrops yield was recorded and startically analyzed.

In pooled analysis, the seed cotton yield (1716 kg ha^{-1}) of sole cotton was significantly superior over different inter cropping system. The seed cotton yield (1364 kg ha^{-1}) recorded in cotton + green gram inter-cropping system was significantly superior over cotton + soybean and cotton + black gram inter-cropping system in pooled analysis. Gadade *et al*. (2006) reported that soybean is promising inter crop in India.

All the inter-cropping systems recorded significantly higher seed

Table 1. Seed cotton yield, seed cotton equivalent yield and gross monetary returns as influenced by different treatments.

Treatment	Seed cotton yield (kg ha^{-1})	Seed cotton equivalent yield (kg ha^{-1})	Gross monetary returns (Rs ha^{-1})
Inter-cropping system :			
Cotton sole	1776	1675	28277
Cotton + green gram	1364	1979	32581
Cotton + soybean	1199	1857	30444
Cotton + black gram	1286	1889	31153
S. E.±	2382	2400	351
C. D. at 5%	7400	7500	1092
Land layouts :			
Flat bed	1268	1751	28689
Opening of furrow after alternate row	1408	1874	30973
Opening of furrow after every row	1468	1944	32180
S. E.±	2063	2090	304
C. D. at 5%	6400	6500	945

cotton equivalent yield over sole cotton. cotton + green gram inter-cropping system recorded significantly highest seed cotton yield (1979 kg) over rest of the inter-cropping systems in pooled analysis. Cotton + Green gram inter cropping system with opening of furrow after every row after harvest of green gram recorded the highest seed cotton equivalent yield and net monetary returns.

Opening of furrows after every row recorded highest seed cotton yield (1468 kg.) over flat bed and it was at par with opening of furrow after alternate row treatment. Opening of furrow after every row recorded significantly higher seed cotton equivalent yield over remaining treatments. Sivanappan (2004) reported that alternate furrow opening was as important agronomic tool for *in-situ* moisture conservation. Giri *et al.* (2007) recorded highest seed equivalent yield in cotton + pigeonpea inter-cropping.

Cotton + green gram inter-cropping system recorded significantly higher gross monetary return (Rs. 32581) over remaining inter-cropping system. Opening of furrow after every row recorded significantly higher gross monetary returns as compared to remaining land layouts.

It clearly indicated that the cotton + green gram inter-cropping system should be followed with opening of furrow after every row after the harvest of green gram, *in situ* moisture conservation and highest monetary returns.

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J. Maharashtra agric. Univ., 34 (2) : 230-231 (2009)

Antagonistic Effect of Some Soil Fungi Against Leaf Spot of Cotton Caused by *Alternaria alternata* (Fr.) C. Keissler

Cotton is one of the most important fibre crops of Maharashtra State; it's production has reduced considerably due to many leaf spot diseases. The leaf spot caused by *Alternaria alternata* is one of them. It attacks most of the varieties of cotton and is considered as most virulent fungus. The disease appeared on the leaves in the form of discoloured isolated patches which eventually turned brown in colour. The patches were 5-10 mm in diameter with borders, at the severity central part of the spot turned to gray followed by cracking of leaf lamina. In advanced stages detachment of the diseased tissues resulted in the formation of "shot-holes".

Infected leaves of cotton were collected from different cultivated fields. *Alternaria alternata* was isolated from infected leaf. Pathogenicity test was confirmed by Koch's postulate method. Antagonistic fungi *Aspergillus flavus*, *A. niger*, *Trichoderma*

Table 1. Effect of different antagonists on radial mycelial growth of *Alternaria alternata*.

Antagonistic fungi	Radial mycelial growth (mm)			% growth inhibition		
	3 DAI	5 DAI	7 DAI	3 DAI	5 DAI	7 DAI
Aspergillus flavus	10.00	10.00	10.00	60.00	100.00	100.00
Aspergillus niger	10.00	10.00	10.00	60.00	100.00	100.00
Trichoderma viride	10.00	10.00	10.00	60.00	100.00	100.00
Trichoderma harzianum	9.00	9.00	9.00	64.00	100.00	100.00
Penicillium oxalicum	20.00	28.00	28.00	20.00	68.00	100.00
Control	25.00	35.00	47.00	-	-	-

DAI - Days After Incubation.

harzianum, *T. viride* and *Penicillium oxalicum* were isolated from rhizosphere of healthy cotton plants during rainy season by dilution plate method and warcup method.

The dual culture method was adopted to observe the antagonism. Different isolates of the test antagonists were screened against *Alternaria alternata* in dual cultures on potato dextrose agar (PDA) in petriplates. 5 mm discs of antagonists and pathogen were inoculated 4 cm apart on PDA in petriplates in which pathogen was placed in centre. In control only disc of pathogen was inoculated. The petriplates were inoculated at 27 ±2°C. The radial mycelial growth of the pathogen was measured on 3rd, 5th and 7th day of incubation and compared with control. The per cent of inhibition was calculated by using formula

$$\text{Per cent inhibition} = \frac{(\text{TFC-TFTr})}{\text{TFC}} \times 100$$

Where, - Test Fungus in control; TFTr - Test Fungus in treatment

The data from Table-1 showed that *Trichoderma harzianum* and *T. viride* found to be highly effective in inhibiting the growth of pathogen since 3rd day of incubation. Significant differences in inhibition rate by different antagonists were noted on 3rd and 5th day of incubation. Maximum radial mycelial growth of *Alternaria alternata* was recorded in control, however the highest inhibition was recorded in *T. harzianum* (64%) and lowest in *Penicillium oxalicum* (20%) at 3rd day of incubation. Cent per cent growth inhibition was observed in all the test antagonist except *P. oxalicum* on 5th day of incubation.

The present investigation clearly indicated that among the five antagonists *T. harzianum* and *T. viride* were most promising antagonists. Weindling (1932) started the pioneering work on *Trichoderma* and he discovered that *T. lignorum* parasitized on number of soil borne fungi. *Trichoderma* produces enzymes that digest mycelial walls or it forms the antibiotics that biologically control the other organisms. The present result coincides the findings of Abraham and Balsundaran (1977), Murugasam (2001), Washimkar (2003) and Autkar (2004).

ACKNOWLEDGEMENTS

The author is greatful to Dr. B. T. Raut, Associate Professor, Deptt. of Plant Pathology Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) for their constant guidance and encouragement during the course of this investigations.

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January 20, 2008

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J. Maharashtra agric. Univ., 34 (2) : 231-233 (2009)

Variability for Callus Induction in Chickpea (*Cicer arietinum* L.) Genotypes

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops in the world. It provides high quality protein, particularly for vegetarians. Callus induction is reported to possess a high regenerative capacity compared to those derived from mature organs, such as leaf, stem and root (Rao and Chopra, 1987).

The present paper describes the *in vitro* callus induction from mature embryo axis of chickpea genotypes with optimization of auxin and sucrose concentrations for proliferation of callus.

Seeds of twenty-five genotypes of chickpea obtained from Pulse Improvement Project, M.P.K.V., Rahuri were used as the experimental material. Seeds were immersed in one per cent tween-20 solution for one minute, followed by two to three washings of sterile water. Seeds were surface sterilized with seventy per cent ethyl alcohol for one minute followed by 0.1 per cent mercuric chloride ($HgCl_2$) solution for eight minutes, with intermittent shaking in a laminar air flow cabinet. Then seeds were rinsed with sterile water to remove all the traces of sterilant and soaked aseptically in sterile water in separate conical flasks for 12-14 hrs. Embryonic axes were isolated from seeds of each genotype and cultured on two media, MS and B5 supplemented with 2, 4-D at concentration 2 mg lit^{-1}. The media were adjusted to pH 5.8, 0.8 per cent agar was added to each medium and autoclaved at pressure 15 psi for 15 minutes. Cultured tubes were plugged and then incubated in dark at 25 ± 2°C for four weeks. The experiment was repeated thrice.

After incubation, days to callus initiation were recorded, while after four weeks on induction media fresh calli were removed from induction media to measure fresh weight. After recording fresh callus weight, these calli were subjected to overnight drying at 60°C and dry weight of callus was recorded.

There were significant differences among genotypes for days to callus initiation, fresh weight of callus and dry weight of callus. Phule G-92926 required minimum two days on B5 medium for callus induction. This was followed by Phule G-97121 (2.33 days), Phule G-96005 (2.33 days), Phule G-9222-2 (2.33 days) and JG-62 (2.66 days). A significant variation was observed for fresh callus weight and dry callus weight. Significant and highest fresh callus weight was obtained by Phule G-9417-3-4-5 (592.667 mg) on B5 medium whereas minimum fresh weight of callus was obtained by Phule G-96005 (119.00 mg) on MS medium. Significant and highest dry weight of callus was obtained by Phule G-9417-3-4-5 (191.00 mg) on B5 medium (Table 1).

Table 1. Genotypic variability in chickpea for days to callus induction and callus weight.

Genotypes	Days to callus induction		Dry weight of callus (mg)	
	MS medium	**B5 medium**	**MS medium**	**B5 medium**
JG-62	3.00	2.66	32.33	33.66
Phule G-95311 (Kabuli)	3.66	3.33	85.00	107.33
Phule G-9404-1-3-6	3.00	3.00	70.33	104.33
Phule G-9414-4-4-9	4.00	3.33	52.66	120.66
Phule G-910153	3.33	3.00	40.33	46.00
Phule G-96006	3.00	3.00	35.33	47.00
Virat (Kabuli)	4.33	3.33	42.33	74.00
Phule G-9417-3-4-5	3.00	3.00	109.66	190.66
Phule G-9410-4-1-3	3.00	3.00	131.33	133.00
Phule G-97110	4.00	3.00	39.00	55.33
Phule G-9426-3-4-2	4.33	3.00	48.00	52.00
Phule G-9417-3-4-3	3.66	3.00	43.33	100.33
Phule G-9423-7-5-6	4.00	3.00	46.33	71.00
ICC-4958	3.33	3.00	28.00	63.66
Vijay	4.33	3.66	31.66	59.33
Phule G-92926	2.66	2.00	67.00	43.66
Phule G-92307 (Kabuli)	5.00	3.66	123.33	141.66
Phule G-5	3.66	3.33	31.00	34.00
Phule G-9222-2	4.33	2.33	31.00	36.00
Phule G-96005	3.66	2.33	12.00	26.00
Phule G-9423-7-5-2	3.33	3.00	26.00	24.66
Phule G-95332 (Kabuli)	5.00	4.00	22.33	104.66
Vishal	3.00	2.66	24.66	36.66
Phule G-9412-3-2-5	3.66	3.00	31.66	83.66
Phule G-97121	3.33	2.33	41.66	60.33
	S. E. ±	C. D. at 5%	S. E. ±	C. D. at 5%
Genotype	0.210	0.584	3.150	8.731
Media	0.059	0.165	0.890	2.469
Iteraction	0.298	0.826	4.455	12.349

Note : MS medium - MS basal + 2 mg/ l 2, 4-D, B5 medium - B5 basal + 2 mg/ l 2, 4-D

Variability for *in vitro* culture response was reported by Adkins *et al*. (1995). Similar observations were also noted by Rao and Chopra (1987), Shankar and Ram (1993). They observed callus induction within 10-15 days. Variation may be due to differences in levels of endogenous hormones of each genotype. In the present investigation all chickpea genotypes gave response for callus induction with 2, 4-D at 2 mg lit^{-1}. Similar observations were made by Barna and Wakhlu (1993), Chauhan and Singh (2002).

Early callus induction was observed by all the genotypes on B5 medium (2-4 days) as compared to that on MS medium (3-5 days). Basal nutrient medium also exhibited differences for callus induction of particular genotype was reported by Rao et al. (1997), Huda *et al*. (2000) and Reddy *et al*. (2001) observed best callus induction on B5 medium supplemented with 3mg lit-1. 2, 4-D or NAA and 3 mg lit^{-1}. BAP. Rao (1989) observed that fresh weight of callus was increased with increase in auxin and cytokinin concentrations.

These results suggested that callus induction efficiency for a specific genotype depends upon the hormonal concentration in the medium as well as endogenous hormone level.

ACKNOWLEDGEMENT

The authors are thankful to the Head, Department of Agricultural Botany for providing facilities for conducting present study.

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J. Maharashtra agric. Univ., 34 (2) : 233-235 (2009)

Genetics of Fertility Restoration in Pigeonpea

Pigeonpea (*Cajanus cajan* L.) Millspaugh is forth most important pulse crop in the world. Globally, pigeonpea is cultivated on 4.68 million hectares of land with an annual production of 3.5 million tones and productivity of 714 kg ha^{-1} (FAO 2005).

The pigeonpea area, production and productivity trends in India in last five decades shows that, there was about 2 per cent increase in the area per year but yield levels are stagnated around 600-700 kg ha^{-1}. In spite of release of over 100 good varieties, yield levels in pigeonpea did not increase significantly (Saxena 2006 b). There are many reasons for low yield in order to maintain self-sufficiency in pulses production for the increasing population; a proportionate increase in their production is essential. In this endeavor, the development of hybrid pigeonpea technology has potential.

Large variability for various characters has been reported in pigeonpea. The stable male sterility system in conjugation with natural out crossing will make the hybrid pigeonpea popular. However, in pigeonpea identification of perfect restorer is one of the important objectives. Many reports have indicated non-availability of restorer and it is one of the limitation in pigeonpea hybrid programme. Genetics of restoration has been studied and reported here.

The experiment was conduct at two locations, Parbhani and Patancheru. The three male-sterile lines were crossed with male parents to obtain 24 crosses. Backcrosses were made at Patancheru to obtain BC_1F_1 population. Out of 24 crosses, 17 crosses, were selected to work out genetics of fertility restoration.

A total of 17 crosses were advanced to F_2 and back cross generation to know the segregation (male-fertile: male-sterile) for fertility restoration (Table-1). The crosses exhibited different ratios ranging from normal monogenic ratio to trigenic ratios. Out of seventeen, eight crosses showed fit to goodness for monogenic ratio (3:1) (serial No. 1-8). The backcross ratios for these crosses were fit for 1:1 ratio. Three crosses exhibited ratio of 15:1 and two corresponding backcrosses showed the digenic control (two duplicate genes) for fertility restoration (serial No.9-11). One cross showed 9:7 ratio and 1:3 ratio in back cross population indicating two complementary genes are responsible for fertility restoration (Serial No. 12). Two crosses exhibited 13:3 F_2 ratios and 3:1 back cross ratio, which showed that there should be one basic gene and one inhibitory gene for fertility restoration (Serial No. 14-15). One cross-exhibited 63:1 ratio and 7:1 back cross ratio, indicating trigenic control for fertility restoration (Serial No. 16-17). Two crosses showed trigenic interaction with 39:25 F_2 ratio, indicating one basic gene, one inhibitory gene and one anti-inhibitory gene for fertility restoration. Among the crosses showing trigenic ratios, one cross was with A4 cytoplasm where as two crosses were with Al cytoplasm. One cross each for digenic and trigenic crosses did not fit for the back cross ratio. This may be due to the environmental sensitivity of the Al cytoplasm. The sterile plants may be converted to fertile, leading to change in the ratio. Murty (1986) and Murty and Gangadhar (1990) reported similar results in sorghum. They reported one to three genes for fertility restoration in sorghum. Yadav (2005) also reported monogenic to trigenic ratios in pearl millet. There may be chance of cytoplasmic difference as like sorghum male-sterile lines. The study also indicated there is scope to develop restorers.

Table 1. Genetics of fertility restoration.

Cross	Total plants	λ^2 cal	Cross	Total plants	λ^2 cal
F_2 ratio			**BC_1F_1 ratio**		
3:1 ratio			**1:1 ratio**		
A_4 x ICP 12320	428	0.2**	A_4 x ICP 12320	103	3.5**
A_4 x ICP 11376	430	1.37**	A_4 x ICP 11376	158	3.06**
A_4 x HPL-24-63	471	4.42*	A_4 x HPL-24-63	115	3.83**
A_2 x ICP 11376	38	0.04**	A_2 x ICP 11376	210	0.30**
A_2 x HPL 24-63	18	1.85**	A_2 x HPL 24-63	98	1.02**
A_2 x ICP 13991	49	3**	A_2 x ICP 13991	156	3.69**
A_2 x ICPL 87119	10	1.2**	A_2 x ICPL 87119	113	2.56**
A_4 x ICP 10934	70	0.17**	A_4 x ICP 10934	90	2.84**
15:1 ratio			**3:1 ratio**		
A_1 x ICPL 87119	376	0.01**	A_1 x ICPL 87119	376	21.57
A_2 x ICP 12320	85	1.07**	A_2 x ICP 12320	97	1.24**
A_4 x ICP 10650	179	0.31**	A_4 x ICP 10650	108	0.44**
9:7 ratio			**1:3 ratio**		
A_4 x ICP 13991	518	2.1**	A_4 x ICP 13991	112	3.86*
13:3 ratio			**3:1 ratio**		
A_1 x ICP 12320	359	2.34**	A_1 x ICP 12320	175	3.20**
A_1 x HPL 24-63	247	2.83**	A_1 x HPL 24-63	154	10.61
63:1 ratio			**7:1 ratio**		
A_1 x ICP 13991	438	0.11**	A_1 x ICP 13991	102	11.34
39:25 ratio			**3:5 ratio**		
A_4 x ICPL 87119	347	3.31**	A_4 x ICPL 87119	201	2.87**
A_1 x ICP 11376	318	2.31**	A_1 x ICP 11376	146	10.83

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

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J. Maharashtra agric. Univ., 34 (2) : 235-237 (2009)

Genetic Association and Path Coefficient Analysis in Sesame (*Sesamum indicum* L.)

The information derived on correlation and path analysis will be helpful in identifying the desirable component characters for bringing improvement in seed yield. The present study was conducted to determine the association between economic traits in sesame and to determine the direct and indirect influence of the traits on seed yield.

The experimental materials for the present investigation consisted thirty F_4 lines of a cross Padma x JLSV-4 of sesame along with parents and standard check. The lines were evaluated in a randomized block design with three replications during *kharif* 2005 at Botany farm, College of Agriculture, Pune. Each entry was represented by a single row of 4.5 m length with a spacing of 30 x 15 cm between and within rows. Five competitive plants from each line were used for recording observations. Observations were recorded for ten different characters *viz*., days to 50 per cent flowering, days to maturity, plant height at harvest, number of branches plant^{-1}, number of capsules bearing nodes, number of capsules plant^{-1}, capsule length (cm), number of seeds capsule^{-1}, seed oil content (%) and seed yield plant^{-1} (g). The data was subjected for correlation and path coefficient analysis by following Singh and Chaudhary (1977) and Dewey and Lu (1959), respectively.

The correlation coefficients among all possible pairs of characters are presented in Table 1. The character capsule length (0.4796) recorded the highest significant positive correlation with seed yield plant^{-1} followed by number of branches plant^{-1} (0.4114) and number of seeds capsule^{-1} (0.3493). Hence selection for high seed yield can be done by selecting more number of branches, seeds capsule^{-1} and capsule length. Similar results were obtained by Thiyagarajan and Ramanathan (1996) and Deepasankar and

Table 1. Correlation coefficient between ten characters in F_4 generation of a cross Padma x JLSV 4 of sesame.

Characters	Days to 50 % flowering	Days to maturity	Plant height at harvest (cm)	Branches plant^{-1}	Capsules bearing nodes	Capsules plant^{-1}	Capsule length (cm)	Seeds capsule^{-1}	Seed oil content (%)	Seed yield plant^{-1} (g)
Days to 50% flowering	**1.0000**	0.6109**	-0.0406	-0.5431**	-0.3552*	-0.1255	-0.2910	-0.2637	-0.4049*	-0.2822
Days to maturity		**1.0000**	-0.1851	-0.5900**	-0.2608	-0.3380	-0.2548	-0.2159	-0.0309	-0.2533
Plant height at harvest (cm)			**1.0000**	0.2156	-0.0041	0.1959	0.2774	-0.0047	0.2667	0.3386
Branches plant^{-1}				**1.0000**	0.3020	0.0331	0.4209*	0.3549*	0.4373*	0.4114*
Capsules bearing nodes					**1.0000**	0.0756	-0.0664	0.2181	0.0570	-0.0582
Capsules plant^{-1}						**1.0000**	-0.1289	-0.1592	-0.0559	-0.1027
Capsule length (cm)							**1.0000**	0.1557	0.3020	0.4796**
Seeds capsule^{-1}								**1.0000**	-0.0135	0.3493*
Seed oil content (%)									**1.0000**	0.2663
Seed yield plant^{-1} (g)										**1.0000**

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

Table 2. Direct (diagonal) and indirect (above and below diagonal) path effects of different characters towards yield in F_4 generation of cross Padma x JLSV 4 of sesame.

Characters	Days to 50 % flowering	Days to maturity	Plant height at harvest (cm)	Branches plant^{-1}	Capsules bearing nodes	Capsules plant^{-1}	Capsule length (cm)	Seeds capsule^{-1}	Seed oil content (%)	Seed yield plant^{-1} (g)
Days to 50% flowering	**-0.1092**	-0.0102	-0.0098	-0.0753	0.0628	0.0109	-0.0716	-0.0674	-0.0124	-0.2822
Days to maturity	-0.0667	**-0.167**	-0.0448	-0.0818	0.0462	0.0293	-0.0627	-0.0552	-0.0009	-0.2535
Plant height at harvest (cm)	0.0044	0.0031	**0.2422**	0.0299	0.0007	-0.0170	0.0683	-0.0012	0.0082	0.3386
Branches plant^{-1}	0.0593	0.0099	0.0522	**0.1386**	-0.0534	-0.0029	0.1036	0.0907	0.0134	0.4114*
Capsules bearing nodes	0.0388	0.0044	-0.0010	0.0419	**-0.1768**	-0.0066	-0.0163	0.0557	0.0017	-0.0582
Capsules plant^{-1}	0.0137	0.0057	0.0475	0.0046	-0.0134	**-0.0867**	-0.0317	-0.0407	-0.0017	-0.1028
Capsule length (cm)	0.0318	0.0043	0.0672	0.0583	0.0117	0.0112	**0.2461**	0.0398	0.0093	0.4796**
Seeds capsule^{-1}	0.0288	0.0036	-0.0011	0.0492	-0.0385	0.0138	0.0383	**0.2556**	-0.0004	0.3493*
Seed oil content (%)	0.0442	0.0005	0.0646	0.0606	-0.0101	0.0049	0.0743	-0.0035	**0.0306**	0.2662

Residual effect = 0.768922, *,** Significant at 5 and 1 per cent probability, respectively.

Anandakumar (2003). However, the association between seed yield plant^{-1} and plant height at harvest and seed oil content was positive and non significant. Similar results were reported by Siva Prasad *et al.* (2007).

Among the component characters days to 50 per cent flowering was positively and significantly associated with days to maturity whereas number of branches plant^{-1} also showed positive and significant association with capsule length, number of seeds capsule^{-1} and seed oil content indicating these characters were independent and could be improved simultaneously by selection.

Looking to the data of direct and indirect effects (Table 2) it was observed that the character number of seeds capsule^{-1} (0.2556) had the highest positive direct effect on seed yield plant^{-1} followed by capsule length (0.2461), plant height at harvest (0.2422) and number of branches plant^{-1} (0.1386). The correlation coefficient between seed yield and number of seeds capsule^{-1}, capsule length and number of branches plant^{-1} were significant and positive indicating true and perfect association between these characters and suggesting importance of direct selection of these traits. These results coincide with Thiyagarajan and Ramanathan (1996) and Deepasanker and Anandakumar (2003).

The traits days to 50 per cent flowering, days to maturity, number of capsules bearing nodes and number of capsules plant^{-1} had negative direct effect on seed yield plant^{-1}. Similar results were reported by Thiyagarajan and Ramanathan (1996).

The character number of capsules bearing nodes had maximum negative direct effect (-0.1768) on seed yield but it had positive indirect effect through number of seeds capsule^{-1} (0.0557) and number of branches plant^{-1} (0.0419). Number of capsules plant^{-1} exerted indirect positive effect on seed yield through plant height and number of branches plant^{-1}. However, its direct effect was negative but low. These results confirm the earlier findings of Vadhavani *et al.* (1992) and Thiyagarajan and Ramanathan (1996).

From this investigation it is clear that number of seeds capsule^{-1}, capsule length and number of branches plant^{-1} are the major component traits for the improvement of seed yield in segregating population of sesame. Selection for yield improvement based on these characters will be more effective.

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J. Maharashtra agric. Univ., 34 (2) : 237-238 (2009)

Effect and Performance of Intercrops in Mango Orchards

Intercropping is a viable agronomic practice for stepping up the production as well as productivity of a system for a unit area during a cropping period. Intercropping of pulses fixes the atmospheric nitrogen which helps in building up of soil fertility and recycling the nutrients from lower soil layer to surface soil (Gangwar *et al.* 2004). Intercropping system is profitable for small as well as marginal farmers. It is also suitable and feasible for the prosperity of Indian farmers. As the hiking of input cost and low commodity prices, the farmers are looking for low cost alternate technology. These alternate management techniques minimize the use of purchases inputs and exploit biological systems to improve the efficiency, to enhance the total output. In view of above, an investigations were undertaken to find out suitable intercropping system of agronomic intercrops in fruit orchards.

The field experiments were undertaken on twelve farmer's field in Beed district during 2001-2004 in a randomized block design with four treatments. The farmers were selected having mango orchard of 5-6 years with fruit bearing condition. One farmer was treated as one replication. The treatments were mango + soybean - gram fram, mango + cowpea - mustard, mango + sesamum -fallow and mango alone (No intercrops during *kharif* and *rabi*). The varieties used for sowing were JS-335, local and Phule-1 of soybean, cowpea and sesamum respectively. The net plot size was 40 x 40 sq. m. and soils of the experimental plots were light to medium. The mango plants were planted at 10 x 10 sq. m. in all plots, which was planted in employment guarantee scheme in Maharashtra State. The sowing was done at both sides of the mango rows forming strips of crop at both sides, standing mango line at the center. All the package of practices for intercrops and fruit trees were followed as per recommendations of the crop from time to time.

The pooled data of three years (Table -1) indicated that the effect of intercropping on plant height, plant spread and stem girth were non-significant. The treatment mango + soybean in *kharif* season and gram in *rabi* season recorded higher plant height as compared to rest of the treatments of intercropping and sole mango planting. The treatment mango + cowpea - mustard recorded maximum height of mango plant as compared to mango + sesamum and mango alone. This indicates that the legume which was intercropped with mango plant gets benefit to main plants. The plant

Table 1. Effect of intercrops in mango on growth parameters, yield and monetary returns (pooled data 2001-2004).

Treatments	Plant height (m)	Plant spread (m)	Stem girth (m)	Fruits plot^{-1}	Monetary returns (Rs ha^{-1}) Gross	Net
T_1	4.59	3.43	3.93	66.83	21089	14813
T_2	4.48	3.35	3.91	63.06	18604	12654
T_3	4.46	3.33	3.96	60.00	11966	7287
T_4	4.29	3.38	3.86	52.60	4783	2718
S. E.±	0.074	0.026	0.610	0.93	708	708
C. D. at 5%	NS	NS	NS	1.89	1445	1445
Mean	4.45	3.37	3.91	60.62	14110	9363

T_1 = mango + soybean - gram, T_2 = mango + cowpea - mustard, T_3 = mango + sesamum - fallow, T_4 = mango alone.

spread of mango was higher in case of soybean followed by mustard cropping system which was higher than all other treatments. The mango alone showed maximum spread of plant as compared to mango + cowpea + gram and mango + sesamum treatments. In case of stem girth, the treatment mango + sesamum showed higher values as compared to rest of the treatments. The treatment mango + soybean - mustard was superior over rest of the two treatments i.e. mango + cowpea - gram and mango alone. The mango alone showed lowest stem girth as there is no beneficial effect from intercrops. The beneficial effect of legumes on succeeding crops under dryland condition was reported by Umrani (1983).

The data from Table 1 indicated that the treatment of intercropping of soybean in *kharif* season followed by mustard in *rabi* season in mango orchard recorded significantly more number of mango fruits per plot during the study period. The treatment of mango + soybean - mustard sequence of intercropping recorded significantly more number of fruits as compared to all other treatments. The treatment mango + cowpea - mustard was significantly superior over mango + sesamum and mango alone by recording more number of fruits. The mango alone showed less number of fruits than any other treatments. This shows that the, intercropping with any crops is beneficial for getting more number of fruits on the trees. All the three intercropping treatments proved better than growing of mango alone in respect of recording number of mango fruits.

The mean gross and net monetary returns obtained were Rs. 14110 ha^{-1} and Rs. 9363 ha^{-1} respectively. The maximum gross monetary returns Rs.21089 ha^{-1} and net monetary returns Rs. 14813 ha^{-1} was significantly superior over rest of the treatments in case of mango + soybean - mustard treatment. The treatment mango + cowpea - gram was again significantly higher for gross and net returns over mango + sesamum and mango alone planting. This was attributed to higher gross returns realized because of additional bonus yield of intercrops which also fetched higher price in market. Kaushik *et al.* (1998) reported higher net monetary returns from intercropping system as compared to sole cropping. The treatment mango + sesamum intercropping also recorded significantly higher returns as compared to mango alone planting. This clearly indicated that the intercropping either with legumes or non-legumes was beneficial for getting maximum returns. Thorve *et al.* (2005) showed that, intercropping system recorded highest monetary returns over sole cropping system.

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J. Maharashtra agric. Univ., 34 (2) : 239-239 (2009)

Productivity of Greengram as Influenced by Growth Regulator Application

Green gram is an important pulse crop, which is an excellent source of protein (25%) and high quality lysine (460 mg g^{-1} N) and tryptophan (60 mg g^{-1} N). It is consumed as whole grain in the form of halva as well as pulse products in vegetarian diet. The protein deficiency particularly in children can be reduced with improvement of production potential of pulses grown. The bio-mass is also a good source of fodder to the cattle or green manure, if incorporated into soil.

The area under this crop in Maharashtra remain unchanged due to problems, like disease incidence and erratic rainfall. The newly released genotype BPMR-145 is high yielding and resistant to powdery mildew and mosaic. This genotype display excessive vegetative growth, which adversely affect the yield of crop. The excessive growth needs to be checked by using growth retardant (cycocil), which will help to divert the photosynthate towards grain development. Retardents are also known to affect vine growth (El - Morsey and Mansoor, 1998) and increase yield, dry matter accumulation (Pandey and Yadav, 1999).

A field experiment was carried out at Agriculture College farm Parbhani, during kharif 2004, to observe the production potential of green gram as influenced by growth regulator (cycocil). The experiment was laid out in a randomized block design replicated thrice. The treatments were, spraying of cycocil @ 25, 50, 75, 100, 125, 150 and 175 ppm and a control without cycocil spraying. The crop was sown at 30 cm plant to plant and 10 cm row to row distance by dibbling. The gross plot size was 5.4 x 3.6 m whereas, net plot size was 4.5 x 2.4 m. The crop was sprayed at 40 days with growth regulator and harvested by picking the pods at maturity and grains separated by threshing. (Table 1).

Table 1. Grain yield, biological yield of green gram as influenced by various concentrations of cycocil.

Cycocil (ppm)	Grain yield (kg ha^{-1})	Biological yield (kg ha^{-1})
Control	689.1	3832.3
25	775.5	4001.6
50	795.0	4037.7
75	803.0	4076.7
100	900.9	4301.7
125	913.8	4340.7
150	1162.5	4536.0
175	1179.3	4565.0
S. E.±	30.9	31.4
C. D. at 5%	92.1	95.2
Mean	903.6	4211.4

The data presented in Table 1 revealed that, the application of cycocil (growth retardant) @ 175 ppm and 150 ppm were at par and both levels recorded significantly higher grain yield over lower cycocil levels and control. Similar response of cycocil spray on green gram to increase yield by 4.5 per cent with 200 ppm spray was reported by Sing *et al*. (1993) and Wasnik and Bagga (1992) in mungbean and Kothale *et al*. (2003) in soyabean.

In general, the application of cycocil @ 150 ppm was found beneficial in checking the excessive vegetative growth of green gram in terms of grain and biological yield.

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J. Maharashtra agric. Univ., 34 (2) : 240-241 (2009)

Ovular Callus Culture Studies in *Carica papaya* L

Papaya is one of the most important fruit crops of tropical and subtropical region known for high nutritive and medicinal value. Papaya stands 5th in global production, among the fruit crops grown all over the world. Though it is highly productive fruit crop the main constraints in the production are heterozygosity, dioeciousness and susceptibility to large number of viral diseases (Kavita and Chezhiyan, 2005). To overcome these limiting factors the best method is to improve papaya through genetic manipulation, i.e. to undertake efficient breeding programme. The embryological studies of distant crosses of *Carica papaya* x *Carica cauliflora* revealed no barriers to fertilization; but subsequent development was abnormal (Manshardt and Wenslaff, 1986). Hence, ovular callus culture studies in papaya was carried out in the crosses Pusa delicious x Carica cauliflora, Pusa magestic x GK PM-1 and Sunrise solo x GK PM-1 at papaya breeding scheme, National Agricultural Research Project, Ganeshkhind, Pune (MS) during the year 2005-06 for standardization of protocol for initiation and regeneration of ovular callus of papaya.

The five diverse nature parents *viz.;* Pusa delicious, Pusa magestic, Sunrise solo, *Carica cauliflora* and GK PM-1 were used for crossing programme and the three crosses Pusa magestic x *Carica cauliflora*, Pusa magestic x GK PM-1 and Sunrise solo x GK PM-1 were used for study.

Immature embryos of the above crosses were rescued after 25, 30, 35, 40, 45, 50, 55 and 60 days of pollination and eight to ten immature embryos of each crosses were transferred into sterile media bottles for the further studies.

Culture media : Three different media *viz.*; MS (Murashige and Skoog, 1962), ½ MS + 0.5 mg lit^{-1} kinetin and MS + 0.5 mg lit^{-1} kinetin were prepared with 3 per cent sucrose and 0.8 per cent agar. The pH of the media was adjusted to 5.7 $\pm$ 0.1 with 1N NaOH before autoclaving. The media was sterilized by autoclaving at 121°C at 15 Ib psi for 15 minutes and then used for regeneration.

Surface sterilization : The fruits were washed with 2-3 drops of twin-20 and then surface sterilized with 0.1 per cent bavistin for one day. Further, the fruits were surface sterilized with 100 ppm streptocycline and 0.1 per cent $HgCl_2$ for 5 minutes each under laminar flow. The fruits were dissected and the immature embryos were rescued and transferred into media carefully.

Culture condition : All the explants were cultured in growth chamber at 28 $\pm$ 1°C and 2000 lux photoperiod for 16 hrs for induction of the callus and development of somaclonal embryos.

The ovular callus formation was observed in the cross Pusa delicious x *Carica cauliflora* of age 35 days after 2 months of inoculation. There was no callus formation observed in other two crosses, only black matured somatic embryos formation was observed in these two crosses. The results are in concurrence with Bhattacharya *et al*. (2002).

Out of the three different media used for regeneration of papaya plant, shootlets were observed in the media of ½ MS supplemented with 0.5 mg lit^{-1} kinetin. These findings were also observed by Kavitha and Chezhiyan (2005) at place of work. Overall regeneration of shootlets from ovular callus was found to be 10 per cent after 339 days from inoculation in the cross between Pusa delicious x *Carica cauliflora*.

Table 1. Per cent regeneration of shootlets from ovular callus of the cross between Pusa delicious x *Carica cauliflora* in papaya.

Treatments (Medium)	Regenerated shootlets after 374 days	% regeneration from ovular callus
MS	0/30	0.0
½ MS + 0.5 mg lit^{-1} kinetin	3/30	10.0
MS + 0.5 mg lit^{-1} kinetin	0/28	0.0

From this study, it can be concluded that ½ MS + 0.5 mg lit^{-1} kinetin is good media for ovular callus formation and regeneration of shootlets from the ovular callus of the cross of Pusa delicious x *Carica cauliflora*, which would be a boon to the breeders for further improvement programme in papaya in future.

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J. Maharashtra agric. Univ., 34 (2) : 241-242 (2009)

Effectiveness of Horticultural Development Programme under Employment Guarantee Scheme

The Government of Maharashtra implemented Horticultural Development Programme with objectives to bring low grade soil under fruit cultivation with increaded income per unit area through Employment Guarantee Scheme from 1 990-91. For assessing the effectiveness of the programme present investigation was carried out

The study was conducted in 12 villages from Junnar, Shirur and Indapur tahsils of Pune district. The list of farmer benefisaries availed benefit of the programme before 2000 was prepared. From each village ten farmers were selected randomly. Thus total sample size for the study was 120. Keeping in view of the objective an interview schedule was prepared and data were collected.

The programme majority (76.67per cent) fruit growers reported that employment has been generated through the two-third (67.50 per cent) of them stated that income has been increased and 43.33 per cent of the opinion that resources were developed because of availing benefit of the programme. The similar observation were also reported by Sagwal and Malik (1995).

It was observed that according to all (100.00 per cent) the fruit growers, employment was generated for self, for family members and others. Majority of the fruit growers (92.40 per cent) reported that sufficient wages were received through employment, followed by employment was generation on large scale (90.21per cent) and employment was generated in respective village (70.65 per cent). The findings are in accordance with the findings of Suryanarayana *et al.* (1990).

Cent per cent (100.00 per cent) of the fruit grower reported that income was increased, followed by increase in standard of living (97.53 per cent), number of occupations (85.19 per cent), capital (83.95 per cent) with availability of balanced diet for family (82.72 per cent). While 60.00 to 70.00 per cent of the fruit growers stated that the increased family income helped in adoption of improved seeds, pesticides, fertilizers for better crop production, to give higher education to children, to avail proper medical treatment, and afford costly garments for family members due to increase in income.

Majority (84.62 per cent) of the fruit growers use toilet and renovated their old house (55.77 per cent) or constructed new house (48.08 per cent) and new well (44.23 per cent). Fruit crop plantation upto 1.00 ha. by 42.30 per cent, land leveling (38.46 per cent) drilling new tube well (32.69 per cent), and purchase of tractor/power tiller and starting dairy as secondary occupation (32.69 per cent each). About 25.00 per cent of the respondents purchased cows, power spray pump, knapsack sprayer, new vehicle and installed new pump set. The findings are similar with those of the Bhosale *et al*. (2000).

It was concluded from the study that the scheme was effective in terms of employment generation increase in income and resources development. The extension agencies should strengthen the field visits, discussions, meetings, campaign and study tours for the beneficiary farmers to motivate them and to rectify their problems on horticultural crops. Literature like leaflets, folders, booklets etc. on horticultural plantation should be prepared with detailed information and circulat among the farmers. Also the success stories should be published and broadcasted regularly.

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J. Maharashtra agric. Univ., 34 (2) : 242-243 (2009)

Resource Optimization for Selected Crops by Using Linear Programming

Linear Programming is a technique for determining an optimal schedule of interdependent activities in view of the available resources in different regions, seasons and situations (Shirgure, 1998, Bankar and Atre 1998, Debnath *et al*. 2002, Shing *et al*. 2005)

The present study was carried out in Maheshghad watershed located in Mahatma Phule Agricultural University campus and district of Ahmednagar of Maharashtra state. Area of watershed is 45.04 ha which includes the area under submergence (4.26 ha) and the area that can not be monitored (4.66 ha). Hence the total area of watershed available for formulating the problem is 36.12 ha. The study area was divided into various sub watersheds based on natural divide using contour map namely, W_{1A}, W_{1B}, W_2, W_3 and W_4 (Table 1).

Water resources in watershed : The total annual rainfall in the watershed is 58.90 cm. The water requirement of *kharif rabi* and summer for custard apple (48, 11.9, 17.4 cm), stylo hemata (38.5, 0, 0 cm) and perlmillet (34.2, 0, 0 cm respectively).

Table 1. Area, average slope, soil type, selected plantation and proposed crop of the sub watersheds.

Sub watersheds	Area (ha)	Slope (%)	Soil type	Selected plantations	Proposed crops
W1A	02.38	08.00	Exposed rocks	Horticulture	Custard apple
W1B	16.28	02.12	Murum	Silvipasture and Horticulture	Stylo Hemata, Custard apple
W2	02.74	01.95	Loamy	Agriculture	Pearl Millet
W3	09.97	02.54	Murum	Silvipasture and Horticulture	Stylo Hemata, Custard apple
W4	04.75	03.07	Murum	Silvipasture and Horticulture	Stylo Hemata, Custard apple

Development of objective function : The objective function to get maximum benefit was formulated as :

$$\text{Maxim } Z = \sum_{i=1}^{n} \sum_{j=1}^{m} C_{ij} X_{ij}$$

Where, Z = Profits in Rs. C_{ij} = Profit of i^{th} crop in j^{th} soil type sub watershed, X_{ij} = Area under i^{th} crop in j^{th} soil type sub watershed, n = number of crops, m = number of soil types in sub watersheds.

Constraints : The above objective function was maximized subject to the following constraints.

Area constraints : X is marked as area available and other variables

Table 2. Contribution of different crops and soil type in watershed profit.

Variable	Crop-Soil type combination	Area allotted (ha)	Contribution (Rs.)
X_{11}	Custard Apple -Rocky	0.06	15000
X_{12}	Custard Apple-Murum	0.74	185000
X_{13}	Custard Apple-Loamy	0.07	11200
X_{22}	Stylo Hemata-Murum	27.58	303380
X_{23}	Stylo Hemata-Loamy	0.00	0.00
X_{33}	Pearl Millet-Loamy	2.67	52866

with this are as follows : X_{11} = Area under custard apple in rocky type soil, X_{12} = area under custard apple in murum type soil, X_{13} = area under custard apple in loamy type soil, X_{21} = area under stylo hemata in rocky type soil, X_{22} = area under stylo hemata in murum type soil, X_{23} = area under stylo hemata in loamy type soil, X_{31} = area under pearl millet in rocky type soil, X_{32} = area under pearl millet in murum type soil, X_{33} = area under pearl millet in loamy type soil.

Considering above variables, generalized equation of area constraints was formulated as follows:

$$\sum_{i=1}^{n} \sum_{j=1}^{m} X_{y} \leq A_j$$

Where, A_j = Total area under sub watershed of j^{th} soil type.

Water constraint : The seasonal water requirement of various crops to be cultivated in the watershed should not exceed the total seasonal water availability in the watershed. The water constraints can be represented as follows:

$$\sum_{i=1}^{n} \sum_{j=1}^{m} W_{ik} X_{ij} \leq WA_k$$

Where, W_{ik} = water requirement of i^{th} crop in k^{th} season in cm, WA_k = water available in k^{th} season in ha-cm.

Case study : The linear programming problem for maximization of profits for watershed was solved for three different plantations - horticulture, silvipasture and agriculture. The final results revealed that the maximum total profit was Rs.5,67446. The maximum contribution in the total profit came from Stylo hemata. Contributions from other crops are tabulated (Table 2).

The LPP for watershed was solved for different plantations for maximization of profits. Under each plantation one crop was considered. The results revealed that the maximum profit was Rs.5,67,446 The contribution to this maximum profit came from Stylo hemata.

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Seasonal Incidence and Weather Correlation of Sorghum Shootfly (*Atherigona soccata* Rondani)

The sorghum shootfly (*Atherigona soccata* Rondani) is one of the major pests of sorghum in India. Rai and Jotwani (1977) estimated the losses in grain yield in sorghum due to shootfly to the tune of 13 to 20 per cent at 20 per cent infestation level and about 60-90 per cent at 90 per cent infestation. It is the pest of significant importance on sorghum, causing deadhearts in seedling stage, reducing plant population and thereby heavy yield losses. The losses due to shootfly alone were to the tune of 22.11 to 83.94 per cent (Jotwani and Sukhani, 1971 and Mote, 1983). In view of these, an experiment was conducted to study the seasonal population fluctuation and thereby to implement the accurate schedule for better management of shootfly so as to minimise the yield losses.

The field experiments in non-replicated trials were conducted at Sorghum Research Station, Marathwada Agricultural University, Parbhani to study the seasonal incidence of shootfly from 1990-2001 for 12 consecutive years. The sorghum hybrid CSH 9 was sown at fortnightly interval starting from 1st June to 1st November every year. Total ten lines of 3.00 m length were planted at 45 x 15 cm spacing. In every sowing, the observations of shootfly deadhearts were recorded on 28th day after emergence of the crop. Simultaneously, the observations on weather parameters i.e. temperature (minimum and maximum), relative humidity (a.m. and p.m.) and rainfall (mm) were also recorded corresponding to the date of observation to work out the correlation.

The results revealed that the maximum shootfly deadhearts were recorded were 73.23 per cent during the meteorological week 32 to 37 in which maximum and minimum temperature, relative humidity at a.m. and p.m. were 30.00, 21.8°C and 86 and 67 per cent, respectively with 244 mm rainfall.

The data on simple correlation between weather parameters and per cent deadhearts caused by *A. soccata* on 28 DAE, revealed that out of the total variables tried, only the relative humidity p.m. and rainfall were positive and significant indicating thereby these variables are mostly responsible for increase in infestation.

The treatment differences were highly significant (at 1 per cent level of significance). The sorghum crop (CSH 9) sown on 16th August has given the highest infestation of shootfly incidence, which was at par with crop planted on 1st August and 1st September. Hence it can be concluded that the shootfly infestation increases consistently in the crop sown from 1st July to 16th August and decline from 16th August to 1st of September. From this analysis it can be concluded that 16th July to 1st September is the period of maximum infestation, hence it can be recommended that sowing of *kharif* sorghum should not be done after 1st of July.

Results of these studies are in line with the findings of Taneja *et al.* (1986). They reported that the shootfly incidence was significantly correlated with evening relative humidity.

The above findings are also in conformity with the results of Singh *et al.* (1986). They reported that high relative humidity (60 %) was favorable for more increase of the fly population and the relationship of shootfly population in traps and deadhearts were positively correlated with relative humidity and negatively with temperature. Balikai (2000) reported that shootfly population began to increase in July, reached to highest peak in August and declined thereafter with a slight peak in October and again declined.

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May 20, 2008

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Edited and Published by Dr. P. N. Harer at College of Agriculture, Pune 411 005.

Typeset Processed and Printed by : Flamingo Business System, 19, Laxminagar Comm. Complex-1, Pune-411 009. Tel. : 24214636

Date of Issue : May, 2009

Date of Publication : May 1, 2009