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Effect of Different Doses and Sources of Potassium on Yield, Spongy Tissue and Nutrient Content of Alphonso Mango

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Abstract

Aplication of recommended dose of NP + 1 kg K_2O through SOP per tree + 1 per cent foliar sprays of potassium nitrate produced significantly more fruit yield (78.57 kg tree^{-1}) over absolute control (40.04 kg tree^{-1}). An application of different levels of potassium significantly increased N, K and Ca content in the mango pulp from 0.96 to 1.11, 0.56-1.16 per cent and 15 to 44.11 C mol (p+) kg^{-1} respectively. Application of different levels of K significantly increased content of N, P, K and Ca in mango leaves at initial, before flowering and post harvest stage. Application of different levels of K significantly influenced the chemical properties of soil such as available N, P, K and exchangeable calcium at post harvest stage.

Key words : SOP, paclobutrazol, exchangeable Ca^{++}.

The low productivity of Alphanso refers to less percentage of composite flowers and pollen grain morphology. Alternate year bearing, appearance of spongy tissue, low stigma pollination process and very susceptible to mites are predominate genetic lacunae in Alphonso mango, resulting into low productivity even though it has acceptable flavour and colour with good test. With a view to improve the yield level, quality parameter and to reduce spongy tissue occurrence, an experiment was conducted from 2000-01 to 2003-04 using different levels of K through potassic fertilizers and foliar sprays of potassium nitrate.

Materials and Methods

The field trial was conducted at Central Experimental Station, Wakawali with nine treatments in a randomized block design and replicated thrice during 2000-2004 as T_1 : Absolute control (No NPK), T_2 : Recommended dose of NP (1.5:0-5 kg N and P_2O_5 kg tree^{-1}), T_3 : Recommended dose of NPK (K through MOP) (1.5:0.5:0-5 kg N, P_2O_5 and K_2O tree^{-1}), T_4 : Recommended NPK K_2O through SOP (1.5:0.5:0.5 kg N, P_2O_5, K_2O tree^{-1}), T_5 : Recommended NP + 1 kg K_2O through SOP (1.5:0.5:1.0 kg N, P_2O_5 and K_2O tree^{-1}), T_6 : Recommended NP + 2 kg K_2O through SOP (1.5:0.5:2.0 kg N, P_2O_5 and K_2O tree^{-1}), T_7 : Recommended dose of NPK (K_2O through SOP) + 1 per cent potassium nitrate spray (1.5:0.5:0.5 kg N, P_2O_5 and K_2O tree^{-1} + 1 per cent foliar sprays of KNO_3), T_8 : Recommended dose of NP + 1 kg K_2O through SOP + 1 per cent foliar sprays of potassium nitrate (1.5:0.5:1.0 kg N, P_2O_5 and K_2O tree^{-1} + 1 per cent foliar sprays of KNO_3), T_9 : Recommended dose of NP + 2 kg K_2O through SOP + 1 per cent foliar sprays of potassium nitrate (1.5:0.5:2.0 kg N, P_2O_5 and K_2O tree^{-1} + 1 per cent foliar sprays of KNO_3).

Inorganic fertilizers were applied in the first fortnight of June. Moreover F.Y.M. @50 kg tree^{-1} was applied to all experimental tress as a basal dose. Paclobutrazol growth hormone @ 0.75 g.a.i. meter^{-1} canopy diameter was

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applied to all experimental trees during 15th July to 15th August and three foliar sprays of 1 per cent KNO3 from peanut stage of mango fruit was given at an interval of one month.

The initial and post harvest soil samples were collected from each treatment and analyzed for different chemical properties. The plant samples were collected from 4-5 positions in all directions of tree to represent composite samples of treatment at initial before flowering and post harvest stage and processed by using standard procedures. The matured fruits were selected by dipping in salt solution and mango pulp was used for estimation. The soil samples, leaf samples and fruit pulp was estimated for N, P, K, Ca by using standard procedure given by Tandon (1987). All the data were statistically processed as per the procedure given by Panse and Sukhatme (1985).

Results and Discussion

Weight of fruits : Application of 1.5 kg N, 0.5 kg P_2O_5 + 0.5 kg K_2O through SOP tree^{-1} + through foliar feeding recorded highest average fruit weight of 258.41 g which was significantly superior over recommended N and P, recommended N, P and K. and recommended NP and 1 kg K_2O through SOP (Table-1).

Yield : Application of 1.5 kg N, 0.5 kg P_2O_5 and 1 kg K_2O through sulphate of potash (SOP) plus 1 per cent KNO_3 through foliar spray produced highest fruit yield (78.57 kg) and number of fruits tree^{-1} (323.66) which was found to be significantly superior over absolute control, recommended dose of N, P, recommended dose of NPK (through MOP), recommended dose of NPK (through SOP),

Table 1. Effect of different doses and sources of potassium on yield and spongy tissue of Alphonso mango and nutrient content in pulp.

Treatment	Average weight (g)	Number of fruits tree^{-1}	Yield (kg ha^{-1})	Spongy tissue (%)	Nitrogen content in pulp (%)			Ca Cmol (p^+) kg^{-1}
					N	P	K	
T_1 : No fertilizers	246.16	166.89	41.04	13.80 (21.79)*	0.96	0.068	0.56	15.00
T_2 : Rec. NP @1.5, 0.5 kg tree^{-1}	238.60	233.89	56.45	15.10 (22.89)	1.11	0.092	0.77	32.44
T_3 : Rec. NPK, K through MOP @1.5:0.5:0-5 kg tree^{-1}	239.89	251.55	60.94	14.10 (22.09)	1.03	0.093	0.88	31.33
T_4 : Rec. NPK, K through SOP	248.54	291.44	71.07	9.10 (17.55)	1.01	0.096	1.04	38.11
T_5 : Rec. NP + 1 kg K through SOP	240.40	247.11	58.86	7.80 (16.18)	0.97	0.094	1.09	38.11
T_6 : Rec. NP + 3 kg K through SOP	255.68	284.89	70.16	8.60 (17.09)	1.10	0.096	1.05	37.88
T_7 : Rec. NPK (SOP) + 1 per cent KNO_3	258.41	275.44	69.27	7.60 (15/98)	1.03	0.086	1.12	43.44
T_8 : Rec. NP + 1 kg (SOP) + 1 per cent KNO_3	252.26	323.66	78.57	4.50 (12.22)	1.02	0.094	1.10	40.33
T_9 : Rec. NP + 2 kg K_2O (SOP) + 1 per cent KNO_3	246.25	225.77	54.71	8.40 (16.89)	1.03	0.097	1.16	44.11
S.E.±	5.541	20.55	3.077	0.8844	0.050	0.0039	0.0553	1.640
CD at 5%	15.35	61.14	9.25	2.451	0.1390	N.S.	0.1534	4.546

* Arc sin values

recommended NP + 2 kg K_2O through SOP + 1 per cent KNO_3 spray. Similar results were also recorded by Syamal and Mishra (1989) and Kanwar *et al*. (1987).

Spongy tissue : The soil application 1.5 kg N, 0.5 kg P_2O_5 and 1.00 kg K_2O through sulphate of potash in June with KNO_3 1 per cent spray at peanut, marble and egg stage significantly reduced the spongy tissue (4.50%) over rest of the treatments and control (13.80%). Burondkar *et al*. (2002) and Jadhav *et al*. (2004) recorded similar results for reduction of spongy tissue. Shinde *et al*. (2005) reported that the soil application of dolomite + KNO_3, irrigation at peanut fruit stage reduced spongy tissue (3.33%) in Alphonso mango as compared to control (22.00%).

Nutrient content in pulp : The nitrogen content in pulp was ranged between 0.96 to 1.11 per cent with a mean value of 1.03 per cent. The maximum N content (1.11%) was observed in recommended NP followed by treatment recommended NP + 2 kg K_2O through SOP (1.10%) which were significantly superior over absolute control and at par with rest of the treatments.

Application of recommended dose of NP and 2 kg K_2O (SOP) $tree^{-1}$ + spray of KNO_3 recorded maximum K content (1.16%) which was significantly superior over absolute control, recommended dose of N, P and recommended dose of NPK (K through MOP). The application of K through sulphate of potash increased the K content in mango pulp (1.04 to 1.1 6%) which might have helped to reduce the spongy tissue.

The maximum calcium content (44.11 C mol (p^+) kg^{-1}) in mango pulp was recorded by the recommended NP + 2 kg K_2O through SOP $tree^{-1}$ + 1 per cent KNO_3 foliar spray which was significantly superior over rest of treatment. It has already been proved that calcium content has some role in reducing spongy tissue (Shinde *et al.* 2005). However role of sulphate of potash on increasing Ca content of mango pulp is observed in these studies which are quite encouraging.

Nutrient content in leaves : The highest nitrogen conten in leaves at initial stage (Table 2) was recorded (1.51%) in the treatment recommended NP + 2 kg K_2O through sulphate of potash and foliar sprays of 1 per cent KNO_3 $tree^{-1}$ which significantly superior over rest of the treatments. The highest phosphorus content (0.086%) was recorded in the treatment recommended NPK and foliar sprays of 1 per cent KNO_3 $tree^{-1}$, rec. NP + 1 kg K (SOP) + 1 per cent KNO_3 which were significantly superior over control, rec. NP, recommended dose of NPK but K through MOP and recommended dose of NPK but K through SOP. The maximum potassium content in leaves was recorded (0.63%) in the treatment recommended dose of NP and 1kg K through SOP and significantly higher K content over control, only NP, recommended dose of NPK but K through MOP. The maximum Ca content in leaves was recorded in the treatments recommended NP and 2 kg K_2O through SOP + KNO_3 1 per cent spray (88 Cmol $(P+)$ kg^{-1}) and in recommended NP + 1 kg K_2O through SOP + 1 per cent KNO_3 spray (83.55 Cmol (P^+) kg^{-1} and these treatments produced significant result over control, only recommended NP, and recommended NPK but K_2O through MOP and recommended dose of NP + 2 kg K_2O through SOP.

The nitrogen content in leaves at before flowering stage was recorded higher in the treatment recommended NPK, K_2O through SOP + 1 per cent KNO_3 spray i.e. 1.73 per cent which was significantly superior over absolute control and at par with rest of the treatments. The phosphorus content was

observed to be maximum in the treatment recommended NP + 1 kg K_2O through SOP (0.089%) which was at par with rest of the treatments except treatment rec. NPK (K through SOP). The maximum potassium content was recorded in the treatment recommended NP + 1 kg K_2O through SOP + 1 per cent KNO_3 spray (0.76%) which was significantly superior over treatments recommended NP + 2 kg K_2O SOP + 1 per cent KNO_3 spray, absolute control, recommended NP and recommended NPK, K_2O through MOP.

The maximum nitrogen content in the leaves at post harvest stage was observed with the treatment recommended NP + 2kg K_2O through SOP + 1 per cent KNO_3 spray (1.20%) which was at par with recommended NP + 1 kg K_2O (SOP), recommended NPK K_2O through SOP + 1 per cent KNO_3 spray, recommended NP + 1 kg K_2O SOP + 1 per cent KNO_3 spray over control and rest of the treatments. The phosphorus content in leaves was ranged between 0.063 to 0.075 per cent with a mean value of 0.069 per cent. The maximum content was observed in the treatment recommended NP + 1 kg K_2O SOP (0.075%) which was significantly superior over recommended NP + 2 kg K_2O SOP + 1 per cent KNO3 spray (0.065%) and recommended NPK, K through SOP (0.063%). The potassium content in leaves was ranged between 0.35 to 0.56 per cent with a mean value of 0.49 per cent. The treatment recommended NP + 1 kg K_2O through SOP and recommended NP + 2 kg K_2O (SOP) + 1 per cent KNO_3 spray showed higher value of 0.56 per cent potassium, which were significantly superior over other treatments.

The calcium content was ranged between 49.66 to 70.66 C mol with mean value of 63.17 C mol (P^+) Kg^{-1}. The highest value of calcium content was observed in the treatment recommended NP + 2 kg K_2O SOP + 1 per cent KNO_3 spray (70.66 Cmol (P^+) kg^{-1}) which was significantly superior over absolute control, recommended NP, recommended NPK (MOP), recommended NP + 2 kg K_2O through SOP. Similar results were recorded by Thakur *et al*. (1983). He applied potassium 2 kg KCl $tree^{-1}$ $year^{-1}$ in two equal split doses (October-January) to mature Dashahari and reported that potassium leaf concentration increased by 43 per cent.

Table 2. Effect of different doses and sources of potassium on nutrient of mango leaves at different stages.

Treatment	Initial				Before flowering				Post harvest			
	N%	P%	K%	Ca Cmol (p^+) kg^{-1}	N%	P%	K%	Ca Cmol (p^+) kg^{-1}	N%	P%	K%	Ca Cmol (p^+) kg^{-1}
T_1	1.21	0.073	0.40	71.44	1.46	0.087	0.57	81.44	0.90	0.068	0.35	49.66
T_2	1.36	0.079	0.79	72.22	1.62	0.086	0.64	84.89	1.08	0.065	0.44	58.00
T_3	1.36	0.075	0.42	71.89	1.59	0.083	0.65	76.77	1.06	0.073	0.42	63.78
T_4	1.40	0.075	0.60	75.27	1.68	0.079	0.73	79.66	1.09	0.063	0.48	66.33
T_5	1.42	0.085	0.63	78.00	1.62	0.089	0.74	89.89	1.16	0.075	0.56	62.44
T_6	1.44	0.073	0.59	74.33	1.68	0.085	0.75	81.44	1.12	0.071	0.53	63.00
T_7	1.44	0.086	0.55	76.66	1.73	0.080	0.74	83.33	1.16	0.074	0.53	66.89
T_8	1.47	0.078	0.61	83.55	1.60	0.087	0.76	88.11	1.15	0.066	0.54	67.78
T_9	1.51	0.082	0.61	88.00	1.65	0.088	0.47	88.11	1.20	0.065	0.56	70.66
S.E.±	0.014	0.003	0.015	3.22	0.05	0.003	0.03	4.05	0.03	0.033	0.02	2.26
CD at 5%	0.04	0.009	0.04	8.92	0.15	0.009	0.08	11.23	0.07	0.009	0.06	6.28

Soil status : The initial (before experimentation) soil analysis indicated that the soils were sandy clay loam in texture, moderately acidic in reaction with low electrical conductivity having high organic carbon content with medium in available N and K and low in available phosphorus and calcium.

Application of potassium with various levels through chloride and sulphate did not significantly influence the soil reaction (Table 3). The soil reaction was ranged between 5.40 to 5.62 after the harvest of the crop.

The electrical conductance of the soil ranged between 0.038 to 0.052 dSm^{-1} with a mean value of 0.044 dSm^{-1}. The maximum electrical conductance was observed in the treatment control, recommended NP, recommended NP + 1 kg K_2O SOP + 1 per cent KNO_3 spray, recommended NPK (MOP) (0.052, 0.052, 0.047 and 0.043 dSm^{-1}) which were significantly superior over rest of the treatments.

The maximum available nitrogen content in the soil was recorded in the treatment recommended NPK, K_2O through SOP + 1 per cent KNO_3 spray (384.77 kg ha^{-1}) which was significantly superior over the treatments control and recommended NPK K_2O through MOP and at par with rest of the treatments.

Application of all treatments except control significantly increased available phosphorus content of soil over absolute control. This indicated that there is need for application of phosphorus through phosphorus fertilizers. The maximum available phosphorus content was recorded in rec. NPK (K through SOP) + 1 per cent foliar spray of potassium nitrate (8.68kg ha^{-1}) while lowest value was reported in the treatment absolute control (5.19 kg ha^{-1}).

The maximum available potassium content was recorded in the recommended NP + 1 kg K_2O through SOP + 1 per cent KNO_3 (335.06 kg ha^{-1}) and lowest in the treatment control (223.10 kg ha^{-1}) with a mean value of 300.62 kg ha^{-1}.

The exchangeable calcium content was ranged between 3.72 to 4.42 Cmol (p^+) kg^{-1} with a mean value of 4.20 Cmol (p^+) kg^{-1}. The maximum calcium content was observed in the treatment recommended NP and recommended NP + 2 kg K_2O through SOP + 1 per cent KNO_3 spray (4.42 Cmol (p^+) kg^{-1}) which were significantly superior over absolute control (3.72 Cmol (p^+) kg^{-1}). This indicated

Table 3. Effect of different doses and sources of potassium nutrient content of soil at post harvest stage.

Treatment	pH	EC (dSm^{-1})	Available nutrients (kg ha^{-1})			Exchan. Ca. Cmol (p^+) kg^{-1}
			N	P	K	
T_1	5.62	0.052	282.88	5.19	223.10	3.72
T_2	5.44	0.052	345.50	7.91	291.19	4.12
T_3	5.42	0.043	327.79	7.50	305.62	4.10
T_4	5.58	0.041	351.05	8.18	332.71	4.13
T_5	5.54	0.042	346.65	7.59	292.90	4.16
T_6	5.47	0.038	351.84	8.14	307.32	4.24
T_7	5.51	0.039	384.77	8.68	316.88	4.41
T_8	5.49	0.047	364.82	8.67	335.06	4.19
T_9	5.42	0.041	370.22	8.41	300.85	4.42
S.E.±	0.03	0.003	12.47	0.089	12.43	0.11
CD at 5%	N.S.	0.009	34.58	0.25	34.46	0.30

that application of NPK fertilizers lead to increase in exchangeable calcium content of soil.

Thus in comparison to initial soil status the soil pH increased, electrical conductivity decreased, the available N, K, Ca increased and P decreased with the application of potassium.

In confirmation to above study it was reported that most woody species and mango in particular, are highly sensitive to chloride toxicity. Hence, K_2SO_4 is generally preferred instead of KCL (Tandon and Kemmler, 1986; Tandon, 1987). Potassium sulphate also supplies the much needed sulphur. Jamdar *et al*. (2003) reported that the soil application of potassium through sulphate of potash and foliar spray of 1 per cent KNO_3 at peanut, marble stage increased fruit yield, quality, N, P, K, Ca, Mg, S content of fruit pulp and leaves with reduction of spongy tissue in Alphonso mango. Nitrogen and potassium fertilization increased dry matter content and plant nitrogen and potassium uptake, although with higher nitrogen and potassium rates, potassium uptake decreased. In 4 years trials, Singh *et al*. (1983) applied nitrogen, phosphorus and potassium (each at 1, 2 and 3%) to 15 year old trees in September and again in April, concluded that although leaf nitrogen, phosphorus and potassium increased with increasing fertilizer spray rates, the number of fruits produced by 1 per cent N, P, K was higher than 3 per cent N, P, K spray. Thus from above 3 years study it can be concluded that for increasing yield quality, nutrient status and reduction of spongy tissue in Alphonso mango K_2SO_4 should be preferred than KCl along with foliar spray of 1 per cent peanut, marble and egg stage of fruit.

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Response of Foliar Feeding of Water Soluble Fertilizers in Onion

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Abstract

The application of three sprays of 20:20:20 NPK grade fertilizers (0.05%) as a foliar application at 30, 45 and 60 days after transplanting recorded the highest yield of 39.17 t ha^{-1} with B:C ratio of 4.95 as compared to control (29.31 t ha^{-1} with 3.98 B:C ratio). Hence it is recommended to give three sprays of 20:20:20 NPK grade fertilizer as a foliar sprays at 30, 45 and 60 days after transplanting for highest bulb yield in rabi onion.

Key worlds : Onion, foliar application, nutrients.

Onion bulbs are demanded throughout the year in the market. Fertilizers used to increase the production can not bring a full profit to the farmers unless they are applied in most efficient and economical way. Fertilizers and micronutrients can be applied through foliar sprays (Jayabal *et al*., 1998). All the essential elements can be taken by the plants through foliage, but only in small quantities at a time. Plants can absorb and utilize the nutrients much more efficiently when they are applied to soil (Tolanur, 2006). Foliar application is not a substitute for soil application but it is an effective additional means of supplying sudden increased demand of nutrients. In case of foliar application, nutrients are supplied directly to where they are required. It is also effective when the root growth is restricted, after pest and disease attack, it is effective for quick recovery. It was proved that fertilizers applied to soil in addition with foliar application based on potential deficient nutrient increases significantly the yield level and biomass of vegetables. Considering the above facts the present investigation was carried out to study response of foliar feeding of water-soluble fertilizers as a foliar application in onion.

Materials and Methods

The experiment was conducted at All India Coordinated Research Project on Vegetable Crops, Mahatma Phule Krishi Vidyapeeth Rahuri during *rabi* season of 2008, 2009 and 2010 and was laid out in a randomized block design with three replications. The soil of the experimental block was medium black clayey in texture with a pH of 8.10 and EC of 0.32 dSm^{-1}. Available nitrogen in soil was 190 kg ha^{-1} and was determined by the method as described by Subbiah and Asija (1956). The available P_2O_5 in soil was 11.5 kg ha^{-1} and was determined by following Olsen *et al*. (1954). The available K_2O in soil was 260 kg ha^{-1} and was determined by method of Hanway and Heidal (1952). The onion variety N-2-4-1 was used for study. The 8 week old seedlings were prepared in nursery and transplanted in flat beds with a spacing of 15 x 10 cm with a plot size of 3 x 2 m having seventeen treatments including one control. The 17 treatment consist of four types of soluble fertilizers with one or

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three sprays in addition to micronutrients mixture maintaining control as given in Table 1.

The different foliar fertilizer grades were sprayed at 30, 45 and 60 days after transplanting for 3 sprays and at 45 days after transplanting for one spray. All the foliar sprays given at 0.05 per cent. All the treatments have been received the recommended dose of fertilizer i.e. 20 tonnes of FYM and 100:50:50 NPK kg ha^{-1}. All the recommended cultural practises were followed to raise the good crop. The observations were recorded on five randomly seleteted plants in each replication on plant height, number of leaves, neck thickness, polar diameter, equatorial diameter, average weight of bulb, TSS, A, B, C grade bulbs, doubles, bolters, total yield and marketable yield. The mean data was statistically analysed as method suggested by Panse and Sukhatme (1985).

Results and Discussion

In the year 2007-08, the highest yield (30.3 t kg^{-1}) was recorded in the treatement NPK 20:20:20, 3 sprays while in control was 25.7 t ha^{-1}. The same treatment has also recorded highest yield for 48.33 t ha^{-1} as compared to control (36.87 t ha^{-1}) in the year 2008-09. In year 2009-10 the same treatment recorded the highest yield of 38.88 t ha^{-1} as compared to control i.e. 25.38 t ha^{-1}. The overall pooled mean, the same treatment (Table 1) recorded the highest yield of 39.17 t ha^{-1} as compared to control (29.31 t ha^{-1}). The same treatment has also recorded 34 per cent more yield and the highest B:C ratio (4.95) as compared to control (3.98). The other treatments also recorded more yield from 7-19 per cent increase over the control. The total bulb yield by foliar application of different fertilizer grades and micronutrients increased the bulb yield over control i.e. only recommended dose. The maximum (34%) increase in total bulb yield was recorded in the treatment 3 sprays of NPK 20:20:20, over the control treatment. These results are in close agreement with those of Singh and Tiwari (1995) and Silman *et al*. (1999). Similar report in okra was also reported by Sundaram and Kanthaswamy (2005).

The maximum plant height (Table 2) was recorded in treatment T_3 (66.65 cm) and minimum in T_{17} i.e. control (59.60 cm). The number of leaves were also high in T_3 (11.8) and minimum in T_{17} (8.9). The neck thickness was maximum in T_3 (1.65 cm) while it was minimum in T_{17} (1.45 cm). The maximum plant height, number of leaves and neck thickness in the foliar application of 3 sprays of

Table 1. Total bulb yield as influenced by different treatments of foliar application in onion.

Treatment	Bulb yield (t ha^{-1})	B:C ratio	% increase over control
T_1 - NPK(19:19:19)-3 spray	3153	4.24	14.00
T_2 - NPK (19:19:19)-1 spray	33.37	4.42	13.85
T_3 - NPK(20:20:20)-3 spray	39.17	4.95	34.00
T_4 - NPK (20:20:20)-1 spray	34.20	4.53	17.00
T_5 - NPK(19:09:19)-3 spray	34.89	4.41	19.00
T_6 - NPK(19:09:19)-1 spray	33.61	4.45	15.00
T_7 - NPK(17:10:27)-3 spray	33.00	4.16	13.00
T_8 - NPK (17:10:27)-1 spray	34.42	4.56	17.30
T_9 - Multi K (0:0:50)-3 spray	34.91	4.20	19.00
T_{10} - MultiK (0:0:50)-1 spray	33.70	4.39	15.00
T_{11} - Mirconutrient mixture -3 spray	31.93	3.83	9.00
T_{12} - Mirconutrient mixture -1 spray	31.38	4.08	7.00
T_{13} - NPK (19:19:19) (30 DAP)	33.86	4.14	16.00
T_{14} - NPK (20:20:20) (30 DAP)	32.54	3.98	11.00
T_{15} - NPK (19:09:19) (30 DAP)	33.28	4.07	14.00
T_{16} - NPK (17:10:27) (30 DAP)	33.18	4.06	13.00
T_{17} - Control - No spray	29.31	3.98	-
SE±	1.35	-	-
CD at 5%	3.82	-	-
CV %	7.22	-	-

DAP- Days After Planting * Treatment T_{13} to T_{16} applied micronutrient mixure (45 DAP) + Multi K (60 DAP)

fertilizer grade 20:20:20 may be due to 100 per cent solubility, high nitrate nitrogen (NO_3-N), NH_4-N and amide-N, which may lead to profused vegetative growth of tissues. The results obtained are in close agreement with the observations recorded by Silman *et al*. (1999) and Singh *et al*. (2001).

The polar diameter of bulb was maximum in T_3 (5.91 cm) followed by T_{12} (5.67 cm) while it was minimum in T_{17} (4.97 cm). The equatorial diameter was maximum in T_3 (5.92 cm) followed by T_4 (5.36 cm) and minimum in T_{17} (4.81 cm). The average weight of bulb was highest in T_3 (75.63 g) followed by T_4 (74.06 g) and lowest in T_{17} (67.46 g). There was no much difference in TSS percentage for all the treatments ranging from 10.94 to 11.67. Similar results were also obtained in onion by Singh *et al*. (200l) and for okra by Sundaram and Kanthaswamy (2005).

The per cent A grade bulb (5.5 to 6.5 cm), B grade bulb (4.5 to 5.5 cm) and C grade bulb (3.5 to 4.5 cm), per cent double bulbs, bolters and per cent marketable yield was recorded on the basis of weight over total yield but bulbs were selected on the basis of size of common onion (Anon, 2011).

The per cent A grade bulb ranged form 10.14 to 21.78, B grade bulb from 62.55 to 74.86, C grade bulbs from 11.64 to 18.44, per cent, doubles from 0.25 to 0.69 and per cent bolters from 0.18 to 0.39 per cent. The marketable bulb yield was computed by

Table 2. Effect of different treatments on growth and yield of onion as influenced by foliar application (Pooled data of three years).

Treatment	Plant height (cm)	Leaves	Neck thickness (cm)	Polar diameter (cm)	Equatorial diameter (cm)	Weight of bulb (g)	TSS (%)	% AGB	% BGB	% CGB	% doubles	% bolters	Total yield (t ha^{-1})	Marketable yield (t ha^{-1})
T_1	62.54	10.9	1.63	5.27	4.96	73.53	11.20	12.63	73.78	12.96	0.39	0.22	33.53	33.33
T_2	62.22	10.7	1.57	5.25	5.13	69.83	11.00	13.06	73.62	12.55	0.38	0.27	33.37	33.15
T_3	66.65	11.8	1.65	5.91	5.92	75.63	11.67	10.14	74.86	14.58	0.28	0.18	39.17	38.99
T_4	62.29	10.4	1.49	5.33	5.36	74.06	11.19	13.42	74.10	11.81	0.44	0.22	34.20	33.97
T_5	61.36	10.6	1.64	5.61	4.93	71.33	11.47	11.51	74.50	13.32	0.40	0.25	34.89	34.66
T_6	63.10	10.3	1.54	5.36	5.48	69.24	11.44	16.09	71.99	11.64	0.40	0.29	33.61	33.38
T_7	62.04	10.5	1.63	5.39	4.87	73.00	11.29	11.01	73.47	14.70	0.50	0.29	33.00	32.74
T_8	63.79	10.8	1.49	5.50	5.05	71.53	11.03	18.40	68.10	12.85	0.43	0.18	34.42	34.21
T_9	62.77	10.2	1.62	5.23	5.15	72.46	11.25	13.75	67.38	18.44	0.35	0.26	34.91	34.70
T_{10}	61.24	10.5	1.51	5.35	4.93	72.60	11.37	14.00	72.51	13.09	0.25	0.24	33.70	33.53
T_{11}	62.62	10.6	1.63	5.25	5.30	72.73	11.26	21.54	62.55	15.17	0.48	0.27	31.93	31.69
T_{12}	62.41	10.7	1.50	5.67	4.97	72.06	11.41	21.78	64.04	13.88	0.69	0.33	31:38	31.06
T_{13}	60.94	10.6	1.64	5.43	4.91	69.26	11.50	15.94	72.50	12.18	0.38	0.28	33.86	33.64
T_{14}	60.15	11.6	1.52	5.44	5.23	69.49	11.28	13.48	71.33	14.64	0.39	0.33	32.54	32.31
T_{15}	62.55	10.8	1.58	5.36	5.03	69.33	11.53	14.43	74.37	13.84	0.46	0.27	33.28	33.04
T_{16}	61.75	9.6	1.49	5.17	4.98	70.23	11.48	10.92	73.12	15.33	0.44	0.39	33.18	32.90
T_{17}	59.60	8.9	1.45	4.97	4.81	67.46	10.94	11.15	70.88	17.08	0.51	0.34	29:31	29.06
SE±	0.93	0.26	0.03	0.19	0.24	1.04	0.24	0.47	0.93	0.93	0.09	0.06	1.35	1.18
CD at 5%	2.69	0.76	0.10	0.54	0.69	3.02	0.70	1.38	2.69	2.69	0.27	0.20	3.82	3.19

AGB - A Grade Bulbs, BGB - B Grade Bulbs, CGB - C Grade Bulbs, TSS - Total Soluble Solids

deducting per cent doubles and bolters from total yield. The marketable yield ranged from 29.06 (T_{17}) to 38.99 t ha^{-1} (T_3). Singh and Tiwari (1995), Singh *et al*. (1999) and Singh *et al*. (2001) also reported that foliar application of nutrient and micronutrients resulted in increased marketable bulb yield of onion crop than, the control i.e. no spray, which were in close agreement with the results of present investigations.

Considering the above discussions,- the application of three sprays of 20:20:20 NPK grade fertilizer (0.05%) as a foliar application at 30, 45 and 60 days after transplanting gave the highest yield of 39.17 t ha^{-1} with B:C ratio of 4.95 as compared to control (29.31 t ha^{-1}) with 3.98 B:C ratio. The other treatments also recorded the highest yields than the control. Based on three years pooled data, it is recommended to give three sprays of 20:20:20 NPK grade fertilizers (0.05%) as a foliar sprays at 30, 45 and 60 days after transplanting for highest bulb yield in rabi onion.

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Effect of Different Organic Leachets on Soybean Crop

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Abstract

An application of organic leachets in organic matter rich soil showed significantly better soybean crop growth than applied in organic matter poor soil and was effective over the control. Application of lignite leachet recorded highest seed germination (93.33%) over all other treatments due to presence of high amounts of humic acid. The poultry manure compost leachet in organic matter rich soil recorded significant increase in plant height (32.25cm), number of leaves (23.33) plant^{-1}, number of branches (10.17) plant^{-1}, number of root nodules (24.00), number of pods (37.00) and dry matter yield (30.35 g) plant^{-1} over all other treatment combinations. The results recorded by the poultry manure compost leachet were followed by leachets from vermicompost, lignite, mushroom spent compost, soybean straw compost and sugarcane trash compost leachet.

Key words : Organic leachets, soybean.

Since there is serious concern for adopting more sustainable environment friendly and low cost farming practices due to energy crisis, high cost of fertilizers and poor purchasing power of marginal and small farmers, it is imperative to develop a strategy in utilizing organic wastes to its maximum potential with proper technology. Thus the supply of plant nutrients could be attained in a balanced way providing humic materials for maintaining soil fertility and productivity. The direct effect of organic relates to the uptake of humic substances or its decomposed products affecting favourably the growth and yield of plant.

Soybean occupies a vital place in Indian agriculture, edible oil economy and foreign exchange. The research aimed to reduce an application of voluminous quantity of organic matter and supply available form of nutrients to the growing crops through their concentrated form as leachets.

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Materials and Methods

The pot culture experiment was conducted at Department of Plant Pathology and Agril. Microbiology, College of Agriculture, Pune under glasshouse condition with six organic leachets obtained from mushroom spent compost, poultry manure compost, soybean straw compost, sugarcane trash compost, vermicompost and lignite by soaking these compost in equal quantity of water for a period of 7 days. In all 14 treatments including leachets from six manures and two soil types maintaining untreated control were replicated thrice in a factorial completely randomized design. Five seeds of JS-335 variety of soybean were sown at equal distance in each pot and then 2 plants were maintained upto harvesting stage. The various growth observations were recorded at different intervals.

The initial composition of organic matter poor and rich soil were total nitrogen (0.085, 0.125%), available phosphorus (10.72, 16.52

kg ha^{-1}); organic carbon (0.42, 1.23%) respectively.

The total nitrogen, available phosphorus and organic carbon were analyzed by methods outlined by Bremner and Mulvaney (1982), Olsen *et al*. (1954) and Walkley and Black (1934) respectively. These leachets were applied in organic matter rich and poor soil at sowing and a monthly interval thereafter upto flowering.

Results and Discussion

The chemical constituents of the organic manures mushroom spent compost, poultry manure compost, soybean straw compost, sugarcane trash compost, vermicompost, lignite and leachets obtained from them as total nitrogen 1.36, 1.68, 1.10, 0.35, 1.52, 0.31 and 0.294, 0.362, 0.246, 0.088, 0.331 and 0.072 whereas available phosphorus 0.83, 1.39, 0.58, 0.10, 1.28, 0.07 and 0.196, 0.293, 0.140, 0.032, 0.260 and 0.028 per cent respectively.

Seed germination : An aplication of different-organic leachets revealed-that an application of organic leachets (Table 1) increased the germination of soybean from 66.67 to 93.33 per cent. The maximum germination was observed due to lignite leachet applied to organic matter rich soil (93.33%) and the least germination (66.67%) was recorded in control. An interaction between organic leachets and soil types showed that OM rich soil increased the germination (79.71%) over OM poor soil (75.24%) treated with various leachets.

Among the organic leachets across the soil types, significantly maximum germinatior (93.33%) was recorded due to application of lignite leachet over mushroom spent compost leachet (76.67%), soybean straw compost leachet (73.33%), sugarcane trash compost leachet (69.00%) and vermicompost leachet (80.00%) but at par with poultry manure compost leachet (83.33%). The least germination being recorded with the control (66.67%) The interaction due to organic leachets and soil types were found to be non significant. Ulukan (2008) also reported that sufficiently high amount of humic acid present in the lignite improves the physico chemical properties of soil and seed germination.

Plant height : An application of organic leachets and their interaction with soil types significantly increased the plant height ol soybean over the control at 90 DAS from 23.88 to 32.25 cm. The maximum height was recorded in OM rich soil treated with poultry manure compost leachet (32.25cm) and minimum (23.88cm) in OM poor soil with control. The significantly, maximum mean height of plant across the organic leachet was more (30:57cm) in OM rich soil than OM poor soil (26.66 cm)

The maximum mean height of plant across the soil types was recorded due (o leachets from poultry manure compost (30.19 cm) followed by vermicompost (29.81 cm), lignite (29.00 cm), mushroom spent compost (28.88 cm), soybean straw compost (28.50 cm) and sugarcane trash compost (28.25 cm). The significantly minimum plant height was recorded with the control (25.69 cm). The interaction due to organic leachets and soil types was found to be significant.

Number of leaves $plant^{-1}$: The. number of leaves per plant as influenced by various treatments ranged from 6.67 to 23.33 at 45 DAS due to types of soils and different organic leachets application. The maximum numbers of leaves were recorded with OM rich soil treated with poultry manure compost leachets (23.33) and least was treated with OM poor soil in control (6.67).

The mean number of leaves plant^{-1} across the organic leachets was recorded significantly higher in OM rich soil (20.36) than OM poor soil (8.93). The significantly maximum mean number of leaves per plant across the soil types were recorded due to leachets from poultry manure compost (17.42) over mushroom spent compost (14.50), soybean straw compost (13.67), sugarcane trash compost (13.25) and lignite (15.08) but were at par with vermicompost leachet (16.17). The least number of leaves were recorded with the control (12.42). The interaction due to organic leachets and soil types were found to be significant. Thus the organic leachets application proved tobe efficient in vigorous growth of plant. Kadhum *et al*. (1987) observed increase in leaf number plant^{-1}, lateral branches leaves and root dry matter yield of brinjal crop due to application of organic manures suspension.

Number of branches plant^{-1} : The observations recorded on number of branches plant^{-1} of soybean as influenced by various treatment were recorded at 45 DAS and ranged from 3.70 to 10.17. The significantly maximum number of branches were recorded with OM rich soil treated with poultry manure compost leachet (10.17) over soybean straw compost leachet and sugarcane trash compost leachet but at par with mushroom spent compost leachet, lignite leachet and vermicompost leachet and least was recorded with OM poor soil alone (3.70). The mean number of branches plant^{-1} across the organic leachets were recorded significantly more in OM rich soil (9.58.) than OM poor soil (5.27). The mean number of branches plant^{-1} across the soil types were recorded significantly maximum due to poultry manure compost leachet (8.00) over mushroom spent composl leachet (6.42), soybean straw compost leachet (6.08) and sugarcane trash compost leachet (5.25) but at par with vermicompost leachet (7.16) and lignite leachet (6.74). The least number of leaves being recorded with the control (4.93). The interaction due to organic

Table 1. Effect of organic leachets and soil types on growth of soybean.

Soil type	Organic leachets (OL)							Mean	SE± CD at 5%	SE± CD at 5%	SE± CD at 5%
	Control	MSCL	PMCL	SSCL	STCL	VCL	LL		OL	S	OL x S
Seed germination :											
OM rich soil	66.67	80.00	86.67	73.33	71.33	86.67	93.33	79.71	4.32	2.360	6.11
OM poor soil	66.67	73.33	80.00	73.33	66.67	73.33	93.33	75.24	12.67	NS	NS
Mean	66.67	76.67	83.33	73.33	69.00	80.00	93.33	77.48	-	-	-
Plant height (90 DAS) :											
OM rich soil	27.50	30.88	32.25	30.38	30.00	31.88	31.13	30.57	0.68	0.36	0.96
OM poor soil	23.88	26.88	28.13	26.63	26.50	27.75	26.88	26.66	1.99	1.06	2.84
Mean	25.69	28.88	30.19	28.50	28.25	29.81	29.00	28.62	-	-	-
Root nodules plant^{-1} :											
OM rich soil	10.00	18.50	24.00	16.50	13.50	21.00	20.00	17.64	0.31	0.16	0.43
OM poor soil	7.50	10.50	14.50	9.00	8.00	13.50	13.00	10.86	0.90	0.48	1.27
Mean	8.75	14.50	19.25	12.75	10.75	17.25	16.50	14.25	-	-	-
Dry matter yield (g plant^{-1}) :											
OM rich soil	18.20	26.70	30.35	26.38	20.85	28.80	27.35	25.52	1.02	0.54	1.44
OM poor soil	13.50	17.35	25.80	16.15	15.25	21.00	19.15	18.17	2.98	1.59	3.73
Mean	15.85	22.03	27.58	21.27	18.05	24.90	23.25	21.85	-	-	-

leachets and soil types were found to be significant for number of branches at 45 DAS.

Number of root nodules : The observations on number of root nodules plant^{-1} as influenced by various treatments were recorded at 45 days after sowing revealed that number of root nodules plant^{-1} ranged from 7.50 to 24.00 due to application of different organic leachets on both types of soil *viz*., organic matter rich and organic matter poor soil. The maximum root nodulation was observed due to poultry manure compost leachets. The highest root nodules plant^{-1} (24.0) were observed in organic matter rich soil treated with poultry manure compost leachet over all other leachets and soil types and least was observed in organic matter poor soil alone (7.50). Significantly higher number of root nodules plant^{-1} across the organic leachets was recorded with OM rich soil (17.64) than OM poor soil (10.86). Among the leachets, significantly highest number of root nodules across the soil types was recorded with the application of poultry manure compost leachet (19.25) over all other leachets followed by vermicompost leachet (17.25), lignite leachets (16.50), mushroom spent compost leachet (14.50), soybean straw compost leachet (12.75) and sugarcane trash compost leachet (10.75). The significantly minimum number of nodules was recorded with the control (8.75). The interaction due to organic leachets and soil types were found to be significant for number of root nodules plant^{-1} indicate positive effect of organic matter and organic leachets on root nodulation.

Number of pods : The number of pods plant^{-1} across the organic leachets were significantly more in OM rich soil (27.54) than OM poor soil (12.79). Among the organic leachets across the soil types, the mean number of pods plant^{-1} were recorded significantly maximum due to poultry manure compost leachets (26.63) over all other organic leachets application followed by leachets from vermicompost (21.88), lignite (20.00), mushroom spent compost (19.50), soybean straw compost (18.50) and sugarcane trash compost leachet (47.75). The least number of pods being recorded with the control (16.88). The interaction due to organic leachets and soil types were found to be significant for number of pods plant^{-1} which showed beneficial effects of organic substances on yield of soybean.

Dry matter yield : Data in respect of dry matter yield of soybean plant^{-1} at 90 days after sowing revealed that the total biomass of soybean plant ranged from 13.50 to 30.35 g plant^{-1}. The significantly highest dry matter yield was recorded in the organic rich soil treated with poultry manure compost leachet (30.35 g plant^{-1}) over sugarcane trash compost leachet but at par with all other leachets and least was observed in organic matter poor soil with control (13.50 g plant^{-1}). The dry matter yield across the organic leachets was recorded significantly more with the OM rich soil (25.52 g plant^{-1}) than OM poor soil (18.17 g plant^{-1}). Among the organic leachets across the soil types significantly maximum biomass was observed with poultry manure compost leachet (27.58 g plant^{-1}) over leachets from mushroom spent compost (22.03 g plant^{-1}), soybean straw compost (21.27 g plant^{-1}) and lignite leachet (23.25 g plant^{-1}) but at par with vermicompost leachet (24.90 g plant^{-1}). The lowest biomass was recorded with control (15.85 g plant^{-1}). Holcomb *et al.* (2007) also reported that dilute leachet collected from fresh mushroom compost could be equivalent to a commercial fertilizer in marigold. Deotale *et al.* (2008) observed the efficiency of vermicompost in increasing growth and yield of soybean crop.

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Physiological Efficiency for Growth and Yield in Cowpea (*Vigna unguiculata* (L.) Walp.)*

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Abstract

The photosynthetic and transpiration rate and stomatal conductance were highest at 50 per cent flowering and decreased after 15 days of 50 per cent flowering. Whereas, water use efficiency increased from 50 per cent flowering to 15 days after that. The genotypes differed significantly for seed yield plant^{-1}. The highest yield was recorded by the genotypes, GC-3 (1514 kg ha^{-1}); C-152 (1500 kg ha^{-1}), PCP-0207-24 (1361 kg ha^{-1}) and Phule Pandhari (1277 kg ha^{-1}). The yield attributes *viz*., number of pods plant^{-1}, number of seeds pod^{-1} and 100 seed weight appeared to be the most important characters to determine sink capacity. The highest protein content (24.50%) and vitamin 'C' (13.82 mg 100 g^{-1}) was maintained by the genotype Phule Pandhari and PCP-05010, respectively. Therefore, the genotypes, GC-3, C-152, PCP-0207-24, Phule Pandhari and PCP-05010 may be considered as important sources for boosting up the breeding programme for yield improvement as well as protein and vitamin 'C' content.

Key words : Dry matter production, physiological parameters, source and sink capacity, cowpea.

Physiological approach to asses the causes for variation in grain yield is the basic attempt towards increasing the crop productivity. Growth analysis is a physiological probe into the development of crop in chronological sequence to elucidate and account the causes for the difference in yield through the events that had occurred earlier in growth. The technique of growth analysis involves estimating the photosynthetically active area and its efficiency, translocation of photosynthates, the rate of dry matter

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production, its distribution into various plant parts and other such related aspects. This technique aids in identifying and defining an ideal plant type which is vital to the breeder in tailoring suitable genotypes. This also helps in identifying the factors responsible for high yield and thereby provides the basis for tailoring agronomic practices. Growth and yield analysis also helps in understanding the contribution of the various growth processes during vegetative and reproductive phases. Based on these studies, it is possible to think of specific desirable characteristics of in genotypes studied for higher yield.

In pulses, the sink potential is not a limiting factor for obtaining yield but the realization of sink is very poor. The poor sink filling could be because of several reasons including poor photosynthesis and limitations in nitrogen fixation during the reproductive phase. Although research work on cowpea was almost neglected in the past, the need for it's improvement has been emphasized by many workers. The seed and fodder yield of cowpea is very low because it is grown as mixed or as an intercrop with other crops. Yield is affected by drought as it is grown as rainfed crop.

Materials and Methods

Twelve cowpea genotypes were evaluated for physiological efficiency for growth and yield during *kharif* 2008 with three replications at Pulses Improvement Project, M.P.K.V., Rahuri, Dist. Ahmednagar (MS). Sowing was done on 30th June, 2008 by dibbling at 30 x 10 cm spacing. The gross and net plot sizes were 4.00 x 2.40 m and 3.60 x 1.80 m. All the recommended package of practices was followed to grow a good crop. The data on dry matter production and its distribution in component parts of plants, growth parameters, vegetative growth and source, generative growth and sink capacity and physiological parameters were collected at various stages of growth. Harvest index, protein content (%) and vitamin 'C' content (mg 100 g^{-1} gm) were estimated by Donald (1962), 'Micro-kjeldhal method' (A.O.A.C., 1960) and 'volumetric method' (A.O.A.C., 1990), respectively. The statistical analysis was carried out by following

Table 1. Dry matter production and it's distribution in component parts of plant (g plant^{-1}), protein content (%) and Vit. C (mg 100 g^{-1}) influenced by cowpea genotypes.

Genotype	Dry matter production (g plant^{-1})					Protein content (%)	Vit. C (mg 100 g^{-1})
	Leaves	Stem	Root	Pods	Total		
VCM-8	3.51	9.88	1.03	22.99	37.41	20.43	8.35
Phule Pandhari	2.48	9.27	0.92	16.14	28.81	24.50	11.06
GC-3	3.31	7.05	1.33	18.74	30.43	21.43	5.56
PCP-05010	2.04	8.62	0.97	16.95	28.58	22.35	13.82
RC-101	3.20	13.40	1.84	18.06	36.50	20.54	8.33
V-240	2.81	11.47	1.58	18.87	34.73	20.25	11.02
CoCp-702	2.87	8.47	0.97	13.50	25.81	21.37	11.05
C-152	3.65	9.64	0.96	18.83	33.08	22.42	11.05
Shubhra	3.74	9.56	1.82	9.72	24.84	21.41	8.32
V-585	2.22	11.74	1.87	18.50	34.33	23.46	11.02
PCP-0207-24	4.21	9.12	1.61	15.70	30.64	21.30	8.32
PCP-05030	3.99	7.47	1.85	14.15	27.46	22.42	8.33
S.E.±	0.003	0.01	0.01	0.12	0.09	0.02	0.02
CD at 5 %	0.01	0.03	0.03	0.36	0.28	0.07	0.06

Panse and Sukhatme (1985).

Results and Discussion

The dry matter accumulation in different plant parts was studied as each part of the plant has a specific function and utility. The dry matter accumulation in roots, stem, leaves and pods showed independent behaviour over the crop growth period. The dry matter accumulation in root was increased steadily with advancing age of the crop whereas in stem the rate was rather high. The rate of dry matter accumulation in leaves was rapid between 20 and 40 DAS however, it was rather slow between 40 and 60 DAS and thereafter decreased towards maturity. This may be due to leaf senescence and translocation of photosynthates towards pod development (Beaver *et al*. 1985 and Appadurai and Rajakaruna, 1967). At maturity the higher rate of dry matter production was observed in pods (Rao and Singh, 1985).

The anabolic and catabolic processes resulted into a net balance of dry matter. The biological productivity of plants is based on their ability to produce and accumulate dry matter, oil content (%) and vitamin 'C' content (mg 100^{-1} g). The dry matter accumulation in different genotypes of cowpea increased continuously up to harvest. During flowering to pod filling stage the growth rate was rapid and thereafter it was rather slow towards maturity (Sahane *et al*. 1994). The genotypes under investigation showed wide range of variability for dry matter accumulation in component parts of plant in cowpea (Table 1). The genotypes, PCP-0207-24 (4.21 g plant^{-1}), PCP-05030 (3.99 g plant^{-1}) and C-152 (3.65 g plant^{-1}) in leaves; RC-101 (13.40 g plant^{-1}), V-585 (11.74 g plant^{-1}), V-240 (11.47 g plant^{-1}) in stem; V-585 (1.87 g plant^{-1}), PCP-05030 (1.85 g plant^{-1}) and RC-101 (1.84 g plant^{-1}) in roots and VCM-8 (22.99 g plant^{-1}), V-240 (18.87 g plant^{-1}) and C-152 (18.83 g plant^{-1}) in pods recorded highest dry matter production in respective plant parts. Similar results were obtained by Ezedinma (1966) and Thandapani

Table 2. Physiological parameters influenced by cowpea genotypes at 50 per cent flowering and 15 days after 50 per cent flowering.

Genotype	At 50% flowering				15 days after 50% flowering			
	Pn	Tn	WUE	Gs	Pn	Tn	WUE	Gs
VCM-8	59.46	1.67	35.01	0.07	51.03	1.12	45.24	0.04
Phule Pandhari	50.73	2.45	20.69	0.03	43.70	1.91	22.81	0.02
GC-3	55.00	1.62	31.80	0.05	45.73	1.30	34.98	0.03
PCP-05010	50.60	1.86	27.17	0.07	43.90	1.13	38.77	0.05
RC-101	57.13	0.56	95.92	0.02	48.08	0.38	124.78	0.01
V-240	50.33	2.15	23.41	0.04	42.37	0.89	47.43	0.02
CoCp-702	47.66	2.54	18.86	0.08	40.20	1.59	25.28	0.03
C-152	51.30	1.28	39.35	0.02	46.26	0.93	49.61	0.01
Shubhra	54.30	1.16	46.53	0.04	47.98	0.88	54.37	0.03
V-585	54.90	1.54	35.67	0.05	49.32	1.02	48.14	0.03
PCP-0207-24	53.93	1.93	27.40	0.04	46.26	1.27	36.25	0.03
PCP-05030	53.40	0.25	206.95	0.02	47.24	0.18	293.40	0.02
S.E.±	1.29	0.04	3.14	0.00	0.17	0.00	10.20	0.00
CD at 5 %	3.80	0.12	9.23	0.00	0.52	0.01	29.93	0.00

Pn : Rate of photosynthesis (µmol CO_2 m^{-2} Sec^{-1}), Tn : Rate of transpiration (mmol CO_2 m^{-2} Sec^{-1}), WUE : water use efficiency, Gs : Stomatal conductance (µmol CO_2 m^{-2} Sec^{-1}).

and Rao (1986). VCM 8 (37.41 g plant^{-1}), RC 101 (36.50 g plant^{-1}) and V 585 (34.33 g plant^{-1}) were found to be superior for total dry matter production. The genotypes, Phule Pandhari (24.50%) and V 585 (23.46%) were rich for protein content whereas, PCP 05010 (13.82 mg 100 g^{-1}) and Phule Pandhari (11.06 mg 400 g^{-1}) were rich for vitamin 'C' (Table 1).

The data regarding photosynthetic rate revealed that, the genotype VCM 8 maintained higher photosynthetic rate at 50 per cent flowering (59.46 µmol CO_2 m^{-2} Sec^{-1}) as well as 15 days after 50 per cent flowering (51.03 µmol CO_2 m^{-2} Sec^{-1}) followed by the genotypes RC 101 (57.13 and 48.08 µmol CO_2 m^{-2} Sec^{-1}), V-585 (54.90 and 49.32 µmol CO_2 m^{-2} Sec^{-1}) and GC-3 (55.00 and 45.73 µmol CO_2 m^{-2} Sec^{-1}).

The data on transpiration rate revealed that, the genotype CoCp-702 (2.54 and 1.91 mmol CO_2 m^{-2} Sec^{-1}) and Phule Pandhari (2.45 and 1.59 mmol CO_2 m^{-2} Sec^{-1}) maintained maximum transpiration rate at 50 per cent flowering as well as 15 days there after. The genotype PCP-05030 (206.95 and 293.40) and RC 101 (95.92 and 124.78) had maximum water use efficiency alongwith low rate of transpiration at 50 per cent flowering as well as 15 days there after. The high rate of transpiration per unit leaf area had lower water use efficiency. Similar results were also obtained by Farquhar (1991).

The genotype CoCp-702 (0.08 µmol CO_2 m^{-2} Sec^{-1}) and VCM-8 and PCP- 05010 (0.07 µmol CO_2 m^{-2} Sec^{-1}) at 50 per cent flowering whereas, the genotypes PCP-05010 (0.05 µmol CO_2 m^{-2} Sec^{-1}) and VCM-8 (0.04 µmol CO_2 m^{-2} Sec^{-1}) 15 days there after recorded higher stomatal conductance. It is necessary to have higher plant conductance to achieve higher photosynthesis which would lead to higher biological yield. Stomatal conductance was observed high due to which there was high transpiration rate (µmol CO_2 m^{-2} Sec^{-1}) and CO_2 exchange rate in the present study. Similar results were obtained by Kalpana *et al*. (2003).

The vegetative phase governs the overall phenotypic expression of the plant and prepares the plant for next important

Table 3. Vegetative growth and source ability as influenced by cowpea genotypes.

Genotype	Days to first flowering	Days to maturity	Plant height (cm)	Primary branches plant^{-1}	Secondary branches plant^{-1}	Leaves plant^{-1}	Leaf area plant^{-1} (dm^2)
VCM-8	35.33	67.66	39.00	18.00	5.56	18.00	2.59
Phule Pandhari	36.33	71.33	98.22	16.33	10.51	18.00	2.47
GC-3	41.66	79.66	96.19	16.66	17.66	18.00	3.25
PCP-05010	40.66	72.33	52.53	16.33	12.66	17.00	2.34
RC-101	36.33	73.00	85.25	17.66	14.66	12.00	5.47
V-240	35.66	72.33	90.79	19.33	15.53	13.00	2.09
CoCp-702	35.66	75.33	95.25	20.33	14.66	16.66	4.27
C-152	43.33	83.33	97.16	16.33	13.66	14.33	1.16
Shubhra	35.33	76.00	94.28	17.66	17.16	19.33	5.24
V-585	36.66	82.66	99.17	17.00	13.66	22.00	6.82
PCP-0207-24	38.33	76.00	96.26	15.66	13.00	14.00	5.82
PCP-05030	36.33	73.66	66.49	17.00	15.33	18.00	4.28
S.E.±	0.82	1.11	0.25	0.50	0.32	1.53	0.01
CD at 5 %	2.41	3.28	0.75	1.48	0.93	4.50	0.05

reproductive phase. The root, stem, branches and leaves, all these parts constitute vegetative phase and perform specific functions. In the present investigation, the plant height was increased progressively with the advancing age of crop. The rate was fast between 20 and 40 DAS, thereafter it was rather slow upto 60 DAS and again rapid towards maturity. The number of leaves increased progressively between 20 and 40 DAS and thereafter decreased toward maturity due to senescence and diversion of photosynthates towards pod development (Beaver *et al*. 1985 and Appadurai and Rajakaruna, 1967). The number of primary branches plant^{-1} increased progressively with the advancing age of crop. The rate was high between 20 and 40 DAS and thereafter steady towards maturity. The development of secondary branching was started after 20 DAS and increased progressively towards maturity.

The genotypes, VCM 8 (35.33 days), Shubhra (35.33 days), V-240 (35.66 days) and CoCp-702 (35.66 days) were earlier for days to flowering, whereas, VCM-8 (67.66 days), Phule Pandhari (71.33 days), PCP-05010 (72.33 days) and V-240 (72.33 days) were earlier for physiological maturity (Table 3). V 585 (99.17 cm), Phule Pandhari (98.22 cm), C 152 (97.16 cm), PCP-0207-24 (96.26 cm) and GC 3 (96.19 cm) were tall genotypes, whereas VCM 8 (39.00 cm), PCP 05010 (52.53 cm) and PCP 05030 (66.49 cm) were found to be dwarf genotypes. In the present investigation, the genotypes, CoCp-702 (20.33) and V 240 (19.33) recorded highest number of primary branches plant^{-1}. However, though the genotype VCM-8 recorded higher number of primary branches (18.00) but least number of secondary branches plant^{-1} (5.56) due to its determinate growth habit. The genotypes, GC 3 (17.66) and Shubhra (17.16) recorded highest number of secondary branches plant^{-1}. The genotype, V 585 recorded highest number of leaves (22.00) as well as leaf area plant^{-1} (6.82 dm^2) followed by PCP-0207-24 (5.82 dm^2) and RC 101 (5.47 dm^2).

In the present investigation, the genotypes, RC 101 (20.21), Shubhra (15.20) and PCP 0207-24 (14.42) for No. of pods plant^{-1}; V

Table 4. Generative growth and sink capacity as influenced by cowpea genotypes.

Genotypes	Pods plant^{-1}	Seeds pod^{-1}	Seeds plant^{-1}	100 grain wt. (g)	Yield plant^{-1} (g)	Yield ha^{-1} (kg)	Harvest index (%)
VCM-8	8.84	12.54	111.81	9.02	10.10	989	41.24
Phule Pandhari	12.10	15.10	186.54	8.02	14.94	1277	36.05
GC-3	13.94	14.81	200.42	9.21	18.44	1514	52.52
PCP-05010	8.80	12.62	112.86	9.32	10.56	908	55.30
RC-101	20.21	11.79	245.49	11.32	27.75	1010	16.78
V-240	13.61	16.17	224.62	11.44	25.70	995	22.42
CoCp-702	14.06	16.25	223.90	10.79	23.36	881	22.91
C-152	8.44	16.26	137.17	8.35	11.56	1500	38.36
Subhra	15.20	11.82	178.26	7.40	13.22	695	13.89
V-585	13.35	16.80	228.41	9.52	21.72	1037	13.66
PCP-0207-24	14.42	14.20	214.40	9.17	19.64	1361	32.00
PCP-05030	6.46	13.17	85.60	10.82	9.28	1047	22.79
S.E.±	0.11	0.06	0.08	0.09	0.03	20.95	0.74
CD at 5 %	0.34	0.17	0.25	0.28	0.09	61.43	2.18

585 (16.80), C-152 (16.26) and CoCp-702 (16.25) for No. of seeds pod^{-1}; RC 101 (245.49), V 585 (228.41), V 240 (224.62) and CoCp-702 (223.90) for No. of seeds plant^{-1}; V 240 (11.44 g), RC 101 (11.32 g) and CoCp-702 (10.79) for 100 seed weight; and RC 101 (27.75 g), V 240 (25.70 g) and CoCp-702 (23.36 g) for seed yield plant^{-1} were promising for respective characters (Table 4).

The genotype GC-3 had high magnitude of harvest index (52.52%) alongwith highest seed yield (1514 kg ha^{-1}). Eventhough, the genotypes, VCM 8 (41.24%) and PCP 05010 (55.30%) produced low yields maintained higher harvest index due to determinate growth habit. In addition to this, C 152 (1500 kg ha^{-1}), PCP 0207-24 (1361 kg ha^{-1}) and Phule Pandhari (1277 kg ha^{-1}) recorded highest seed yield.

GC-3 and C-152 were high yielding genotypes because of higher dry matter accumulation in root, leaves and pods, optimum rate of photosynthesis and transpiration and higher water use efficiencies at 50 per cent flowering, midlate in maturity, bearing higher number of branches and leaves. PCP-05030 and RC-101 maintained higher rate of photosynthesis and transpiration alongwith high water use efficiencies. PCP-0207-24, Phule Pandhari and V-585 recorded higher number pods plant^{-1}, seeds pod^{-1}, 100 seed weight. It could be concluded that the traits related with dry matter production and it's distribution in component plant parts, rate of transpiration and photosynthesis, water use efficiencies, vegetative growth and source ability and generative growth and sink capacity may be considered while selecting the high yielding genotypes (Bhaskarain *et al.*, 1980). In the present investigation the above mentioned genotypes has possessed such related aspects.

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Response of IBA to Different Types of Stem Cuttings in Bougainvillea (Var. Torch Glow)

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Abstract

Among the types of cutting, the hard wood cuttings of bougainvillea variety Torch Glow applied with 2000 ppm of IBA treatment for half an hour showed the maximum increase of all growth parameters, with minimum number of days for sprouting and rooting having maximum root length and number of leaves per cutting. The treatment 2000 ppm IBA proved superior over all other treatments and was followed by treatment 1000, 3000, 4000 and 5000 ppm IBA.

Key words : IBA, hard wood cutting, soft wood cutting, Torch glow.

Bougainvillea is a versatile plant bestowed with special qualities which makes it a unique ornamental of the tropics and subtropics offering a profusion of colour, it can serve as a standard hedge or a creeper. Bougainvillea is native of South Africa. The Bougainvillea belongs to family Nyctaginaceae and described under the generic name of Bougainvillea in genera plantarum in 1789, (Pal and Swarup, 1974) from South America. Due to hard nature of cuttings, the rooting is difficult and hence the horticulturists and garden growers are facing difficulty in multiplying the material quickly on large scale.

Plant growth regulators play very important role in stimulation and initiation of roots in the propagating material. Many research workers worked on this Issue (Chakravarty, 1970, Nathulal *et al*. 1972 and Bhattacharjee and Balkrishna, 1983). Therefore, keeping in view, an investigation was carried to study the response of IBA to different types of stem cutting for better rooting in bougainvillea and to find out the suitable concentration of IBA and type of cutting for commercial propagation of bougainvillea.

Materials and Methods

An experiment was conducted at an experimental field of Horticulture Section, Satpuda Botanic Garden, College of Agriculture, Nagpur during the month of July, 2010 to September, 2010. Experiment was conducted in earthen pots washed with copper oxychloride having size 8". The pots were filled with 5 kg planting media of 2:1 ratio of sand well decomposed farm yard manure and silt. The planting media was of moderate fertility having pH value 7.5. The experiment was laid out in factorial completely randomized design with twelve treatments and four replications. The treatment combinations includes five, concentrations of growth regulator i.e. control (water dipping), 1000, 2000, 3000, 4000 and 5000 ppm IBA and two types of stem cutting i.e. hard wood cutting and semi-hard wood cutting. The cuttings of 25 cm length and of about 1.5 cm diameter with 6-7 internodes of buds were selected from 2 years old plants.

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The observations on five cuttings at random regarding number of roots, length of root (cm), number of leaves, average fresh and dry weight of roots (g), survival percentage of roots, days required for sprouting and rooting as influenced by IBA to different types of stem cuttings were recorded up to 60 days after planting. Statistical analysis of the data was done as per the method given by Panse and Sukhatme (1967).

Results and Discussion

The days required for sprouting of roots of bougainvillea (Table 1) cuttings were significantly influenced by IBA application. The treatment IBA 2000 ppm (5.75 days) was statistically superior over rest of the treatment. However, the maximum number of days required for sprouting roots were recorded in control treatment (12.50 days). According to the concentration of IBA the maximum days for sprouting of cuttings were recorded in semi hard wood cutting treated with IBA 5000 ppm (12.25 days)r It also revealed that the hard wood cuttings required minimum days (8.50 days) for sprouting as compared to semi hard wood cutting (10.04 days). Therefore, the hard wood cutting is best for rooting. Whereas, the interaction effect due to types of cutting and treatment combination of IBA was found to be non significant. Similar results were also recorded by Shiva and Nair (2008) in hibiscus.

The hard wood and semi hard wood types of cuttings treated with the treatment IBA 2000 ppm required statistically minimum number of days for rooting (7.25 days) and average number of roots after 50 days of planting (17.40), respectively followed by IBA 1000 ppm (8.00 days and 11.63), IBA 3000 ppm (9.88 days and 10.33), IBA 4000 ppm (11.25 days and 7.23) and IBA 5000 ppm (12.25 days and 3.85 respectively). However, the maximum days required for rooting of cuttings (13.50 days) and minimum average number of roots after 60 days of planting (2.23) was recorded in control treatment. The interaction effect in both the parameters were non significant. In case of types of cutting, in semi hard wood cuttings the

Table 1. Effect of IBA to different types of stem cuttings on days required for sprouting, rooting, average number of roots and length of roots after 60 days of planting.

Treatments IBA ppm	Days required for sprouting			Days required for rooting			Roots			Length of roots		
	Hard-wood cutting	Semi hard-wood cutting	Mean	Hard-wood cutting	Semi hard-wood cutting	Mean	Hard-wood cutting	Semi hard-wood cutting	Mean	Hard-wood cutting	Semi hard-wood cutting	Mean
Contol	11.75	13.25	12.50	12.75	14.25	13.50	2.65	1.80	2.23	2.01	1.63	1.82
1000	6.50	7.25	6-88	7.50	8.50	8.00	12.30	10.95	11.63	16.43	13.66	15.05
2000	5.25	6.25	5.75	6.75	7.75	7.25	18.50	16.30	17.40	21.66	19.10	20.38
3000	8.00	10.00	9.00	8.75	11.00	9.88	10.95	9.70	10.33	15.55	11.92	13.73
4000	9.25	11.25	10.25	10.25	12.25	11.25	7.50	6.95	7.23	12.89	8.89	10.89
5000	10.25	12.25	11.25	11.25	13.25	12.25	4.30	3.40	3.85	6.99	6.08	6.53
Mean	8.50	10.04	9.27	9.54	11.17	10.35	9.37	8.18	8.76	12.59	10.21	11.40
	Factor A	Factor B	Interaction (A x B)	Factor A	Factor B	Interaction (A x B)	Factor A	Factor B	Interaction (A x B)	Factor A	Factor B	Interaction (A x B)
S.E.±	0.202	0.116	0.286	0.226	0.131	0.320	0.222	0.128	0.314	0.447	0.275	0.675
C.D. at 5%	0.579	0.334	N.S.	0.649	0.375	N.S.	0.637	0.367	N.S.	1.368	0.790	N.S.

control treatment recorded the maximum number of days to rooting (14.25 days) as compared to hard wood cutting (12.75 days). However, in case of average roots after 60 days of planting, the hard wood cutting showed maximum number of roots (9.37 roots) as compared to semi hard wood cutting (8.18 roots) which showed that the hard wood cutting is best for commercial propogation of bougainvillea variety Torch Glow. Similar results were reported by Singh (1976).

The average length of roots and average number of leaves after 60 days of planting was significantly influenced by the application of IBA and types of 4M, cuttings (Table 1 and 2). The maximum average length of roots and number of leaves were recorded in treatment IBA 2000 ppm (20.38 cm and 98.58/cutting), respectively. However, hard wood cutting recorded longest roots (12.59 cm) and maximum number of leaves (68.40) as compared to semi hard wood cutting. The interaction effects of treatment combination of IBA and types of cuttings was found to be non significant in both parameters. The results are in confirmity with the findings of Singh (1981) in Ixora and Panwar *et al*., (1994) in bougainvillea.

There was a significant difference in the average fresh weight and dry weight of roots. Among the IBA concentration the maximum fresh and dry weight of roots were recorded in case of treatment IBA 2000 ppm (1.95 and 0.58 g respectively) and lowest were noted in control treatment (0.36 and 0.12 g, respectively). Among the type of cutting, the maximum fresh and dry weight of roots were recorded in hard wood cuttings of bougainvillea variety Torch Glow i.e. 1.14 and 0.36 g, respectively as compeered to semi hard wood cuttings. The interaction effect due to different treatment combinations was non significant. Similar results were also recorded by Parminder and Singh (2003) in bougainvillea and Shiv and Nair (2008) in hibiscus.

The treatment IBA 2000 ppm (75%) gave statistically maximum survival percentage of

Table 2. Effect of IBA to different types of stem cutting on no. of leaves, fresh and dry weight of roots and survival percentage of rooted cuttings after 60 days of planting.

Treatments IBA ppm	Leaves			Fresh weight of roots (g)			Dry weight of roots (g)			Survival percentage of rooted cuttings (%)		
	Hard-wood cutting	Semi hard-wood cutting	Mean	Hard-wood cutting	Semi hard-wood cutting	Mean	Hard-wood cutting	Semi hard-wood cutting	Mean	Hard-wood cutting	Semi hard-wood cutting	Mean
Contol	25.45	19.05	22.25	0.41	0.30	0.36	0.14	0.10	0.12	35.00	20.00	27.50
1000	99.60	84.05	91.83	1.19	0.95	1.07	0.38	0.33	0.35	73.75	57.50	65.63
2000	105.40	91.75	98.57	2.55	1.35	1.95	0.72	0.44	0.58	86.25	63.75	75.00
3000	78.60	78.20	78.40	1.13	0.76	0.95	0.36	0.28	0.32	66.25	23.75	45.00
4000	58.55	55.10	56.83	0.83	0.61	0.72	0.28	0.24	0.26	46.25	33.75	40.00
5000	42.80	38.35	40.57	0.75	0.51	0.63	0.26	0.24	0.25	53.75	22.50	38.13
Mean	68.40	61.08	64.74	1.14	0.75	0.95	0.36	0.27	0.33	60.21	36.87	48.54
	Factor A	Factor B	Interaction (A x B)	Factor A	Factor B	Interaction (A x B)	Factor A	Factor B	Interaction (A x B)	Factor A	Factor B	Interaction (A x B)
S.E.±	1.985	1.146	2.808	0.129	0.075	0.183	0.031	0.018	0.044	3.73	2.15	5.27
C.D. at 5%	5.694	3.288	N.S.	0.371	0.214	N.S.	0.088	0.051	N.S.	10.68	6.17	N.S.

rooted cuttings as compared to IBA 3000 ppm (45%), IBA 4000 ppm (40%) and IBA 5000 ppm (38.13%), respectively. However, the minimum percentage of rooted cutting survival was observed in control treatment (27.50%). The hard wood cutting recorded maximum survival percentage of rooted cuttings (60.21%) as compeered to semi hard wood cutting (36.68%) which revealed that for the commercial propogation of bougainvillea variety Torch Glow, the hard wood cutting were having the best rooting percentage. These results are in conformity with the findings of Gupta and Kher (1991), Battacharjee and Balkrishna (1983) and Shiva and Nair (2008).

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Genotype x Environment Interaction in *Kabuli* Chickpea Under Rainfed and Irrigated Conditions

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Abstract

Stability analysis indicated that both linear and non linear components of G x E interaction were observed to be important for seed yield in kabuli chickpea. Among the genotypes Phule G 06304, Phule G 07304 and Phule G 04305 were found to be ideal with wider adaptability over all the environments. The genotype Phule G 0027 exhibited highest mean seed yield with below average stability was better for favourable (irrigated) environments.

Key words : G x E interaction, stability, *kabuli*, chickpea.

Kabuli chickpea receives better price in the market because of special demand for the preparation of attractive and delicious dishes. It's cultivation has attracted several progressive farmers in the Central and South zone of India, as it fetches premium price compared to desi. *Kabuli* chickpea is mostly suitable for the regions where the span of winter is long. Hence developing a *kabuli* chickpea with stable yield potential for the region with mild and short winter having large seed size and resistance to Fusarium wilt is a prime need.

Stability is practicable performance of genotypes under changing environmental conditions. In agricultural sense, it means whether species display the same production efficiency as predicted. Stability indicates the constant mean efficiency in different environments (Kam *et al*. 2010). The present investigation was undertaken to identify stable genotype under different growing situations (rainfed, irrigated), comprising ten promising *kabuli* genotypes, for their stability for yield potential under six different environments of Maharashtra.

Materials and Methods

The regional varietal trial comprising of ten *kabuli* chickpea genotypes along with 2 checks *viz*., Virat and Vihar developed at Mahatma Phule Krishi Vidyapeeth, Rahuri were grown in a randomized block design with three replications during *rabi* 2008-09 at Rahuri, Digras and Gadhinglaj (rainfed condition), Rahuri Savalivihir and Pandharpur (irrigated condition). Three irrigations, at the time of sowing, flowering and pod filling stages were

Table 1. Analysis of variance (mean squares) for stability with six environments.

Source of variation	df	Sum of squares	Mean sum of squares
Genotypes	11	236.30	21.48
Environments + (G x E)	60	14475.5	241.26**
Environments	5	12611.24*	2522.24 **
Genotypes x environments	55	1864.30	33.89
Environments (linear)	1	12611.20	12611.20**
Genotypes x Environments (linear)	11	338.60	30.78 **
Pooled deviation	48	1525.68	31.78**
Pooled error	132	2046.07	15.50

1., 2., 3., Jr. Res. Asstt., 4. Scientist (Plant Breeding) and 5. Principal Scientist.

Table 2. Estimates of environmental index (Ij) for seed yield (kg ha^{-1}) expressed as deviation from grand mean.

Character	E_1 (Rahuri)	E_2 (Digraj)	E_3 (Gadhinglaj)	E_4 (Rahuri)	E_5 (Savalivihir)	E_6 (Pandharpur)
Seed yield kg ha^{-1}	-97.676	-628.45	-333.31	252.66	133.16	673.60

given to irrigated trials. All recommended package of practices for chickpea were followed. Data were recorded on grain yield and other ancillary characters. The statistical analysis was carried out according to Eberhart and Russell (1966).

Results and Discussion

The analysis of variance (Table 1) indicated that, the mean differences due to genotypes were statistically significant for seed yield when tested against G x E and pooled deviation. Environmental variances were significant suggesting the presence of genetic variability among the genotypes and over environments. The G x E interaction was partitioned into linear and nonlinear (pooled deviation) components. The variance due to G x E (linear) was significant for seed yield, indicating that major portion of interaction was linear in nature and prediction over environment would be possible. Significance of pooled deviation suggested importance of nonlinear component of G x E interaction for seed yield. Similar results were also reported by Deshmukh *et al*. (1998), Altinbas (2003) and Mhase *et al*. (1998).

Estimation of environmental indices(Ij) (Table 2), suggested that the environments E_4, E_5, E_6, were the most favourable, environments for seed yield, because these trials were conducted under irrigated environments.

In the present study, genotype with regression coefficient (bi) near to unity and non significant deviation from regression (S^2di) associated with high mean ($\bar{X}$) performance were considered having general adaptability (Table 3).

Six genotypes produced higher seed yield than the mean value of the population(1488.10 kg ha^{-1}). Of these, four had non significant and two had significant deviation from regression (S^2di). Among the genotypes, Phule G 06304, Phule G 07304 and Phule G 04305 had regression coefficient equal to unity (bi=l.001, 1.031, 0.907 respectively) and nonsignificant S^2di (16.5, -4.42, -4.27 respectively) associated with high mean grain yield (1525, 1511, 1512 kg ha^{-1} respectively), could be considered as stable genotypes having wider adaptability at all locations (rainfed, and irrigated conditions). However, genotype Phule G 0027 recorded highest mean seed yield (1620 kg ha^{-1}) among all the genotypes with bi value greater than unity (bi=1.417) with non-

Table 3. Estimates of stability parameters for seed yield (kg ha^{-1}) in *kabuli* chickpea over rainfed and irrigated conditions.

Genotype	Mean yield (kg ha^{-1}) ($\bar{X}$)	Regression coefficient (hi)	Deviation from regression (S^2 di)
Phule G 7301	1454	0.759	7.13
Phule G 07304	1511	1.031	-4.42
Phule G 04305	1512	0.907	-4.27
Phule G 05311	1418	0.854	-7.95
Phule G 0027	1620	1.417	13.37
Phule G 0043-3	1403	0.970	23.74
Phule G 06302	1486	0.914	32.07*
Phule G 06304	1525	1.001	16.50
Phule G 05313	1434	1.217	39.08*
Phule G 06303	1455	0.994	-5.12
Virat (Ch)	1527	0.997	33.98*
Vihar (Ch)	1512	-0.939	32.23*

Table 4. Mean performance of *Kabuli* chickpea genotypes for the yield contributing characters.

Genotype	Days to 50% flowering	Days to maturity	Plant spread (cm)	Fruiting branches plant^{-1}	Pods plant^{-1}	Seed yield (kg ha^{-1})	100 seed weight (g)
Phule G 7301	39	97	20.3	11.6	45.0	1454	44.8
Phule G 07304	40	96	19.6	8.7	32.1	1511	44.8
Phule G 04305	43	95	18.8	10.8	42.1	1512	36.6
Phule G 05311	39	96	18.0	11.4	37.7	1418	36.8
Phule G 0027	40	97	21.2	14.5	48.6	1620	44.4
Phule G 0043-3	44	98	21.5	14.1	40.9	1403	32.6
Phule G 06302	38	97	20.2	14.2	41.3	1486	47.4
Phule G 06304	42	97	16.9	9.3	36.9	1525	47.4
Phule G 05313	39	97	19.5	9.9	40.9	1434	34.4
Phule G 06303	46	97	27.8	13.6	45.7	1455	38.8
Virat (Ch)	42	98	24.0	15.0	41.0	1527	35.2
Vihar (Ch)	43	99	21.1	14.7	48.1	1512	36.2

significant S^2di (13.37) indicated that, it was below average in stability. This could perform better in favorable environmental conditions (E_3, E_4, E_5) i.e. under irrigated conditions. Similar results were reported by Deshmukh *et al*. (1998), Altinbas (2003), Atta *et al*. (2009), and Kam *et al*. (2010).

The mean performance of genotypes for yield contributing characters is presented in Table 4. The stable genotypes Phule G 06304, Phule G 07304 and Phule G 04305 were early in flowering (ranges from 39 to 43 days) and maturity (ranges from 95 to 96 days). The genotype Phule G 06304 recorded highest 100 seed weight (47.4 g) among the stable genotypes, followed by Phule G 07304 (44.89 g). The No. of pods plant^{-1} were highest in genotype Phule G 04305 (42.10) among stable genotypes.

However, the genotype Phule G 0027 recorded highest No. of pods plant^{-1} (48.60) among all the genotypes with, 44.4 g 100 seed weight coupled with highest seed yield (1620 kg ha^{-1}). This genotype performed better under irrigated condition.

It is, concluded that, the genotypes Phule G 06304, Phule G 07304 and Phule G 04305 showed average stability for seed yield and could be useful for general cultivation, while the genotype Phule G 0027 will be ideal under irrigated conditions, after further testing.

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Comparison of Physiological, Biochemical and Yield Responses of Ten High Yielding Rice Cultivars

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Abstract

The mean performance of genotypes varied significantly for yield attributing components. Non-significant results for morpho-physiological characters and stress parameters indicated that the genotypes could not respond to the stress linearly and behaved differently under different environmental condition depending upon their level of tolerance. The maximum H.I. was recorded in Pant-10 (42.2%), which was followed by Ratna (40.4%) and Kranti (39.9%). The maximum grain yield was recorded for the genotype Kranti (53.5 q ha^{-1}) followed by Pant-10 (53.3 q ha^{-1}) and Ratna (52.9 q ha^{-1}). The level of nitrogen content in leaves and grain showed higher values (11.69 and 10.14 mg g^{-1} dry weight respectively) in Ratna while the activity of Nitrate Reductase (NR) was slightly higher in CSAR-78 than Ratna (779 and 768 n mol NO_2 h^{-1} g^{-1} fresh weight respectively). Stress tolerance genotype Ratna (showed highest proline content and lowest membrane injury) appear to be the most stable and highly adaptable in that environment for most of the traits as evident from the mean grain yield and proline content as well as low membrane injury. During whole life of the crop no artificial stress was given to crop.

Key words : Yield attributes, physiological parameters, harvest index, biological yield, stress tolerance.

Uder rain fed condition drought stress is a major limiting factor for higher productivity (Widawsky and O'Toole, 1996). Tiller density at maturity is relatively independent of initial sowing density (Kataoka *et al.* 1991). Similarly other yield determinants like filled grains ear^{-1}, grain weight ear-1 and test weight suffer much due to suboptimal condition that slower the movement of photosynthate towards the sink. The yield is highly influenced by both genetic and environmental factors. Nitrate nitrogen, essential for normal plant growth, development and yield is well associated with enhancing nitrate reductase (NR) activity (Krishnoter *et al.* 2009). Bose and Mishra (1999) noticed that increasing NR activity leads to enhance total nitrogen in plant and finally attribute to higher yield. Proline, which is generally thought to counteract the injury exerted by water stress, was progressively accumulated in the main plant organs (leaves, stems and roots) with decrease in moisture content (Tall *et al*., 1979, Bhul and Stewart, 1983). During stress condition formation of reactive oxygen species (ROS) takes place which oxidatively damage lipid bilayer and leads to leakage of solutes metabolites (Scandalios, 1993). Dhindsa *et al.* (1981) concluded that under stress condition membrane become leakier (electrolyte leakage) and lipid peroxidation takes place.

Thus there is a need to develop / find and evaluate genotypes which have great stability and tolerant capacity to grow well and produce maximum yield in different conditions. The present study was carried out to identify the stable and tolerant genotype among ten rice genotypes.

1. Res. Scientist, Nimbkar Agril. Res. Inst., Phaltan - 415 553 and 2. Scientist.

Materials and Methods

Experimental material consist of ten promising rice (*Oryza saliva* L.) genotypes (Pant-10, Pant-12, Kranti, NDR-359, CSAR-13, CSAR-41, CSAR-78, Sarjoo-52, 1ET-31128 and Ratna), diverse in nature (long medium and short duration) developed in India. These elite advanced genetic materials were screened and selected for higher yield and stress tolerance in field at the research farm of Chandra Shekhar Azad University of Agricultural and Technology, Kanpur, Uttar Pradesh, India. The trial was laid out in completely randomized block design with three replications. Observations were recorded on ten randomly selected plants from each replication for physiological and yield parameters. The net plot size was 6 m^2 and 3 plants $hill^{-1}$ were transplanted at each location with spacing of 20 x 10 cm.

After sterilization of seeds with 0.1 per cent solutions of $HgCl_2$ for two minutes. The seeds were washed thoroughly with distilled water. The seeds were sown with recommended agronomical practices. The leaf area was taken with help of leaf area meter model (Systronics leaf area meter-211) at flowering stage. Harvest index was calculated as economic yield (grain yield) divided by total biomass (Biological yield).

$$\text{H.I. \%} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

The weight of grain and straw yield produced $plot^{-1}$ was reported in per hectare basis after changing the grain and straw yield in hectare. Seedlings were transplanted after 21 days after sowing. Fertilizer was applied as per recommended doses. Whole quantities of phosphorus, potash and zinc and a half dose of nitrogen were applied at transplanting and rest of the nitrogen was used in two equal splits, one at tillering stage and other at panicle initiation stage. Eight irrigations were given during the crop growth period. Irrigation was halted 10 days prior to harvesting. RWC per cent, membrane stability index (% membrane injury) were measured as per the procedure described by Barrs and Weatherly, (1962) and Shanahan *el al*., (1990). Spectrophotometeric analysis of proline content, nitrate reductase activity,

Table 1. Allometry of ten rice cultivars.

Cultivars	Plant height at 50% flowering	Leaf area (cm^2)		Number of leaves $hill^{-1}$	Fresh weight of plant (g)	Dry weight of plant (g)	RWC (%)	Days to 50% flowering	Days to maturity	Days between flowering and maturity
		At flag leaf	At 50% flowering							
Pant-10	56.5	20.9	965	39.1	40.73	10.46	74.32	88	133	45
Pant- 12	68.5	16.4	978	39.2	42.35	11.04	73.94	84	12.5	41
Kranti	63.5	19.2	1032	41.4	46.21	12.42	73.13	83	125	42
NDR-359	66.7	17.1	944	37.6	41.45	10.83	73.87	91	136	45
CSAR-13	62.5	18.6	998	39.3	49.52	13.33	73.08	87	120	33
CSAR-41	65.5	15.4	1073	38.2	43.33	11.02	74.57	94	135	41
CSAR-78	65.6	17.1	890	40.5	45.38	11.67	74.28	91	130	39
Sarjoo-52	67.7	13.8	963	39.8	52.94	13.83	73.87	97	138	41
IET-31128	71.2	16.3	1048	41.4	46.75	12.86	72.50	85	125	40
Ratna	70.0	20.8	1092	40.9	48.67	12.61	74.10	84	120	36
SE±	1.81	1.10	6.14	0.52	0.61	0.07	0.57	0.49	0.79	0.85
C.D. at 5%	3.71	2.26	18.22	1.55	1.81	0.21	1.69	1.45	1.62	2.53

protein, chlorophyll and nitrogen contents in different plant parts were measured as per the procedure described by Bates *et al*. (1973).

Results and Discussion

Data of plant height (Table-1) showed different length, where variety IET-31128 recorded highest among the tested varieties (71.2 cm). However, situation was completely different in case of leaf area where Pant-10 had the maximum flag leaf area but the maximum total leaf area was measured in Ratna. In case of number of leaf hill^{-1} variety Kranti and IET-31128 had produced similar number of leaf hill^{-1} (41.4) at 50 per cent flowering stage. As for as plant weight was concern, variety Sarjoo-52 gathered maximum fresh as well as dry weight of plant but could not retain much water. Therefore, the highest relative water content (RWC) was noted in CSAR-41 (74.57%). Phenological characteristics regarding days to 50 per cent flowering, maturity and days between both the formers showed that Sarjoo-52 took more days to flower and maturity though duration between these two stages was not much. However, the same was noted in two distinct varieties named Pant-10 and NDR-359 which exhibited equal days between flowering and maturity. However, data of above three parameters were not found significant. Similarly, all the tested varieties produced different tiller number at 50 per cent flowering stage but only variety IET-31128 retain the most tillers at maturity as well as panicle bearing tillers. Similar results were obtained in case of effective tillers in the same variety. The variety Ratna had the highest grain yield hill^{-1} and harvest index (13.46 g and 40.4%) but could't produce maximum grain yield ha^{-1} due to smaller size of panicle length and total number of grain per panicle than other tested cultivars. Maximum grain yield was measured in Kranti whereas the same position was held by Sarjoo-52 in case of biological weight, test weight and grain yield. Close scrutiny of data regarding panicle characteristics and grain quality parameters showed that most number of total grains was counted in variety CSAR-78 due to more number of filled, sterile and opaque grains panicle whereas the highest filled, grain were noted in Pant-10 but owing to

Table 2. Tiller and yield characteristics of 10 cultivars.

Cultivars	Number of tillers hill^{-1}			LAI at 50% flowering	Grain yield hill-1 (g)	Test weight (g)	Grain yield (q ha^{-1})	Biological yield (q ha^{-1})	H.I. (%)	Straw yield (q ha^{-1})
	At 50% flowering	At maturity	Effective tillers							
Pant-10	10.83	8.67	8.20	5.22	53.3	21.2	53.3	133.8	42.2	80.5
Pant-12	10.30	8.55	8.10	4.89	45.8	21.5	45.8	125.8	36.4	80.0
Kranti	11.35	9.90	8.85	5.16	53.5	23.5	53.5	132.5	39.9	79.0
NDR-359	10.20	8.50	7.90	4.72	47.5	22.2	47.5	130.4	37.7	82.9
CSAR-13	9.65	8.33	7.72	4.99	42.5	23.2	42.5	122.9	36.6	80.4
CSAR-41	10.85	9.10	8.25	5.36	48.8	24.0	48.8	128.3	37.9	79.5
CSAR-78	10.50	9.28	8.33	4.45	46.7	19.5	46.7	130.0	35.9	83.3
Sarjoo-52	11.15	9.75	8.93	4.81	50.4	24.4	50.4	142.5	35.7	92.1
IET-31128	11.10	10.10	9.60	5.24	49.6	20.5	49.6	127.5	38.9	77.9
Ratna	10.70	9.30	8.56	5.46	52.9	23.2	52.9	130.8	40.4	77.9
SE±	0.07	0.09	0.15	0.04	0.53	0.63	0.53	1.23	0.36	0.24
C.D. at 5%	0.19	0.28	0.45	0.11	1.58	1.29	1.58	3.65	1.08	0.72

fewer number of sterile (7.60) and opaque (4.34) grains panicale^{-1}. It contained the second highest total grain (86). The variety Ratna and Pant-10 lead to other tested varieties for total grain weight and panicle weight due to more filled grain and test weight but the length of panicle was recorded maximum in NDR-359.

The chlorophyll content, estimated in leaves of rice at flowering stage revealed that the highest chlorophyll was found in CSAR-41 followed by Pant-10 and NDR-359 while the lowest was observed in Ratna. However, more membrane injury was measured in cultivar Sarjoo-52 followed by NDR-359. Nitrogen and protein content in leaves measured at the same stage exhibited similar trend where cultivar Ratna gathered the highest value in both the parameters. Nitrate reductase (NR) activity and proline content estimated in leaves at flowering stage showed higher value in cultivars CSAR-78 for both the former parameters. However, other cultivars could't shows this result. The cultivar Ratna had the highest nitrogen content followed by Sarjoo-52 and CSAR-41. Cultivar Kranti contained least value in this regard. The varieties showed their different behaviors in their phenology and the potential yield of a crop, to a great extent, is determined by photosynthesizing capacity of plant (Rao, 1997). A high rate of photosynthesis is always associated with higher productivity, unless sink capacity is limiting (Evans, 1975). Number of leaves hill^{-1} and leaf area produce source for the carbohydrate and spikelets work the sink which store the photosynthate and plant thus, can produce maximum if environmental conditions are optimum. Optimum LAI (4-5 for dwarf and 5-6 for semi dwarf and long varieties) is sufficient to give maximum yield. In present study, Ratna being although a short duration variety had LAI that was optimum for given maximum yield followed by CSAR-41 that was a long duration. Early flowering and longer maturity period provide sufficient time for accumulation of photosynthate in spikelets. The flag leaf makes a major contribution towards the grain yield of cereals. Since the flag leaf plays predominant role, its size is likely to be important. As mentioned by Monyo and Whittington (1973) flag leaf area can be indicator of grain yield in wheat. Physiological studies of wheat have indicated that flag leaf contribution towards grain weight accounts for 41-43 per cent dry matter in the kernel at maturity and are the major photosynthetic site

Table 3. Panicle characteristics of 10 rice cultivars.

Cultivars	Filled grains ear-1	Sterile grains ear-1	Opaque grains ear-1	Total number of grains ear-1	Grain weight ear-1 (g)	Panicle weight (g)	Panicle length (cm)	Branches panicle-1
Pant-10	74.06	7.60	4.34	86.00	1.57	1.68	20.84	10.13
Pant- 12	65.58	12.20	1.39	79.17	1.41	1.54	20.66	12.38
Kranti	60.85	8.35	1.18	70.38	1.43	1.53	21.26	12.25
NDR-359	66.67	14.10	3.80	84.57	1.48	1.61	21.96	9.67
CSAR-13	64.22	7.13	5.60	76.95	1.49	1.60	21.32	10.00
CSAR-41	63.75	18.25	2.63	84.63	1.53	1.64	21.31	10.10
CSAR-78	71.79	16.78	3.72	92.29	1.40	1.52	19.54	11.35
Sarjoo-52	60.66	16.55	1.29	78.50	1.48	1.59	18.35	9.90
IET-31128	65.37	9.96	2.79	78.12	1.34	1.48	20.84	11.45
Ratna	67.67	6.13	2.71	76.51	1.57	1.69	18.38	10.60
SE±	1.01	0.37	0.11	1.06	0.02	0.01	0.04	0.12
C.D. at 5%	3.00	1.11	0.32	3.14	0.06	0.02	0.13	0.36

during the grain filling stage (Rao, 1997; Berdhal *et al*. 1972). In present case Pant-10 had highest flag leaf area (20.9 cm^2) that gave it paramount yield in comparison to other varieties. Similar trend was obtained in Ratna that had just lower flag leaf area (20.8) (Table-1).

Fresh and dry weight of plant and RWC represented a sign of vegetative growth and stress tolerance (Table-1). Plants with high RWC retain more water and can survive in water stress situation for longer duration. Improved chlorophyll content, more leaf area and higher number of leaves are well associated with higher photosynthate production which transferred food towards sink parts. Higher photosynthate production and transportation improved filled grains $panicle^{-1}$, test weight, grain weight $panicle^{-1}$ panicle weight and yield $hill^{-1}$ and reduced sterile and opaque spikelets in var. Ratna (Ntanos and Koutroubas, 2002) (Table 2 and 3). However, grain number $panicle^{-1}$ was more in CSAR-78 (92.29) but poor photosynthate production and partitioning reduced filled grain number and test weight. In contrast elevated sterile and opaque spikelet that ultimately reduced grain weight $panicle^{-1}$, yield $hill^{-1}$ and harvest index (Table-2 and 3).

Rice tiller is a major yield attribute and determinant for panicle production (Miller *et al*., 1991) and as a consequence affect total yield (Ekamber and Pravat Kumar, 2007). Due to more competition of assimilate, weak tillers die and tiller number is reduced till harvest. Not all tillers had fertile panicle so effective tiller number was diminished further and express lower value that was recorded at harvest. Higher LAI, dry weight of plant and tiller number attributed to increase biological weight (BW) and good nitrogen accumulation in plant and seed part with greater, stress tolerance that was a sign of enhanced grain production with good nutrition.

In crux, these finding suggested that the cultivar Ratna has vigorous growth, allometory, yield attributes, kernel quality, photo assimilate synthesis and partitioning resulted in reduction in spikelet sterility. It also proved fruitful with increasing proline contents and reducing membrane injury to create stress tolerance as well as good nitrogen and NR activity in plants facilitate protein contents. Therefore, rice cultivar Ratna is to be cultivated for obtaining higher yield with stress tolerance in gangatic region of India.

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Assessment of Genetic Variability, Direct and Indirect Effects in Mungbean (*Vigna radiata* L. Wilczek) Mutant Lines

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Abstract

High magnitude of GCV and PCV were recorded for number of clusters plant^{-1}, number of branches plant^{-1} and number of pods plant^{-1}, whereas low estimates were observed for days to maturity. High heritability was recorded for plant height and days to maturity. The high genetic advance coupled with moderate heritability was observed for number of clusters plant^{-1}. The seed yield plant^{-1} showed significant positive association with number of pods cluster^{-1}, number of pods plant^{-1}, plant height and number of clusters plant^{-1}, days to maturity, number of seeds pod^{-1}, seed index and number of pods plant^{-1} recorded positive direct effect on seed yield, suggesting the use of these above mentioned characters as selection indices for yield improvement in mungbean.

Key words : Mungbean, variability, heritability, direct effect, selection indices.

Mungbean is one of the important and widely cultivated pulse crops in India. Pulses are rich source of protein, especially in those areas of the world, where economy does not support large scale production and utilization of animal protein. Yield is a complex character and is

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interrelated with different yield component characters. Genetic improvement in any organism rests on the platform architected by genetic variability in the base population for selection of genotypes. Broader the genetic variability, more effective could be the selection. When the natural genetic variability becomes depleted through continuous selection endeavours, it becomes imperative to induce variability for selection of elite genotypes. Hybridization has played important role through shuffling of genetic information of two or more parent genotypes to produce desirable recombination. Plant breeders, most often than not, require altogether new alleles and mutation is the ultimate origin of new genes, that is why mutation has played important role in the course of plant breeding endeavours. Sustainable efforts for crop improvement through induced mutations have resulted in the development and release of about 1790 varieties of crop plants worldwide and more than 40 varieties of major pulse crops have been developed in India through mutation breeding programmes (Chaturvedi, 2002). The present study was taken up to determine the extent of variability, relationship between yield and yield component characters and their direct and indirect effects on yield in 47 mutant lines of mungbean in M_4 generation.

Materials and Methods

The experimental material comprised of 47 mutant lines of M_4 generation, derived by treating a mungbean genotype KM7-180 with gamma rays and sodium azide and the present experiment was conducted in randomized block design at Field Experimentation Centre, Department of Genetics and Plant Breeding, Allahabad during *kharif*, 2010. Seeds were sown in 8 m^2 plots with spacing of 30 x 20 cm under recommended package of practices. Observations were collected on five randomly selected plants of each mutant line in each replication on days to 50 per cent flowering, plant height, number of branches $plant^{-1}$, number of clusters $plant^{-1}$, number of seeds pod^{-1}, seed index, seed yield $plant^{-1}$ and protein content. The GCV and PCV (Burton, 1952), heritability and genetic gain (Johnson *et al*. 1955) were estimated while the correlation coefficients were estimated as per Al-Jibouri *et al*. (1958), direct and indirect effects were also estimated (Dewey and Lu, 1959).

Results and Discussion

Analysis of variance revealed significant differences for all yield attributing characters studied (Table 1). In general, phenotypic coefficient of variation (PCV) values were higher than genotypic coefficient of variation (GCV) values, which indicated the effect of environment on the expression of characters (Table 2). High PCV and moderate GCV were recorded for number of clusters $plant^{-1}$, number of pods $cluster^{-1}$, days to maturity and number of pods $plant^{-1}$. Pandiyan *et al*. (2006) reported high phenotypic (PCV) and genotypic (GCV)

Table 1. Analysis of variance for 11 different characters in mungbean mutant lines.

Characters	Mean sum of squares		
	Replications (df=2)	Treatment (df=46)	Error (df=92)
Days to 50% flowering	8.39	396.58**	118.26
Days to maturity	20.52	512.73**	113.47
Plant height (cm)	24.52	14240.14**	1015.47
Primary branches $plant^{-1}$	4.69	31.91**	46.63
Clusters $plant^{-1}$	82.31	1452.00**	1093.02
Pods $cluster^{-1}$	0.69	57.40**	66.63
Pods $plant^{-1}$	497.14	9025.09**	6854.18
Seeds pod^{-1}	10.89	102.26**	151.77
Pod length	2.39	45.56**	39.60
Seed index	0.05	6.41**	11.09
Seed yield $plant^{-1}$	25.12	303.85**	376.94

* and ** significant at 5 and 1% level of significance, respectively.

coefficients of variation for single plant yield, number of branches plant^{-1}, number of pods plant^{-1}, number of clusters plant^{-1}, plant height and length of branch, indicating greater scope for selection of these traits.

High heritability estimates were observed for plant height, days to maturity and days to 50

Table 2. Estimates of genetic parameters for 11 different characters in mungbean mutant lines.

Characters	Coefficient of variation		Heritability (%) (bs)	Genetic advance	Genetic gain
	GCV (%)	PCV (%)			
Days to 50% flowering	3.95	4.89	65.00	2.60	6.60
Days to maturity	3.05	3.58	72.00	3.19	3.19
Plant height (cm)	14.79	4.89	90.00	19.49	28.92
Primary branches plant^{-1}	11.53	34.87	10.00	0.17	7.86
Clusters plant^{-1}	17.87	29.96	35.00	3.14	21.95
Pods cluster^{-1}	11.73	26.62	19.00	0.37	10.65
Pods plant^{-1}	16.79	28.27	35.00	7.79	20.53
Seeds pod^{-1}	3.65	11.32	10.00	0.29	2.42
Pod length	6.33	11.51	30.00	0.48	7.17
Seed index	1.93	8.67	4.00	0.03	0.88
Seed yield plant^{-1}	7.16	17.40	16.00	0.77	6.07

Table 3. Phenotypic (rp) and genotypic (rg) correlation coefficients for different characters in mungbean.

Character	Level	Plant height	Branches plant^{-1}	Clusters plant^{-1}	Pods plant-1	Days to maturity	Pod length	Seeds pod^{-1}	Seed index	Seed yield plant^{-1}
Days to 50% flowering	rp	0.029	0.020	0.009	-0.061	0.628**	-0.165	-0.082	-0.110	-0.035
	rg	0.033	0.321**	-0.020	-0.155	0.948**	-0.451	-0.395	-0.490	-0.168
Days to maturity	rp		0.007	0.231**	0.191*	0.050	0.060	-0.048	-0.052	0.216*
	rg		-0.106	0.500**	0.441**	0.094	0.257**	-0.045	-0.133	0.726**
Plant height (cm)	rp			0.123	0.134	0.057	-0.096	-0.112	-0.076	0.100
	rg			0.236**	0.233**	0.135	-0.029	0.045	1.114	-0.036
Primary branches plant^{-1}	rp				0.840**	0.030	0.108	0.045	0.156	0.807**
	rg				0.717**	0.068	0.097	-0.029	0.127	0.623**
Clusters plant^{-1}	rp				0.290**	-0.081	0.148	0.143	-0.027	0.226*
	rg				0.875**	-0.173	0.286**	0.766**	-0.826	0.908**
Pods cluster^{-1}	rp					0.026	0.131	0.081	0.117	0.898**
	rg					0.015	0.201*	0.235**	-0.199	0.866**
Pods plant^{-1}	rp						-0.114	-0.082	-0.089	0.042
	rg						-0.224	-0.132	-0.554	0.161
Seeds pod^{-1}	rp							0.563**	-0.062	0.090
	rg							0.815**	-0.381	0.279**
Pod length	rp								0.039	0.028
	rg								-0.987	0.070
Seed index	rp									0.208*
	rg									0.210*

* and ** significant at 5 and 1% level of significance, respectively.

per cent flowering, whereas it was low for seed index, number of branches plant^{-1}, number of seeds pod^{-1}, seed yield plant^{-1} and number of pods cluster^{-1} (Table 2). Moderate heritability was recorded for number of pods plant^{-1}, number of clusters plant^{-1} and pod length. The high genetic gain (21.95) coupled with moderate heritability (35%) was recorded for number of clusters plant^{-1}. The trait number of clusters plant^{-1} was controlled mainly by additive genes. High genetic gain (28.92) coupled with high heritability (90%) was observed for plant height, indicating that these characters were mainly controlled by additive genes. Mishra *et al*. (2008) reported high estimates of genetic advance as per cent of mean for number of pods plant^{-1}, plant height and number of branches plant^{-1}, while it was moderate for number of seeds pod^{-1}, 50 per cent flowering and seed yield.

Genotypic correlation coefficient analysis measures the mutual relationship between various plant characters (Table 3). The characters number of pods cluster^{-1}, number of pods plant^{-1}, plant height and number of clusters plant^{-1} showed significant positive correlation with seed yield plant^{-1} at genotypic level, while number of pods plant^{-1} and number of clusters plant^{-1} showed significant positive correlation with seed yield at phenotypic level. Plant height showed significant positive correlation with number of clusters plant^{-1} and number of pods plant^{-1}, number of pods cluster^{-1} and pod length. This result indicates that there should be optimum plant height, high

Table 4. Direct (diagonal) and indirect effects of component characters contributing to yield in mungbean at phenotypic (p) and genotypic (g) levels.

Characters	Level	Days to 50% flowering	Plant height	Branches plant^{-1}	Clusters plant^{-1}	Pods cluster^{-1}	Pods plant^{-1}	Days to maturity	Pod length	Seeds pod^{-1}	Seed index plant^{-1}	Seed yield
Days to 50% flowering	p	**0.0047**	0.0001	0.0001	0.0000	-0.0005	-0.0003	0.0029	-0.0008	-0.0004	-0.0005	-0.0350
	g	**-4.5600**	-0.1510	-1.4690	0.0910	1.8010	0.7120	-4.332	2.0610	1.8040	2.2380	
Days to maturity	p	0.0012	**0.0406**	0.0003	0.0094	0.0054	0.0078	0.0021	0.0025	-0.0020	-0.0022	0.2160
	g	0.0360	**1.0950**	-0.1160	0.5480	0.3480	0.4820	0.1030	0.2820	-0.0500	-0.1460	
Plant height (cm)	p	-0.0004	-0.0001	**-0.0190**	-0.0023	0.0006	-0.0026	-0.0011	0.0018	0.0021	0.0014	0.1000
	g	0.0380	-0.0120	**0.1190**	0.0280	0.0100	0.0270	0.0160	-0.0030	0.0050	0.1330	
Primary branches plant^{-1}	p	0.0013	0.0318	0.0170	**0.1372**	0.0222	0.1154	0.0042	0.0149	0.0063	0.0215	0.8070
	g	0.0030	-0.0920	-0.0430	**-0.1840**	-0.0670	-0.1320	-0.0120	-0.0180	0.0230	-0.0230	
Clusters plant^{-1}	p	0.0016	-0.0021	0.0005	-0.0002	**-0.0161**	-0.0047	0.0013	-0.0024	-0.0024	0.0004	0.2260
	g	0.0990	-0.0800	-0.0210	-0.0910	**-0.2530**	-0.2210	0.0440	-0.0720	-0.1940	0.2090	
Pods cluster^{-1}	p	-0.0474	0.1479	0.1040	0.6506	0.2243	**0.7736**	0.0201	0.1019	0.0626	0.0910	0.8980
	g	-0.0220	0.0620	0.0330	0.1010	0.1240	**0.1410**	0.0020	0.0280	0.0330	-0.0280	
Pods plant^{-1}	p	0.0116	0.0009	0.0011	0.0006	-0.0015	0.0005	**0.0185**	-0.0021	-0.0015	-0.0017	0.0420
	g	4.2760	0.4270	0.6100	0.3100	-0.7830	0.0710	**4.5100**	-1.0100	-0.5970	-2.4980	
Seeds pod^{-1}	p	-0.0009	0.0003	-0.0005	0.0006	0.0008	0.0007	-0.0006	**0.0055**	0.0031	-0.0003	0.0900
	g	0.6750	-0.3850	0.0430	-0.1460	-0.4280	-0.3010	0.3350	**-1.496**	-1.2210	0.5710	
Pod length	p	0.0036	0.0021	0.0049	-0.0020	-0.0065	-0.0035	0.0036	-0.0245	**-0.0434**	-0.0017	0.0280
	g	-0.372.	-0.0430	0.0430	-0.1210	0.7230	0.2210	-0.1240	0.7690	**0.9430**	-0.9310	
Seed index	p	-0.0110	-0.0053	-0.0077	0.0157	-0.0028	0.0118	-0.0090	-0.0063	0.0040	**0.1004**	0.2080
	g	-0.3360	-0.0910	0.7640	0.0870	-0.5670	-0.1360	-0.3860	-0.2610	-0.6770	**0.6860**	

number of clusters plant^{-1} and number of pods cluster^{-1} with good pod length to get more seed yield. Singh and Singh (2003) reported that seed yield plant^{-1} was strongly and positively correlated with the number of pods plant^{-1}, seed index, plant height and number of primary and secondary branches plant^{-1}. Rao *et al*. (2006) recorded that the total dry matter, number of pods plant^{-1}, number of clusters plant^{-1}, number of branches plant^{-1} and days to 50 per cent flowering were positive and significantly associated with seed yield.

Days to maturity had positive direct effect on seed yield and its indirect effects through other characters were also cumulated to positive correlation with seed yield. Plant height, number of seeds pod^{-1}, seed index and number of pods plant^{-1} recorded positive direct effect. Tadele *et al*. (2005) revealed that pods plant^{-1} had the largest positive direct effect in both control and mutant populations, while 100 seed weight had second largest direct positive effect on seed yield only in the mutant population. Days to 50 per cent flowering showed negative direct effect on seed yield plant^{-1}. Henry and Mathur (2007) reported that more number of days to flowering had a negative direct effect on seed yield while number of pods plant^{-1}, seed index, number of seeds pod^{-1}, plant height and days to maturity exert positive direct effects on seed yield.

The present study revealed that there was significant amount of variability for the characters, number of pods cluster^{-1} and number of clusters plant^{-1}. In order to develop high yielding varieties, selection pressure has to be imposed on number of pods cluster^{-1}, number of pods plant^{-1}, plant height and pod length which had positive significant association with seed yield.

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Effect of Foliar Application of Different Plant Growth Regulators on Growth, Yield and Quality of Gaillardia (var. Yellow Dusty)

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Abstract

Foliar application of 200 ppm GA_3 recorded maximum growth (68.28 cm), early flowering (67.30 days), diameter of flower (6.68 cm) and length of flower stalk (21.30 cm) in gaillardia. Whereas, application of MH 500 ppm produced maximum number of flowers hectare^{-1} (57.62 lakh) and higher yield (114.12 q ha^{-1}).

Key words : Foliar application, growth regulators, gaillardia.

Among the flowers used for domestic market, gaillardia (*Gaillardia pulchella*) is one of the important commercial flowers. Plant growth regulators are organic substances other than nutrients, which can modify or regulate physiological processes in the plants, when used in small quantities. Plant growth regulators have played a significant role by modifying the growth, flowering, seed set and seed yield of plants. Gaillardia grown under field condition produces flowers of inferior quality. Similarly, apical dominance in gaillardia has been one of the factors which limit the production of flower. Plant growth regulators are being increasingly used to manipulate the growth and flowering of ornamental plants (Shanmugan *et al*. 1973).

In Vidarbha region, farmers raise this crop mainly in rabi season. Presently the area under this crop is less and it is likely to be increased in the near future because of heavy demand for flowers. However, the yield and quality of the flowers is low, which needs to be increased by adapting improved agro-technique. Therefore, keeping this in view, the present investigation was carried out to study the effect of foliar application of different plant growth regulators on growth, yield and quality of gaillardia.

Materials and Methods

A field experiment was conducted during *rabi* season of 2006-07 at Satpuda Botanic Garden, College of Agriculture, Nagpur. The pH of the soil was 9.4, electrical conductivity 0.33 dsm^{-1}, total nitrogen 315 kg ha^{-1}, available phosphorus 29 kg ha^{-1} and available potash 345 kg ha^{-1}. The experiment was laid out in a randomized block design replicated thrice. The treatments comprised of different growth regulators i.e. T_1 (GA_3 100 ppm), T_2 (GA_3 200 ppm), T_3 (NAA 100 ppm), T_4 (NAA 200 ppm), T_5 (MH 250 ppm), T_6 (MH 500 ppm), T_7 (Ethrel 100 ppm), T_8 (Ethrel 200 ppm) and control (No spray). The net plot size was 2.4 x 1.8 m. The gaillardia variety Yellow Dusty was sown on 5th October, 2006 to raise seedlings. The seedlings were transplanted when attained three to four leaves growth after 30 days. Half dose of N was applied through inorganic source (50 kg N ha^{-1}), full dose of phosphorus (50 kg P_20_5 ha^{-1}) and potash (50 kg K_20 ha^{-1}) and FYM (10 tonnes ha^{-1}) was applied at the time of transplanting. The

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remaining dose of nitrogen (50 kg N ha^{-1}) was applied one month after transplanting. The 100 ppm GA_3 solution was prepared by dissolving 100 mg GA_3 in few ml of alcohol and the volume was made to one liter by adding distilled water. The same procedure was adopted for preparing NAA, MH and ethrel solution. The first and second foliar spray was given after 30 days and 60 days after transplanting, respectively. The irrigation was applied at an interval of 8 to 10 days during the entire period of crop growth. The growth parameters, flowering attributes and yield was recorded and data was analyzed to test the significance by standard procedure (Gomez and Gomez, 1984).

Results and Discussion

The data in Table 1 revealed that the maximum plant height was recorded in the GA_3 200 ppm (68.28 cm) treatment and minimum height (50.76 cm) in the treatment MH 500 ppm at 105th days after transplanting of seedlings. Similar growth pattern of plant was observed due to different growth regulators during 45th to 105th days of crop growth. GA_3 increased the plant height by increasing internodal length, whereas, MH and NAA decreased the plant height by decreasing the internodal length. These results are in close confirmity with the findings of Sen and Maharana (1971), who noted that GA_3 at 100 and 200 ppm concentration promoted the plant growth in chrysanthemum. While, Gowda and Jayanti (1991) observed that foliar application of MH at 500, 1000 and 1500 ppm concentration in marigold, reduced the plant height. Patil (2006) also reported maximum height of plants with 200 ppm GA_3 in china aster.

The maximum spread of plant at 105th days after transplanting was recorded in the treatment MH 500 ppm (75.43 cm), followed by treatment MH 250 ppm (73.53 cm). Treatments NAA 100 and 200 ppm (68.05 and 67.25 cm) showed more spread of plant than plant treated with GA_3 100 (65.90 cm) and 200 ppm (64.95 cm), respectively. The same trend was observed in the treatments ethrel 100 and 200 ppm (69.33 and 71.32 cm). However, minimum spread of plant was recorded in control (62.97 cm). The increase in spread of plant was due to inhibiting the division and subsequent elongation of the apical meristematic cells. MH suppresses the plant height, which leads to increase in spread of plant. NAA and ethrel application also resulted in less plant spread than MH treatments, but more than GA_3 and control treatments. Similar results were also recorded by Singh (2003) who reported reduction in plant height and maximum spreading of plant at MH 400 ppm in African merigold.

Significantly maximum number of branches were recorded in the treatment MH 500 ppm (111.09) at all stages of crop growth i.e. from 45th to 105th day. Similar trend showed by other plant growth regulator in respect of number of branches per plant from 45th to

Table 1. Effect of growth regulators on plant height, branches and leaves $plant^{-1}$, spread of plant in gaillardia at 105 DAT.

Treatment	Plant height (cm)	Spread of plant (cm)	Branches $plant^{-1}$	Leaves $plant^{-1}$
T_1 - GA_3 100 ppm	66.31	65.90	24.01	845.20
T_2 - GA_3 200 ppm	68.28	64.95	25.21	846.20
T_3 - NAA 100 ppm	65.16	68.05	25.58	832.37
T_4 - NAA 200 ppm	63.21	67.25	25.47	834.33
T_5 - MH 250 ppm	51.13	73.53	28.29	817.23
T_6 - MH 500 ppm	50.76	75.43	30.03	820.20
T_7 - Ethrel 100 ppm	55.81	69.33	26.45	815.80
T_8 - Ethrel 200 ppm	55.22	71.32	27.82	808.73
T_9 - Control	60.31	62.97	23.83	599.22
SE (m)±	0.025	0.30	0.14	2.22
CD at 5%	0.076	0.89	0.40	6.63

DAT = Days after transplanting

105th day of crop growth. MH increased the number of branches as compared to control. Apparently higher concentration of GA_3 enhanced apical dominance indirectly by increasing auxin content. The suppression of apical dominance with consequent increase in number of branches at lower concentration of MH is well known effect observed in several ornamental plants like calendula (Shrivastava and Bajpai, 1964) and in chrysanthemum (Sen and Maharana, 1971). Singh (2003) also reported maximum number of branches per plant with MH 400 ppm in African marigold.

Maximum number of leaves plant^{-1} was recorded in the treatment GA_3 200 ppm (846.20) and minimum in control (599.22). Lowest number of leaves were recorded at 15th day and highest at 105th day of crop growth in the same treatment i.e. GA_3 200 ppm. Number of leaves plant^{-1} was found significant from 45th to 105th day of crop growth. GA_3 increased number of leaves. The increase in number of leaves was due to increase in number of branches. Ethrel, NAA and MH decreased the number of leaves. The less number of leaves was due to reduction in plant height. Lal and Mishra (1986) reported that 200 ppm GA_3 was most effective in increasing plant height and number of leaves in aster and marigold. Similarly, Sanap *et al*. (2004) also observed maximum number of leaves clump^{-1} at 90 and 150 days with increase in length of leaves at different stages of plant growth, when tuberose plant cv. Singly sprayed with GA_3 150 ppm concentration.

Significantly earlier flower bud emergence (Table 2) was noticed in GA_3 100 ppm (67.30 days) which was significantly superior over all other treatments and closely followed by treatment GA_3 200 ppm (69.23 days). Treatment NAA 100 ppm (70.47 days), MH 500 ppm (70.21 days) and MH 250 ppm (71.40 days) were at par with each other. The late flowering bud emergence was noticed in the control (77.21 days). With regard to flower bud opening, GA_3 100 ppm showed early opening of flower bud (4.01 days) than other treatments followed by GA_3 200 ppm (4.53 days), NAA 100 ppm (5.56 days), NAA 200 ppm (5.67 days), MH and ethrel. MH and ethrel increased the number of days required for opening of flowering from transplanting, GA_3 100 ppm significantly reduced the days required for 50 per cent flowering (76.30 days),

Table 2. Effect of growth regulators on flowering attributes and yield in gaillardia.

Treatment (Planting dates)	Days for first flower emergence	Days for opening flower bud	Days for 50% flower-ing	Diameter of flower (cm)	Length of flower stalk (cm)	Vase life of flower (days)	Flowers hectare^{-1} (Lakh)	Weight of flower hectare^{-1} (q)
T_1 - GA_3 100 ppm	67.30	4.01	76.30	6.58	20.20	3.70	49.82	104.39
T_2 - GA_3 200 ppm	69.23	4.53	79.50	6.68	21.30	3.40	50.50	105.78
T_3 - NAA 100 ppm	70.47	5.56	80.30	5.49	17.90	3.10	44.53	91.20
T_4 - NAA 200 ppm	72.21	5.67	81.10	5.57	18.20	3.30	46.33	93.28
T_5 - MH 250 ppm	71.40	5.20	84.60	4.45	18.90	4.70	55.62	106.01
T_6 - MH 500 ppm	70.21	5.18	84.80	4.39	18.20	4.90	57.62	114.12
T_7 - Ethrel 100 ppm	75.20	6.01	86.40	5.33	19.00	3.60	50.81	94.90
T_8 - Ethrel 200 ppm	74.30	5.38	85.50	5.15	19.10	4.20	51.40	98.61
T_9 - Control	77.21	6.15	83.70	3.90	12.90	2.90	40.65	78.00
SE (m)±	0.56	0.11	0.82	0.33	0.20	0.16	0.22	4.77
CD at 5%	1.69	0.32	2.49	0.97	0.59	0.49	0.66	14.31

whereas, other treatments of NAA, ethrel and MH increased the days required for 50 per cent flowering from transplanting. These results are in conformity with the findings of Lal and Mishra (1986) who reported that spraying at 200 ppm GA_3 was beneficial to induce early flowering in marigold and china aster, whereas, size of flower was more at 50 ppm and Nagarajaih and Reddy (1986) also recorded early flower bud appearance with spraying of GA_3 50 ppm as compared to 100, 200 and 400 ppm GA_3. Mukhopadhyay (1990) recorded delayed bud emergence for several days by NAA. Kumar and Singh (2004) also noticed that GA_3 200 ppm induced early flowering as like in GA_3 100 ppm in carnation.

Plant sprayed with GA_3 200 ppm produced flowers of larger size (6.68 cm) which was significantly superior over all other treatment but at par with treatment GA_3 100 ppm (6.58 cm). NAA 100 ppm produced flower of larger size (5.49 cm) than control (3.90 cm) but increase in concentration decreased flower size. All concentration of MH and ethrel produced flower of smaller size due to adverse effect of MH on development of flower. As regard stalk length (Table 3), the maximum stalk length was recorded in the treatment GA_3 200 ppm (21.30 cm), which was significantly superior over all other treatments followed by treatment GA_3 100 ppm (20.20 cm), ethrel 200 ppm (19.10 cm), ethrel 100 ppm (19.00 cm), MH 250 ppm (18.90 cm) and found at par with each other. From results, it was indicated that GA_3 and NAA increased the length of flower stalk, while MH and ethrel treatments decreased the length of flower stalk. In case of vase life of flower, the maximum vase life of cut flowers was observed in the flower harvested from the treatment MH 500 ppm (4.90 days) which was at par with treatment MH 250 ppm (4.70 days). Treatment GA_3 100 ppm (3.70 days), GA_3 200 ppm (3.40 days) and NAA 200 ppm (3.30 days) were found at par with each other. The minimum vase life of flower was recorded in the control (2.90 days) which was at par with NAA 100 ppm (3.10 days). Increased in vase life with MH was due to retarded metabolism and respiration, while with GA_3, it was due to differed flower senescence. The results regarding flower size are in confirmity with the findings of Mukhopadhyay (1990) who observed increased flower size at all levels of GA_3 treatment in carnation. Dahale *et al*. (1993) also recorded that application of 100 ppm of GA_3 to chrysanthemum increased the diameter and vase life of flowers. Dutta *et al*. (1993) noticed that NAA and GA_3 significantly increased the flower size and length of flower stalk over control. While, MH at 250, 500 and 1000 ppm reduced the flower size and stalk length in chrysanthemum.

With regard to yield of flower, the treatment MH 500 ppm produced highest number of flowers (57.62 lakh hectare^{-1}) which was significantly superior over all other treatments followed by treatment MH 250 ppm (55.62 lakh hectare^{-1}). The lowest number of flowers was obtained from the control (40.65 lakh hectare^{-1}). Whereas, the weight of flowers per hectare was more in MH 500 ppm (114.12 q) followed by MH 250 ppm (106.01 q). The increased weight of flower is directly related to the number of flowers. These results are in conformity with the findings of Gowda and Jayanti (1991) and Dutta *et al*. (1993) who reported that spraying of MH increased the yield of flowers.

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Assessment of Diversity and Agro-Morphological Characteristics of Some Landraces of Little Millet Germplasm from India

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Abstract

The analysis of variance for majority of quantitative traits in little millet indicated significant variation for treatment adjusted, among treatments, among controls and treatment versus control. The morphological and agronomical data revealed significant differences in all the traits studied. High CV was observed in plant height (26.49%) followed by flag leaf length (11.20%) and inflorescence length (10.19%). Among the accessions studied, IC 340246 - a tall, late maturing accession having high index score of 25 is identified as promising for future crop improvement programme.

Key words : Little millet diversity, morphological, agronomical, characterization.

Little millet (*Panicum sumatrense* Roth. ex. Roem. et Schult.) is an important millet among the small millet species. It belongs to the family Poaceae and sub family Panicoideae. It is self pollinated with 2n=36. It is nutritious and contains about 7.7 per cent protein, 4.7 per cent fat, 1.5 per cent minerals, 67.0 per cent carbohydrate, 341 Kcal energy, 0.30 thiamine, 0.09 riboflavin and 3.2 niacin (Gopalan *et al*. 1987). But so far no systematic approach has

1. Sr. Scientist and 2. Scientist (S.G.)

been made to characterize an assemblage of little millet germplasm from different parts of western and central India. Hence, an attempt was made to study the morphological and agronomical characteristics of 47 indigenous little millet accessions collected from various part of the country.

Materials and Methods

Forty seven accessions of little millet germplasm collected from ten different districts of four Indian states namely, Maharashtra (35 accns.), Gujarat (6 accns.), Madhya Pradesh (4 accns.) and Andhra Pradesh (2 accns.) were used for the study (Table 1).

These accessions were grown in an augmented design during the wet season of 2007 in three metre row length each with a row to row spacing of 65 cm along with three check varieties *viz*., Co-2, JK-8 and PRC-3 at the experimental farm of NBPGR Regional station, Akola. Nine qualitative and ten quantitative traits were recorded as per the Descriptors for Panicum miliaceum and *P. sumatrense* (Anonymous, 1985). The qualitative traits studied were growth habit, plant pigmentation, blade pubescence, sheath pubescence, ligule pubescence, inflorescence shape, degree of lodging at maturity, compactness of inflorescence and senescence. The quantitative traits included plant height, days to 50 per cent flowering, number of effective tillers, culm branches, flag leaf length, sheath length of flag leaf, inflorescence length, nodes/primary axis of inflorescence, days to maturity and 100-seed weight. Statistical parameters like range, mean, coefficient of variation and Shannon diversity index (H') were analyzed for qualitative traits and analysis of variance, range, mean, coefficient of variation for assessing the extent of variation in quantitative traits among the accessions. The Shannon-Weaver diversity index (H') (Shannon

Table 1. Passport data of little millet accessions.

S.No.	Accn. No.	Collection site	State
1	IC340090	Mangya, Amravati	MH
2	IC340093	Bori, Amravati	MH
3	IC340095	Bod, Aniravati	MH
4	IC340099	Utavli, Amravati	MH
5	IC340102	Pohra, Amravati	MH
6	IC340104	Chilpi, Amravati	MH
7	1C340105	Chilpi, Amravati	MH
8	IC340111	Raipur, Amravati	MH
9	IC340117	Makla, Amravati	MH
10	IC340120	Semadoh, Amravati	MH
11	IC340122	Bhawai, Amravati	MH
12	IC340126	Hathru, Amravati	MH
13	IC340132	Maritha, Amravati	MH
14	IC340135	Chilhati, Amravati	MH
15	IC340139	Ruipathar, Amravati	MH
16	IC340143	Rettikhed, Amravati	MH
17	IC34Q148	Rora, Amravati	MH
18	IC340152	Harisal, Amravati	MH
19	IC340153	Chourakund, Amravati	MH
20	IC340157	Tangra, Amravati	MH
21	IC340160	Patiya, Amravati	MH
22	IC340166	Amravati	MH
23	IC34Q171	Chakardha, Amravati	MH
24	IC340182	Chakardha, Amravati	MH
25	IC340186	Lawada, Amravati	MH
26	IC340192	Ranamalur, Amravati	MH
27	IC340193	Bhot, Amravati	MH
28	IC340215	Patherpur, Amravati	MH
29	IC340219	Chootiya, Amravati	MH
30	IC340227	Dhabia, Amravati	MH
31	IC340233	Dhabia, Amravati	MH
32	IC340246	Girgoti, Amravati	MH
33	IC341305	Aurangabad	MH
34	IC344220	Sindhudurg	MH
35	IC344655	Narmada	GJ
36	IC344663	Narmada	GJ
37	IC344766	Surat	GJ
38	IC333296	Kerelimawadi, Jhabua	MP
39	IC333325	Mathwad, Jhabua	MP
40	IC331103	Dhumkhal, Narmada	GJ
41	1C396691	Nandurbar	MH
42	IC344739	Surat	GJ
43	IC396718	Seoni	MP
44	IC331019	Makarkheda, Narmada	GJ
45	IC274578	Chhatarpur	MP
46	IC383899	Godavari	AP
47	IC383903	Godavari	AP

States : MH = Maharashtra, GJ = Gujarat, MP = Madhya Pradesh, AP = Andhra Pradesh

and Weaver, 1949) for the qualitative traits was estimated for assessing the diversity among the accessions. The index score method was used to study the diversity among the accessions (Anderson, 1957). The range of variability in each trait was classified into low (1), medium (2) and high (3) index scores by using suitable class intervals. The index score of each accession was estimated by summing up the index score values of all the characters.

Results and Discussion

Wide range of variation was observed in morphological characters. The plants were mostly erect (65.96%) and some were erect geniculate (23.4%) and decumbent (10.64%). Majority of the accessions were green (93.62%) and only three accessions (6.38%) were pigmented (IC 340171, IC 340182, IC 340193). Leaf blade, sheath and ligule pubescence were mostly medium and in some accessions it was glabrous. The shapes of the majority of the inflorescences were oblong and some were ovate. Degree of lodging at maturity varied from slight, medium to executive. The inflorescences were mostly open and few were compact. The Shannon-Weaver diversity index (H') varied from low (0.24) to high (1.01) suggesting that diversity exists among the accessions (Table 2).

The analysis of variance for majority of quantitative traits indicated significant variation for treatment adjusted, among treatments, among controls and treatment versus control. Among these traits, the tillers plant^{-1}, culm branching, flag leaf length, sheath length of flag leaf, nodes primary^{-1} axis, days to 50 per cent flowering and 100-seed weight exhibited significant variation at 1 per cent level whereas inflorescence length and days to maturity expressed significant variation at 1 per cent level for treatment adjusted, among treatments

Table 2. Frequency distribution of qualitative traits, in little millet accessions.

Descriptors	Descriptor states	Frequency	Percentage	Shannon-Weaver Diversity index (H')
Growth habit	Erect	31	65.96	0.85
	Erect geniculate	11	23.40	
	Decumbent	5	0.64	
Plant pigmentation	Green	44	93.62	0.24
	Pigmented	3	6.38	
Blade pubescence	Glabrous	14	29.79	0.60
	Medium	33	70.21	
Sheath pubescence	Glabrous	25	53.19	0.69
	Medium	22	46.81	
Ligule pubescence	Glabrous	8	17.02	0.45
	Medium	39	82.98	
Inflorescence shape	Oblong	40	85.11	0.42
	Ovate	7	14.89	
Degree of lodging at maturity	Slight	16	34.04	1.01
	Medium	23	48.94	
	Executive	8	17.02	
Senescence	Actively growing	21	44.68	0.68
	Dead	26	55.32	
Compactness of inflorescence	Open	30	63.83	0.82
	Medium	14	29.79	
	Compact	3	6.38	

and test versus control (Table 3). The range of variation for adjusted means in respect of different quantitative traits were plant height (39.07-119.58 cm), days to 50 per cent flowering (46.76-64.1), effective tillers plant^{-1} (2.62-9.36), culm branching (2.85-6.22), flag leaf length (7.57-28.57 cm), sheath length of flag leaf (3.70-13.31 cm), inflorescence length (9.7-32.82 cm), nodes primary^{-1} axis (3.46-7.31), days to 80 per cent maturity (78.48-95.14) and 100-seed weight (0.17-0.31 g). Low coefficient of variation were observed in days to flowering and days to maturity compared to moderate CV in nodes primary^{-1} axis, sheath length of flag leaf, number of effective tillers plant^{-1} and 100-seed weight. High CV was observed in plant height, flag leaf length and inflorescence length (Table 4). The data revealed that tall types (> 90 cm) constituted 23.41 per cent of the accessions whereas 51.06 per cent of the germplasm were between the heights of 60-90 cm and 25.53 per cent below < 60 cm. Early flowering (47 days) types were IC 340095, IC 340102, IC 340104, IC 340105, IC 340111 and IC 340135. Days to maturity when grouped conveniently into three groups, it was observed that 59.57 per cent were early (78-84 days),

Table 3. Analysis of variance for quantitative traits in little millet accessions.

Source of variaton	Degrees of freedom	Plant height (cm)	Days to 50% flowering	Effective tillers plant^{-1}	Culm branching	Flag leaf length (cm)	Sheath length of flag leaf (cm)	Inflorescence length (cm)	Nodes primary-1 axis	Days to 80% maturity	100 seed weight (g)
Block adjusted	6	519.326	0.079	0.131	0.498*	4.425	1.818*	5.125	0.130	1.523	0.0004
Treatment adjusted	49	418.264	36.754**	4.198**	0.009**	21.045**	4.424**	3.862**	0.106**	1.261**	0.0012**
Among treatments	46	250.969	23.530**	1.380**	0.412**	18.942**	3.207**	20.719**	0.395**	18.671**	0.0010**
Among controls	2	3,669.637**	1.857**	49.500**	2.877**	73.414**	4.484**	5.878	32.430**	0.619**	0.0003
Test vs. control	1	1,422.540	721.731**	40.290**	4.021**	13.811	58.297**	277.039**	13.849**	542.183**	0.0110**
Error	12	411.994	0.079	0.183	0.009	3.147	0.372	3.862	0.104	0.841	0.0002

*, ** Significant at the 5 and 1 % levels respectively.

Table 4. Range, SE, CV and CD values of adjusted means of quantitative traits in little millet accessions.

Parameters	Plant height (cm)	Days to 50% flowering	Effective tillers plant^{-1}	Culm branching	Flag leaf length (cm)	Sheath length of flag leaf (cm)	Inflorescence length (cm)	Nodes primary^{-1} axis	Days to 80% maturity	100 seed weight (g)
Range	39.07-119.58	46.76-64.1	2.62-9.36	2.85-6.22	7.57-28.57	3.70-13.31	9.70-32.82	3.46-7.31	78.48-95.14	0.17-0.31
Mean	76.60	55.52	5.90	4.69	15.83	8.85	19.28	5.26	86.57	0.22
SE±	20.29	0.28	0.43	0.09	1.77	0.61	1.96	0.32	0.92	0.01
CV%	26.49	0.50	7.27	2.11	11.20	6.89	10.19	6.19	1.06	6.71
CD at 5%	52.86	0.73	1.12	0.26	4.62	1.59	5.12	0.85	2.39	0.04
CD at 1%	74.11	1.03	1.56	0.36	6.48	2.23	7.18	1.19	3.35	0.05

29.79 per cent were medium (85-91 days) and 10.64 per cent were late (92-95 days). The late maturing accessions were IC 340117, IC 396691, IC 344739 and IC 396718 and IC 331019. Number of effective tillers plant^{-1} in 65.96 per cent of the accessions were low (<5), in 31.91 per cent it was medium (5-7) and in the remaining 2.13 per cent it was high (>7). The inflorescences were short (9.7-17.4 cm) in 44.68 per cent of the accessions, medium long (17.5-25.1 cm) in 48.94 per cent and long (25.2-32.8 cm) in 6.38 per cent. The accessions when analyzed as per the index score method (Anderson, 1957), it was observed that 17 accessions (36.17%) were in the index score range of 11- 15, 23 (48.93%) in the range of 16- 20 and the remaining 7 (14.89%) in the range of 21-25. The frequency distribution of index scores depicted that the accessions of Gujarat had the highest index score of 19.67 followed by Madhya Pradesh (17.0), Maharashtra (16.82) and Andhra Pradesh (14.5) compared to the average index score of 16.74. The index score analysis suggested that IC 340246 had the high index score (25) followed by IC 340233, IC 396691, IC 344663 and IC 333296 (23) compared to score 25 for the check variety PRC-3.

Morphological characteristics indicated that accessions vary significantly among the accessions studied. The Shannon-Weaver diversity index (H') also corroborate that diversity exists among the accessions. Analysis of variance revealed significant variation in majority of the traits among the genotypes studied. High coefficient of variation was observed with respect to plant height, flag leaf length and inflorescence length. Reddy *et al*. (1984) also reported plant height had a positive indirect effect on yield through straw weight and suggested that plant height rather than tiller number seemed to be important for augmenting the yield of little millet. Arunachalam *et al*. (2005) reported the days to flowering and maturity contributed the most to genetic differentiation. Their study also confirmed distinct genetic divergence among seven landraces from Kolli hills of Tamil Nadu and one check variety based on morphometric traits in little millet. Yadav and Srivastava (1976) reported maximum GCV estimates for straw yield and productive tillers. The results of index score method also confirm the existence of sufficient variation among the accessions collected from different states. Considering the desirable traits among the accessions studied for the above parameters, IC 340246 - a tall, late maturing accession having a high index score of 25 is identified as promising for future crop improvement programmes. Further study on biochemical and molecular aspect would help in understanding the diversity existing among the accessions.

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Evaluation of Synthetic Insecticides Against Thrips (*Thrips tabaci* Lind.) in Bt Cotton

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Abstract

The novel synthetic insecticides *viz*., imidacloprid 7.8 SL @ 25 g a.i., thiamethoxam 25 WG @ 25 g a.i., acetamiprid 20 SP @ 30 g a.i., clothianidin 50 WDG @ 25 g a.i., triazophos 40 EC @ 600 g a.i., acephate 75 SP @ 750 g a.i., lambda cyhalothrin 5 EC @25 g a.i. and indoxacarb 14.5 SC @ 75 g a. i. along with standard check of oxydemeton methyl 25 EC @ 300 g a.i. hectare^{-1} were evaluated against thrips in Bt cotton. The cumulative means of two years data computed from 1-10 DAS indicated that the supremacy of clothianidin (5.77) continued over rest of the treatments except, thiamethoxam (6.47) and acetamiprid (7.12), which were on par. In the descending order of bioefficacy the next promising treatments were triazophos (7.68), imidacloprid (8.81) and lambda-cyhalothrin (9.50), followed by indoxacarb (10.00), acephate (11.29) and oxydemeton methyl (11.82), the treated check. These treatments amongst each of the groups were however, on par with each other.

Key words : Bt cotton, thrips, evaluation, novel synthetic insecticides.

Cotton (*Gossypium hirsutum* Linn.) is the most important cash crop plays vital role in industrial econoy and social affairs of India and the world. With the introduction of transgenic cotton, the insect pest scenario on cotton is also changing. The sap sucking insect pests becoming a serious menace to Bt cotton cultivation. The sap suckers not only reduce the yield to the tune of 50-60 per cent but also adversely affect the quality of lint and seed (Sundramurthy, 1985). Among the sap suckers, thrips (*Thrips tabaci* (Lind.)) achieved a status of major and most serious pest of Bt cotton. The estimated loss in chillies due to thrips damage is around 109 kg acre^{-1} (Ananthakrishnan, 1973). G. M. cotton acerage in India continued to grow at rapid rate and reached 8.4 million ha in 2009. Bt cotton hybrids were found to be more susceptible to the attack of thrips and jassids (Rao *et al*. 2002, Bhosale *et a*l. 2004 and Vennila *et al*. 2004). The continuous and indiscriminate use of the broad spectrum convectional insecticides causes needlessly increase in flair-ups of the sap suckers and the insecticidal resistance thereby. The present investigations were therefore carried out to study the bioefficacy of novel mode synthetic insecticides against thrips in Bt cotton.

Materials and Methods

A field experiment was conducted on summer irrigated Bt cotton at All India Co-ordinated Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri during 2007-08 and 2008-09. The sowing of Bt cotton hybrid RC-2 Bt was done on 23.5.2007 and 21.5.2008 following randomised block design with a spacing of 90 x 90 cm[2]. All the agronomic practices were followed including the fertilizer dose @ 120:60:60 kg of N, P_2O_5 and K_2O ha^{-1}, respectively for raising the good crop. The

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spray fluid was applied at the rate of 500 litres hectare^{-1} with hand operated knapsack sprayer. The observations on number of thrips were recorded on top, middle and bottom leaves of five randomly selected plants in each treatment at 1,3,5,7 and 10 days after spraying. Application of insecticides commenced from 45 days of the crop. In all three rounds of spray applications were undertaken at an interval of 20 days. The experimental data on number of thrips were first transformed to their corresponding square root of x+0.5values and then statistically analysed.

Results and Discussion

The data (Table 1) on the post-treatment mean thrips count three^{-1} leaves revealed that all the insecticidal treatments were significantly superior over untreated control. During 2007, among the evaluated insecticides, the treatment with clothianidin was found to be most effective against thrips by recording lowest population (5.53), followed by thiamethoxam (6.21) and acetamiprid (6.82). The next best treatments in order of efficacy were triazophos (7.35), imidacloprid (8.47) and lambda cyhalothrin (9.13) followed by indoxacarb (9.60), acephate

Table 1. Overall field bioefficacy of synthetic chemical insecticides against thrips, *T. tabaci* on Bt cotton.

Treatment	Dose (g a.i. ha^{-1})	Mean No. of thrips 3^{-1} leaves												
		2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	Mean of 2007-08	Mean of 2008-09	Cumulative mean of two years
		1 DAS		3 DAS		5 DAS		7 DAS		10 DAS				
T_1	25	12.03 (3.54)	13.52 (3.74)	9.98 (3.24)	11.22 (3.42)	8.42 (2.99)	9.45 (3.15)	6.84 (2.71)	7.70 (2.86)	5.07 (2.36)	5.71 (2.49)	8.47 (2.97)	9.52 (3-17)	8.81 (3.05)
T_2	25	9.07 (3.09)	10.19 (3.27)	7.04 (2.75)	7.93 (2.90)	6.02 (2.55)	6.75 (2.69)	4.99 (2.34)	5.61 (2.47)	3.94 (2.11)	4.41 (2.22)	6.21 (2.57)	6.98 (2.73)	6.47 (2.64)
T_3	30	9.89 (3.22)	11.12 (3-41)	7.57 (2.84)	8.49 (3.00)	6.66 (2.68)	7.51 (2.83)	5.77 (2.50)	6.49 (2.64)	4.24 (2.18)	4.78 (2.30)	6.82 (2.68)	7.68 (2.86)	7.12 (2.76)
T_4	25	7.78 (2.88)	8.72 (3.04)	6.35 (2.62)	7.13 (2.76)	5.50 (2.45)	6.19 (2.59)	4.59 (2.26)	5.16 (2.38)	3.45 (1.99)	3.88 (2.09)	5.53 (2.44)	6.22 (2.59)	5.77 (2.50)
T_5	600	10.52 (3.32)	11.82 (3.51)	8.20 (2.95)	9.23 (3.12)	7.10 (2.76)	7.99 (2.91)	6.29 (2.61)	7.08 (2.75)	4.65 (2.27)	5.23 (2.39)	7.35 (2.78)	8.27 (2.96)	7.68 (2.86)
T_6	750	14.97 (3.93)	16.83 (4.16)	12.90 (3.66)	14.50 (3.87)	10.79 (3.36)	12.13 (3.55)	8.72 (3.04)	9.80 (3.21)	6.79 (2.70)	7.62 (2.85)	10.83 (3.34)	12.17 (3.56)	11.29 (3.43)
T_7	25	13.02 (3.68)	14.64 (3.89)	10.54 (3.32)	11.85 (3.51)	9.07 (3.09)	10.19 (3.27)	7.49 (2.83)	8.43 (2.99)	5.52 (2.45)	6.19 (2.59)	9.13 (3.07)	10.26 (3.28)	9.50 (3.16)
T8	75	13.61 (3.76)	15.30 (3.97)	11.17 (3.42)	12.55 (3.61)	9.42 (3.15)	10.58 (3.33)	7.81 (2.88)	8.76 (3.04)	5.99 (2.55)	6.72 (2.69)	9.60 (3.15)	10.78 (3.36)	10.00 (3.24)
T_9	300	15.69 (4.02)	17.64 (4.26)	13.46 (3.74)	15.13 (3.95)	11.31 (3.44)	12.73 (3.64)	9.15 (3.11)	10.27 (3.28)	7.08 (2.75)	7.95 (2.91)	11.34 (3.41)	12.74 (3.64)	11.82 (3.51)
T_{10}	-	33.06 (5.79)	37.13 (6.13)	34.39 (5.91)	38.66 (6.26)	35.30 (5.98)	39.64 (6.34)	36.30 (6.07)	40.79 (6.43)	36.79 (6.11)	41.36 (6.47)	35.17 (5.97)	39.52 (6.33)	37.30 (6.15)
SE m±		0.14	0.15	0.11	0.11	0.15	0.10	0.11	0.10	0.10	0.08	0.10	0.11	0.11
CD at 5%		0.41	0.44	0.32	0.34	0.44	0.30	0.34	0.29	0.30	0.25	0.31	0.32	0.32

T_1 - Imidacloprid 17.8 SL, T_2 - Thiamethoxam 25 WG, T_3 - Acetamiprid 40 SP, T_4 - Clothianidin 50 WDG, T_5 - Triazophos 40 WP, T_6 - Acephate 20 SP, T_7 - Lambda cyhalothrin SEC, T_8 - Indoxacarb 14.5 SC, T_9 - Oxydemeton Imethyl 20 EC, T_{10} - Untreated control. Figures in parentheses are square root of (X + 0.5) transformed values.

(10.83) and oxydemeton methyl (11.34). These effective treatments amongst each of the groups were on par with each other. During 2008, the data on the post-treatment mean thrips count $three^{-1}$ leaves indicated that clothianidin (6.22), thiamethoxam (6.98) and acetamiprid (7.68) continued to be the most potent treatments, which were stastiscally in similar range. The next effective treatments were triazophos (8.27), imidacloprid (9.52) and lambda cyhalothrin (10.26) followed by indoxacarb (10.78), acephate (12.17) and oxydemeton methyl (12.74). These treatments amongst each of the groups were however, on par with each other. The cumulative mean of the two years data revealed that (Table 1) at 3 DAS, clothianidin (6.73) was found to be most effective treatment than rest of the treatments except, thiamethoxam (7.48) and acetamiprid (8.02). In the descending order of efficacy the next promising treatments were triazophos (8.71) and imidacloprid (10.59), which were also on par followed by lambda cyhalothrin (11.19) and indoxacarb (11.85) followed by acephate (13.68) and oxydemeton methyl (14.28); treatments amongst each of the groups were however, on par with each other. At 5 and 7 DAS, the similar trend of efficacy was observed. At 10 DAS, the most effective treatments were clothianidin (3.66), thiamethoxam (4.17) and acetamiprid (4.50), which were statistically in similar range. Triazophos (4.94), imidacloprid (5.39) and lambda cyhalothrin (5.85) were observed to be the next promising treatments on par and followed by indoxacarb (6.35), acephate (7.20) and oxydemeton methyl (7.51), which were also on par with each other. The overall cumulative results revealed that the means computed from 1-10 DAS indicated that the supremacy of clothianidin (5.77) continued over rest of the treatments except, thiamethoxam (6.47) and acetamiprid (7.12), which were on par. In the descending order of bioefficacy the next promising treatments were triazophos (7.68), imidacloprid (8.81) and lambda cyhalothrin (9.50), followed by indoxacarb (10.00), acephate (11.29) and oxydemeton methyl (11.82), the treated check. These treatments amongst each of the groups were however, on par with each other. General trend of field bioefficacy of the treatments under the studies against the thrips indicated as clothianidin, thiamethoxam and acetamiprid > triazophos, imidacloprid and lambda cyhalothrin > indoxacarb, acephate and the standard treated check, oxydemeton methyl.

The results of the present findings are in accordance with the findings of the earlier workers. Wahla *et al*. (1997) reported that thiamethoxam, imidacloprid were effective against thrips on cotton. Holloway and Forrester (1998) found that indoxacarb, imidacloprid was effective against thrips. Vadodaria *et al*. (2001) reported that thiamethoxam and imidacloprid were effective in keeping thrips population below ETL. Dhandapani *et al*. (2002) reported that clothianidin was found to be effective against thrips on cotton. Bhosle *et al*. (2004) found that imidacloprid and indoxacarb were effective against thrips. Das and Veda (2004) reported effectiveness of imidacloprid and acephate against thrips. Muhammad *et al*. (2004) observed that imidacloprid, acetamiprid, thiamethoxam were excellent against thrips by recording maximum decrease in population. Wadnerkar *et al*. (2004) found that thiamethoxam was effective against thrips. Ulganathan and Gupta (2004) reported that imidacloprid, acetamiprid, indoxacarb and lamda-cyhalothrin were effective against thrips on cotton. Singh and Kumar (2005) recorded maximum reduction in population of thrips with acetamiprid and imidacloprid. Patil *et al*. (2006) observed that foliar sprays of acetamiprid were effective against thrips on cotton.

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Efficacy of Some Newer Insecticides in Controlling Leaf Miner (*Liriomyza trifolli* Burgess) and Fruit Fly (*Bactrocera cucurbitae* Coq.) on Cucumber*

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Abstract

Treatment of cartap hydrochloride recorded significantly highest per cent decline of live mines of *L. trifolli* on cucumber leaves (71.78%) followed by treatments of imidacloprid, thiomethoxam and spinosad. Similarly treatment of spinosad was found most effective showing least per cent fruit infestation by *B. cucurbitae* on number (16.73%) and weight (10.61%) basis followed by treatments of cartap hydrochloride and NSKE. Application of spinosad (109.26 q ha^{-1}), cartap hydrochloride (101.00 q ha^{-1}) and NSKE (95.63 q ha^{-1}) sprays gave better yield of healthy cucumber fruits resulting in higher monetary returns compared to other treatments and best cost:benefit ratio (CBR) of 1:27.7 recorded for the treatment of NSKE sprays followed by treatments of acetamaprid (1:18.3) and cartap hydrochloride (1:15.4).

Key words : *Liriomyza trifolli* (Burgess), *Bactrocera cucurbitae* Coq., chemical control, insecticides, cucumber.

The American serpentine leaf miner, *Liriomyza trifolii* (Agromyzidae : Diptera) (Burgess) and the melon fly or cucurbit fly, *Bactrocera cucurbitae* Coq. (Tephritidae : Diptera) are key pests of cucumber reported from all the areas wherever this crop is grown. Besides cucumber, the leaf miner infests castor, cotton, tomato, leafy vegetables, gourds, marigold and various weeds (Lakshminarayana *et al*., 1992) whereas fruit fly also infests beans, eggplant, tomato, gourds etc., which are severely damaged by its attack and often more than fifty per cent of the fruits are damaged either partially or totally rendering them unsuitable for human consumption. Stonehouse (2001) estimated loss of Rs 26.902 million due to fruit fly attack in India. Considering the economic importance of these two pests and their severe infestation on cucumber crop in Western Maharashtra region, the effectiveness of some newer insecticides was studied for control of these pests under field conditions.

Materials and Methods

The experiment was conducted in a randomized block design with seven insecticidal treatments and untreated plot (Table 1) replicated thrice during summer period of 2005-06 at IARI Regional Station Farm, Baner phata, Pune. The cucumber variety 'Himangi' was sown in field at the spacing of 1.5m between rows and o.5m between the plants. All other recommended horticultural practices were followed for raising the cucumber crop. At the time of each application the solution of neem seed kernel (NSKE) was prepared freshly by overnight presoaking of 500 g of NSKE powder in 100ml water which was filtered and squeezed next day by giving 2-3 washings and making 10 litres of solution with addition of 20 g of soap powder as wetting agent. The measured quantity of each of the remaining insecticides was dissolved in required quantity of

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Table 1. Effectiveness of newer insecticides for control of Leaf miner (*L. trifolli*) on cucumber.

Treatments	% decline of live mines of *L. trifolli* after			
	1st spray	2nd spray	3rd spray	Pooled
Cartap hydrochloride (50 SP) 0.05%	66.56 (54.63)*	62.15 (52.13)*	71.95 (58.5)*	66.88 (55.10)*
Acetamaprid (20 SP) 0.005%	57.50 (49.33)	51.13 (45.63)	59.3 (50.71)	55.97 (48.55)
Spinosad (2.5 SC) 0.01%	61.08 (51.39)	41.94 (40.07)	70.85 (57.35)	57.95 (49.58)
Imidacloprid (17.8SL) 0.0025%	64.51(53.42)	65.44 (54.10)	57.87 (49.72)	62.60 (52.41)
Buprofezin (25 SC) 0.025%	52.01 (46.13)	41.02 (39.76)	54.16 (50.72)	49.06 (44.53)
Thiomethoxam (25 WG) 0.005%	63.50 (52.85)	61.16 (51.49)	60.68 (51.18)	61.78 (51.84)
NSKE 5%	49.65 (44.79)	57.6 (49.45)	48.83 (44.28)	52.02 (46.17)
Untreated control	0.0	0.0	0.0	0.00
SEm±	1.77	2.69	4.07	2.28
CD @ 5%	5.37	8.14	12.35	6.94

*Figures in parentheses are arc-sine transformed values.

water and sprayed at fortnightly intervals starting 15 days after seed germination and initiation of flowering. Total three spray applications were carried out. For leaf miner infestation, pre and post counts of number of live mines of *L. trifolli* were recorded in morning hours on six leaves (top-2, middle-2 and bottom-2) of each of randomly selected three plants per plot on 3rd, 7th and 14th day after each spray application from which the per cent decline of live mines were worked out by using the following formula

$$\text{\% decline of live mines} = \frac{\text{Pre count of live mines} - \text{post count of live mines}}{\text{Pre count of live mines}} \times 100$$

Observations on fruit fly incidence were recorded at each picking of cucumber fruits at an interval of eight days. The number and weight of total and infested fruits were counted separately for each plot to work out the percentage infestation due to *B. cucurbitae* on number and weight basis. The data for all the pickings were pooled after final harvesting. The cost:benefit ratio (CBR) for individual treatment was worked out on the basis of yield data of marketable healthy cucumber fruits and the monetary returns it fetched.

Results and Discussion

Decline of live mines : All the treatments showed significant differences (Table 1) over

Table 2. Effectiveness of newer insecticides against fruit fly (*B. cucurbitae*) on cucumber.

Treatment	Fruit infestation on number (fruits ha^{-1}) basis (%)	Fruit infestation on weight (q ha^{-1}) basis (%)
Cartap hydrochloride (50 SP) 0.05%	19.53 (26.21)*	12.46 (20.62)*
Acetamaprid (20 SP) 0.005%	24.55 (29.67)	16.98 (24.27)
Spinosad (2.5 SC) 0.01%	16.73 (24.12)	10.61 (19.00)
Imidacloprid (17.8SL) 0.0025%	25.3 (30.26)	17.21 (24.50)
Buprofezin (25 SC) 0.025%	24.46 (29.60)	19.71 (26.35)
Thiomethoxam (25 WG) 0.005%	27.8 (31.82)	15.63 (23.34)
NSKE 5%	21.79 (27.83)	12.63 (20.79)
Untreated control	63.81 (53.01)	56.15 (48.50)
SEm±	2.87	2.47
CD @ 5%	8.71	7.37

* Figures in parethesis are arc-sine transformed values.

control plot in reducing the percentage live mines of leaf miner on cucumber crop after all the three spray applications. The treatment with cartap hydrochloride recorded highest decline of 66.56 and 71.95 per cent after first and third applications respectively, whereas spray of imidacloprid was found most effective showing 64.51 per cent decline of live mines after second application. The other promising treatments exhibiting equally good control of leaf miner damage during all the three spray applications included thiomethoxam, NSKE and spinosad.

The pooled data of three spray applications indicated significant reduction in incidence of cucumber leaf miner in all insecticides treated plots with highest decline of live mines recorded in plots treated with cartap hydrochloride (66.88%) followed by imidacloprid (62.60%), thiomethoxam (61.78%), and spinosad (57.95%).The efficiency of cartap hydrochloride in controlling *L. trifolli* has been reported by many workers (Saito *et al*., 1993; Lima and Machado, 1994; Gawade, 2003); Jagannatha (1994), Paradikovic (1998) and Gahbiche (2001) also reported effective control of *L. trifolli* with imidacloprid, spinosad and NSKE, respectively. The present investigations also proved thiomethoxam, a neonecotinoid compound, quite effective against leaf miner of cucumber, a sensitive vegetable crop.

Infestation of cucumber fruits : The fruit fly infestation was significantly controlled by different insecticides (Table 2) as compared to control plot showing highest number of infested fruits (63.81%). The treatment of spinosad showed least infestation (16.73%) followed by treatments of cartap hydrochloride, NSKE, buprofenzin, acetamaprid and imidacloprid.

The results as regards percentage infestation of cucumber fruits by fruit fly on weight basis also showed significant reduction in the pest attack due to insecticide treatments as compared to control plot (56.15%). Treatment with spinosad showed minimum infested fruits (10.61%) followed by treatments of NSKE, cartap hydrochloride, thiomethoxam, acetamaprid and imidacloprid.

The results obtained with the use of spinosad 2.5 SC against fruit fly are in close agreement with the report of Sooker *et al*.

Table 3. Yield and economics of insecticidal treatments used against leaf miner (*L. trifolli*) and fruit fly (*B. cucurbitae*) on cucumber.

Treatment	Yield of healthy fruits (q ha^{-1})	Gross income (Rs. ha^{-1})	Additional income over control (Rs.)	Cost of treatments + labour charges (Rs.)	Net profit over control (Ra. ha^{-1})	Cost benefit ratio (CBR)
Cartap hydrochloride (50 SP) 0.05%	101.00	40440	30680	1860	28820	1:15.4
Acetamiprid (20 SP) 0.005%	80.66	32264	22504	1164	21340	1:18.3
Spinosad (2.5 SC) 0.01%	109.26	43704	33944	3000	30944	1:10.3
Imidacloprid (17.8SL) 0.0025%	76.11	30440	20680	2611	18069	1:06.9
Buprofezin (25 SC) 0.025%	69.66	27864	18104	2610	15494	1:05.9
Thiomethoxam (25 WG) 0.005%	86.86	34744	24984	1860	23124	1:12.4
NSKE 5%	95.63	38252	28492	990	27502	1:27.7
Untreated control	24.40	9760	-	-	-	-
SEm±	6.20	-	-	-	-	-
CD @ 5%	18.81	-	-	-	-	-

(2001). The another treatment of cartap hydrochloride 50 SP was also found very effective against this pest by Reddy (1997) whereas findings obtained with the use of neem product such as NSKE are in close conformity with the results obtained by Ranganath *et al*. (1997), Rajapakse (2000), Chadramani *et al*. (2000), Schmutterer and Singh (2002) and Babu *et al.* (2002).

Cost : benefit ratio(C:B) : All the treatments produced significantly superior yield of healthy cucumber fruits (Table 3), as compared to control plot (24.40 q ha^{-1}). The yield (109.26 q ha^{-1}) was significantly highest in plots treated with spinosad followed by cartap hydrochloride and NSKE. Accordingly the maximum net monetary returns of Rs.30,944 ha^{-1} was obtained from the plot receiving spinosad sprays followed by treatments of cartap hydrochloride and NSKE.

The highest C:B (1:27.7) was recorded with NSKE sprays closely followed by the plots receiving sprays with acetamaprid (1:18.3) and cartap hydrochloride (1:15.4). The least C:B of 1:5.93 was obtained from treatment with buprofezin (0.025%).

It could be interpreted from these results that although the treatment with NSKE provided highest CBR, the additional returns over cost of treatment in NSKE treated plots (Rs.27502 ha^{-1}) were less than that obtained from plots receiving the treatment with spinosad (Rs. 30944 ha^{-1}) and cartap hydrochloride (Rs. 28820 ha^{-1}). It is, therefore, concluded that fortnightly spray applications of cartap hydrochloride (0.05%) or spinosad (0.01%) or NSKE (5%) can effectively and economically control the leaf miner as well as fruit fly damage on cucumber plants however, sufficient time gap is to be followed in between spray application and fruit harvesting operations.

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Effect of Newer Insecticides Against Whitefly (*Bemisia tabaci* Genn.), a Vector of Yellow Vein Mosaic Virus on Okra*

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Abstract

The fortnightly spray application of thiomethoxam (0.005%) 20 days after sowing was found most effective in suppressing the population of nymphs and adults of whitefly as well as the incidence of YVMV in treated plots. It also recorded the maximum mean yield (84.80 q ha^{-1}) of okra fruits and net monetary return of Rs. 26060.00 ha^{-1}. The other promising treatments in checking the whitefly population and incidence of YVMV on okra included spray applications of acetamiprid and imidacloprid which recorded 80.62 and 75.60 q ha^{-1} yield of okra fruits and monetary returns of Rs 22200 and 16656 ha^{-1}, respectively. The highest C:B ratio of 1:24.1 was obtained with treatment of acetamiprid followed by thiomethoxam (1:19.7).

Key words : *Bemisia tabaci* Gennadius, YVMV, insecticide effect, okra.

Okra or lady's finger (*Abelomoschus esculentus* Moench) is a high value vegetable crop which faces considerable economic losses due to consistent damage caused by whitefly (*Bemisia tabaci* Gennadius). Besides causing direct damage, whitefly acts as a vector of yellow vein mosaic virus (YVMV) which is a major constraint in okra cultivation (Neeraja *et al*., 2004). Thus the whitefly, both as a pest and vector of YVMV, causes heavy losses to okra crop by affecting the quality and yield. Considering the economic importance of this pest and its severe infestation on okra crop in Western Maharashtra region, the management of whitefly and YVMV with newer insecticides was studied under field conditions.

* Part of M.Sc. (Agri.) thesis submitted to the MPKV, Rahuri.

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Materials and Methods

The experiment was conducted in randomized block design (RBD) with seven insecticidal treatments and untreated plot (Table 1) replicated thrice. At the time of each application the measured quantity of each of the insecticides was dissolved in required quantity of water and sprayed at fortnightly intervals starting from 20 days after seed sowing. Total two spray applications were carried out. For white fly incidence, observations were recorded in early morning hours for number of nymphs and adults of white flies on three leaves (top, middle and bottom) of each of randomly selected five plants per plot. Pre and post counts on 3rd, 7th and 14th day after each spray applications provided the percent mortality count of nymphs and adults of white flies by using the formula % mortality of white fly (nymph/adult) = Pre count-post count of white fly (nymph/adult) / Pre count of white fly (nymph/adult) x 100.

Incidence of YVMV on okra crop was measured in terms of observations recorded on total number of plants and the plants showing YVMV symptoms in each plot on 3rd, 7th and 14th day after each spray applications. Percentages of disease incidence was worked out for knowing the effect of insecticides on spread of disease.

On the basis of yield of marketable healthy fruits plot^{-1} (q ha^{-1}) obtained from each treatment and the cost of application of the treatment, cost:benefit ratio (C:B) for individual treatment was worked out.

Results and Discussion

Nymps : All insecticidal treatments were found significantly superior (Table 1) over control in checking the white fly nymphs on okra after both the applications. The plots treated with thiomethoxam (0.005%) recorded highest nymphal mortality of 73.70 and 86.82 pet cent followed by treatment of acetamiprid

Table 1. Effectiveness of insecticides against nymphs and adults of whitefly (*B. tabaci* Gen).

Treatment	% mortality of whitefly nymphs			% mortality of whitefly adults		
	First spray*	Second spray*	Pooled average	First spray*	Second spray*	Pooled average
Thiomethoxam 25 WG (0.005%)	73.70 (60.32)**	86.82 (69.67)	80.26 (63.93)	73.27 (59.97)	90.73 (72.91)	82.00 (65.57)
Imidacloprid 17.8SL (0.01%)	57.99 (49.81)	72.99 (59.22)	65.49 (54.15)	58.71 (50.24)	72.66 (58.99)	65.68 (54.25)
Spinosad 2.5 SC (0.0025%)	41.23 (39.07)	55.42 (48.17)	48.33 (44.03)	43.98 (41.09)	51.42 (45.81)	47.70 (43.68)
Oxydemeton-methyl 25EC (0.03%)	44.36 (41.25)	55.60 (48.32)	49.98 (44.99)	47.13 (43.19)	57.56 (49.53)	52.35 (46.35)
Fenpropathrin 30EC (0.02%)	53.02 (46.73)	66.03 (54.73)	59.52 (50.54)	55.19 (48.08)	65.34 (54.25)	60.27 (50.96)
Triazophos 20 EC (0.05%)	55.03 (47.96)	68.43 (56.22)	61.73 (51.85)	55.02 (47.95)	68.76 (56.35)	61.89 (51.95)
Acetamiprid 20SP (0.005%)	64.52 (53.73)	74.09 (59.91)	69.31 (56.42)	66.51 (55.24)	67.09 (55.72)	66.79 (54.81)
Untreated (control)	0.0	0.0	0.0	0.0	0.0	0.0
S. Em.±	3.02	2.22	1.51	2.79	2.52	2.21
C. D. @ 5%	9.16	6.73	5.04	8.47	7.64	7.38

*Means of three observations on 3rd, 7th and 14th DAS, ** Figures in parentheses are arc sin transformed values.

(0.005%) showing 64.52 and 74.09 per cent nymphal mortality after first and second spray applications, respectively. The average effect of two sprays indicated all insecticides treated plots having significant reduction in pest incidence over untreated control which showed no nymphal mortality. Significantly highest nymphal mortality of 80.26 per cent was recorded on the plants treated with thiomethoxam followed by treatments of acetamiprid, imidacloprid, triazophos and fenpropathrin indicating 69.31, 65.49, 61.73 and 59.52 per cent mortality of white fly nymphs, respectively on okra crop.

Adults : The adult population of white fly was significantly controlled by different insecticides as compared to control plot which showed no adult mortality after both first and second spray. The treatment of thiomethoxam showed highest adult mortalities (73.27% and 90.73%) followed by treatments of acetamiprid, imidacloprid, fenpropathrin and triazophos showing 66.51 and 67.09, 58.71 and 72.66, 55.19 and 65.34, 55.02 and 68.76 per cent adult mortalities of white fly after first and second spray applications, respectively. The pooled data of two applications revealed significant reduction in pest incidence over untreated control exhibiting zero mortality of whitefly adults. Compared to other treatments, significantly higher adult mortality of 82.00 per cent was recorded in plots treated with thiomethoxam followed by treatments of acetamiprid, imidacloprid, triazophos and fenpropathrin showing 66.79. 65.68, 61.89 and 60.27 per cent white fly adult mortality, respectively.

The above findings of most effective control of nymphs and adults of whitefly on okra crop with thiomethoxam (0.005%) are in conformity with the results obtained by Sharma and Lal (2002), Muhammad *et al.*, (2003), Ganapathy and Karuppiah (2004) and Bhalala *et al*. (2006). Though Lopez and Rivera (1997) as well as Horowiz et al. (1998) reported better control of whitefly with acetamiprid than imidacloprid, Mote *et al*. (1994) and Nemade *et al.* (2007) proved imidacloprid as effective as other insecticides against whitefly pest. Similarly effectiveness of triazophos in checking whitefly infestation on crops has been demonstrated by Vidyashekhar *et al*. (1989), Somasekhara *et al*. (1997) and Ameta *et al*. (2006) whereas Gowdar *et al*. (2007) found all the three insecticides i. e. acetamaprid, imidacloprid and triazophos significantly

Table 2. Effectiveness of insecticides against yellow vein mosaic virus (YVMV) on okra.

Treatment	**% incidence of YVMV**		
	First spray*	**Second spray***	**Pooled average**
Thiomethoxam 25 WG (0.005%)	3.37 (10.51)**	10.56 (18.95)	6.94 (15.27)
Imidacloprid 17.8SL (0.01%)	3.89 (11.20)	12.22 (20.44)	8.06 (16.49)
Spinosad 2.5 SC (0.0025%)	10.00 (18.31)	27.22 (31.37)	18.61 (25.48)
Oxydemeton-methyl 25EC (0.03%)	6.12 (14.28)	19.44 (26.10)	12.78 (20.92)
Fenpropathrin 30EC (0.02%)	5.55 (13.46)	18.33 (25.31)	11.95 (20.17)
Triazophos 20 EC (0.05%)	6.11 (14.22)	14.72 (22.41)	10.42 (18.71)
Acetamiprid 20SP (0.005%)	3.89 (11.32)	11.95 (20.17)	7.92 (16.30)
Untreated (control)	46.44 (42.96)	75.56 (60.38)	61.00 (51.36)
S. Em.±	1.23	1.38	1.04
C. D. @ 5%	3.72	4.19	3.14

*Means of three observations on 3rd, 7th and 14th DAS, ** Figures in parentheses are arc sin transformed values.

reducing the whitefly population on okra and Zhu *et al*. (1998) showed better efficacy of imidacloprid than that of fenpropathrin against whitefly corroborating the results obtained in the present investigation.

YVMV incidence : After first spray, all insecticidal treatments significantly recorded lower incidence of YVMV as compared to untreated control showing 46.44 per cent disease incidence. Plots treated with thiomethoxam exhibited lowest disease incidence (3.37%) followed by treatments of acetamiprid (3.89%), imidacloprid (3.89%), fenpropathrin (5.55%), triazophos (6.11%) and oxydemeton-methyl (6.12%). After second spray application also, the treatments recorded significantly lower incidence of YVMV on okra crop compared to control plot (75.56%). In this case also thiomethoxam was most effective recording minimum disease incidence (10.56%) followed by treatments of acetamiprid (11.95%), imidacloprid (12.22%) and triazophos (14.72%). The average effect of both the sprays indicated all the treatments as significantly superior over control in checking the YVMV incidence. The lowest incidence of 6.94 per cent was observed in plots treated with thiomethoxam followed by treatments of acetamaprid and imidacloprid showing 7.92 and 8.06 per cent disease incidence.

The results obtained in present investigation are supported by the work of Yadav *et al*. (2007) who reported the reduction of incidence of YVMV from 59.19 per cent in control plot to 22.14 per cent in plots treated with thiomethoxam, imidacloprid, acetamiprid and other insecticides. The effectiveness of acetamiprid and imidacloprid in checking the incidence of YVMV has also been demonstrated by Mote *et al*. (1994), Shivpuri *et al*. (2004), Safder-Ali *et al*. (2005) and Gowdar *et al*. (2007).

Cost:benefit ratio : The C:B ratio worked out on the basis of yield of healthy fruits obtained from individual treatment revealed maximum monetary returns (Rs. 25980) from plot receiving thiomethoxam spray followed by acetamiprid (Rs. 22200) and imidacloprid (Rs. 16656). The maximum C:B ratio of 1:24.1 was recorded from treatment with acetamiprid sprays closely followed by the plots receiving spray of thiomethoxam (1:19.7). The other treatments in order of merit were fenpropathrin (1:12.5), imidacloprid (1:11.5), oxydemeton methyl (1:10.8) and triazophos (1:10.3).

It can be interpreted from these results that although the treatment of acetamaprid provided higher C:B ratio, considering the additional returns over cost of treatment as well

Table 3. Economics of insecticide spray application.

Treatment	Yield (q ha^{-1})	Gross income (Rs.)	Additional income over control (Rs.)	Cost of treatment + labour (Rs.)	Net proft on control (Rs.)	C:B ratio
Thiomethoxam 25 WG (0.005%)	84.80	84800	27300	1320	25980	1:19.7
Imidacloprid 17.8SL (0.01%)	75.60	75600	18100	1444	16656	1:11.5
Spinosad 2.5 SC (0.0025%)	67.20	67200	9700	1720	7980	1:4.6
Oxydemeton-methyl 25EC (0.03%)	67.85	67850	10350	877	9473	1:10.8
Fenpropathrin 30EC (0.02%)	69.50	69500	12000	886	11114	1:12.5
Triazophos 20 EC (0.05%)	73.10	73100	15600	1375	14225	1:10.3
Acetamiprid 20SP (0.005%)	80.62	80620	23120	920	22200	1:24.1
Untreated (control)	57.50	57500				

Sale price of okra - Rs. 10 kg^{-1}

as efficacy against nymphs and adults of white fly and incidence of YVMV, thiomethoxam followed by acetamaprid and imidacloprid were most promising insecticides in controlling the whitefly pest *vis-a-vis* YVMV incidence on okra crop.

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Effect of Amino Acids on Induction of Resistance and Peroxidase Activity Against *Albugo candida* in Mustard (*Brassica juncea*)*

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Abstract

The mustard genotype EC-399301 (RESJ-177) (white rust-susceptible at cotyledonary leaf stage but resistant at the true leaf stage), when treated with the ammo acids at the cotyledonary leaf stage following pre inoculation application of *A. candida* showed no development symptoms in contrast to profuse development of white rust (WR) pustules on cotyledons of similarly inoculated check plant of the same genotype. The results thus revealed induction of host resistance of otherwise susceptible cotyledonary stage of EC-399301 (RESJ-177). No symptom development due to the amino acids was characterized by expression of hypersensitive-like necrotic lesions on the cotyledons in T_1 L-Pro (@1000 ppm), T_7 L-Glu acid (@1000 ppm), T_9 L-Cys Hyd (@1500 ppm) treatments. The significant maximum peroxidase activity was recorded in treatment T_5 L-Cys at 2000 ppm (0.073 unit mg^{-1}) in comparison to check (0.04 unit mg^{-1}). Following post inoculation application of *A. candida* no symptom development due to the amino acids was characterized by expression of hypersensitive-like necrotic regions on the cotyledons in all treatments of amino acids @ 2000 ppm except T_3 L-Tyr. The peroxidase activity was recorded in the range of 0.013-0.367 unit mg^{-1} in comparison to check (0.049 unit mg^{-1}). In both the cases of pre and post inoculation application of the above amino acids hypersensitive response of the treated cotyledons was associated with concomitant increase in the peroxidase activity. The results thus revealed induction of host resistance of otherwise susceptible cotyledonary stage of EC-399301 (RESJ-177).

Key words : Peroxidase, *Albugo candida*, genotype EC-399301 (RESJ-177), amino acids, induced host resistance.

Host resistance can be induced by the application of non pathogenic micro organisms (Vishwanath *et al*., 1999 and Singh *et al.*, 1999) and certain chemicals such as salicylic acid (Spletzer and Enyedi, 1999) and β - amino butyric acid (Cohen *et al*., 1994; Kaur and Kolte, 2001). Plant adopts a variety of biochemical defense towards microbial attack. Various metabolic changes in plant tissues induced by biotic and abiotic inducers have been reported by various research workers (Gorlach *et al*., 1996; Reuveni *et al*., 1997; Sticher *et al*. 1997; Benhamou and Belanger, 1999; Singh *et al*., 1999; and Howell *et al*., 2000). It is well established fact that the resistance can be induced in plants by biotic as well as abiotic agents (Kessman *et al.*, 1994, Sticher *et al*., 1997, Kaur and Kolte, 2001). Genes in the susceptible plants can be activated to show resistance by inoculation with biotic as well as abiotic inducers (Vishwanath *et al*., 1999). Therefore, the exploitation of possibility of utilizing induced host resistance as a realistic alternative to classical fungicides, needs to be studied in specific host pathogen interaction.

In this context, the present investigation was carried out to study mechanism of induction of host resistance due to pre- and post - inoculation of amino acids against white rust of true leaf- resistant mustered genotype EC-399301 (RESJ-177) but susceptible at the

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cotyledonary leaf stage (Mishra *et al.*, 2009).

Materials and Methods

In the present study, laboratory- cum-glasshouse experiments was conducted on white rust true leaf -resistant mustard genotype EC-399301 (RESJ-177) but susceptible at cotyledonary leaf stage at GBPUA and T., Pantnagar. The healthy seeds maintained through selfing were obtained from oilseed pathology laboratory, GBPUA and T., Pantnagar which were earlier obtained through NBPGR under the Indo-UK collaboration on oilseeds (Kolte *et al*., 2006). All chemicals and reagents were of analytical grade. Chemicals used in the study of peroxidase assay were obtained from Sigma Chemical Company, USA.

Induction of resistance using cotyledons : The seeds were sown in plastic pots and arranged in propagator trays (41 x 30 x 7 cm) in three rows. Two to three seedlings were maintained per pot of the propagator trays. Seven-day-old seedlings with expanded cotyledons were used for inoculation.

Humid chambers : The humid chambers were prepared by putting the iron frame of 1.5 x 0.6 x 0.7 m size over the cement pit of 1.45 x 0.45 x 0.45 m size containing water and covered by plastic sheet. This helps in providing high humidity for infection. Four sets of such humid chambers were prepared maintaining the inoculating treatments in isolation treatments to avoid any drift. Another type of humid chamber was prepared by propagators trays of size 41x30x7cm containing water and covered by plastic sheet.

Induction of host resistance using amino acids :

Preparation of *A. candida* inoculum : WR infected leaves were collected from field - grown white rust (WR) susceptible mustard cultivar "varuna" at the Crop Research Centre (CRC) GBPUA and T., Pantnagar and further maintained as generation of single WR pustule on the same cultivar on pot-grown mustard plants under glasshouse conditions. Zoosporangial powder was obtained by scrapping the surface of pustules with sterilized blade. Sporangia of *A. candida* @200 mg sporangial powder was added to 100 ml of double glass distilled water in 200 ml of flask. The flask was then covered with parafilm and shaken vigorously to obtain uniform suspension of sporangia in water. The culture was then incubated for 4 hrs at 15°C to obtain germination of sporangia so as to obtain zoospores suspension which served as the inoculum for inoculation on the cotyledons. The zoospore concentration was adjusted to 10^5 zoospores per ml. The amino acids with 500, 1000, 1500 and 2000 ppm concentration used were L-Proline (T_1 L-Pro), L-Lysine Monohydrochloride (T_2 L-Lys Mon), L-Tyrosine (T_3 L-Tyr), L-Leucine (T_4 L-Leu), L-Cystine (T_5 L-Cys), L-Arginine Monohydrochloride (T_6 L-Arg Mon), L-glutamic acid (T_7 L-Glu Acid), Glycine (T_8 Gly), L-Cysteine Hydrochloride (T_9 L-Cys Hyd), L-Histidine Monohydrochloride (T_{10} L-His Mon) and Unsprayed (check).

Mustard seedlings treated with different amino acids at 500, 1000, 1500 and 2000 ppm concentrations were challenge inoculated after 24 hrs with *A. candida* keeping suitable control. In another experiment, cotyledons were first inoculated with *A. candida* suitable control and after 24 hrs., treatments of amino acids were given keeping suitable control. In each case of the two methods of inoculation, effect of amino acid with the same concentrations was tested by placing 2 drops (10 µl) with the help of Eppendorf pipette on adaxial surface of each cotyledon and the same

leaf surface was used for inoculation of *A. candida*. Propogator trays were covered with polythene to obtain 90 to 100 per cent relative humidity for 72 hr.

Observations on WR severity on cotyledonary leaves were recorded 15 days after inoculation by using an interaction phenotype (IP) rating scale of 0-9 given by Williams (1985) where, IP of 0-1 (no or traces of WR infection) was rated as resistant hypersensitive reactions and IP of 7-9 (profuse WR symptoms on lower surface of cotyledons) was rated as susceptible reaction.

Leaf samples were collected randomly from 2000 ppm concentration and check treatments. Immediately after sampling, the leaf materials were wrapped in aluminium foil, weighed and stored in 1 g packs at -80°C. Then extracted supernatant was used for the estimation of peroxidase assays. One gram of fresh leaf tissues were macerated in 3 ml of 0.1 M extraction buffer (pH 7.0) in a prechilled mortar with pestle at 4°C for 20 minutes. The supernatant was aspirated with the help of micropipette and was kept on ice. This mixture was used as crude enzyme for estimation of peroxidase. Peroxidase activity was measured at 510 nm, Waventength.

Reagents of 0.2 M potassium phosphate buffer (pH 7.0) 0.0017 M H_2O_2 prepared by dilution of 1 ml of 30 per cent H_2O_2 to 100 ml with reagent grade water and further diluted 1 ml of this solution to 5 ml with 0.2 M phosphate buffer (pH 7.0) prepared freshly. 0.0025 M amino antipyrine with 0.17 M phenol prepared by dissolving 810 mg phenol in 40 ml reagent grade water and 25 mg 4 amino antipyrine added and diluted to final volume of 50 ml with grade water.

One mg ml^{-1} of enzyme was dissolved grade

Table 1. Effect of pre-inoculation application of amino acids at different concentrations on reaction of mustard genotype EC-399301 at cotyledonary leaf stage against WR under glasshouse conditions.

Treatment	**Disease index (%) (15 DAI)***				
	Concentration (ppm)				
	500	**1000**	**1500**	**2000**	**Mean**
T_1 L-Pro	1.84 (7.63)	0.00 (0.57)	1.84 (6.57)	1.83 (4.90)	1.37* (4.77)
T_2 L-Lys Mon	4.00 (11.30)	7.71 (15.28)	1.53 (6.86)	0.30 (2.21)	3.38* (8.90)
T_3 L-Tyr	4.91 (10.61)	3.08 (8.30)	4.61 (10.30)	1.23 (4.07)	3.45* (8.32)
T_4 L-Leu	0.30 (2.21)	2.15 (8.22)	8.62 (15.07)	3.70 (10.71)	3.69* (9.05)
T_5 L-Cys	0.30 (2.21)	3.06 (8.40)	1.83 (4.90)	0.30 (2.21)	1.37* (4.43)
T_6 L- Arg Mon	2.15 (6.56)	4.31 (11.87)	2.46 (7.33)	0.30 (2.21)	2.30* (5.67)
T_7 L-Glu acid	2.15 (8.22)	0.00 (0.57)	2.46 (7.33)	1.84 (6.57)	1.61* (6.57)
T_8 Gly	1.84 (6.57)	2.77 (9.49)	1.23 (4.07)	0.61 (3.86)	1.61* (3.86)
T_9 L-CysHyd	1.84 (6.57)	1.54 (5.72)	0.00 (0.57)	1.85 (6.49)	1.30* (6.49)
T_{10} L-HisMon	1.23 (5.40)	2.46 (8.57)	3.08 (9.75)	2.46 (8.90)	2.14* (8.16)
Check	39.14 (38.71)	39.14 (38.71)	39.14 (38.71)	39.14 (38.71)	39.14 (38.71)
Mean	5.43 (7.44)	6.02 (8.17)	6.07 (8.01)	4.87 (6.49)	5.58 (7.47)
C.D. at 5%					
Treatment					3.95
Concentration					2.38
Interaction					7.91

*DAI = Days after inoculation, Figures in parenthesis are angular transformed values, * Statistically on par.

water immediately prior to use and dilute further to obtain a rate of 0.02 to 0.04 DA per minute. The spectrophotometer was adjusted to 510 nm and 25 µl of dilute was pipetted into each cuvette as phenol amino antipyrine solution (1.4 ml) and 0.0017 M H_2O_2 (1.5 ml). Incubated in spectrophotometer at 25°C for 3 to 4 minutes to achieve temperature equilibrium and blank reaction establishment. One ml of dilute enzyme was added and the increase in A 510 for 4 to 5 minutes was recorded. Calculated A 510 per minute from linear portion of curve. Peroxidase activity was calculated as Peroxidase activity (units mg^{-1}) = A 510 min^{-1} / 6.58 x mg of enzyme ml^{-1} reaction mixture.

Results and Discussion

Disease intensity on cotyledons : After fifteen days of pre-inoculation application of amino acid, the highly significant difference was found among treatment concentrations and interaction (Table 1). All treatments were significantly superior over untreated plants (check) (39.14%). All concentrations of amino acid were found to be stastically on par with each other. This revealed that lower concentration of 500 ppm is equally effective in all amino acid treatment.

It was observed that minimum disease index was observed at cotyledonary leaf stage when it was pre-inoculated with T_9 L-Cys Hyd (1.30%) which was at par with T_1 L-Pro (1.37%), T_5 L-Cys (1.37%), T_8 Gly (1.61%) and T_7 L-Glu acid (1.61).

After fifteen days of post-inoculation application of amino acid, the highly significant difference was found among treatment concentrations and interactions in genotype EC-399301 at cotyledonary leaf stage (Table 2). All treatments were superior over untreated

Table 2. Effect of post-inoculation application of amino acids at different concentrations on reaction of mustard genotype 'EC-399301' at cotyledonary leaf stage against WR under glasshouse conditions.

Amino acid treatment (Aa treatment)	Disease index (%) (15 DAI)*				
	Aa concentration (ppm)				
	500	1000	1500	2000	Mean
T_1 L-Pro	2.77 (9.58)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.69 (1.84)
T_2 L-Lys Mon	2.77 (7.73)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.84 (5.90)
T_3 L-Tyr	0.00 (0.00)	0.00 (0.00)	2.77 (7.73)	3.70 (10.93)	1.61 (4.66)
T_4 L-Leu	0.00 (0.00)	2.77 (9.58)	0.00 (0.00)	0.00 (0.00)	0.69 (2.39)
T_5 L-Cys	2.77 (7.73)	2.77 (7.73)	0.00 (0.00)	0.00 (0.00)	1.38 (3.86)
T_6 L- Arg Mon	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_7 L-Glu acid	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_8 Gly	0.00 (0.00)	2.77 (9.58)	2.77 (9.58)	0.00 (0.00)	1.38 (4.79)
T_9 L-CysHyd	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_{10} L-HisMon	0.00 (0.00)	2.77 (3.19)	0.00 (0.00)	0.00 (0.00)	0.69 (0.79)
Check	38.62 (38.93)	38.62 (38.93)	38.62 (38.93)	38.62 (38.93)	38.62 (38.93)
Mean	4.27 (5.01)	4.52 (5.36)	4.01 (4.54)	3.85 (4.18)	4.26 (4.97)
C.D. at 5%					
Treatment					2.12
Concentration					1.28
Interaction					4.25

*DAI = Days after inoculation, Figures in parenthesis are angular transformed values.

check. It was observed that T_9 L-Cys Hyd, T_7 L-Glu acid and T_6 L-Arg Mon recorded (0.0%) disease index which was at par with T_1 L-pro (0.69%) and T_{10} L-Hiz Mon (0.69%). The disease index in T_8 Gly was 0.38 per cent, T_3 L-Tyr 1.61 per cent and T_2 L-LycMon 1.84 per cent.

The mustard genotype EC-399301 (RESJ-177) (WR susceptible at cotyledonary leaf stage but resistant at true leaf stage), when treated with the amino acids at the cotyledonary leaf stage following post inoculation application of *A. Candida* expressed no symptoms in contrast to profuse development of WR pustules on cotyledons of similarly inoculated check plant of the same genotype.

The results thus revealed that the amino acids at 500 ppm conc can be better used to induce resistance in the host by following pre and post inoculation method. In the present studies, the amino acids as tested for their in vitro effect on *A. candida* indicated the tendency of reduction of sprorangial germination of *A. candida*. However, the results on inhibition on the fungal growth was non-significant.

The post-inoculation application of different amino acids on cotyledonary leaves of mustard genotype EC 399301 indicated maximum peroxidase activity (0.367 unit mg^{-1}) due to T_8 Gly, (0.303 unit mg^{-1}) , T_6 L-Arg Mon and (0.086 unit mg^{-1}) in comparison to check. All amino acids treatments following post inoculation showed no development of WR symptoms as against 38.62 per cent disease index in the case of check (Table 3).

In the present investigation, it was revealed that induction of host resistance of otherwise susceptible cotyledonary stage of EC-399301 (RESJ-177). The mustard genotype EC-399301 (RESJ-177) (WR susceptible at cotyledonary leaf stage but resistant at true leaf stage), when treated with the amino acids at the cotyledonary leaf stage following pre inoculation application of *A. candida* showed no development symptoms in contrast to profuse development of WR pustules on cotyledons of similarly inoculated check plant of the same genotype. No symptom development due to the amino acids was characterized by expression of hypersensitive-like necrotic regions on the cotyledons in T_1 L-Pro (@1 000 ppm), T_7 L-Glu acid (@1000 ppm), T_9 L-Cys Hyd (@1500 ppm).

The results thus revealed induction of host resistance of otherwise susceptible cotyledonary stage of EC-399301 (RESJ-177). No symptom development due to the amino acids was characterized by expression of hypersensitive-like necrotic regions on the cotyledons in T_6 L-Arg Mon, T_7 L-Glu acid and T_9 L-Cys Hyd (@500, 1000, 1500, 2000 ppm) when treated with the amino acids at the cotyledonary leaf stage following post inoculation application of *A. candida*.

Table 3. Effect of post-inoculation application of amino acids on peroxidase activity against *Albugo candida* on mustard genotype EC-399301 using cotyledonary leaves.

Treatment	Disease index (%)	Peroxidase activity (unit mg^{-1})
T_1 L-Pro	0.00 (0.00)	0.033
T_2 L-Lys Mon	0.00 (0.00)	0.086
T_3 L-Tyr	3.70 (10.93)	0.066
T_4 L-Leu	0.00 (0.00)	0.022
T_5 L-Cys	0.00 (0.00)	0.033
T_6 L- Arg Mon	0.00 (0.00)	0.303
T_7 L-Glu acid	0.00 (0.00)	0.055
T_8 Gly	0.00 (0.00)	0.367
T_9 L-CysHyd	0.00 (0.00)	0.019
T_{10} L-HisMon	0.00 (0.00)	0.013
Check	38.62 (38.93)	0.049
C.D. at 5%	1.121	0.12

Figures in parenthesis are angular transformed values. Enzyme activity in leaves from 2000 ppm conc. in ten amino acids treatment (s) were estimated.

The correlation analysis between proxidose activity and disease severy will help in better understanding the actual effect of preoxidose activity on disease development.

The induction of host resistance due to pre and post-inoculation application of amino acids was found to be associated with enhance activity of Peroxidase enzymes. Similar results were also reported by other research workers in other host-pathogen system. The role of salicylic acid in the induction of host resistance was also been reported by several other workers in different host-pathogen systems (Yalpani *et al*. 1991; Sticher *et al*. 1997; Harman, 2000 and Rohilla *et al*. 2001). Enhanced activity of peroxidase leads to the production and accumulation of hydroxyproline rich glycoprotein (HRCP) into the cell wall (Bradley *et al*. 1992). Peroxidases are also involved in lignin polymerization. The enzyme has multifaceted role in cell wall metabolism as well as in defense (Reuveni *et al*., 1997 and Singh *et al*., 1999).

The enzyme is involved in the synthesis of lignin and suberin and catalyze the oxidation of many mono and diphenol aromatic amines in the presence of hydrogen peroxide. The enzyme is also involved in crosslinking of polyphenol to the HRPGs molecules to strengthen the cell wall (Hammerschmidt and Kuc, 1992). Systemic protection of *B. juncea* against the compatible isolate by treatment with incompatible isolate of *A. candida* is host mediated with increased peroxidase and PAL-activity (Singh *et al*., 1999).

This information on the effectiveness of amino acids on reaction of mustard to WR infection will be useful in designing and understanding the mechanism of resistance in future studies. WR- true leaf resistant mustard genotype EC-399301 but susceptible at the cotyledonary leaf stage showed differences in response to amino acids application indicates the interaction between the host genotype and pathogen.

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Effect of Fungicidal Seed Treatment and Commercially Available Seed Dressers on Safflower Seed Germination and Seedling Vigour

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Abstract

The seeds treated with Thiram + Carbendazim showed lowest percentage of mycoflora and recorded superiority over rest of the treatments in all the test varieties followed by Thiram. In case of individual seed flora systemic fungicides yielded better result against *Alternaria carthami* and non-systemic fungicides against *Aspergillus flavus*. While in total seed flora PBNS 12 cultivar showed overall best response to all fungicidal treatments. Thiram + Carbendazim treatment over total seed mycoflora was recorded to the tune of 12.8 (Manjira), 10.9 (Sharda), 8.5 (PBNS 12) and 13.9 (Nira) per cent in blotter paper method, while 13.0 (Manjira), 11.0 (Sharda), 9.9 (PBNS 12) and 14.9 (Nira) per cent in rolled towel method. All the fungicides improved the germination percentage and restricted pre and post emergence mortality. Thiram + Carbendazim and Thiram treatments gave maximum germination percentage with increased vigour index and reduced- seed mycoflora percentage in all varieties and methods.

Key words : Seed treatment, seed dresser, seed germination, seedling vigour, safflower.

Seed act as vehicle for transport of micro organisms and harmful to plant. Seed borne pathogen particularly fungal pathogens affects directly and indirectly the quality and quantity of the oilseed crops in terms of deterioration and reduction in oil content, reduction in germination, viability of seed and potential losses in yields. As primary importance it is the fact that seed borne plant pathogens, introduce diseases. Safflower is known to suffer from many fungal, bacterial and viral diseases at different stage of crop growth (Bhale *et al*., 1998), such as *Fusarium* wilt, *Macrophomina* root rot, *Alternaria* blight as externally or internally seed borne fungi which are causing heavy losses to safflower crop.

Seed is the basic unit in the production technology of a crop. Use of healthy seed improves the seed quality in terms of variety, purity, germination and seed health. Microorganisms like fungi, bacteria, viruses, nematodes, etc. get associated with the seed internally, externally or as concomitant contamination keeping in view the importance of seed borne mycoflora in safflower, the present study was taken up.

Materials and Methods

For evaluation of efficacy of different fungicides, *viz*., Captan, Thiram, Mancozeb, Carboxin, Carbendazim and Thiram + Carbendazim were used. For this purpose healthy seeds of safflower were selected and divided into two lots. First lot was treated by dry seed treatment, by each fungicide as recommended by National Seed Corporation (NSC) and second lot was kept as untreated control. Then the seed samples were stored at room temperature in the laboratory for few days. These seed samples were tested further for seed mycoflora, seed germination and seedling vigour index by following rolled towel and blotter paper method. The formula used

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for calculating vigour index is Vigour Index = Germination percentage x (Root length + Shoot length).

Results and Discussion

Seed germination : Systemic and non systemic fungicides were evaluated for their efficacy in controlling mycoflora and improvement in germination of safflower. From the results presented in Table 1 it was observed that all the fungicides improved the seed germination in roll towel method when compared with the control. However, the effect varied with each fungicide. 96 per cent seed germination was recorded due to Thiram + Carbendazim seed treatment followed by Thiram in between 91 to 95. In control, seed germination was varied in between 76 to 84 per cent. The fungicides Captan, Thiram, Mancozeb, Carboxin, Carbendazim and fungicidal combination of Thiram + Carbendazim showed 87.25, 92.00, 86.00, 84.00, 85.00, 93.75 per cent mean germination respectively. The mean germination of control over all cultivars was 80.00 per cent.

The cultivars *viz*., Manjira, Sharda, PBNS 12 and Nira showed 86.28, 87.71, 89.71 and 84.00 per cent respectively. Thiram +

Table 1. Effect of fungicides on seed germination, vigour index and seed mycoflora of different cultivars by rolled towel method.

Fungicide	Manjira			Sharda			PBNS-12			Nira		
	Germination	Vigour index	Seed mycoflora	Germination	Vigour index	Seed mycoflora	Germination	Vigour index	Seed mycoflora	Germination	Vigour index	Seed mycoflora
Captan (0.25%)	86	670	13.9	88	690	11.2	91	709	10.5	84	646	15.5
Thiram (0.30%)	90	715	13.5	92	726	11.0	95	760	10.2	91	714	15.2
Mancozeb (0.25%)	87	669	14.7	86	670	11.7	88	690	11.48	83	630	16.3
Carboxin (0.25%)	84	638	14.1	85	654	12.8	86	679	11.3	81	607	17.0
Carbendazim (0.20%)	84	642	13.7	86	666	11.5	88	699	10.7	82	619	15.9
Thiram+ Carbendazim (0.30%)	93	753	13.0	95	779	11.0	96	806	9.9	91	728	14.9
Control	80	624	18.3	82	643	15.7	84	655	14.0	76	585	20.5

Table 2. Effect of fungicides on seed germination, vigour index and seed mycoflora by blotter towel method (cv. Manjira and Sharda).

Fungicide	Manjira			Sharda		
	Germination	Vigour index	Seed mycoflora	Germination	Vigour index	Seed mycoflora
Captan (0.25%)	85	407	13.5	87	421	11.7
Thiram (0.30%)	88	435	13.1	90	440	11.3
Mancozeb (0.25%)	85	398	14.7	84	402	13.0
Carboxin (0.25%)	84	386	14.5	85	399	13.2
Carbendazim (0.20%)	84	390	13.8	86	408	11.8
Thiram + Carbendazim (0.30%)	92	469	12.8	94	488	10.9
Control	80	384	16.2	82	397	14.5

Carbendazim and Thiram exhibited high degree of efficacy in per cent seed germination in all cultivars of safflower. The results obtained in respect to effectiveness of Thiram + Carbendazim and Thiram seed treatment in present investigation are in agreement with those reported in safflower by Prashanthi *et al.* (2000), Bramhankar *et al.* (2002) and Rao *et al*. (2007).

Seed flora : Results (Table 1) revealed that greater efficacy of systemic fungicides against *Alternaria carthami* as compared to non-systemic fungicides and of non-systemic fungicides against *Aspergillus flavus* compared to systemic fungicides. The fungicides Thiram and Thiram + Carbendazim were highly efficient over all other fungicides. Both fungicides showed highest efficacy against *Fusarium moniliforme*, *Rhizopus* spp. and *Macrophomina phaseolina* followed by *Alternaria carthami*, *Fusarium oxysporum* and *Aspergillus niger*.

The fungi *Fusarium* spp. and *Rhizopus* spp., showed greater reduction in seed flora as compared with control followed by *A. niger*, *Alternaria carthami* and *M. phaseolina* due to fungicide treatment. While seed treatment reduced *A. flavus* in all cultivars of safflower.

The cultivars PBNS 12 and Sharda showed greater, reduction in seed microflora due to seed treatment followed by Manjira cultivar. In variety Nira all fungi were observed on seed coat and reduced due to seed treatment as compared with control. The result obtained in present investigation are in conformity with those reported in past by Lahoti and Potdukhe (1990) and Charjan and Tarar (1991). Parihar and Kodmelwar (1995) reported that Thiram fungicide seed treatemnt improvemd the seed germination. Similarly Thiram + Bavistin in ratio (2:1) showed higher percentage of seed germination with number of fungal populations on seed.

Vigour index : The cultivar Manjira was recorded vigour index in the range of 638 to 7.53 and seed flora in 13.0 to 14.7 per cent whereas in control it was 624 and 18.3 per cent respectively. Similarly, the cultivars Sharda was recorded vigour index 654 to 779 and 11.0 to 12.8 per cent seed flora. Both cultivars showed significantly superior results over control. The cultivar PBNS 12 showed vigour index in the range of 679 to 806 and 9.9 to 11.4 per cent seed mycoflora. Similarly, the cultivar Nira recorded vigour index in range of 607 to 728 and 14.9 to 17.0 per cent seed flora while it was 585 and 20.5 per cent respectively in control.

The cultivar Manjira was recorded 386 to 469 vigour index and 12.8 to 14.7 per cent seed flora, while in control it was 384 and 16.2 per cent respectively by blotter paper method. Similarly, Sharda cultivars recorded 99 to 488 vigour index and 10.9 to 13.2 per cent seed flora. Both cultivars showed significantly superior results over control (Table 2).

The cultivar PBNS 12 showed 416 to 512 vigour index and 8.5 to 10.2 per cent seed mycoflora. Similarly, the cultivar Nira was recorded vigour index in the range of 364 to 450 and seed flora in 13.9 to 14.8 per cent. Where as it was 357 and 19.2 per cent respectively in control treatment.

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Effect of Amino Acids on Mycelial Growth of Mustard Alternaria blight (*Alternaria brassica*) Isolates

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Abstract

After fourteen days of incubation, the maximum colony diameter of isolate A was measured in check (8.63 cm). The minimum colony diameter was measured in T_{17} DL-Met (3.82 cm) which was at par with T_9 L-Cys Hyd (3.98 cm) followed by T_8 Gly (4.11 cm), T_{13} DL Ser (4.58 cm) and T_{18} DL-Val (4.99 cm). All other treatment also showed colony diameter in the range of 5.14 to 7.98 cm. The highly significant minimum colony diameter of isolate C was measured in T_8 Gly (2.71 cm) but at par with T_9 L-Cys Hyd (2.95 cm) followed by T_{20} DL-Iso Len (3.08 cm) and T_1 L-Pro (3.26 cm). All other treatment showed colony diameter in the range of 5.60 to 4.76 cm in comparison to check (4.17 cm).

Key words : Amino acids, *Brassica juncea*, *Alternaria brassicae*, isolates, growth inhibition.

Alternaria blight of rapeseed-mustard has been found to be a major constraints in the production of mustered crop in India (Kolte, 1986). Though many strategies of disease management are available, use of fungicides for the management of the diseases is the most convenient way. Systemic acquired resistance (SAR) can provide protection against broad spectrum of pathogen in the plants and induced by the application of non-pathogenic microorganisms (Vishwanath *et al.* 1999, Singh *et al*. 1999) and certain chemicals like salicylic acid (Spletzer and Enyedi, 1999) and B-Amino butyric acid (Cohen, 1994; Kaur and Kolte, 2001). However, genes in the susceptible plants can be activated to show resistance by inoculation with biotic as well as abiotic inducers (Vishwanath *et al*., 1999). In recent years, plant defense activators activate host defense mechanism and protect the plant against pathogens has been developed to manage crop diseases (Romero *et al*. 2001),.

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Salicylic acid mimic compound (acibenzolar-s-methyl, Bion), phosphorus salts (Foli-R-Fos 400, Nutri-Phite-P) and micronutrient potassium salts (Canon, Phytogard and Nutrol) have been developed as commercial plant activator (Graham and Leite,2004; Becot *et al.*, 2000; Macmillan *et al.*, 2000; Pajot *et al.*, 2001;).

Not much work has been done to utilize induced host resistance by using a biotic inducers in rapeseed-mustard. Keeping in mind this fact, the present studies on efficacy of amino acids in the control of mustard Alternaria blight was undertaken.

Materials and Methods

Efficacy of the amino acids in the control of mustard *Alternaria blight* was assessed laboratory-cum-glass house experiments at G. B. Pant University of Agriculture and Technology (GBPUA&T) Pantnagar, Uttaranchal. The mustard cv. Kranti was used as experimental host for pathogenecity test. The trial was conducted in a randomized block design in laboratory and there were three replications. *Alternaria brassicae* infected leaves of mustard were collected for isolation and maintenance of culture of isolates (Isolate A, C and D) and pathogenicity of *Alternaria. blight* was proved on susceptible mustard cv. Kranti.

Only those infected leaf spots were selected which showed presence of typical *A. brassicae* conidia. Surface sterilized leaf spot pieces were aseptically transferred into petri dishes containing PDA media keeping 4-5 pieces at an equal distance with the help of sterilized forceps. These petri dishes were then sealed with the help of paraffin film and placed in an incubator at 23±2°c for 7 days. The isolates were as ascertain on the basis of their conspicuous characteristic morphology as described by Awasthi and Kolte (1989). Culture tubes containing single spore of A, C and D isolates were incubated at 23±2°C for 15 days. The pathogenecity test was carried out under glasshouse conditions with cv. Kranti. Two-week-old culture of each isolate with 10^5 spres ml^{-1} concentration sprayed on the plant surface using automizer. Inoculated plants were incubated for 72 h in humid chamber at 90-100 per cent relative humidity. Symptons were observed and isolates were reisolated from infected leaves for further studies.

The inhibitory effect of all twenty-one amino acids was studied. The solutions were prepared in distilled water and added to potato sucrose agar (PSA) medium to make final concentration of 0, 500, 1000, 1500 and 2000 ppm after autoclaving. Medium without chemical solution served as control. Six mm disc of *A. brassicae* isolate A and C was placed in the center of petri plates with three replications. Mycelial growth inhibition was recorded after 7 and 15 days of inoculation by measuring the distance between the edges of mycelium.

Amino acids used for studying growth of A. brassicae in vitro conditions and their treatment symbols are T_1 - L-Proline (L-Pro), T_2 - L-Lysine Monohydrochloride (L-Lys Mon), T_3 - L-Tyrosine (L-Tyr), T_4 - L-Leucine (L-Leu), T_5 - L-Cystine (L-Cys), T_6 - L-Arginine Monohydrochloride (L-Arg Mon), T_7 - L-glutamic acid (L-Glu Acid), T_8 - Glycine (Gly), T_9 - L-Cysteine Hydrochloride (L-Cys Hyd), T_{10} - L-Histidine Monohydrochloride (L-His Mon), T_{11} - DL-Alanine (Dl-Ala), T_{12} - DL-Threonine (Dl-Thr), T_{13} - DL-Serine (Dl-Ser), T_{14} - DL-Tryptophan (Dl-Try), T_{15} - DL-2-Amino-N-Butyric Acid (Dl-2-Ami), T_{16} - L-Ornithine Monohydrochloride (L-Orn), T_{17} - DL-Methionine (Dl-Met), T_{18} - DL-Valine (Dl-Val), T_{19} - DL-Aspartic Acid (DL-Asp acid), T_{20} - DL-Iso-Leucine (Dl-Iso Leu), T_{21} - D-B-phenylalanine (Dl-Phe) and Check (distilled water).

Results and Discussion

***A. brassicae* isolate 'A' :** After seven days of inoculation the maximum radial growth (colony diameter) was measured in comparison to check. The highly significant difference was found among treatments, concentration and interaction. The minimum colony diameter was measured in T_9 L-Cys Hyd (1.66 cm) followed by T_{17} DL-met (2.33 cm) but at par with T_{15} DL-2-Ami-N-But acid (2.38 cm) at par with T_8 Gly (2.35 cm), T_{19} Dl-Asp acid (2.55 cm), T_{13} DL-Ser (2.56 cm). The colony diameter in T_{18} DL-Val (2.83 cm) was measured which was at par with T_{12} DL-Thr (2.88 cm) and T_{21} DL-Phe-Ala (2.91 cm). All other treatment also showed colony diameter in the range of 3.48 to 5.33 cm.

After fifteen days of incubation, the maximum colony diameter (Table 1) was measured in check (8.63 cm). The minimum colony diameter was measured in T_{17} DL-Met (3.82 cm) which was at par with T_9 L-Cys Hyd (3.98 cm) followed by T_8 Gly (4.1 1 cm), T_{13} DL Ser (4.58 cm) and T_{18} DL-Val (4.99 cm). All other treatment also showed colony diameter in the range 5.14 to 7.98 cm. The highly significant difference was found among treatment, concentration and interaction.

Table 1. Effect of amino acids at different concentrations on colony diameter of *Alternaria brassicae* isolate 'A' on potato sucrose agar (PSA) medium.

Treatment	7 days after incubation				15 days after incubation			
	500*	1000	2000	Mean	500*	1000	2000	Mean
T_1 - L-Pro	4.50	4.10	3.95	4.18	6.93	6.05	7.20	6.72
T_2 - L-Lys Mon	4.90	4.66	4.10	4.48	6.81	4.81	6.52	6.04
T_3 - L-Tyr	5.10	4.36	3.85	4.43	7.31	8.11	8.50	7.97
T_4 - L-Leu	4.05	3.85	3.58	3.82	6.07	5.86	5.46	5.78
T_5 - L-Cys	3.76	3.25	3.43	3.48	7.83	6.60	7.70	7.37
T_6 - L-Arg Mon	4.15	4.00	3.85	4.00	7.18	7.57	7.51	7.42
T_7 - L-Glu Acid	5.60	5.16	3.25	4.67	8.37	8.20	6.02	7.53
T_8 - Gly	2.70	2.40	1.95	2.35	3.67	5.52	3.15	4.11
T_9 - L-Cys Hyd	2.80	1.85	0.33	1.66	8.16	2.95	0.83	3.98
T_{10} - L-His Mon	5.00	5.15	4.90	5.01	7.83	7.55	7.98	7.78
T_{11} - Dl-Ala	5.65	5.90	5.05	5.33	8.15	8.45	7.35	7.98
T_{12} - Dl-Thr	3.10	2.85	2.70	2.88	4.98	5.08	5.36	5.14
T_{13} - Dl-Ser	3.20	2.38	2.10	2.56	5.36	4.50	3.90	4.58
T_{14} - Dl-Try	4.01	4.35	3.95	4.10	6.80	7.85	6.05	6.90
T_{15} - Dl-2-Ami	3.50	1.90	1.75	2.38	5.90	2.83	3.05	3.92
T_{16} - L-Orn	5.50	5.10	4.75	5.12	6.33	7.95	7.66	7.31
T_{17} - Dl-Met	3.05	2.85	1.10	2.33	4.15	5.15	2.18	3.82
T_{18} - Dl-Val	3.20	2.90	2.40	2.83	5.80	4.83	4.35	4.99
T_{19} - DL-Asp acid	2.80	2.65	2.20	2.55	3.91	4.55	3.38	3.95
T_{20} - Dl-Iso Leu	5.25	4.50	3.50	4.41	8.05	6.63	5.31	6.66
T_{21} - Dl-Phe	3.05	2.95	2.75	2.91	5.23	5.66	5.10	5.33
Check	6.10	6.10	6.10	6.10	8.70	8.50	8.70	7.63
C.D. at 5% Treatment				-0.66				0.59
Concentration				-0.24				0.21
Interaction				-1.15				1.02

* Concentration in ppm.

***A. brasssica* isolate 'C' :** After seven day of incubation, it was observed that all treatment showed highly significant differences among each other, concentration and between interactions. The maximum colony diameter was measured in check (2.85 cm). The highly significant minimum colony diameter was measured in T_8 Gly (1.70 cm) but at par with T_{20} L-Iso-Len (1.78 cm) followed by T_{19} DL-Asp acid (1.91 cm) at par with T_{21} DL-pheAla (1.97 cm) and T_1 L-Cys Hyd (2.04 cm). All other treatment showed colony diameter in the range 2.17 to 2.78 cm.

After fifteen days of incubation, all treatments showed highly significant difference among themselves, concentration and between interactions (Table 2). The highly significant minimum colony diameter was measured in T_8 Gly (2.71 cm) but at par with T_9 L-Cys Hyd (2.95 cm) followed by T_{20} DL-Iso Len (3.08 cm) T_1 L-Pro (3.26 cm). All other treatments showed colony diameter in the range 3.60 to 4.761 cm. This is for the first time information on the effectiveness of amino acids on mustard *Alternaria blight* (*Alternaria brassicae*) isolates A and C was generated and will be useful in designing and understanding the research experiment in future studies.

Table 2. Effect of amino acids at different concentrations on colony diameter (cm) of *Alternaria brassicae* isolate 'C' on potato sucrose agar (PSA) medium.

Treatment	7 days after incubation				15 days after incubation			
	500*	1000	2000	Mean	500*	1000	2000	Mean
T_1 - L-Pro	2.32	2.10	2.37	2.26	3.60	2.76	3.42	3.26
T_2 - L-Lys Mon	2.54	2.60	2.45	2.53	3.77	3.83	3.65	3.75
T_3 - L-Tyr	2.80	2.90	2.95	2.70	3.70	3.84	3.92	3.82
T_4 - L-Leu	2.62	2.70	2.45	2.71	3.85	4.10	3.60	3.85
T_5 - L-Cys	2.67	2.10	2.37	2.38	3.95	3.17	3.58	3.60
T_6 - L-Arg Mon	2.85	2.50	2.65	2.67	4.10	3.50	3.75	3.78
T_7 - L-Glu Acid	2.95	2.25	2.10	2.43	3.85	3.30	3.50	3.70
T_8 - Gly	1.55	2.20	1.35	1.70	2.70	3.10	2.36	2.71
T_9 - L-Cys Hyd	2.86	2.56	0.70	2.04	4.20	3.95	0.70	2.95
T_{10} - L-His Mon	2.75	2.73	2.65	2.71	3.97	3.68	3.67	3.84
T_{11} - Dl-Ala	2.51	2.22	2.58	2.42	4.26	3.95	4.30	3.83
T_{12} - Dl-Thr	2.56	2.65	2.50	2.57	4.05	4.42	4.65	4.73
T_{13} - Dl-Ser	2.83	2.70	2.81	2.78	4.75	4.95	4.60	4.76
T_{14} - Dl-Try	1.68	2.81	2.31	2.26	3.30	4.43	3.75	3.82
T_{15} - Dl-2-Ami	2.66	2.71	1.60	2.32	4.90	5.15	3.80	4.45
T_{16} - L-Orn	2.25	2.61	2.36	2.39	4.01	4.06	4.00	4.02
T_{17} - Dl-Met	2.38	2.30	1.85	2.17	3.91	4.26	3.32	3.83
T_{18} - Dl-Val	2.47	2.60	2.95	2.67	4.12	4.25	3.40	3.92
T_{19} - DL-Asp acid	2.11	2.26	2.05	1.91	4.06	3.71	3.20	3.65
T_{20} - Dl-Iso Leu	1.65	1.70	2.00	1.78	3.55	3.15	2.55	3.08
T_{21} - Dl-Phe	2.18	1.91	1.81	1.97	3.50	3.85	2.45	3.26
Check	2.85	2.85	2.85	2.85	4.17	4.17	4.17	4.17
C.D. at 5% Treatment				0.32				0.37
Concentration				0.11				0.13
Interaction				0.56				0.64

* Concentration in ppm.

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Idiosyncrasies of Small and Marginal Farmers in Distress Prone District of Vidarbha

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Abstract

The study revealed that medium family size with low education level, lack of irrigation facilities, weak cropping pattern, low annual income and weak socio-economic status, lack of integration of farming system with other remunerative ventures, indebtedness, health problems were the important characteristics of the farmers in distress prone districts.

Key words : Idiosyncrasies, farmers, Vidarbha.

The Government of India declared 31 districts in four States (Andhra Pradesh-16, Karnataka-6, Maharashtra-6 and Kerala-3) as distress districts. These districts are mostly

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rainfed, agriculturally less developed and low productivity districts, where the Prime Minister's Relief and Rehabilitation package is jbeing implemented. This package designed with regional specificity .to address issues of moisture conservation, infrastructural development, augmentation of non-farm sources of - income and employment to farmers. Among distress Districts six districts are from Vidarbha region of Maharashtra State. These districts are Yavatmal, Buldana, Amravati, Akola, Washim and Wardha (Anonymous, 2007).

The current research study has been formulated in order to assess the various characteristics of small and marginal farmers in distress districts with objectives to study the personal, socio-economic, situational, communication and psychological characteristic of the farmers of distress districtss with suggestions perceived from the respondent for improving distress prone condition of farming business.

Materials and Methods

The present study was purposively conducted in Akola District of Vidarbha region of Maharashtra state as this is one of the distress prone districts of Vidarbha, declared by government of India. Exploratory design of social research, was used. Out of 199 villages of Akola district 10 villages were selected randomly and from each selected villages 10 small and marginal farmers (Mix population of small and marginal farmers) were selected randomly to constitute sample size of 100 respondents.

Results and Discussion

Distribution : It is observed from Table 1 that 40 per cent of the espondens were under middle age group, followed by old age category contributed 34 per cent, whereas remaining one fourth of the respondents were in age category. It is inferred that all age groups of the farmer are suffered due to distress situation in distress district. Out of the total sample, 20 per cent were illiterate and remaining 80 per cent were literates. Within the literates 26 per cent were educated up to middle school level and 25 per cent respondents were having education up to high school level. While 18 per cent had primary school level education and 06 per cent respondents had higher secondary school level education. Only 5 per cent had college level education. Maximum (64%) of the respondents were concentrated in medium size family having 4 to 6 family members. While nearly equal number of the respondents were concentrated in large family size (16%) and small size (15%) having family members 7 to 9 and up to 3 respectively. Whereas only 5 per cent respondents were from very large family group having 10 or more than 10 family members. Thus, it is inferred that majority of the farmers were concentrated between medium family size.

Family type is an important social aspect. Now a days big families are divided into small families. This hamper not only the development of individual but also minimize the chances of sharing the feeling among the members of family. Therefore, it was felt necessary to study the family type of the respondents under present investigation. Maximum 56 per cent of the respondents were from nuclear type of families and 44 per cent respondents belonged to joint family. It was found that, small and marginal farmers bear the brunt of crop failures and had virtually no access to credit due to limited repaying capacity. The present research investigation confined to the farmers having land holding up to five acres only. Majority (79%) of the respondents were small farmers having land holding between 1.01 to 2.00 hectares followed by 21 per cent respondents were marginal farmers possessing land up to

Table 1. Distribution of respondents accoring to different parameters.

Parameters	Number (n=100)	Per-centage
Age :		
Young	26	26
Middile	40	40
Old	34	34
Education :		
Primary school	18	18.00
Middle school	26	26.00
High school	25	25.00
Higher secondary school	06	06.00
College	05	05.00
Family size :		
Small (Upto 3)	15	15.00
Medium (4 to 6)	64	64.00
Large (7 to 9)	16	16.00
Very large (Above 9)	05	05.00
Family type :		
Nuclear	56	56.00
Joint	44	44.00
Land holding :		
Marainal	21	21.00
Small	79	79.00
Cropping pattern :		
Seasonal	78	78
Bi-seasonal	13	13
Annual	07	07
Perennial	02	02
Annual income (Rs.) :		
Up to 25,000	12	12.00
25,001 to 50,000	57	57.00
50,001 to 75,000	26	26.00
Above 75,000	05	05.00
Socio- economic status :		
Very low	25	25
Low	52	52
Medium	23	23
Irrigation sources :		
No source	56	56.00
River	07	07.00
Well / Tube well	32	32.00
Canal	05	05.00
Subsidiary occupation :		
Agriculture + Labour	57	57.00
Agriculture (Only farming)	26	26.00
Agriculture + Allied occupation (Goat farming/Poultry/Apiculture/ Sericulture)	03	03.00
Agriculture + Non professional business	08	08.00
Agriculture + Service	06	06.00
Amount of debts in Rs. :		
No Debt	26	26.00
Up to Rs. 25,000/-	54	54.00
Rs. 25,001/- to 50,000/-	12	12.00
Rs. 50,001/- to 75,000/-	05	05.00
Above Rs. 75,000/-	03	03.00
Family health :		
Family members having health problem	30	30
Family members free from health problem	70	70

1.00 hectare. The average sizes of holding of the respondents was 1.38 ha. These findings also corroborate with the findings reported by Gill and Singhi (2006) and Kale (2008).

More than three-fourth (78 %) of the respondents had seasonal type of cropping pattern. It might be due to rainfed situation and no rains after September in study area followed by 13 per cent of the respondents having bi-seasonal cropping pattern. Meagre numbers of the respondents followed annual type (7%) and perennial (2%) type of cropping pattern. No respondents were following biannual type of cropping pattern. From the result it is concluded that majority of the respondents were following seasonal cropping pattern which might be due to the rainfed situation in study area.

Income is a major determinant of the economic status of an individual. Every individual's style of living is decided to a great

extent by his income. His expenditure on farming, allied occupations, household matters and indebtedness is decided by the income he earns. Low income very difficulty for an individual to manage affairs of the family. Such people become discouraged and cannot perform their functions properly (Madan, 1980). Maximum number of the respondents (57%) had annual income in range of Rs. 25,001 to 50,000. About one fourth (26%) of the respondents belonging to income group with annual income between Rs. 50,001 to 75,000. Whereas 12 per cent of the respondents had annual income up to Rs. 25,000 and only 5 per cent respondents had annual income above Rs. 75,000. The average annual income of all respondents was Rs. 44,450, which includes cultivation, wages, non-professional business income, service and income from allied occupatioris. Thus it is pbserved. that majority (57%) of respondents were concentrated having annual income in the range of Rs. 25,001 to 50,000 and Rs. 50,001 to 75,000 (26%). Hence the low income of the farmers is proved as important identified factor for farmers' distress in Western Vidarbha Region of Maharashtra State.

The socio-economic status showed the position of the individual and his family members occupied with reference to prevailing average standard of cultural position, effective income, material possession and participation in the group activities of the community (Bertrand, 1958). It could be noted that 52 per cent of the respondent were categorized in low and one fourth (25%) farmers having very low socio-economic status. While remaining 23 per cent of the respondents were in medium level of socio-economic status. Not a single respondent was found from medium high and high socio-economic status groups. Thus the present research study accepted that more than three fourth (77%) respondents were concentrated between very low and low level of socio-economic status group in selected distress district.

Availability of irrigation facilities and their irrigation potential significantly affect the cropping pattern, production, productivity and ultimately incomelevel of farmers by many folds (Shivappa 2006). More than half (56%) of the respondents were not having any source to access the irrigation. They solely depended on monsoon rains. Followed by 32 per cent of the respondents were having only open well or tube well as irrigation source. Whereas, remaining 7 and 5 per cent of the respondents canal as the Source to access irrigation respectively. It is also noticed that most of the wells were either dry or do not have sufficient water for irrigation

Table 2. Suggestions perceived from the respondents for improving distress prone condition of farming business.

Suggestions perceived	Number	Percentage
Government should offer remunerative price for farm produce	85	85
Provision / creation of irrigation facilities	78	78
Abundant electrical supply for farming	60	60
Complete waiving of old loan	60	60
Provision of easy, timely and sufficient credit at low interest rate	57	57
Creation of subsidiary occupation and other income sources	55	55
Crop insurance cover	22	22
Timely employment by creating non-farm employment opportunities	20	20
Government should be provided input at 50%subsidies	20	20
There should be direct link between producer and consumer	18	18
Agriculture processing plants should be made at grass root level	10	10

due to depletion of groundwater and less rains in recent years. In addition to this, for using available water for irrigation, load shading of electricity was also the main hurdle, as mentioned by the respondents.

Subsidiary occupation is an important indicator of socio-economic position of an individual through income status in a society, hence this variable was considered for the study. The data indicated that majority of respondents (57%) were engaged in farm labour for wage earning as a supportive endeavour to farming. While 26 per cent respondents were having only farming as their main occupation and they did not have any back up system. Whereas 8 per cent respondents were doing either caste related or other non-professional business with farming. Howerve, 6 per cent of the respondents having monthly income from service and only 3 per cent respondents possessed dairy as an allied occupation through buffalo rearing in addition to farming. Thus it could be concluded that there were only three farmers where the respondent earned their livelihood by engaging in allied -occupations to supplement their income. Secondly it is pointed out that majority of the respondents were having labour/wage earning as the only supportive endeavour to farming and did not have any supplementary occupation. The findings of the present study also collaborate with the findings reported by Kale (2008) that majority (70.30%) victims were engaged as farm labour on other big farmers' farm for wage earning and majority of them were marginal and small farmers. Only 1 per cent deceased farmers possessed dairy as an allied occupation through buffalo rearing fn addition to farming.

Out of 100 respondents, 74 per cent respondents were found indebted with average debt at Rs. 16,704. Amongst the indebted 54 per cent of the respondents had outstanding debt up to Rs. 25,000. Whereas, 12 per cent of the respondents had debts in the range of Rs. 25,001 to 50,000 and five per cent respondents had the debt in the range of Rs 50,001 to 75,000. While 3.00 per cent bave over dues above Rs. 75,000. Whereas 26 per cent were not found indebted. It means that majority of the respondents had an obligation to pay debts to borrowed agencies/sources in distress district.

The family health indicates the health status of respondents, household during last one years. The 7 per cent family members were free from health problem. Whereas 30 per cent family members, having health problem.

Suggestions : In Table 2 showed the suggestions perceived from the respondent for improving distress prone condition of farming business. Majority of the respondents (85%) suggested that Government should offer remunerative price for farm produe, 78 per cent of respondents suggested for provision/ creation of irrigation facilities. Suggestions for abundant electric supply for farming and complete waiving of old loan come from 60 per cent of the respondents. Provision of easy, timely and sufficient credit at low interest rate and creation of subsidiary occupation/other income sources suggested by 57 and 55 per cent of the respondents respectively. While crop insurance cover, timely employment by creating non-farm employment opportunities and Government should provided input at 50 per cent subsidies was suggested by 22, 20 and 20 per cent farmers respectively. Whereas there should be direct link between producer and consumer (18%) and agriculture processing plants should be made available at grass root level was suggested by the 10 per cent farmers.

Thus, majority of the respondents suggested remunerative prices to-their farm produce and provision/creation of irrigation facilities for

their farming as the important measures to be taken to reduce the distress condition of the farmers in Western Vidarbha region.

The distress prone condition of the small and marginal farmers in distress district cannot be solved only with fire fighting techniques. A well thought concerted strategy for both the short and long term is needed. While planning short and long term measures, the government should focus on above suggestions made by the respondents, as remunerative prices for their farm produce and creating irrigation facilities. It means that as short term measures there is an urgent need to declare the remunerative prices for all the crops and secondly, as long term measures, the government should focus more on increasing irrigation facilities in Vidarbha region because irrigation facilities are very poor in Vidarbha region. These things are also helpful to the farmers for improving cropping pattern, annual income, socio-economic status, allied occupations, repayment capacity, health status, etc. in distress districts.

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Economic Analysis of Investment in Cashew Orchard in Konkan Region of Maharashtra

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Abstract

The per hectare amount of Rs. 77519.97 was required for establishment of HYV's cashew orchard and Rs. 27253.29 was for local varieties cashew orchard. Out of total establishment cost, maximum expenditure (63.41%) was incurred during first year. Pay back period is 12 years for local variety and 8 years for HYV's of cashew orchard without discount. The net present worth is positive within the stated period for both the varieties. Internal rate of return was 18.58 and 24.67 per cent for local and HYV's respectively which is greater than the prevailing rate of interest on borrowing. The net income from HYV's of cashew was Rs. 37708.50 and benefit cost ratio was 1.95. Local varieties net returns was Rs. 10329.13 and benefit cost ratio was 1.71 on the basis of all these economic parameters the cashew plantation is commercially profitable venture in Konkan region. Further HYV's cashew plantation is more profitable than local variety cashew orchards.

Key words : Cashew orchard, net present value, internal rate of returns, high yielding varieties.

Cashew is a very important plantation crop of Konkan region and plays significant role in India's economy. Cashew accounts an export earning of Rs. 2905.82 crores from cashew kernels and Rs. 24.12 crores from cashewenut shell liquid (2009-10). India produced 6.13 lakh tones of cashewnut from an area of 9.23 lakh hectares (2009-10). Maharashtra is one of the leading cashew growing state. In Maharashtra three-fourth of the area under cashew is concentrated in Konkan region. Since agro-climatic conditions of the Konkan region are favourable for cashew cultivation.

Area under cashew crop has increased to 1.67 lakh hectares and production to 2.10 lakh MT with the inception of massive horticultural development programme in 1990-91 and till there is scope for cashewnut plantation upto 6.0 lakh ha on waste lands available. Since, the recommended package of practices for the particular cultivars are not followed the hectare^{-1} yield is low. Therefore, it is necessary to increase the productivity through adoption of high yielding varieties and recommended package of practices for cashew orchard. Looking into importance of this crop for economy of Konkan region attempts are made in this study to make economic analysis of investment in cashew orchard to get an insight into the economic potential of the crop.

Materials and Methods

The expenditure during the pre-bearing stage constitute the investment on establishment of crop, while after four years phase bearing, start. In this period growers have to incur the expenses every year for maintaining the cashew orchard.

The financial feasibility analysis was carried out to evaluate the feasibility of investment in cashew orchard for this analysis. All future costs

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Table 1. Per hectare cost of establishment for local and HYVs varieties of cashew orchard (up to fourth year) (Rs.).

Year	Cashew	
	Local	**HYV's**
First	17282.11 (63.41)	37362.02 (48.20)
Second	4111.32 (15.09)	13370.66 (17.25)
Third	3292.96 (12.08)	13197.2 (17.02)
Fourth	2566.90 (9.42)	13590.09 (17.53)
Total	27253.29 (100.00)	77519.97 (100.00)

Figures in the parenthesis are percentage to total.

and returns are discounted to present value at appropriate discount rate and appropriate productive life period of an investment. For this following standard measures net present value (NPV), pay back period (PBP), benefit cost ratio (BCR) and internal rate of return (IRR) developed by Reddy and Ram (2000) were used.

Results and Discussion

The establishment of cashew orchard needs four years and the establishment cost includes the labour and material cost. Labour cost comprised of expenses on operations like land preparation, digging of pits, planting and gap filling, manures and fertilizers application, spraying, irrigation, watch and ward etc. Material costs included costs of items like seedlings/grafts, manures, fertilizers, plant protection chemicals, fencing etc.

The total hectare^{-1} establishment cost for local varieties of cashew orchard was Rs. 27253.29. Out of these in the first year cost incurred was Rs. 17282.11 followed by Rs. 4111.32 in second year, subsequently Rs. 3292.96 in third years and Rs. 2566.90 in fourth year. In the first year more than 63 per cent of the total four, years investment was required. The hectare^{-1} establishment cost of HYVs orchard was Rs. 77519.97 of which Rs. 37362.02 (48.20%) was incurred during the first year. Sivanantham *et al*. (1991) and Naik *et al*. (1992) observed similar results for establishment of local and HYVs of cashew orchards. This indicate that maximum expenditure was incurred during the first year and it declined with subsequent years.

Taking into account the yearly cost of establishment of first four years and maintenance cost for different varietal group i.e. local varieties and HYVs upto 40 years age of orchard, a series of cash out flow (costs) were estimated. Similarly, a series of cash inflow (returns) were estimated taking into account the hectare^{-1} returns received (net at marketing cost). With the help of these series of cash flows and by using the economic parameters as pay back period, net present value, benefit cost ratio and internal rate of returns as per the procedure outlined in methodology by Reddy and Ram (2000) the economic feasibility of investment in cashew plantation was tested. The estimated values of these parameters for local variety and HYVs cashew orchard are presented in Table 2.

It is revealed from the Table 2 that pay back period for local variety was 12 years for recovery of capital cost without discounting. The net present value (NPV) were Rs. 39638.07, Rs. 29981.21 and Rs. 16708.91

Table 2. Financial feasibility tests in local and high yielding varieties of cashew orchard.

Parameters/ Units	Discount rates (%) local varieties			Discount rates (%) HYV		
	9	**10**	**12**	**9**	**10**	**12**
Net present value (NPV) (Rs. ha^{-1})	39638.07	29981.21	16708.91	146936.07	111676.37	74268.58
B:C ratio	1.54	1.43	1.28	1.91	1.64	1.50
Internal rate of returns (IRR)/(%)	-	18.58	-	-	24.67	-
Pay back period/(years) [without discounting]	-	12	-	-	8	-

at 9, 10 and 12 per cent discount rates, respectively. The internal rate of returns (IRR) came to 18.58 per cent which was greater than prevailing rate of interest on borrowing from institutional sources. Pay back period for high yielding variety orchard, was estimated to 8 years for recovery of capital cost only without discounting. The net present value was Rs. 146936.07, Rs. 111676.37 and Rs. 74268.58 at 9,10 and 12 per cent discount rate respectively. The benefit cost ratio for same discount rates were 1.91, 1.64 and 1.50. The internal rate of return was found to be 24.67 per cent which was greater than the prevailing rate of interest on borrowing from institutional resources.

In both the local and HYVs cases the benefit cost ratios were considerably greater than unity. The net present value (NPV) was positive in case of both the groups. Internal rate of return was much higher in HYVs (24.67%) than local variety (18.58%). Also the pay back period was quite desirable considering the life of cashew orchard in case of high yielding variety.

Financial feasibility tests in both local and HYVs were positive, indicating profitability of cashew orchard. On the basis of all these economic parameters, it can be concluded that, the HYVs cashew plantation is commercially more profitable venture in the Konkan region than existing local variety plantation.

On the basis of hectare^{-1} production of cashewnut, its byproducts and price received by the growers, gross returns were worked out for local and HYVs varieties of cashew orchards. The income at various costs level *viz*., cost A, B abd C were higher (Table 3) in case of HYVs accounting for Rs. 9117.09, Rs. 33494.39 and Rs. 39548.50, respectively than that of local varieties due to use of more inputs. Whereas, the per quintal cost of production was more (Rs. 2458.16) in local varieties as compared to HYVs (Rs. 2218.09). It was mainly due to higher yield by HYVs because of proper utilization of inputs than local varieties of cashew.

Table 3. Per hectare profitability (Rs.) of adult cashew orchard.

Particulars	Local varieties (LV)	High yielding varieties (HYVs)
Cost A	2991.15	9117.09
Cost B	11012.15	33494.39
Cost C	14576.87	39548.50
Hectare^{-1} yield (q)	5.93	17.83
Quintal^{-1} cost of production	2458.16	2218.09
Gross returns (Rs ha^{-1})	24906.00	77257.00
Farm business income (profit at cost A)	21914.85	68139.91
Farm labour income (profit at cost B)	13893.85	54762.61
Net income (profit at cost C)	10329.13	37708.50
Benefit cost ratio (B:C ratio)	1.71	1.95

The hectare^{-1} gross returns received were Rs. 24906 in local varieties and Rs. 77257 in HYVs of cashew. Accordingly, the farm business income, farm labour income and net income were also marginally higher in case of HYVs of cashew orchard accounting for Rs. 68139.91 (profit at cost A), Rs. 54762.61 (profit at cost B) and Rs. 37708.50 (profit at cost C), respectively as compared to local variety. The net income from HYVs of cashew was Rs. 37708.50 and benefit cost ratio was 1.95 as compared to local varieties for which net returns were Rs. 10329.13 and benefit cost ratio was 1.71. The findings of the study are in the line with studies from Dalvi *et al*. (1991) from Maharashtra for cashew and Gangwar *et al*. (2008) for peach cultivation in Panjab and Uttarakhand. This indicate that HYVs were more profitable than local varieties of cashew.

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Nutritional Quality of High Yielding *Rabi* Sorghum Genotypes

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Abstract

Seven *rabi* sorghum genotypes, consisting of released and newly developed varieties were evaluated against Maldandi (M 35-1) for various quality traits, such as roti making, grain quality and for fodder palatability. Overall roti making quality was the best for the variety M-35-1 (9.35) on a rating scale of 1-10, followed by RSV 423 (9.10) and SPV 1546 (8.95). Among the new genotypes, the grain quality of RSV 423 and SPV 1546 were superior to others. Highest grain yield was recorded in RSV 423 (26.8, q ha^{-1}) followed by SPV 1546 (25.3, q ha^{-1}). The new genotype RSV 423 recorded highest total sugars (2.78%), crude fiber (1.47%) and water uptake (191 ml 100^{-1} g). Overall high acceptability of the sorghum genotypes was correlated with high fiber and high crude protein content in the grain. However, the fodder quality of M 35-1 was superior than the newly developed genotypes with highest crude protein (6.63%) and *in vitro* dry matter digestibility (IVDMD) (63.82%). SPV 1546 was most palatable (86.8%). On the basis of all quality parameters studied, the new genotype SPV 1546 was found to be most promising followed. by RSV-423.

Key words: Sorghum, grain and fodder quality, M 35-1, RSV 423.

Being a drought-resistant crop, sorghum can give dependable and stable yields in both *kharif* and *rabi* seasons (Audilakshmi *et al*., 2007). Sorghun is mainly consumed in the form of unleavened pancake (*bhakri*). However, several indigenous processed food products such as *bhatwadi*, *papadi* and *roti* are prepared and consumed in the semi-arid tropics (Bhatnagar *et al.* 1995). Besides, sorghum has a large potential for its use in the fermentation industry (Hamad and Fields, 1979) puffed products and in weaning foods for the children of developing countries (Desikachar, 1980). In view of the relevance of sorghum crop as food and feed, evaluation of nutritional quality of new and released genotypes of sorghum is important. This study was conducted with eight sorghum genotypes.

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Materials and Methods

Samples of sorghum grain and stover of new and popular sorghum genotypes were obtained from the Sorghum Improvement Project, Mahatma Phule Krishi Vidyapeeth Rahuri. Seven genotypes, RSLG 262, CSV 216, RSV 423, RSV 458, RSV 672, SPV 1546 and CSV 18 were compared with the

best and most popular variety M 35-1 for grain, *roti* making and stover quality. For roti quality evaluation, the colour and appearance texture, smoothness, taste and overall acceptability parameters were considered. Samples were collected from each replication for analysis during *rabi* season 2004-2005. The grain samples were first studied for physico-chemical parameters such as hectoliter weight in kg (AACC 1975) and then ground to 60 mesh using A-1 stainless steel grinding mill (M/s. Kamda Machines and Tools, Ahmednagar) and used for chemical analysis. Sorghum *roti* (bhakari) was prepared with traditional method on a hot concave iron pan. locally called as "Tava". The sorghum straw samples were cut into small pieces and ground into fine powder (60 mesh) and used for chemical analysis. Protein, fiber contents and water uptake were analyzed using standard procedures of AOAC (1990). Total sugars were determined from grain flour samples by using standard procedure of Dubois *et al.* (1956). Tannins and phytic acid were determined using standard methods of Price *et al*. (1978) and Tangkongchitr *et al*. (1986) with some modification by Naczk *et al*. (1986) respectively. The neutral detergent fiber (NDF), acid detergent fiber (ADF) and *in vitro* dry matter digestibility (IVDMD) were estimated by using standard method of Vonset *et al*. (1967). Sorghum *roti* quality was judged from semi-trained judges using 10 points scale (Amerine *et al*. 1980) as a Duncan multiple range test (DMRT). Palatability of sorghum stover was judged at Cattle Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India. All determinations were carried out in triplicate as per the replications drawn from the field and mean for the genotypes, range (maximum and minimum), standard error of means (±S.E.) and critical difference (C.D. at 5%) were computed for identifying genotypic differences, usjng standard methods given by Panse and Sukhatme (1967).

Results and Discussion

Grain quality : The sorghum grains having pearly white colour, bold in size, high hectoliter weight, and attractiveness are prefered by the consumers. The flour of sorghum genotypes having above grain quality parameters along

Table 1. Grain yield, chemical composition and overall acceptability of selected sorghum genotypes.

Genotype	Grain yield (q ha^{-1})	Crude protein (%)	Total sugars (%)	Crude fiber (%)	Hectoliter weight (kg ha^{-1})	Water absorption (%)	Tannin (%)	Phytic acid (mg $100^{-1}g$)	Overall acceptability
M 35-1	20.0	10.43	2.68	1.36	81.76	186	0.53	173	9.35
RSLG-262	18.7	9.51	2.40	1.17	82.02	189	0.58	182	8.23
CSV-216	23.2	9.63	2.56	1.28	80.59	191	0.58	171	8.40
RSV-423	26.8	9.74	2.78	1.47	82.30	191	0.48	168	9.10
RSV-458	17.7	9.27	2.20	1.22	84.29	177	0.59	170	8.80
RSV-672	21.5	9.04	2.48	1.19	80.22	151	0.63	176	8.32
SPV-1546	25.3	9.70	2.57	1.31	82.29	168	0.50	165	8.95
CSV-18	17.3	8.80	2.41	1.25	81.33	153	0.55	172	8.27
Range	17.3-26.8	8.80-10.43	2.20-2.78	1.17-1.47	80.22-84.29	151-191	0.48-0.63	165-182	-
Mean	21.3	9.52	2.51	1.28	81.85	176	0.56	172	8.68
S.E.±	1.40	0.46	0.16	0.09	1.16	15	0.056	4.83	0.40
C.D. at 5%	4.10	1.40	0.50	0.28	3.50	47	0.17	14.50	1.21
Correlation with taste n=8	-	0.74	0.62	0.80	0.28	0.26	0.63	0.31	1.0

with high water holding capacity, crude protein content, soluble proteins and total sugars gave good quality roll (bhakari). Therefore, selected sorghum genotypes having above characters were used for the roil quality evaluation.

***Roti* quality :** Maldandi (M 35-1) is well known for its excellent *roti* (*Bhakari*) making quality (Raghavendra Rao *et al.*, 1979 and Vimala *et al*., 1996).

Maldhandi (M 35-1) genotype scored highest (Table 1) for all parameters as well as-overall acceptability of roti followed by new genotypes RSV 423, SPV 1546, RSV 458 and CSV 216. The overall acceptability score of roti for RSV 423 (9.10) and SPV 1546 (8.95), newly developed genotypes were highest than the released popular genotypes CSV 216 (8.40) and RSLG 262 (8.23) but slightly lower than the Maldandi (9.35). The hectoliter weight of grains was highest for RSV 458 (84.3) followed by RSV 423 (82.30) and SPV 1546 (82.29). These genotypes gave very heavy weight grains and higher yield of flour. The crude protein content was higher in M 35-1 (10.43%) followed by RSV 423 (9.74%) and SPV 1546 (9.70%) (Kadam *et al*., 1977). The crude fiber, total sugars and also at higher levels in RSV 423 followed by M 35-1 and SPV 1546. The water absorption capacity was highest in RSV 423 and CSV 216 followed by RSLG 262 and M 35-1. Higher content of fiber, sugar as well as water absorption capacity may be responsible to keep *roti* smooth for longer period and gives good taste (Chandrashekar and DesikaChar, 1982). Among the new genotypes RSV 423 and SPV 1546 were found to be promising genotypes for *roti* quality.

Although the number of genotypes were limited (n=8) the trend suggests that among different organoleptic and physico-chemical characteristics of the grain, the overall acceptability of a genotype for *roti* quality was most closely correlated with taste (Table 1) and the taste in turn was correlated in decreasing order of magnitude as: crude fiber (%) > crude protein (%) > total sugars (%). Water absorption

Table 2. Fodder yield and biochemical constituents of sorghum fodder.

Genotype	Straw yield (q ha^{-1})	Crude protein (%)	Crude fiber (%)	NDF (%)	ADF (%)	IVDMAD (%)	Palatability (voluntary intake) (%)
M35-1	58.2	6.63	37.23	68.22	42.11	63.82	80.6
RSLG-262	52.0	6.03	32.55	63.47	39.36	59.48	81.0
CSV-216	66.9	6.23	27.69	62.92	37.31	54.39	73.3
RSV-423	61.8	6.08	28.33	63.79	43.32	61.20	85.2
RSV-458	56.2	5.92	39.87	69.13	42.42	58.03	85.1
RSV-672	56.0	6.07	37.50	66.93	46.59	53.63	84.2
SPV-1546	64.2	6.03	33.53	68.46	40.53	62.93	86.8
CSV-18	62.5	5.98	28.87	53.78	36.58	61.03	81.9
Range	52.0-66.9	5.92-6.63	27.69-39.87	53.78-69.13	36.58-46.59	53.63-63.82	73.3-86.8
Mean	59.7	6.12	33.20	64.58	41.03	59.31	82.3
S.E.±	4.6	0.21	4.36	4.68	3.08	3.50	3.96
C.D. at 5%	13.9	0.63	13.10	14.06	9.25	10.51	11.90
Correlation with palatability (n=8)		-0.43	0.43	0.32	0.56	0.39	1.00
Correlation with IVDMD (n=8)		0.28	-0.03	-0.01	-0.18	1.00	0.39

capacity was least related to taste. Most of the variation in taste seems to be associated with fiber and crude protein. A step-wise regression between taste as dependent variable and the three other parameters as independent-variable should help in computing the relative contributions of these parameters in determining-taste Fig 1.

Antinutritional factors : The tannin content ranged from 0.48 to 0.63 per cent. The phytic acid content also ranged from 165 to 182 mg 100^{-1}g. Similar results were reported by Kadam *et al*. (1977). Those genotypes having lower tannins and phytic acid showed higher organoleptic score for *roti* quality (RSV 423 and SPY J546). The new genotypes showed lower level of tannins and phytic acid levels as compared to the earlier released cultivars (RSLG 262 and M 35-1).

Stover quality : The crude protein content in sorghum stover ranged from 5.92 to 6.63 per cent. The highest protein content was observed in M 35-1 (6.63%) followed by CSV 216 (6.23%) (Anonymous 2006b). The crude fiber content was high in RSV 458 (39.87%) followed by RSV 672 (37.20%) and M 35-1 (37.23%), (Table 2). The NDF content was higher level in RSV 458 (69.13%) while ADF in RSV 672 (46.59%). The most prominent parameter for nutritional quality of fodder/straw is the *in vitro* dry matter digestibility (IVDMD) (Raymond 1969). It was highest in M 35-1 (63.82%) followed by SPV 1546 (62.93%), RSV 423 (61.20%) and CSV 18 (61.03%). The new genotype RSV 423 had higher IVDMD than the CSV 216 and RSLG 262. Palatability as a voluntary intake of straw ranged from 73.3 to 86.8 per cent. The voluntary intake of straw was highest in SPV 1546 followed by RSV 423 (85.2%) and RSV 458 (85.1%). Considering various quality parameters as well as yield, it concluded that SPV 1546 and RSV 423, the two new high

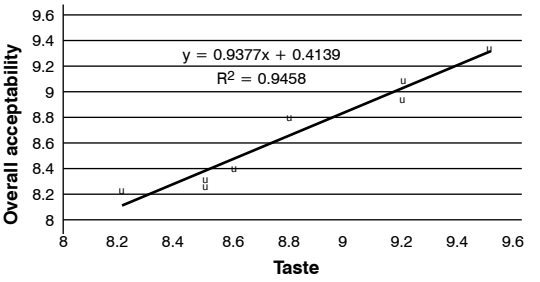

Fig. 1. Correlation between taste and overall acceptability.

yielding genotypes were promising for grain as well as stover quality. These genotypes were comparable to the most popular and acceptable genotype M 35-1. Large scale demonstration and extension of these high yielding genotypes for superior grain and stover quality would contribute to greater profitability to sorghum farmers.

Future research should focus on identifying the causal relationship between organoleptic and physiochemical characteristics of the grain for overall acceptability for roll making and for-fodder for palatability and IVDMD. This would be possible by including more and very diverse genotypes in studies.

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Method Development for Estimation of CO_2 Utilization and Nutrients Requirement for Fodder Maize Crop

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Abstract

Among the methods developed, methods (1) and (2) are accurate for estimation of volume and mass absorption of CO_2 for the maize crop while method (3) is also a reliable method for estimation of reduction of CO_2 from the atmosphere and method (4) is equally important for estimation of requirement of other nutrients ha^{-1} $season^{-1}$ by the maize crop. The absorption and reduction of CO_2 ha^{-1} $season^{-1}$ were found 4568.55 and 1266.35 kg in control plot and 8405.15 and 2329.80 kg for treated plot. If total 100 kg macro-nutrients are required for the crop, 50 kg N, 4 kg P and 46 kg K are absorbed.

Key words : Fodder maize, absorption and reduction of CO_2, nutrients requirement and multiple linear regression.

The photosynthesis is a very important process occurring in the leaves of a plant or tree. In this process, the atmospheric carbon dioxide is absorbed and oxygen is released from the leaves of the plants or trees. There occurs the exchange of equal amount of CO_2 absorbed and O_2 released in the photosynthesis process which reaches maximum when temperature lies between 10-35°C and minimum at -30°C (Thomas *et al*., 1973). The exchange of mass of CO_2 absorbed and O_2 released are unequal because of their different densities. The photosynthesis rates were reported 16 mg CO_2 dm^{-2} hr^{-1} for forest trees (Sun and Ehleringer, 1986), 0.31 mg CO_2 m^{-2} S^{-1} for papaya tree (Allen and Jager, 1979), 0.34 mg CO_2 m^{-2} S^{-1} for guava tree (Khan, 1999) and 0.28 mg CO_2 m^{-2} S^{-1} for Kesar mango tree (Khan, 2004). Khan and Mahajan (1990) developed method for annual crops but not for the total absorption of CO_2 and its impact on yield and nutrient requirements for production of seasonal crop. They developed method of estimation of total leaf area of a guava tree. Khan (2008) developed a method for estimation of utilization of CO_2 in Alphanso mango tree. Much work has been done in this direction for annual crops but not for the total absorption of CO_2 and its impact on the yield and nutrient requirement for the production of the crop. The total absorption of CO_2 by a crop has not been estimated because of the difficulty of measuring its total leaf area ha^{-1} for the crop. The leaf area of a plant is the sum of area of all leaves on the plant and the total leaf area ha^{-1} is the sum of leaf area of all plants ha^{-1} for a crop. So, the total absorption of CO_2 depends upon the total number of plants ha^{-1} i.e. total leaf area ha^{-1} for a crop. Since, the total absorption of CO_2 is the main cause of the production of crop, its effect is to be studied and quantified in relation to the requirement of nutrients like N, P, K and other micro nutrients for the crop. Keeping in view, the aim of the present study is to develop new methods by using the width of leaves for estimation of total absorption of CO_2 and requirement of macro and micro nutrients for the fodder maize crop (variety African tall).

1. and 2. Asso. Professors and 3. Sr. Res. Asstt.

Materials and Methods

The experiment on fodder maize crop (African tall) was conducted at National Agricultural Research Project (NARP), Kolhapur. The experiment on fertility gradients concept for which four fertility gradient strips (L_0, $L_{1/2}$, L_1, L_2) were created on which experiment was conducted. Out of all combinations of N, P, K, 4 x 3 x 2, 21 treatment combinations were experimented in four strips along with six control plots in each strips. Thus, in all, 84 treated plots and 24 control plots were used in the experiment. The data of yield and uptake of N, P, K in kg ha^{-1} for treated and control plots were taken from the annual report (Anonymous, 2001). The number of plants, dry matter yield and water ha^{-1} for each treated and control plots were observed separately. The photosynthesis rate of fodder maize leaves was measured by portable photosynthesis system machine (LCA-4) in standard unit mg CO_2 m^{-2} S^{-1}. The mean photosynthesis rate was found 1.40 mg CO_2 m^{-2} S^{-1}. A random sample of 50 matured leaves covering complete range of variation of thickness was considered and the leaf width from middle of each leave was separately measured in cm by width gauge meter and mean width (W) was computed. Similarly from a random sample of 50 plants, covering complete range of variation, the leaf area of all leaves for each plant were obtained in cm^2 separately and mean leaf area $plant^{-1}$ was computed. As leaf area for whole plants ha^{-1} is not possible to measure, by the method of Khan and Mahajan, (1990), the total leaf area (A) of maiza ha^{-1}in cm^2 was worked out for each plot separately.

The faster photosynthesis in the leaves of the maize crops happens since it comes under C_4 plants. The photosynthesis happens in leaf thickness which is formed by the layers of cell that contains chlorophyll. Leaf width is supposed to be the width of chlorophyll content of a leaf. Therefore, it is assumed that width of absorbed CO_2 or released O_2 gas layers per unit time by a leaf is equal to the some multiple of width of the leaf. Assuming the same for all the leaves of maize crop, with the assumptions that, during the photosynthesis process in maize leaves, the width of layers of CO_2 gas absorbed or the width of layers of CO_2 gas released by the leaves per hour is equal to 4 times of the mean width of leaves of maize as it is C_4 plant since the intensity of sunlight remains very low in the morning and evening every day. So, the effective period of photosynthesis process has been considered 10 hours day^{-1}. Since, fodder maize (African tall) is of 2 months duration crop, in addition to this, it is also assumed that the plants after germination are very small and tender which takes 5 to 10 days for proper activity. So, the actual crop period was taken 60 days of duration.

Assumptions have facilitated the evaluation of exchange of volume and mass of CO_2 absorbed or O_2 released from the total leaf area ha^{-1} of standing maize crop. On the basis of above assumptions, the mass of CO_2 (M) absorbed or O_2 released hr^{-1} and reduction of CO_2 mass (M_1) hr^{-1} from the atmosphere were estimated in gram for each plot separately (Khan, 1999). The total mass of CO_2 (M_2) absorbed or O_2 released ha^{-1} and mass reduction of CO_2 from atmosphere were estimated in kg for the complete cropping season of 60 days required from germination to harvesting of the crop for each plot. Thus output i.e. yield and total input (CO_2, water, uptake N,P,K) were noted for each plot separately for cropping season of 60 days.

Some new methods were developed for the estimation of exchange of volume (V) of CO_2 absorbed or O_2 released hr^{-1}, mass of CO_2 (M) absorbed or O_2 released hr^{-1} and mass

reduction of CO_2 (M_1) hr^{-1} from the atmosphere by fodder maize crop were given, also the nutrients (F) absorbed in the cropping season of 60 days.

$V = A\ W$.....(1)

$M = VD$ .....(2)

$M_1 = V(D-D1)$.....(3)

F = Total output - Total input (Mass of CO_2, Water, uptake N,P,K)

Where,

A = Total leaf area of fodder maize ha^{-1}

W = Mean width of maize leaves

D = 0.001 977 g cc^{-1} and

D_1 = 0.001429 g cc^{-1} are the densities of CO_2 and O_2 gases, respectively.

M_3 = Yield (kg ha^{-1}),

M_4 = (Mass of CO_2, Water, uptake N,P,K).

The yield (Y) for treated plots or control plots and CO_2 absorbed (X1), water (X2), UN(X3), UP(X4), UK(X5) were fitted in the following multiple linear equation

$Y = a+b_1X_1 + b_2X_2+....+ b_5X_5$ ..... (5) for treated plot

and

$Y=a + b_iX_1 + b_2X_2+....+ b_5X_5$...(6) for control plot

Likewise, the multiple linear regression between dry matter yield and other variables for treated plots and control plots (CO_2, UN, UP, UK) were fitted as follows :

$Y = a+b_1X_1 + b_2X_2+.....+ b_4X_4$ .....(7) for treated plot

$Y = a+b_1X_1 + b_2X_2+.....+b_4X_4$ ....(8) for control plot

where, UN = Uptake N, UP- Uptake P and UK = Uptake K

Results and Discussion

Based on leaf width : The mean leaf width (W) of fodder maize was obtained from a sample of 50 leaves based on the large sample. The mean value of leaf width (0.0616 cm) from 50 leaves is an estimate for the population of leaves of maize crop. In other words W is the estimate of population mean value of maize leaves. Therefore, the mean leaf width (W) was considered an acceptable parameter for the estimation of exchange of volume and mass of CO_2 and O_2 hr^{-1} of maize crop.

Table 1. Exchange of CO_2 and O_2 from atmosphere for fodder maize crop.

Parameter	Control plot	Treated plot
Total leaf area ha^{-1} (cm^2)	15630736.417	28757217.971
Exchange of volume of CO_2 and O_2 ha^{-1} hr^{-1} (cc)	3851413.453	7085778.508
Absorption of mass of CO_2 ha^{-1} hr^{-1} (kg)	7.614	14.009
Release of mass of O_2 ha^{-1} hr^{-1} (kg)	5.504	10.126
Reduction of mass of CO_2 ha^{-1} hr^{-1} (kg)	2.110	3.883
Absorption of mass of CO_2 ha^{-1} day^{-1} (kg)	76.142	140.086
Release of mass of O_2 ha^{-1} day^{-1} (kg)	55.037	101.256
Reduction of mass of CO_2 ha^{-1} day^{-1} (kg)	21.105	38.830
Absorption of mass of CO_2 ha^{-1} $season^{-1}$ of 60 days (kg)	4568.547	8405.150
Release of mass of O_2 ha^{-1} $season^{-1}$ of 60 days (kg)	3302.202	6075.346
Reduction of mass of CO_2 ha^{-1} $season^{-1}$ of 60 days (kg)	1266.345	2329.804

The combination of total leaf area and mean leaf width resulted the method (1) for estimation of exchange of volume (V) of CO_2 absorbed or O_2 released hr^{-1} by the leaves of fodder maize crop. The estimation of mass of CO_2 absorbed or O_2 released hr^{-1} by maize crop leaves considering the densities was done by method (2) which is a reliable method of estimation (Table 1). The mean of estimated mass of CO_2 absorbed ha^{-1} hr^{-1} was found 7.614 and 14.009 kg for control and treated plot, respectively. The photosynthesis rate was 1.35 mg CO_2 m^{-2} S^{-1} approximately equal to the observed value 1.40 CO_2 mg m^{-2} S^{-1} indicating the validity of method (2) and accuracy of estimation. This is very important for a method validation. In spite of the large range of variation of mass of CO_2 hr^{-1} in maize crop, the method (2) gave very accurate estimation in different plots. Thus, the mean photosynthesis rate 1 .40 mg CO_2 m^{-2} S^{-1} estimated by the use of mean width of leaves are in accordance with the assumptions made. It provides a base to evaluate the exchange of mass of CO_2 and O_2 hr^{-1} for maize crop and also becomes an alternative method for accurate estimation of photosynthesis rate of maize crop. This method may possibly be applicable for other crops too.

On the basis of above results, the mass of CO_2 absorbed or O_2 released and mass reduction of CO_2 by the maize crop day^{-1} and in the whole cropping season of 60 days were calculated (Table 1).

Pollution reduction of CO_2 : Being the difference of masses of two gases, method (3) is also a reliable and accurate method for estimation of mass reduction of CO_2 ha^{-1} hr^{-1} from the atmosphere. This reduction occurs because of the unequal densities of CO_2 and O_2 gases. The estimated mass of pollution reduction due to CO_2 ha^{-1} hr^{-1} was found 2.110 and 3.883 kg for control plot and treated plot, respectively (Table 1). The mean reduction of CO_2 by crop day^{-1} was 21.105 kg for control plot and 38.830 kg for treated plot. The estimated mass of pollution reduction due to CO_2 ha^{-1} $season^{-1}$ of 60 days was found to be 1266.345 kg for control plot and 2329.804 kg for treated plot.

Nutrient requirement : The law of equality of relationship states that the total output of crop ha^{-1} = total input of the crop ha^{-2} in cropping season. Total output of crop is its yield kg ha^{-1} whereas the inputs include the mass of CO_2 absorbed, N, P, K and other nutrients along with water taken from the soil. Hence, other nutrients absorbed by the crop ha^{-1} $season^{-1}$ was estimated by method (4) which is very reliable and accurate method of estimation because of the accurate estimation

Table 2. Output, input and nutrients requirements for fodder maize crop.

Parameter	Control plot	Treated plot
Input :		
Absorption of mass of CO_2 ha^{-1} $season^{-1}$ of 60 days (kg)	4568.547	8405.150
Absorption of mass of water of ha^{-1} $season^{-1}$ of 60 days (kg)	16109.875	30111.821
Uptake of mass of N ha^{-1} $season^{-1}$ of 60 days (kg)	94.333	192.131
Uptake of mass of P ha^{-1} $season^{-1}$ of 60 days (kg)	6.821	15.063
Uptake of mass of K ha^{-1} $season^{-1}$ of 60 days (kg)	86.625	150.000
Total	20866.201	38874.166
Output :		
Yield ha^{-1} $season^{-1}$ of 60 days(kg)	21265.833	39616.429
Other nutrients requirement ha^{-1} $season^{-1}$ of 60 days (kg)	399.632	742.263

of CO_2 absorbed in photosynthesis process in the leaves of maize crop throughout the cropping season and observed uptake of N, P, K and water in the cropping season. Thus the law of 'input = output' has provided the method to estimate the other nutrients required for the crop ha^{-1} $season^{-1}$.

The other nutrients requirement of maize crop were evaluated for control plot and treated plot kg ha^{-1} $season^{-1}$, separately (Table 2), which were found 399.632 and 742.263 kg ha^{-1} for control and treated plots, respectively which were 2 per cent of the yield. The proportion out of 100 of N, P, and K were found as 53:4:43 for control plots and 50:4:46 for treated plots, from the observed total uptake. While the quantity of water remains constant throughout the growth process of crop in cropping season. It gave a guideline to use the fertilizer with respect to photosynthesis process in the crop. Thus, the fertilizer requirement may be estimated on the basis of photosynthesis of the crop as explained prepages, which will reduce the excess use of fertilizer and also the expenditure on it and the soil health may also be maintained accordingly. Similarly, based on photosynthesis, the method for estimation of fertilizer requirement may also be developed for other crops also.

The multiple linear regression between yield and CO_2, water, uptake N, P, K were found similar to that of between dry matter yield and CO_2, uptake N, P, K for treated and control plots which clearly indicated that the water works as a catalyst in the plant growth process. This is an important and useful finding which has been obtained mathematically for role water as a catalyst throughout the growth process of the maize crop (Table 3).

The coefficients of regression line either for yield or dry matter yield were found to be approximately equal for the constituents of CO_2, UN, UP, UK in the equation. This has very clearly indicated and advocated that whatever the increase occurs in yield that increases the dry matter yield only (Table 3). Because of this relation, the proportion out of 100 uptake of N, P, K were found to be constant approximately 53:4:43 for control plots and 50:4:46 for treated plots. Which is further advocating that, availability of N, P, K may be made such that the plant can absorb the required nutrients. Since, more the availability provides required uptake of N, P, K and more the production. It means the nutrient availability technique may be developed for proper utilization of nutrients from the soil. If this can be done then proportional uptake of N, P, K will occur up to the maximum and the proper production of the crop may also be achieved accordingly.

Table 3. The multiple linear regression equations between yield / dry matter and the related variables.

Regression equation	R^2
Control plot :	
1. **Yield :** $Y = 247.767 + 1.037^{**}CO_2 + 0.993^{**}$ water + 0.815 UN +18.883 UP + 1.001 UK	0.99995
2. **Dry matter yield :** $Y = 234.413 + 1.017^{**}CO_2 + 0.894$ UN +17.263 UP + 0.833 UK	0.9993
Treated plot :	
1. **Yield :** $Y = 196.448 + 1.065^{**}CO_2 + 1.000^{**}$water + 0.693 UN-1.206 UP + 1.615^{**} UK	0.99998
2. **Dry matter yield :** $Y = 196.421 + 1.065^{**}C0_2 + 0.691$ UN - 1.205 UP + 1.616^{**} UK	0.9996

The linear equation explained, when there is an absorption of one kg CO_2, there happens 1.037 and 1.065 kg increase in the yield of maize crop for control and treated plot, respectively indicating that 1 kg CO_2 is used for yielding 1.037 to 1.065 kg fodder maize from germination to harvest of crop throughout the cropping season of 60 days duration (Table 3).

Similarly, there is increase in maize yield by 1.000, 0.693 and 1.615 kg due to one unit increase in water, UN and UK, respectively while decreases by 1.260 kg as one unit increase in UP, throughout the season in treated plots. Likewise, CO_2 (1.037 kg), water (0.993 kg), UN (0.815 kg), UP (18.883 kg) and UK (1.001 kg) contributed against per unit change in these variables in the control plots. The relationship obtained between dry matter yield and CO_2, UN, UP, UK indicated the similar effect. Thus, the equations of yield and dry matter yield are expressed the same analysis of result of the growth process of the crop. The coefficient of multiple determination (R^2) explained, the total contribution of these variables as 99.998 and 99.995 per cent for treated and control plots, respectively indicated the crop has fully utilized the CO_2 and macro nutrients along with water. In consideration of CO_2 consumption by the crop, the estimated proportion of N, P, K nutrient requirement was 50:4:46 as a whole, while other nutrients were 2 per cent of yield ha^{-1} for the crop. Therefore, it is guiding point that, 50 kg N, 4 kg P and 46 kg K are absorbed if total 100 kg macro-nutrients are required for the crop.

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Evaluation of Crop Pest Surveillance and Advisory Project (CROPSAP) for Soybean Crop in Nashik District of Maharashtra

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Abstract

The print media was the most preferred component of the, multimedia used in creating awareness on Crop Pest Surveillance and Advisory Project (CROPSAP) followed by video shows and power point presentations. There has been considerable decrease in the cost incurred on crop protection measures due to CROPSAP. Moreover there has been good increase in crop production and net income to the farmers. The findings would be useful to outline interventions that are for bringing out efficacy in implementation of the project for benefit of the farming community in general and reducing the losses in crop production due to incidence of pests by timely identifying them and suggesting preventive eco and user friendly measures through sharing and caring.

Key words : Crop pest surveillance, multimedia, awareness, information.

Pest surveillance and management aims to envisage strengthening the infrastructure of the squad and organized proper insect pest and disease survey and forecast the incident when it goes above economic thresh-hold level and thereby increasing the production in the whole state. Department of Agriculture (MS) implements the mobile squad for providing timely plant protection facilities to the farmers for effective control of any pest, insect and disease in field crops through use of different multimedia approach (Deshmukh 2009). The attempt has been therefore, made to know the effectiveness of multimedia in creating awareness about CROPSAP amongst the producers of soybean, benefits accrued by them and constraints faced.

Material and Methods

The relevant information was collected and analyzed from the participant farmers through special questionnaire designed for the same. In all 40 respondent farmers who had been selected as fixed plot beneficiary for soybean crop from Niphad taluka under the project were selected purposively. Niphad block having highest area under soybean crop in the district during the year 2010-11 has been purposively selected.

The various multimedia tools used for dissemination of the information on crop pests and diseases while implementing this project are print media, datasheet, GIS equipments, magnifying lenses, internet and mobiles for sending SMS. The special schedule was developed for the study of this variable and the same was quantified by assigning scores by developing arbitrary scale as score 3 for most effective, score 2 for somewhat effective and score 1 for less effective. The statistical tools used in the recent research study were frequency distribution and percentage distribution, B:C ratio etc.

Results and Discussion

Awareness : It can be revealed from the Table 1 that on an average pre project, 25.5

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per cent respondents were having the awareness about the CROPSAP. This showed that, the awareness level of the respondents, regarding the project was very low. This awareness level has shown good increase by 93.5 per cent in post project evaluation. The overall increase was 68 per cent. Hence, continuous orientation about the project through awareness programmes is very effective for pest and disease management.

Multimedia in awareness : The awareness programmes by way of participatory training are very crucial, to have an effective impact and to increase the level of project awareness. Needless to add, the various components of multimedia used in program implementation i.e. print media, power point presentations, audio-video CDs, radio talks, mobile SMS, etc are having direct bearing on this effectiveness. It can be revealed (Table 2) that 87.50 per cent respondents indicated that the printed study material supplied to them was most effective, while 7.5 per cent respondents were of the opinion that the print media has been somewhat effective and rest 5 per cent indicated that it was less effective. The 72.5 per cent respondents opined that the power point presentations were most effective media followed by somewhat effective 15 per cent and less effective 12.5 per cent. Further, 82.5 per cent respondents indicated that video films shown during the training programme was most effective to create direct impact on increasing awareness level while 10.84 per cent opined somewhat effective and 7.5 per cent were of the view that it was less effective. Similarly, 75.0 cent respondents indicated that mobile SMS received during the implementation of the programme was most effective to create direct impact on increasing awareness level while 15 per cent opined somewhat effective and 10 per cent were of the view that it was less effective. Therefore, on an average, the multimedia components used were most effective according to 79.38 per cent respondents, while 11.87 per cent indicated somewhat effective and rest 8.75 per cent respondents felt less effective. Similar results were also reported by Krishna (2008) and Mishra (2010).

Print Media : Print media was more preferred due to its simplicity and the hard copy can be referred anytime and anywhere. Moreover, it does not require any sophisticated hardware and also free from maintenance. However, the respondents having comparatively low level of literacy have shown lower degree of preference for the same.

Table 1. Awareness on CROPSAP amongst the respondents: (N=40).

Questions on CROPSAP	Pre project responses		Post project responses		Increase in level of awareness	
	No.	%	No.	%	No.	%
Do you agree that pest and disease attack affects the crop yields?	11	27.5	36	90.0	25	62.5
Do you buy the pesticides from the market, as per the recommendations of the Agriculture Department?	15	37.5	40	100.0	25	62.5
Do you identify the different pests and diseases?	06	15.0	37	92.5	31	77.5
Do you know what IPM is?	13	32.5	39	97.5	16	40.0
Do you think that CROPSAP has helped you to get first hand information on pest attack?	06	15.0	35	87.5	29	72.5
Mean	10.2	25.5	37.4	93.5	27.2	68.0

Especially jumbo xerox for alertness on attack or spread of various pests and diseases was found most effective tools to create the awareness.

Power point : Majority of the respondents have opined that PPT has its own usefulness and effectiveness in expression and communication. It is the powerful tool for the trainers. The photos displayed with the help of PPTs have been found most effective in identification of pests and diseases. However, text is hard to read on screen as it sometimes strains eyes than reading from paper, if proper fonts and style are not used.

Audio : The Radio talks on incidence on spread of various pests and diseases were quite effective inorder to have preventive measures. Radio talks and Jingles were found to be most effective tool and easy to understand the epidemic situation of pests and diseases.

Video : It is said that one video clip is equivalent to one book. Many respondents have preferred this component; however it was more popular amongst the respondents who did not have time to read and wish to grasp the things for their immediate use. Video CDs were seen as an ideal medium to promote motivation, attitudinal change and behavior reinforcement and community participation regarding pest and diseases management in a mission mode.

All these four components of multimedia have combined effective impact on transfer of technology and creating general awareness amongst the farmers (NCIPM 2007). Therefore, the combination of these components should be used most judiciously to create an effective positive impact in technology dissemination.

Benefits : The per hectare cost of cultivation (Table 3) of soybean crop pre project was Rs. 11180 which has been reduced to Rs. 10680 after the project. This has been mainly due to reduction in cost on crop protection measures. The cost benefit ratio has been considerably increased from 2.15 to 2.70.

There has been considerable reduction in cost of pesticides and its application (Table 4) to the tune of Rs 500 hectare^{-1}. However, it was very important to witness the per hectare increase in yield by 20 per cent i.e. 3 quintals. On an average hectare^{-1} percentage increase in net income worked out to more than 40 per cent. This has been only because of timely applications of the pesticides as per the recommendations of the Universities and

Table 2. Effectiveness of various components of multimedia used in the training prograrnrne: (N=40).

Components	Most effective	Somewhat effective	Less effective
Print media	35 (87.50)	3 (7.50)	2 (5.00)
Power point presentation	29 (72.50)	6 (15.00)	5 (12.50)
Audio-video aids	33 (82.50)	4 (10.00)	3 (7.50)
Mobile SMS	30 (75.00)	6 (15.00)	4 (10.00)
Overall multimedia	31.75 (79.38)	4.75 (11.87)	3.50 (8.75)

Table 3. Per hectare cost of cultivation of soybean crop.

Particulars	Before project		After project	
	Amt.	%	Amt.	%
Land preparation	3000	26.83	3000	28.08
Seeds and sowing	1500	13.42	1500	14.04
Manures and manuring	2030	18.15	2030	19.01
Intercultural operations and irrigations	1500	13.42	1500	14.04
Plant protection	1150	10.29	650	6.09
Harvesting expenses	2000	17.89	2000	18.74
Total expenses	11180	100.00	10680	100.00
Yield in quintals	15	-	18	-
Gross income	24000	-	28800	-
Net income	12820	-	18120	-
Cost benefit ratio	2.15	-	2.70	-

Table 4. Extent of benefits derived from CROPSAP to the respondents (N = 40).

Particulars	Before project	After project	Increase in extent of benefits	
			Rs.	%
Quantity of produce (q ha^{-1})	15	18	3	20.00
Value of produce (Rs. ha^{-1})	24000	28800	4800	20.00
Reduction in cost on pesticides (Rs. ha^{-1})		500	-	-
Increase in yield due to scheme (kg ha^{-1})	1500	1800	300	20.00
Increase in net income due to scheme (Rs. ha^{-1})	12820	18120	5300	41.00

adoption of integrated pest management. The various methods adopted for the pest management which include intercropping, pheromone traps, trap crops, bio-pesticides etc. All these factors had combined effect on increase in the yield and reduction of cost on crop protection measures.

Constraints : Non supply of electricity during the day time emerged as a most important constraint amongst all the participating farmers followed by the nonavailability of recommended bio-pesticides. The farmers are still not well versed with the preparation of bio-pesticides at the farm itself and desire readymade products for the same. The other constraints were non availability of mobile range, irregular visits of the scouts in the village and difficulty.in understanding the message due to usage of english language etc can be very well taken care of by undertaking remedial measures for the same.

Suggestions : The project may be continued in future to overcome the epidemic situation of the pests due to timely alertness signals. Regular visits of the scouts to be ensured. The language of the SMS should be marathi in appropriate fonts. More awareness training programmes should be undertaken on preparation of bio-pesticides at the farm itself so that the cost of the pesticides can be considerably reduced with the production of quality and residue free crop products. The supply of pesticides should be at fully subsidized cost to reduce the burden of the cost of cultivation of the crop by reducing the cost on crop protection.

Conclusion : The print media was the most preferred component of the multimedia used in creating awareness on crop surveillance and advisory project followed by video shows and power point presentations. There has been considerable decrease in the cost incurred on crop protection measures due to CROPSAP. Moreover there has been good increase in crop production and net income to the farmers. The findings of the study will be helpful for the personnel from the Department of Agriculture for arranging training programmes on creating awareness through effective use of various components of multimedia, on CROPSAP amongst farmers and staff members. The personnel from the various stakeholders of the project, conducting such training programmes can devise proper curriculum and plan for judicious use of various components of the multimedia to improve the effectiveness in technology dissemination.

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Yield and Quality of Summer Groundnut under Different Irrigation Scheduling through Microsprinkler in Clay Loam Soils of Western Maharashtra

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Abstract

The growth and yield contributing characters were observed significantly superior under micro-sprinkler irrigation at 1.05 IW/CPE ratio as compared to other treatments. Microsprinkler method proved effective for maintaining proportion of air, soil and water at optimum level throughout the period of crop resulted into improved yield parameters and making the nutrients available to the plants easily.

Key words : Microsprinkler, summer groundnut, IW/CPE ratio. irrigation regimes.

Irrigation scheduling through microsprinkler has proved to be an effective tool in optimizing the water need of groundnut crop and it can be considered as a better option for irrigation scheduling and maximization of yield of groundnut. However, information regarding appropriate irrigation scheduling criteria for summer groundnut under micro-sprinkler is not available. Hence, efforts have been made to assess the effect of irrigation methods and regimes on growth and yield of groundnut.

Materials and Methods

The field experiment was conducted to study the yield of summer groundnut as influenced by irrigation methods and regimes at Mahatma Phule Krishi Vidyapeeth, Rahuri during summer season. Agroclimatically, the area falls under the scarcity zone of Maharashtra with annual average rainfall of 520 mm which is mostly erratic and uncertain in nature. The topography of the experimental field was uniform and levelled. The soil was 30 cm deep and water table was more than 3 m below soil surface. The soil was having good drainage with infiltration rate 1 cm hr^{-1}. The soil texture was sandy clay loam having 16.40 per cent coarse sand, 26.95 per cent fine sand, 26.15 per cent silt and 29.4 per cent clay. The soil was alkaline in nature with pH of 8.57 and electrical conductivity of 0.79 dSm^{-1}. The bulk

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density of soil was 1.34 g cm^{-3} and having organic carbon as 0.65 per cent. The soil was low in available N (172 kg ha^{-1}), and P (12.78 kg ha^{-1}) and high in available K (302.4 kg ha^{-1}) content. The moisture contents at field capacity, permanent wilting point and available soil moisture was 28.36, 14.17 and 14.19 per cent, respectively.

The experiment was laid down in a split plot design with 2 main levels and 5 sub levels replicated thrice. The ten treatment combinations comprised five different irrigation schedules viz., 0.6, 0.75, 0.9, 1.05 and 1.20 IW/CPE ratios and two irrigation methods *viz*., micro-sprinkler and surface method. The sowing of summer groundnut (var TAG-24) was done at the spacing of 30 x 10 cm. The recommended dose of fertilizer (25:50:0 N:P_2O:kg ha^{-1}) was applied as basal dose for all the treatments.

In micro-sprinkler system, the depth of irrigation to be applied was estimated using cumulative pan evaporation (CPE) and irrigation were applied twice in a week. The daily pan evaporation data was recorded from USWB class A pan. The quantity of water to be applied per irrigation and seasonal water requirement of crop was worked out. The subsequent irrigations were scheduled as per the treatments. The rotating microsprinklers were placed on laterals of diameter 16 mm. The spacing between two adjacent laterals and microsprinklers within plot was kept as 1.80 and 1.5 m, respectively. The average coefficient of uniformity for microsprinkler irrigation system was estimated as 82.5 per cent for all treatments. In surface irrigation, 5 cm depth of irrigation was applied at 50 mm cumulative pan evaporation. The quantity of water applied was measured by replogal flume.

Results and Discussion

The microsprinkler system of irrigation resulted superior over surface method of irrigation with increasing trend of growth

Table 1. Influence of irrigation methods and regimes on yield and its contributing characters in summer groundnut.

Treatment	Dry pod yield (q ha^{-1})	Haulm yield (q ha^{-1})	Pod to haulm ratio	Kernel yield (q ha^{-1})	Oil content (%)	Oil yield (q ha^{-1})
A. Irrigation methods :						
I_1 : Microsprinkler	27.45	21.49	1.28	21.83	49.33	10.81
I_2 : Surface	20:38	16.30	1.25	15.21	48.35	7.35
S.E.±	0.227	0.306	-	0.172	0.023	0.085
CD at 5 %	1.380	1.859	-	1.046	0.139	0.519
B. Irrigation regimes :						
L_1 : 1W/CPE = 0.6	17.89	14.21	1.26	14.22	48.47	6.89
L_2 : IW/CPE = 0.75	21.18	16.53	1.28	15.97	48.56	7.75
L_3 : IW/CPE = 0.90	26.94	21.56	1.25	21.51	49.66	10.77
L_4 : IW/CPE = 1.05	28.21	21.91	1,29	22.21	49.02	10.90
L_5 : IW/CPE = 1.20	25.36	20.25	1.25	18.69	48.51	9.07
S.E.±	0.580	0.539	-	0.509	0.047	0.248
CD at 5 %	1.739	1.616	-	1.524	0.140	0.744
C. Interaction :						
S.E.±	0.821	0.763	-	0.719	-	0.351
CD at 5 %	2.459	2.286	-	2.155	-	1.053
General Mean	23.92	18.90	1.27	18.52	48.84	9.08

parameters since germination to harvesting. This increasing trend was due to proper availability of moisture in the root zone of the crop throughout the growth period. The mean dry matter plant^{-1} at harvest differed significantly by various irrigation methods. The dry matter yield at harvest was highest in microsprinkler (29.29 g plant^{-1}) as compared to surface irrigation (18.90 g plant^{-1}). The uniform distribution of water through microsprinkler created microclimate, which induced the plant for more number of branching as well as increase in leaf size which ultimately resulted in increased dry matter yield.

The growth parameters also significantly influenced by different irrigation regimes. The plant height was found maximum when irrigation applied at 1.05 IW/CPE ratio. The treatment 1.20 IW/CPE ratio was found the next best treatment after 1.05 IW/CPE ratio. Number of branches plant^{-1} at irrigation regime of 1.20 IW/CPE ratio was on par with IW/CPE ratio of 0.90 and 1.05. The treatment 0.6 IW/CPE ratio recorded minimum branches than all other treatments. The low frequency of irrigations at various growth stages reduced the number of branches. In case of plant spread, application of irrigation at 1.20 IW/CPE ratio recorded significantly superior value (28.68 cm). The increase in spread of plant was observed due to proper availability of moisture in the root zone of the crop throughout the growth period. The total dry matter plant^{-1} at harvest was also significantly influenced by different irrigation regimes. There was progressive increase in dry matter accumulation from 0.6 to 1.05 IW/CPE ratio and then decreased at 1.20 IW/CPE ratio with increase in level of irrigations. The optimum soil moisture conditions in the root zone of the crop increased the total dry matter content plant^{-1}. The treatment of irrigation applied at 0.6 IW/CPE ratio recorded minimum values of all growth parameters of crop. Similar results were also reported by Firake and Shinde (2002) and Kadam *et al*. (2006).

The results revealed that microsprinkler irrigation method (Table 1) gave the higher values of post harvest characters as compared to surface method of irrigation. The mean thousand pod and kernels weight were observed maximum as 592.28 and 406.15 g under microsprinkler method of irrigation which was significantly superior over the values obtained in surface method of irrigation as 586.86 and 400.81 g, respectively.

It can be seen that thousand pod weight was maximum (595.08 g) in the treatment with 1.05 IW/CPE ratio which was significantly superior over rest of treatments. The thousand pod weight with 0.75 and 0:6 IW/CPE was minimum than rest of the treatments as 583.72 and 580.97 g, respectively. Similarly, weight of thousand kernels was maximum (407.82 g) with 1.05 IW/CPE ratio and was significantly superior over rest of the treatments. However, shelling percentage of summer groundnut was not influenced significantly with irrigation methods as well as for irrigation regimes. The interaction effect between irrigation methods and irrigation regimes for all growth contributing and post harvest characters were found as non significant in the present investigation.

The yield contributing characters were found improved in microsprinkler than surface irrigation method. The dry pod yield and haulm yield were maximum (27.45 and 21.49 q ha^{-1}) with microsprinkler irrigation system which were significantly superior over surface irrigation method (20.38 and 16.30 q ha^{-1}). The crop received sufficient moisture from frequent irrigations with microsprinkler during pegging and pod formation from early to maturity stages. The frequent irrigations

through, microsprinkler during these stages maintained the soil moisture content almost near to the field capacity and crop did not experienced moisture stress during the crop growth hence produced more yields. Similarly, values of kernel yield (21.83 q ha^{-1}), oil content of groundnut kernel (49.33%) and oil yield (10.81 q ha^{-1}) were significantly superior in microsprinkler as compared to respective values obtained in surface method of irrigation (15.21 q ha^{-1}, 48.35 % and 7.35 q ha^{-1}).

Application of irrigation at 1.05 IW/CPE ratio produced significantly higher dry pod yield (28.21 q ha^{-1}) than those registered in rest of the treatments. The treatment 0.9 IW/CPE. (26.94 q ha^{-1}) was at par with the treatment 1.05 IW/CPE ratio. Significant decrease in dry pod yield was recorded (17.89 q ha^{-1}) when irrigations were given at 0.6 IW/CPE ratio. The combined effect of irrigation methods and irrigation regimes used water judiciously and maintened proper moisture in soil. Optimum soil water-air balance in root zone resulted into good physiological activity and enhanced the yield. In case of haulm yield, highest values (21.91 q ha^{-1}) at application of irrigation at 1.05 IW/CPE ratio was obtained than rest of the treatments. However, it was at par with that of 0.9 IW/CPE ratio i.e, 21.56 q ha^{-1}. However, pod to haulm ratio was not differed significantly with difference in irrigation method or irrigation regimes.

In case of kernel yield, the irrigations applied at 1.05 IW/CPE ratio produced significantly higher kernel yield (22.21 q ha^{-1}) followed by irrigation applied at 1.20 IW/CPE ratio (18.69 q ha^{-1}). This indicated higher moisture regime exerted adverse effect on yield of crop. Continuous stress of moisture at lower moisture regimes (0.6 IW/CPE ratio) observed with significant decrease in kernel yield (14.22 q ha^{-1}). The maximum oil content was recorded under 0.9 IW/CPE ratio (49.66%) followed by 1.05 IW/CPE (49.66%). The lowest values of all yield-contributing characters were recorded at irrigation applied lower regime i. e. 0.6 IW/CPE. This is revealed that moisture stress in summer groundnut resulted in less vegetative growth and hence reduced yield characters drastically.

The interaction effect between irrigation methods and irrigation regimes for all yield contributing characters were found significant for microsprinkler with 1 .05 IW/CPE ratio as compared to other treatments/interactions. However, oil content of kernels was not influenced significantly by the interaction of different irrigation methods and irrigation regimes. The combined effect of irrigation methods and irrigation regimes resulted into good physiological activity and increase in yield contributing characters. These results are in conformity with those reported by Pawar (1999) and Kumar *et al*. (2000).

Total nitrogen (65.74 kg ha^{-1}), phosphorus (25.45 kg ha^{-1}) and potassium (25.43 kg ha^{-1}) uptake recorded significantly higher under microsprinkler treatment over surface method of irrigation. Similarly, the effect of irrigation methods on available N, P and K was found significantly maximum under microsprinkler over the surface method of irrigation. The restricted leaching of nutrients in microsprinkler improved the root nodulation which ultimately increased the nutrient uptake more than twice (N and P uptake) as compared to surface method.

Application of irrigation at 1.05 IW/CPE ratio recorded significantly higher total nitrogen uptake (70.55 kg ha^{-1}) than other treatments. It is observed that total nitrogen uptake increased from 0.6 IW/CPE ratio upto 1.05 IW/CPE and then decreased at the treatment of 1.20 IW/CPE ratio (38.47 kg ha^{-1}). The highest P uptake was recorded at 1.05 IW/CPE ratio

(26.01 kg ha^{-1}) which was at par with 0.9 IW/CPE treatment. Significantly lowest P uptake observed in irrigation regimes 0.6 IW/CPE (12.30 kg ha^{-1}). Similar trend of nutrient uptake was obtained for potassium uptake. The maximum potassium uptake recorded under 1.05 IW/CPE (25.53 kg ha^{-1}) was at par with 0.9 IW/CPE. Significantly lowest potassium uptake was recorded with 0.6 IW/CPE ratio (16.04 kg ha^{-1}). Similarly, application of irrigations at 1.05 IW/CPE ratio followed by 0.9 IW/CPE ratio recorded significantly higher total nitrogen, phosphorus and potassium availability in soil. Significantly lowest nitrogen, phosphorus and potassium availability was recorded with 0.6 IW/CPE ratio. Similar results were also reported by Husen (1995), Firake and Shinde (2000) and Dahiwalkar *et al*. (2004).

In general, the uptake of nutrients was comparatively more in treatments where higher IW/CPE ratios provided. This indicated that nutrients uptake in groundnut is better utilized when adequate moisture in root zone is present.

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Influence of Different Irrigation Scheduling and Land Configurations on Growth and Yield of Chickpea

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Abstract

Chickpea showed significantly higher yield of 24.74 q ha^{-1} for irrigation scheduling at 1.0 IW/CPE ratio and found to be the best proposition for chickpea crop. The field water use efficiency was maximum i.e. 12.37 kg ha^{-1} mm^{-1} at 1.0 IW/CPE ratio and ridges and furrows land configurations as compared to other treatments. The second order quadratic water production functions were found best fit for irrigation water applied for chickpea biological and grain yield for flat bed and ridges and furrow layouts. The estimated yield was determined by using water productions function and variations with actual values were observed less than 1 per cent. It can be concluded that, for *rabi* gram cultivated in sandy clay loam soil, the surface method of irrigation with 1.0 IW/CPE ratio at 50 mm CPE growing on ridges and furrows found to be best practice to obtain better growth and yield among the practices studied.

Key words : IW/CPE ratio, irrigation scheduling, regimes, land configurations.

For chickpea crop, water-yield relationship is quite complex. This is because the economic yield of chickpea not only depends upon total water supplied during growing season but also on its allocation throughout the growth period. However, information is needed to guide farmers when and how much to irrigate with controlled deficit irrigation practices in order to reduce the unwanted effect of water stress on crop yield. Thus, water production functions need to be derived for the crop so that, the available water resources can be used more effectively producing more yields.

The proper land configuration is one of the most important factor responsible for managing the irrigation water. In Maharashtra, chickpea is generally grown on flat bed resulting into low yields due to temporary water logged condition coupled with compaction, especially in clay soil. The ridges and furrows can provide good aeration and seedbed for better irrigation and drainage of excess water than flat bed (Shaikh and Mungse, 1998). Therefore, irrigation scheduling in combination with land configurations forms an important aspect in managing the irrigation water. The present investigation was undertaken to study the effect of irrigation scheduling and land configurations on yield of chickpea in Western Maharashtra.

Materials and Methods

The field experiment was conducted to study the yield of chickpea as influenced by different irrigation layouts at research farm of Mahatma Phule Krishi Vidyapeeth, Rahuri, Distt. Ahmednagar (M.S.) during 2007-08. Geographically, the study area is located at 19° 24' N latitude and 74° 39' E longitude at an altitude of 500 m. Agro climatically the area falls under scarcity zone of Maharashtra with annual rainfall of 520 mm, which is mostly concentrated during the monsoon months from June to September. The soil of the experiment field was sandy clay loam texture having sand,

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silt and clay percentage as 14.77, 22.86, and 23.56 respectively. The moisture content at field capacity and permanent wilting point were 27.07 and 12.09 per cent respectively. The bulk density of experimental site was 1.37 g cm^{-3}. The soil was slightly alkaline in reaction (pH 8.10). The water table was more than 3 m below soil surface hence; there was no contribution to soil moisture from the underground water table.

In the present investigation, ten treatment combinations with five different irrigation schedules *viz*., 0.6, 0.8, 1.0, 1.2 IW/CPE ratios and irrigation at critical growth stages (3 irrigations at 30, 60 and 90 days after sowing) and two land configurations *viz*., flat bed and ridge and furrows were studied in factorial randomized block design with three replications. The sowing of chickpea (var Digvijay) was done during November 2007 at the spacing of 30 x 10 cm by dibbling one seed in all land configurations. In case of flat beds, the dibbling was done by maintaining the spacing of 30 cm between the rows, while in ridges and furrows, the seeds were dibbled on both sides of ridges maintaining the row to row spacing.

The irrigations were scheduled at 50 mm cumulative pan evaporation (CPE). The recommended dose of fertilizer (25:50:0 N P_2O_5 kg ha^{-1}) was applied as basal dose for all the treatments. The quantity of water to be applied per irrigation and seasonal water requirement of crop was worked out. The consumptive use of water was determined for each treatment from the depth of moisture depleted in each layer *viz*., 0, 15 and 30 cm during an irrigation cycle taking into account effective rainfall (Michel, 2008).

The water production functions were established between biological and grain yield of chickpea with actual water applied for each treatment. Mathematically the function may be expressed as : Y=F(X)..... (1)

Where, Y is the yield of crop and X is represented by actual depth of irrigation water applied (IW). In this study, the water production

Table 1. Influence of irrigation regimes and land configurations on growth and yield characters of chick pea.

Treatment	Dry matter accumulation (g) $plant^{-1}$	Plant height (cm)	Plant spread (cm)	Branches $plant^{-1}$	Biological yield (q ha^{-1})
Irrigation regimes :					
0.6 IW/CPE	28.64	39.63	36.83	7.33	31.67
0.8 IW/CPE	29.80	42.39	38.92	9.18	35.69
1.0 IW/CPE	30.66	46.22	44.14	10.26	47.05
1.2 IW/CPE	31.73	49.07	44.94	10.23	46.48
At critical growth stages	29.89	46.30	41.74	9.25	39.62
S.Em±	0.383	0.109	0.142	0.032	0.028
CD at 5 %	1.138	0.324	0.421	0.096	0.082
Land configurations :					
Flat bed	29.72	43.76	40.54	9.14	38.90
Ridges and furrows	30.57	45.66	42.08	9.36	41.30
S. Em±	0.242	0.069	0.09	0.020	0.017
C.D. at 5 %	1.138	0.205	0.266	0.061	0.052
Interaction :					
S.Em±	-	-	-	-	0.166

functions based on both grain yield and biological yield have been derived.

Results and Discussion

Irrigation : The results shown in Table 1 revealed that all the growth contributing characters significantly influenced by different irrigation regimes. The mean plant height at harvest (49.07 cm) and plant spread (44.94 cm) were recorded maximum at 1.2 IW/CPE ratio which was significantly superior over 0.6, 0.8, 1.0 and at critical growth stages. The proper available moisture conditions in the root zone of the crop throughout the crop growth period at 1.2 IW/CPE ratio resulted into improved plant height and spread. The mean number of branches plant^{-1} was found to have been increased with advancement in the age of the crop. At harvest the maximum mean number of branches (10.26) was recorded at 1.0 IW/CPE ratio which was significantly superior over 0.6, 0.8 ratio and at critical growth stages. However, it was at par with that of irrigations at 1.2 IW/CPE ratio. At harvest, the maximum mean dry matter of plant (31.73 g) was recorded at 1.2 IW/CPE ratio which was significantly superior over 0.6, 0.8 IW/CPE ratio and at critical growth stages, however, it was at par with 1.0 IW/CPE ratio. The lowest growth characters *viz*., mean plant height (39.63 cm), plant spread (36.83 cm), mean number of branches (7.33) and lowest dry matter plant^{-1} (28.64) was recorded at 0.6 IW/CPE ratio.

Land configurations : The ridges and furrows found superior over flat bed method of land configuration with increasing trend of growth parameters since initiation to harvesting. This increasing trend was due to proper availability of moisture in the root zone of the crop throughout the growth period. Significantly superior mean plant spread (31.84 cm), mean number of branches (9.36) and mean dry matter plant^{-1} (30.57 g) was observed in ridges and furrows over flat bed. In case of ridges and furrows, proper soil-air-water

Table 2. Yield and yield contributing characters at harvest as influenced by different treatments.

Treatment	Number of pods plant^{-1}	Weight of pod plant^{-1} (g)	Weight of grain plant^{-1} (g)	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
Irrigation regimes :						
0.6 IW/CPE	33.61	15.27	12.33	230.62	18.95	12.72
0.8 IW/CPE	37.00	17.60	15.34	248.86	20.07	15.62
1.0 IW/CPE	44.49	20.35	19.35	269.45	24.74	22.32
1.2 IW/CPE	41.51	19.53	17.63	250.50	24.05	22.42
At critical growth stages	42.16	18.32	15.90	256.87	20.15	19.47
S.Em±	0.372	0.013	0.01	-	0.051	0.038
CD at 5 %	1.104	0.039	0.034	-	18.95	12.72
Land configurations :						
Flat bed	33.59	17.27	15.44	237.77	21.09	17.81
Ridges and furrows	40.92	19.15	17.19	264.75	22.09	19.21
S. Em±	0.235	0.008	0.007	6.63	0.032	0.024
C.D. at 5 %	0.698	0.025	0.022	19.70	21.09	17.81
Interaction :						
S.Em±	-	0.019	0.016	-	0.024	0.018
C.D. at 5 %	-	0.055	0.048	-	0.073	0.054

equilibrium maintained at rhizosphere which gave more nitrogen fixation and resulted into favourable enhancement of growth attributes.

Interaction : The interaction effect between irrigation regimes and land configurations for all growth contributing characters of chickpea were found non significant in the present investigation.

Yield and yield contributing characters: The yield contributing characters (Table 2) were found improved with increase in irrigation regimes upto 1.0 IW/CPE ratio. The maximum number of pods plant^{-1} (44.49), mean maximum weight of pods plant^{-1} (20.35 g) in 1.0 IW/CPE ratio was significantly superior over 0.6, 0.8, 1.2 IW/CPE ratio and at critical growth stages. It was due to better soil moisture conditions in the root zone of the crop during vegetative as well as reproductive phases of crop growth. The maximum mean weight of seeds plant^{-1} was 19.35 g at 1.0 IW/CPE ratio and was significantly superior over all other treatments.

The maximum mean seed yield of chickpea was obtained as 24.74 q ha^{-1} when irrigation applied at 1.0 IW/CPE ratio which was significantly superior over all other treatments (Table 2). Application of irrigation at 1.2 IW/CPE ratio recorded 24.05 q ha^{-1} seed yield which was lower than 1.0 IW/CPE ratio. The maximum straw yield was 22.42 q ha^{-1} for irrigation at 1.2 IW/CPE ratio and was significantly superior over 0.6, 0.8 IW/CPE ratio and at critical growth stages. However, it was at par with that of 1.0 IW/CPE ratio i.e. 22.32 q ha^{-1}. The maximum biological yield found as 47.05 q ha^{-1} for irrigation at 1.0 IW/CPE ratio and was significantly superior over all other treatments.

The lowest values of all yield-contributing characters recorded at irrigation applied at lower regimes i. e. 0.6 IW/CPE. This is revealed that continuous moisture stress at lower regimes in chickpea resulted into less vegetative growth and hence reduced yield characters drastically.

The planting of chickpea on ridges and furrows were proved beneficial for all yield-contributing characters over flat bed planting. The mean number of pods plant^{-1} (40.92), mean weight of pods plant^{-1} (19.15) and mean weight of grains (17.19 g) found significantly superior over flat bed layout. The mean grain (22.09 q ha^{-1}) and straw yield (19.21 q ha^{-1}) of chickpea was significantly superior in ridges and furrows over that of flat bed i.e. 21.09 q ha^{-1} and 17.81 q ha^{-1}, respectively. The

Table 3. Yield and water applied to chickpea as influenced by different irrigation layouts.

Treatment	Irrigation water applied (cm)	Effective rainfall (cm)	Seasonal water requirement (cm)	Consumptive use of water (cm)	Water use efficiency (q ha^{-1} cm^{-1})
Irrigation regimes (IW/CPE) :					
0.6	17.0	1.32	18.32	16.80	1.13
0.8	21.0	1.32	22.32	17.29	1.16
1.0	25.0	1.32	26.32	20.00	1.24
1.2	29.0	1.32	30.32	22.00	1.09
At critical growth stages	20.0	1.32	21.32	17.95	1.12
Land configurations :					
Flat bed	22.4	1.32	23.72	17.44	1.21
Ridges and furrows	22.4	1.32	23.72	17.74	1.25

beneficial effect of ridges and furrows on productivity of chickpea might be due to favorable environment for optimum soil-water-air equilibrium. The results are in conformity as reported by More (1979).

The interaction effect between irrigation regimes and land configurations for all yield contributing characters and yield were found significant and ridges and furrows with 1.0 IW/CPE ratio was found superior as compared to other interactions. The combined effect of irrigation regimes and ridges and furrows resulted into good physiological activity and increased yield-contributing characters.

Water use : The quantity of irrigation water applied (Table 3) for different irrigation scheduling varied considerably from 17 to 29 cm. The seasonal water requirement was found maximum (30.32 cm) when irrigation provided at 1.2 IW/CPE ratio as compared to other treatments. The consumptive use of water increased with the increasing depth of irrigations and was ranged from 16.8 to 22 cm. The maximum total consumptive use of water was 22 cm when irrigation was applied at 1.2 IW/CPE ratio. The seasonal water requirement was not affected by land configurations. The water use efficiency was found highest (1.24 q ha^{-1} cm^{-1}) when irrigation was given at 1.0 IW/CPE ratio which was higher than 1.2 IW/CPE ratio (1.09 q ha^{-1} cm^{-1}). It was observed that water use efficiency for ridges and furrow (1.25 q ha^{-1} cm) was found higher than flat bed (1.21 q ha^{-1} cm).

Water production function : Water production function for chickpea under surface method of irrigation was developed using data on grain yield and biological yield versus depth of water applied for two different layouts. The linear, second order polynomial, power, exponential, and logarithmic relationships were tried, out of which second order polynomial relationship was found best fit for all the combinations. The second order quadratic crop water production functions developed for different combinations are listed below.

Ridges and furrow irrigation layout :

$Y = -0.027 x^2 + 1.763x - 3.136$ $R^2=0.85$

Table 4. Relationship between observed and estimated yield of chickpea with irrigation water applied.

Treatment	Water applied (cm)	Observed bicological yield (q ha^{-1})	Estimated biological yield (q ha^{-1})	% variation	Observed grain yield (q ha^{-1})	Estimated grain yield (q ha^{-1})	% variation
Flat bed planting layout :							
0.6	17.0	29.57	29.57	0.00	18.4	17.85	0.09
0.8	21.0	34.387	34.387	1.42	19.4	20.62	0.43
1.0	25.0	46.083	46.083	0.17	24.3	22.74	0.39
1.2	29.0	45.657	45.657	0.03	23.7	24.23	0.04
At critical growth stages	20.0	38.81	38.81	0.35	19.7	19.99	0.02
Ridges and furrows planting layout :							
0.6	17.0	33.763	33.46	0.01	19.487	19.03	0.05
0.8	21.0	36.983	41.01	1.18	20.783	21.98	0.33
1.0	25.0	48.027	46.12	0.16	25.22	24.06	0.21
1.2	29.0	47.307	48.80	0.10	24.377	25.28	0.14
At critical growth stages	20.0	40.43	39.35	0.07	20.587	21.32	0.13

$Y = 0.0706\ x^2 + 4.774x - 25.73$ $R^2=0.86$

Flat bed irrigation layout :

$Y = -0.02\ x^2 + 1.451x - 1.033$ $R^2=0.84$

$Y = -0.107\ x^2 + 6.341X - 47.89$ $R^2=0.87$

It was indicated from water production function that increasing water application, the biological as well as grain yield of chickpea was increased upto some extent but declined with further increase in water quantum. It revealed that irrigation quantity beyond a certain amount exerted a reverse effect on growth and yield of chickpea.

The estimated biological and grain yield of chickpea were obtained using water production functions for two different layouts and compared with actual observed values of yields (Table 4). The results indicated that, the deviation between observed and estimated chickpea yields were less than 1 per cent indicating that the relationship could be used to predict biological and grain yield of chickpea under surface method of irrigation if depth of irrigation water applied is known.

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Effect of Varieties and Pre-Treatments on Physico-Chemical and Sensory Characteristics of Banana Crisps*

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Abstract

Crisps made from Monthan variety showed the lowest moisture content in T_5 (4.19%). Whereas, the maximum moisture was found in the crisps of T_3 (7.05%) made from the same variety. The maximum total sugars (63.34%) were noticed in crisps of T_6 made from Grand Naine. With respect to sensory quality the highest score for texture (4.20), taste and flavour (4.33) and overall acceptability (4.20) recorded in crisps of T_5 made from variety Grand Naine. Whereas, the scores for colour and appearance were higher (4.13) in T_5 with crisps made from Monthan.

Key words : Banana crisps, pre-treatments, Monthan, Grand Naine, moisture, sugar, sensory quality.

Being a climacteric fruit, banana fruits are kept well for not more than a week after harvest and deteriorates in one or two days after ripening due to rapid metabolism. Under these circumstances, it is necessary to develop shelf stable products, such as banana powder, flour, chips, dried slices, jam, beverages, baby foods, etc (Patel *et al*., 1999). Among the several techniques available for preservation/ processing of different fruits, dehydration is widely adopted technique for many fruits. Pre-treatments before drying are necessary in order to check the undesirable physico-chemical and other qualitative changes that may occur during drying process. The changes in quality or physico-chemical characteristics, such as discolouration and off-flavour development in the product are mainly attributed to the enzymes present in the fruit. The present work was therefore undertaken to study the effect of varieties and certain pretreatments on physico-chemical and organoleptic quality of banana crisps. Various pre-treatments like sulphuring (exposure to SO_2 fumes), steeping in KMS and ascorbic acids and in sugar syrup containing citric acid at different concentrations for different durations have been recommended by different workers in various kinds of fruits Kotimani, 2003, Rajendra, 2005 and Rajashekhar, 2007 in fig, Rekha, 2009 in aonla, Ravi, 2010 in banana and Thakor *et al*. 2010 in pineapple.

Materials and Methods

Healthy, matured, unripe banana fruits of cv. Grand Naine and Monthan were washed in tap water, peeled and cut into slices of 2 mm thickness. The slices (in lots of 0.5 kg treatment^{-1} replication^{-1}) were subjected to various pre treatments *viz.*, T_1 (Dipping in 0.5% KMS for 30 min followed by dipping in 60° brix sugar syrup + 1% citric acid for 12 hours), T_2 (Sulphur fumigation of slices (2 g kg^{-1}) for 30 min followed by dipping in 60° brix sugar syrup + 1% citric acid for 12 hours), T_3 (Dipping in 0.5% KMS for 30 min followed by deep frying in ground nut oil followed by dipping in 60° brix sugar syrup + 1% citric acid

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for 12 hours), T_4 (Sulphur fumigation of slices (2 g kg^{-1}) for 30 min followed by deep frying in ground nut oil followed by dipping in 60° brix sugar syrup + 1% citric acid for 12 hours), T_5 (Sulphur fumigation of slices (2 g kg^{-1}) for 30 min followed by dipping in $CaCl_2$ (0.5%) for 10 minutes followed by deep frying in ground nut oil followed by dipping in 60° brix sugar syrup + 1% citric acid for 12 hours) and T_6 (Sulphur fumigation of slices (2 g kg^{-1}) for 30 min followed by dipping in $CaCl_2$ (0.5%) for 10 minutes followed by dipping in 60° brix sugar syrup + 1% citric acid for 12 hours). After imposing the treatments, banana slices were spread on the trays and dried in an electric tray drier at temperature of 65°C. Dehydrated banana crisps (sweetened dehydrated banana chips or slices) were packed in 200 gauge polyethylene bags and stored in a cool and dry place for further study. There were 3 replications for each treatment and experiment was laid out in factorial completely randomized design. The moisture content of osmotically dehydrated banana crisps was determined using Ohaus Halogen moisture analyser which reads moisture directly in percentage. Total sugars were determined by following DNSA method (Miller, 1972). Organoleptic evaluation of banana crisps with respect to colour and appearance, crispness. taste and flavour and overall acceptability was examined on a 5 point scale by a panel of 10 judges.

Results and Discussion

Moisture content (%) : Amongst two varieties minimum moisture content was found in the crisps made from Monthan (5.30%) and 5.75 per cent in crisps made from Grand Naine. Among various pre treatments significantly minimum mean moisture content

Table 1. Effect of varieties and pre-treatments on moisture (%) and total sugars (%) of banana crisps.

Treatment	Moisture content (%)		Mean	Total sugars (%)		Mean
	Varieties			Varieties		
	Grand Naine	Monthan		Grand Naine	Monthan	
T_1	6.67	6.74	6.71	52.67	40.84	46.75
T_2	5.93	4.94	5.44	62.12	143.14	52.64
T_3	6.93	7.05	6.99	45.94	24.08	35.01
T_4	5.22	4.39	4.81	33.08	25.19	29.14
T_5	4.82	4.19	4.51	33.83	27.13	30.48
T_6	4.94	4.51	4.73	63.34	33.88	48.61
Mean	5.75	5.30		48.49	32.38	
For comparing the means	S.E.±	CD at 1%		S.E.±	CD at 1%	
Varieties	0.03	0.11		0.34	1.25	
Pre-treatments	0.06	0.21		0.59	2.18	
Varieties x pre-treatments	0.08	0.28		0.86	3.07	

T_1 - 0.5% KMS for 30 min followed by dipping in 60° brix syrup dip + 1% citric acid, T_2 - Sulphur fumigation of slices (2 g kg^{-1}) for 30 min followed by dipping in 60° brix sugar syrup + 1% citric acid for 24 hours, T_3 - Dipping the banana slices in 0.5% KMS for 30 minutes + frying + followed by dipping in 60° brix sugar syrup + 1% citric acid for 24 hours, T_4 - Sulphur fumigation of slices (2 g kg^{-1}) for 30 minutes + frying + followed by dipping in 60° brix sugar syrup + 1% citric acid for 24 hours, T_5 - Sulphur fumigation of slices (2 g kg^{-1}) for 30 minnutes + $CaCl_2$ (0.5%) + frying + followed by dipping in 60° brix sugar syrup + 1% citric acid for 24 hours, T_6 - Sulphur fumigation of slices (2 g kg^{-1}) for 30 minutes + $CaCl_2$ (0.5%) + followed by dipping in 60° brix sugar syrup + 1% citric acid for 24 hours.

was recorded in T_5 (4.51%) while it was maximum in T_3 (6.99%). The interactions of Monthan and moisture content in T_5 (4.19%) showed lowest moisture content. The maximum moisture was found in T_3 (7.05%) in same variety (Table 1). The long duration ol dipping in pretreatmcnt solution might have increased in the moisture content of tissues and lead to more moisture content in the end product of T_5 with the other conditions being constant.

Sugars : Maximum total sugars were found in crisps of the variety Grand Naine (Table 1). With respect to treatments, highest total sugars were observed with T_6 in the variety Grand Naine (63.34%). This might be due to the combined effect of varietal sugar composition and osmotic dehydration process leading to absorption of sugar. The variety Grand Naine might have absorbed more sugar due to its high intrinsic moisture content. The food stuff high in free moisture level when subjected for osmotic process is ought to witness high rale of osmotic phenomenon. Similar findings were recorded in osmotically dehydrated products of apricots (Sharma *et al*. 2004), sapota (Kotimani, 2003 and Tiakum, 2007), fig (Rajashekar, 2007) and banana (Shobana, 2003 and Ravi, 2010).

Sensory characteristics : The varieties of banana showed significant effect on organoleptic characters of osmotically dehydrated banana crisps made from them. Maximum scores for texture, taste and flavour and overall acceptability were noticed in Grand Naine (Table 2 and 3) slices dried after pre-treating with sulphur fumigation @ 2 g kg^{-1} for 30 minutes followed by dipping in 0.5 per cent $CaCl_2$ + frying in ground nut oil followed by dipping in 60°B sugar syrup + 1 per cent citric acid for 12 hours (4.20, 4.33 and 4.20. respectively). But values for colour and appearance were maximum in Monthan slices dried after pre-treating with sulphur fumigation @ 2 g kg^{-1} for 30 minutes followed by dipping in 0.5 per cent $CaCl_2$ + frying in ground nut oil followed by dipping in 60°B sugar syrup + 1 per cent citric acid for 12 hours (4.13). This

Table 2. Effect of varieties and pre-treatments on colour, taste, flavour and acceptability, appearance, texture of banana crisps.

Treatment	Colour and appearance		Mean	Texture		Mean	Taste and flavour		Mean	Overall acceptability		Mean
	Varieties			Varieties			Varieties			Varieties		
	Grand Naine	Monthan		Grand Naine	Monthan		Grand Naine	Monthan		Grand Naine	Monthan	
T_1	3.77	4.03	3.90	3.53	3.67	3.60	3.67	3.63	3.65	3.77	3.70	3.73
T_2	3.73	3.90	3.82	3.47	3.50	3.48	3.53	3.63	3.58	3.57	3.80	3.68
T_3	3.70	4.10	3.90	4.17	3.80	3.98	4.17	3.70	3.93	3.93	4.07	4.00
T_4	4.10	4.00	4.03	4.20	4.00	4.10	4.20	3.97	4.08	4.13	3.87	4.00
T_5	4.07	4.13	4.10	4.20	4.17	4.18	4.33	4.07	4.20	4.20	4.10	4.15
T_6	3.40	3.37	3.38	3.47	3.47	3.47	3.67	3.43	3.55	3.77	3.60	3.68
Mean	3.79	3.92	-	3.84	3.77	-	3.93	3.74		3.89	3.86	
For comparing the means	S.E.±	CD at 1%		S.E.±	CD at 1%		S.E.±	CD at 1%		S.E.±	CD at 1%	
Varieties	0.10	0.13		0.01	0.05		0.05	0.20		0.01	0.03	
Pre-treatments	0.17	0.67		0.90	0.35		0.10	0.37		0.09	0.35	
Varieties x pre-treatments	0.26	0.53		0.13	0.50		0.14	0.51		0.13	0.49	

was due to the KMS and sulphur acting as anti-browning agents, thereby retaining the colour and reducing undesirable biochemical changes during drying. With respect to varieties Monthan contain inheritently less sugars as compared to Grand Naine leading to more browning in the end product than the former. Therefore, the crisps made from Monthan obtained more organoleptic score for colour and appearance (Ravi, 2010). The taste and flavour scores were found high and statistically same in crisps of T_3 and T_4 made from Grand Naine due to better blending of sugars and citric acid besides the favourable biochemical composition of variety. The texture scores were found high in the treatments T_5, T_4 and T_3 involving the varieties Grand Naine and Monthan due to frying of banana slices in oil which induces crispness. The T_5 and T_4 treatments under the variety Grand Naine did score maximum for overall acceptability followed T_3. Among the crisps made from Monthan, the treatment T_5 and T_3 have scored more. This might be due to the biochemical make up of varieties, frying in oil and also clue to osmotically absorbed sugar as well as acid rendering acceptable crispy texture and taste to the product. These findings are in line with the dehydrated products researched.by Ravi (2010).

The results in general suggest that the sweetened banana slices (crisps) made from Grand Naine after pre-treating with sulphur fumigation @ 2 g kg^{-1} for 30 minutes followed by dipping in 0.5 per cent $CaCl_2$ + frying in ground nut oil followed by dipping in 60°B sugar syrup + 1 per cent citric acid for 12 hours recorded maximum score for texture, taste and flavour and overall acceptability. But the score for colour and appearance was recorded to be more in crisps made from Monthan pre-treated with sulphur fumigation @ 2 g kg^{-1} for 30 minutes followed by dipping in 0.5 per cent $CaCl_2$ frying in ground nut oil followed by dipping in 60°B sugar syrup + 1 per cent citric acid for 12 hours.

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Generationwise Production Efficiency of Phule Triveni Synthetic Cow

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Abstract

The overall least squares means of AFC, WFC, CI, LL, 300 DMY, DMY/LL, DMY/CI, MPEK and MPEKD in Phule Triveni synthetic cow were 984.88 ± 15.66 days, 403.92 ± 8.62 kg, 446.00 ± 37 days, 339.73 ± 3.54 days, 2897.46 ± 26.15, 9.23 ± 0.07 kg, 7.71 ± 0.13 kg, 6.69 ± 0.29 kg. and 20.26 ± 0.86 g, respectively. The effect of generation was non-significant on AFC, WFC, CI, LL, 300 DMY, DMY/LL, DMY/CI, MPEK and MPEKD. The productive performance of Phule Triveni synthetic cow gradually declined during later generations. In Phule Triveni triple cross the effect of period of calving was highly significant on age at first calving, 300 days milk yield, calving interval, MPEK, MPKED, daily milk yield lactation^{-1} length and daily milk yield calving^{-1} interval. It showed non-significant effect on lactation length and weight at first calving traits of milk production . The season of calving had non-significant effect on LL, CI, MPEK, MPKED, AFC, WFC, DMY/LL, DMY/CI traits except in 300 DMY ($P<0.05$). The lactation order significantly influenced on DMY/LL, DMY/CI and 300 DMY. The effect of period of calving was significant on MPEK, however, the effect of generation and season of calving were nonsignificant on MPEK. The high estimates for herifability of WFC, LL ,DMY/LL and MPEK were observed in present study, however, moderate heritability estimates were observed for DMY/CI. The milk production efficiency traits i.e. MPEK, MPEKD, DMY/LL, DMY/CI showed the positive and non-significant genetic and phenotypic correlation amongst them, however, negative and significant correlation was observed among DMY/LL with WFC and AFC. The CI showed positive and significant phenotypic and genotypic correlation with MPEK.

Key words: Phule triveni, production traits, reproduction traits.

India possesses a large number of non-descript livestock population. The most important reason behind low production is the low genetic potential for milk production of the indigenous cows. To overcome this problem, crossing of indigenous cattle with elite breeds along with application of selection pressure is the remedy for increasing milk production, better adaptability to environment and improved reproductive efficiency.

The concept of white revolution got stabilized due to the increased milk production through crossbreeding programme. Further, it is essential to fix the level of exotic inheritance to have our own breed of milch cow. To decide our breeding plan, it is necessary to evaluate the local breeds, crossbreeds and their interse progenies in all the favourable possible combinations. Growth, reproduction and production are important economic traits, which ultimately influences the sustainability of dairy enterprise (Joshi *et al*., 1991).Production efficiency provides information on reproduction and production performance of an animal. The knowledge of heritability and repeatability of economic traits provides a quantitative measure for genetic gain and prediction of future milk yield at an early age. Milk production efficiency can be measured by various ways. Among the methods the MPEK (Milk production efficiency kg^{-1} body weight at first calving) and MPEKD (Milk production efficiency kg^{-1} body weight at first calving and day^{-1} of lactation length) give

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more accurate results. The attemept had been made to study gererationwise production efficiency of Phule Triveni triple crossbreds maintained at RCDP on cattle, MPKV, Rahuri.

Materials and Methods

The observations pertaining to Phule Triveni triple crossbred (50% Friesian + 25% Jersey + 25% Gir) cattle, *viz.*, period of calving, generation, season of calving, order of lactation were collected from history and pedigree sheets maintained at R.C.D.P. on cattle, M.P.K.V., Rahuri, from 1977-2009 were used for this study. The observations on age at first calving (AFC), weight at first calving (WFC), calving interval (CI), lactation length (LL), 300 days milk yield (300 DMY), daily milk yield day^{-1} of lactation length (DMY/LL), daily milk yield day^{-1} of calving interval (DMY/CI), milk production efficiency kg^{-1} body weight at first calving (MPEK), milk production efficiency kg^{-1} body weight at first calving and day^{-1} of lactation length (MPEKD) were collected. The data was classified according to generation, period of calving, season of calving and lactation order and analysed by least squares method (Harvey 1990). The models used were as under,

$$Y_{ij} = \mu + G_i + e_{ij}$$

Where, Y_{ij} = j^{th} observation on production traits in ith generation, μ = production mean, G_i = effect of i^{th} generation (i=1,2,…6), e_{ij}=Random error associated with NID ~ (0, $\sigma^2 e$).

Least squares means of milk yield day^{-1} lactation length (DMY/LL), 300 days milk yield (300DMY), milk yield day^{-1} of calving interval (DMY/CL), MPEK, MPEKD, was estimated by considering period of calving, season of calving, order of lactation. The following model was used for estimation.

$$Y_{ijkl} = \mu + P_i + S_j + L_k + e_{ijkl}$$

Where, Y_{ijkl}= l^{th} observation of production traits in ith period of calving, j^{th} season of calving and k^{th} lactation order, P_i=Effect of i^{th} period of calving (i=1, 2 ...8), S_j=Effect of j^{th} season of calving (j=1, 2, 3), L_k=Effect of k^{th} parity (k=1,2,…5), e_{ijkl}=Random error associated with NID~(0, $\sigma^2 e$). Ducan's Multiple Range Test (DMRT) modified by Kramer (1957) was used to test significanet difference between the means.

Milk production efficiency kilogram^{-1} of body weight at first calving (MPEK) was estimated by the formula suggested by Gaines (1940) and the milk production efficiency kilogram^{-1} of body weight and day^{-1} of first lactation length (MPEKD) was worked out by the formula given by Bhadula and Desai (1977) which was based on first lactation length.

Paternal half sib correlation method (Decker, 1975) was used to estimate the heritability of different characters and their genetic correlations. The sires with five or more than five progenies were included for the estimation of heritability. The data adjusted for significant effects of non-genetic factors was used for estimation of heritability. The model used to estimate the heritability was $Y_{ij} = \mu + S_i + e_{ij}$. Where, Y_{ij}= observation of the j^{th} progeny of the i^{th} sire, μ=overall mean, S_i=effect of the i^{th} sire, e_{ij}=random error associated with NID~(0, $\sigma^2 e$). The genetic and phenotypic correlation among production traits were calculated from analysis of variance and co-variance among five groups as given by Becker (1975). The statistical significance of correlation was tested by the test given by Snedecor and Cochran (1994).

Results and Discussion

Age at first calving : The least squares analysis of variance and least squares mean for

age at first calving are presented in Table 1. The overall least squares mean of age at first calving (AFC) was 984.88 ± 15.66 days (Table 2). These results were in close agreement with Bhoite (1996) and Singh *et al.* (2002) reported in FG (837.44 ± 11.98) and FH (953.02 ± 17.49) halfbreds. The lower age at first calving than the present results were reported by Bhoite (1996) in JG genetic groups. However, higher values of age at first calving were noticed by Thombre *et al*. (2002) in H.F x D halfbreds, (1308.75 ± 76.44), Singh *et al*. (2002) in BH (1022.69 ± 21.85), Dahiya *et al*. (2003) in FH halfbreds (1101.04 ± 22.34) and Bhagat *et al*. (2006) in FG halfbreds (1054.67 ± 12.63).

Table 1. Least squares means of age at first calving (days), weight at first calving (kg) and calving interval (days) in PT synthetic cow.

Source of variation	AFC			Weight at first calving			Calving interval		
	N	Mean	SE±	N	Mean	SE±	N	Mean	SE±
Overall mean (μ)	485	984.88	15.66	485	403.92	8.62	1140	446.00	3.57
Generations :									
G_1	138	968.45	25.77	138	393.33	14.18	325	442.41	5.6
G_2	123	978.52	27.29	123	409.93	1 5.02	300	445.77	5.83
G_3	88	995.45	32.27	89	351.63	17.66	225	442.27	6.73
G_4	54	947.34	41.19	54	394.59	22.67	104	425.45	9.90
G_5	48	999.05	43.69	48	436.50	24.05	126	451.09	8.99
G_6	34	1020.49	52.69	33	437.55	28.10	60	469.05	13.03
Significance		NS			NS			NS	
Period of calving :									
P_1	118	859.73^b	28.01	118	395.37	15.56	243	416.17^b	6.96
P_2	98	892.59^b	30.68	98	407.60	17.04	180	414.47^b	7.89
P_3	63	909.00^b	38.23	63	378.84	21.24	201	425.57^b	7.39
P_4	73	912.02^b	35.51	73	378.46	19.72	167	411.83^b	8.09
P_5	63	952.29^b	38.43	63	389.11	21.34	144	457.09^b	8.76
P_6	28	1110.61^a	57.29	29	416.39	31.27	96	437.73^b	10.45
P_7	32	1156.20^a	54.53	31	439.27	30.29	74	460.16^b	11.92
P_8	10	1036.92^a	95.96	10	413.93	53.30	35	498.49^a	17.21
Significance		**			NS			**	
Season of calving :									
S_1	153	960.71	28.11	152	391.43	15.61	363	437.68	5.99
S_2	173	1020.71	26.11	174	414.41	14.43	411	439.66	5.64
S_3	159	954.60	26.38	159	401.26	14.65	366	443.24	5.96
Significance		NS			NS			NS	
Order of lactation :									
L_1							417	449.52	5.49
L_2							293	443.50	6.26
L_3							205	443.64	7.35
L_4							151	441.15	8.45
L_5							74	423.13	11.93
Significance								NS	

Means in the same column with different superscript differed significantly . *'**P< 0.01

Effect of generation : The effect of generation on age at first calving in Phule Triveni cow was non significant (Table 1). Overall least squares means for age at first calving was 984.88 ± 15.66, these results indicated that the higher age at first calving was observed in G_6 and G_5 generations as compared to G_4, G_7, G_2 and G_3. Similar results were reported by Bhoite (1996), Bhagat *et al*.(2006) in Gir corssbred cows and Singh *et al*. (2002) and Dahiya *et al*. (2003) in Hariana crossbred. These results revealed that the age at first calving was lowest in G_4.

Effect of period of calving : The analysis of variance indicated that the period of calving had significant ($P<0.01$) influence on age at first calving in PT synthetic cow (Table 1). Similar results were reported by Bhoite (1996) in triple crossbred and Dahiya *et al.* (2003) in Hariyana crossbreds.

The age at first calving of heifers born during different period differed significantly from each other. In the present study age at first calving (days) of heifers born during P_7 (1156.20 ± 54.53) was significantly higher than born in P_1 (859.73 ± 28.01). The results indicated that the age at first calving of PT synthetic cow was increased gradually up to P_7 group.

Effect of season of calving : The influence of season of calving on age at first calving was non significant. The highest age at first calving was observed during winter season (1020.71 ± 26.11) followed by rainy (960.71 ± 28.11) and summer (954.60 ± 26.38) season. These findings were in close agreement with Bhoite (1996), Dahiya *et al*. (2003) and Zol (2007), whereas contradictory results were reported by Varade (2002). Variation in age at first calving observed might be due to influence of environmental factors and also genetic inheritance of parents or origins.

Weight at first calving : The least squares analysis of variance and least squares means for weight at first calving are presented in Table 1. The overall least squares mean of weight at first calving was 403.92 ± 8.62 kg. The mean WFC obtained in three breed crosses was in accordance with those reported by Kulkarni (1985) and Navale (1991) in triple crosses of Friesian, Jersey and Brown Swiss with Gir cows.

Effect of generation : The analysis of variance indicated that the influence of generation on weight at first calving was found to be non-significant. The values observed in G_6 (437.55 ± 28.10) generation were higher than the other generations. Whereas, Pachpute (1985) in triple crosses and Patel and Trivedi (1989) in Jersey x Kankrej crosbreds observed the contravarsy effect.

Effect of period of calving : The analysis of variance indicated that the period of calving had non-significant effect on weight at first calving. The higher means was observed in P_7 (439.27 ± 30.29) and P_8 (413.93+53.30) and lowest mean in P_5 (389.11 ± 21.34) as compared with other periods. Singh and Bhat (1987) showed contradictory results.

Effect of season of calving : Influence of season of calving on weight at first calving was non-significant in PT synthetic cow. The higher weight at first calving was observed in heifers born during the winter season (414.41 ± 14.43) than the rainy (391.43 ± 15.61) and summer season (401.26 ± 14.65). Similar results were observed by Singh and Bhat (1987) in Friesian x Sahiwal, Nautiyal and Bhat (1989) in Holstein, Jersey and Brown Swiss with Mariana. However, Singh *et al*. (1989) observed contradictory effect.

Calving interval : The overall mean of calving interval in PT synthetic cow was 446.00 ± 3.57 days. Among all the

generations G_6 (469.05 ± 13.03) had longest and G_4 group had shortest calving period. The longer calving intervals than the present results were reported by Narula *et al*. (2005). However, shorter calving interval was observed by Deokar *et al*. (2005) in H.F x Gir and Jersey x Gir halfbreds.

Effect of generation : The effect of generation on calving interval was non-significant. Similar results were reported by Bhagat *et al*. (2006) in crossbred of HF, Jersey and Brown Swiss with Gir cows. The contradictory results were observed by Bhoite (1996), in crosses of HF and Jersey with Gir cows, Singh *et al*. (2002) and Dahiya *et al*. (2003) in Hariyana crossbred cows.

Effect of period of calving : The analysis of variance revealed that the period of calving had significant ($P<0.01$) influence on calving interval in PT synthetic cow. These results corroborated with Bhoite (1996) and Kamble (2003) in Gir crossbred, Singh *et al.* (2002) in Hariana crossbred cows and Thombare *et al*. (2002) in HF x Deoni halfbreds. In present study the calving interval of cows calved during P_8 (498.49 ± 17.21) was significantly higher than those calved during P_1 (416.17 ± 6.96), P_2 (414.47 ± 7.89), P_3 (425.57 ± 7.39), P_4 (411.83 ± 8.09), P_5 (457.09 ± 8.76), P_6 (437.73 ± 10.45), P_7 (460.16 ± 11.92). The variation in calving interval differed during different periods might be due to change in the feeding and management practices of PT synthetic cows.

Effect of season of calving : The influence of season of calving on calving interval was non-significant. The higher calving interval of cows calved during Summer season (443.24 ± 11.93) than lower in rainy season (437.68 ± 5.99). These findings were contradictory with Singh *et al*. (2002) in crossbred of Friesian. Jersey and Brown Swiss with Mariana cows.

Effect of lactation order : The variation due to lactation order in calving interval was non significant in PT synthetic cows. Similar results were reported by Bhoite *et al*. (1999) in triple crossbreds and contradictory to results by Dalai *et al*. (1991). In the present study although the lactation order effect on calving interval was non-significant the highest calving interval was noticed in cows calved in L_1 (449.52 ± 5.49) and lowest in L_4 (441.15 ± 8.45).

Lactation length : The overall least squares means of lactation length (Table 2) in PT synthetic cow was 339.73 ± 3.54 days. The longest lactation length was recorded in G_6 (354.62 ± 12.93) and shortest in G_1 group (323.88 ± 5.81) i.e. first generation. Almost similar lactation length was recorded by Khade (2001) in HG halfbreds (315.44 ± 7.24) and Zol (2007) in Phule Triveni crossbred.

Effect of generation : The influence of generations on lactation length was non-significant (Table 2). Similar results were obtained by Sivaiah *et al*. (1986) in Ongole triple crosses cows and significant results showed by Khade (2001), Parmar *et al*. (1986) in halfbreds. The lactation length of G_1 group was shortest (323.88 ± 5.81) compared with other generations.

Effect of period of calving : The variation due to period of calving in lactation length was non-significant in PT synthetic cow. These findings were in agreement with Dalai *et al*. (1991) in Mariana halfbreds, Khade (2001) in HG and IFJG crossbreds and Varade *et al.* (2002) in JGT triple crosses. Whereas, Bhoite (1996) in FG, JG and FJG and Kamble (2003) in Gir crossbreds reported contradictory findings. The overall mean lactation length of PT synthetic cow calved during P_7 (356.08 ± 14.79) was higher than other periods.

Effect of season of calving : The influence of season of calving on lactation

length was non-significant in PT synthetic cow. Whereas, contradictory results observed by Bhoite (1996) in Gir halfbreds and Varade *et al*. (2001) in JFG triple crosses. In the present study lactation length of cows calved during summer (341.74 ± 11.00) season was higher than those calved in winter (334.79 ± 11.22) and rainy (337.85 ± 11.31) season which are at par with each other.

Effect of lactation order : The effect due to lactation order on lactation length was non-significant in PT synthetic cow. Khade (2001) in FG and IFJG genetic groups and Kulkarni (1985) in Gir Triple crosses. Whereas Agasti *et al*. (1983) in Friesian x Hariana cows observed

Table 2. Least squares means of lactation length (days), 300 days milk yield and daily milk yield day^{-1} of lactation length.

Source of variation	Laction length (days)			300 days milk yield			Daily milk yield day^{-1} of laction length		
	N	Mean	SE±	N	Mean	SE±	N	Mean	SE±
Overall mean (μ)	1408	339.73	3.54	1324	2897.46	26.15	1408	9.23	0.07
Generations :									
G_1	376	323.88	5.81	369	2941.47	39.95	376	9.40	0.12
G_2	371	335.12	5.85	372	2857.99	39.78	371	9.10	0.12
G_3	291	334.83	6.60	294	2846.62	44.75	291	9.13	0.13
G_4	138	345.92	9.59	104	2921.62	75.24	138	9.21	0.20
G_5	156	344.00	9.02	118	2914.19	70.64	156	9.01	0.18
G_6	76	354.62	12.93	67	2902.90	93.74	76	9.52	0.26
Significance		NS			NS			NS	
Period of calving :									
P_1	275	322.75	12.14	262	3153.89^b	83.72	275	10.46^a	0.25
P_2	217	329.30	12.63	219	2899.54^b	86.24	217	9.49^b	0.26
P_3	243	337.17	12.27	249	3275.09^a	83.36	243	10.77^a	0.25
P_4	218	332.84	12.31	215	2706.10^b	84.22	218	8.95^b	0.25
P_5	185	347.07	12.96	167	2174.24^b	90.32	185	6.88^c	0.26
P_6	122	337.21	13.83	95	3073.19^b	100.92	122	9.43^b	0.28
P_7	96	356.08	14.79	77	2573.68^b	107.73	96	7.64^c	0.30
P_8	52	342.58	18.65	40	3272.35^a	140.59	52	10.04^a	0.38
Significance					**			**	
Season of calving :									
S_1	434	337.85	11.31	413	2910.63^b	77.99	434	9.19	0.23
S_2	511	334.79	11.22	473	2964.35^a	77.62	511	9.43	0.23
S_3	463	341.74	11.00	438	2798.05^b	75.77	463	9.01	0.22'
Significance					*				
Order of lactation :									
L_1	456	355.14	5.73	433	2667.26b	41.12	456	8.15^b	0.12
L_2	378	332.44	6.09	358	2846.15b	43.74	378	9.07^b	0.12
L_3	260	331.11	7.24	243	3001.71a	51.89	260	9.56^a	0.15
L_4	185	342.89	8.5	167	3190.34a	60.95	185	9.98^a	0.17
L_5	129	331.89	10.10	123	3031.13a	70.93	129	9.71^a	0.21
Significance					**			**	

Means in the same column with different superscript differed significantly . *'**P< 0.01

significant effect. Although the lactation order effect was non- significant, the lactation length was highest in L_1 (355.14 ± 5.73) and lowest in L_3 (331.11 ± 7.24) lactation order.

300 Days milk : The overall least squares mean of 300 days milk yield was 2897.46 ± 26.15 in PT synthetic cows. The 300 days milk yield obtained in PT triple crosses were similar to those reported by Kulkarni (1985). The lower 300 days milk yield than present values were reported by Agasti *et al*. (1983).

Effect of generation : The effect of generations on 300 days milk yield was non-significant. The DMR test revealed that the 300 days milk yield was highest in FJG group (2897.46 + 26.15) and lowest in 3H group (2846.62 ± 44.75). Contradictory results were obtained by Kulkarni (1985), Patel and Dev (1987) in various two and three breed crosses.

Effect of period of calving : The differences due to period of calving in 300 days milk yield were significant (P<0.01) in PT synthetic cow. The results revealed that P3 (3275.09 ± 83.36) and P_3 (3272.35 ± 140.59) periods had significantly higher 300 days milk yield than other periods and they both were at par with each other. Significant effect of period of calving on 300 days milk yield was noticed by Agasti *et al*. (1983), Kulkarni (1985) and Pandey *et al*. (1988) in different crossbred cows.

Effect of season of calving : The influence of season of calving on 300 days milk yield was significant (P<0.05) in PT synthetic cows. Winter (2964.35 ± 77.62) and rainy (2910.63 ± 77.99) season calvers had significantly higher milk yield than summer (2798.05 ± 75.77) season calvers. Winter season and rainy season calvers were on par with each other.The significant effect of season of calving on 300 days milk yield was harmonious with Mishra *et al*. (1989) in Jersey halfbreds and Navale (1991) in FJG, JFG and BFG triple crosses. Whereas, Jadahv *et al*. (1991) observed non-significant effect of season of calving on 300days milk yield in Friesian x Sahiwal halfbred cows.

Effect of lactation order : The effect of lactation order on 300 days milk yield was significant (P<0.01) in PT synthetic cows. The 300 days milk yield was the highest in L_4 (3190.34 ± 60.95) and lowest in L_1 (2667.26 ± 41.12) of PT synthetic cow. The DMRT revealed that 300 DMY was significantly higher in L_3, L_4, L_5 than L_1 and L_2. Significant effect of lactation order on 300 days milk yield was reported by Agasti *et al*. (1983), Kulkarni (1985) and Mandakmale and Kale (1990) in two and three breed exotic crosses. Similarly, Patel and Trivedi (1989) indicated that 300 days milk in Jersey x Kankrej halfbreds increased upto third lactation and declined thereafter.

Daily milk yield day^{-1} of lactation length :

Effect of generation : The overall mean of DMY/LL in PT synthetic cows was 9.23 ± 0.07 and the generations had non-significant effect on DMY/LL, though it was higher in G_6 genetic group (9.52 ± 0.26) as compared with G_5 genetic group (9.01 ± 0.18). The results were in agreement with Pandey *et al*. (1988) and disagreed with Parmar *et al*. (1986) and Navale (1991) in Sahiwal and Gir triple crosses and Singh *et al*. (1993) in Jersey x Sahiwal halfbred cows This might be due to longer lactation length and lower milk yield in interbreds than their original triple crosses.

Effect of period of calving : Analysis of variance revealed that the period of calving had significant (P<0.01) effect on DMY/LL in PT synthetic cow. Although period of calving effect

on DMY/LL was significant, in general the results showed irregular trend of milk yield in different periods of calving. However, cows calved during P_1, P_3 and P_5 had significantly higher DMY/LL than those calved during other periods .These results assented with Butte and Deshpande (1987) and Singh *et al.* (1993) in Friesian and Jersey halfbreds of Sahiwal cows.

Effect of season of calving : The effect of season of calving on DMY/LL was non-significant in PT synthetic cow. The cows calved during winter season (9.43 + 0.23) was higher than rainy (9.19 + 0.23) and summer (9.01 ± 0.22) season calvers. Higher DMY/LL during winter might be due to favourable climate and ample green fodder availability. Similar non-significant effect of season of calving on DMY/LL was reported by Pandey *et al.* (1988) and Singh *et al*. (1993). However, Parmar et al. (1986) in Sahiwal crossbred cows reported contradictory findings in two and three breed crosses.

Effect of lactation order : The differences due to lactation order in DMY/LL were significant in PT synthetic cow. The highest DMY/LL (9.98 ± 0.17) was observed in L_4 lactation and the lowest (8.15 ± 0.12) during 1st lactation. PT triple crossbreds showed increasing trend up to 4th lactation. The increasing trend of DMY/LL during succeeding lactations over preceding lactation was in agreement with Bhatnagar *et al*. (1986) in Karan- Swiss and Karan- Fries cows. However, non-significant influence of lactation order on DMY/LL was noticed by Dhumal *et al*. (1988) in Jersey x Red Kandhari cows.

Daily milk yield day^{-1} of calving interval : The overall least squares mean of daily milk yield day^{-1} of calving interval in PT synthetic cow was 7.71 ± 0.13 kg (Table 3). The lower values of DMY/CI than the present estimates reported by Butte and Deshpande (1987) in Sahiwal halfbreds and Pandey et al. (1988) in three breed crosses.

Effect of generation : The influence of generations on DMY/CI was non-significant in PT synthetic cows. The G_1 group (7.89 ± 0.21) had higher DMY/CI than G_2, G_3, G_4, G_5 and G_6 groups of PT cows. Similar non-significant differences in DMY/CI due to generations were noticed in Parmar *et al*. (1986), Pandey *et al*. (1988) in various three breed crosses. However, Nagarcenkar and Rao (1982) in Friesian x Tharparkar halfbreds and Navale (1991) reported significant differences in triple crosses of Friesian, Jersey and Brown Swiss with Gir.

Effect of period of calving : The effect of period of calving on DMY/CI was significant in PT synthetic cows. The highest DMY observed in P_1 (9.20 ± 0.26) and lowest value was obtained in P_5 (5.73 + 0.32). Significant effect of period of calving on DMY/CI was resembled with Butte and Deshpande (1987) noticed in Friesian x Sahiwal halfbred cows.

Effect of season of calving : The differences due to season of calving in DMY/CI were non-significant in PT synthetic cows. Rainy season calvers (7.78 ± 0.22) had higher daily milk yield than summer season (7.61+0.22) calvers. Non-significant influence of season of calving on DMY/CI was reported by Butte and Deshpande (1987), Pandey *et al*. (1988) and Navale (1991).

Effect of lactation order : The variations due tolactation order in DMY/CI were significant ($P<0.01$) in PT synthetic cow. The DMY/CI was highest (8.50 ± 0.44) during 5th lactation and the lowest (6.70 ± 0.20) during 1st lactation. In PT triple cross DMY/CI increased gradually up to 5th lactation. Butte and Deshpande (1987) in Friesian x Sahiwal and Patel and Trivedi (1989) in Jersey x Kankrej halfbreds reported consistent increase in DMY/CI with the advancement of parities.

Milk production efficiency kg^{-1} body weight at first calving : The overall mean MPEK was 6.69 ± 0.29 kg. It was highest in G_3 (7.64 ± 0.61) and lowest in G_6 (6.37 ± 1.00). Lower values than present results were reported by Singh *et al*. (1982) in Friesian x Sahiwal and Patel and Trivedi (1989) in Jersey x Kankrej halfbred cows. Whereas, Mishra *et al*. (1989) observed higher values in Jersey x Sahiwal halfbreds.

Effect of generation : The influence of generations on MPEK was non-significant. The G_3 (7.64 ± 0.61) and G_5 (6.88 ± 0.49)

Table 3. Least squares means of daily milk yield day^{-1} of calving interval (kg day^{-1}), milk production efficiency kg^{-1} body weight at first calving and milk production efficiency kg^{-1} weight and day^{-1} of lactation length in PT synthetic cow.

Source of variation	Daily milk yield day^{-1} of calving interval (kg day^{-1})			MPEK (kg)			MPEKD (g)		
	N	Mean	SE±	N	Mean	SE±	N	Mean	SE±
Overall mean (μ)	1140	7.71	0.13	485	6.69	0.29	485	20.16	0.86
Generations :									
G_1	325	7.89	0.21	138	6.88	0.49	138	20.87	1.42
G_2	300	7.62	0.22	123	6.39	0.52	123	19.36	1.50
G_3	225	7.55	0.25	89	7.64	0.61	89	22.93	1.77
G_4	104	7.79	0.37	54	6.53	0.78	54	20.06	2.27
G_5	126	7.60	0.33	48	6.39	0.83	48	19.18	2.40
G_6	60	7.80	0.48	138	6.88	0.49	33	18.59	2.70
Significance		NS			NS			NS	
Period of calving :									
P_1	243	9.20^{a}	0.26	118	8.54^{a}	0.54	118	26.99^{a}	1.55
P_2	180	7.98^{b}	0.29	98	6.81^{b}	0.59	98	19.61^{c}	1.70
P_3	201	9.10^{a}	0.27	63	9.03^{a}	0.73	63	26.03^{a}	2.12
P_4	167	7.71^{b}	0.30	73	7.47^{b}	0.68	73	21.11^{b}	1.97
P_5	144	5.73^{d}	0.32	63	6.14^{b}	0.74	63	17.52^{c}	2.13
P_6	96	7.89^{b}	0.39	29	5.86^{b}	1.08	29	17.81^{c}	3.12
P_7	74	6.52^{cd}	0.44	31	5.30^{b}	1.04	31	14.97^{c}	3.02
P_8	35	7.50^{bc}	0.64	10	5.09^{b}	1.84	10	18.65^{c}	5.31
Significance		**			*			**	
Season of calving :									
S_1	363	7.78	0.22	152	6.95	0.54	152	20.68	1.56
S_2	411	7.74	0.21	174	6.49	0.49	174	20.03	1.44
S_3	366	7.61	0.22	159	6.90	0.50	159	20.75	1.46
Significance		NS			NS			NS	
Order of lactation :									
L_1	417	6.70^{c}	0.20						
L_2	293	7.48^{b}	0.23						
L_3	205	7.68^{ab}	0.27						
L_4	151	8.16^{b}	0.31						
L_5	74	8.50^{a}	0.44						
Significance									

Means in the same column with different superscript differed significantly . *'**P< 0.01

generations had higher MPEK than G_2 (6.39 ± 0.52), G_4 (6.53 ± 0.78), G_5 (6.39 ± 0.83), and G_6 (6.37 ± 1.00). The contradictory results reported by Tate (1986) in the generations of Gir triple crosses and Patel and Trivedi (1989) in Jersey x Kankrej halfbreds generations.

Effect of period of calving : The influence of period of calving on MPEK was significant (P<0.05) in PT synthetic cow (Table 3). The cows calved during P_1 and P_3 had significantly higher MPEK than those calved during other periods. The result was similar with Bhoite (1996) in Jersey x Gir halfbred and in IFJG triple crosses.

Effect of season of calving : The analysis of variance revealed that the season of calving had non-significant effect on MPEK in PT synthetic cow. The rainy (6.95 ± 0.54) and summer (6.90 ± 0.50) season born cow had significantly higher MPEK than winter (6.49 ± 0.49) born cow. Similar nonsignificant effect was obtained Tate (1986) and Bhoite (1996) in various triple crosses and in halfbreds.

Milk production efficiency kg^{-1} body weight and day^{-1} of lactation length : The overall least squares mean of MPEKD was observed to be 20.16 ± 0.86 g. in PT synthetic cow (Table 3). The results obtained were close agreement to Tate (1986) in Gir triple crosses and their interbreds. Whereas, Singh *et al*. (1982) quoted lower values in Friesian x Sahiwal halfbreds and their succeeding generations. However, Patel and Trivedi (1989) reported higher estimates in Jersey x Kankrej halfbreds and their interbreds.

Effect of generation : The analysis of variance indicated that the generations had non-significant influence on MPEKD in PT synthetic cow. The results revealed that the G_3 (22.93 ± 1.77) generation had highest MPEKD than the G_6 (18.59 ± 2.70) generation. The MPEKD in all generation showed irregular trend in production. Contradictory results noticed by Tate (1986) in Gir exotic triple crosses and their interbreds and Patel and Trivedi (1989) in various generation in Kankrej halfbred cow.

Effect of period of calving : The effect of period of calving on MPEKD was significant in PT synthetic cow. The cows calved during P_1 (26.99 ± 1.55) and P3 (26.03 ± 2.12) periods had highest MPEKD than the P_7 (14.97 ± 3.02) period which was lowest one in all periods. The P_1 and P_3 had at par with each other. Significant effect of period of calving was

Table 4. Heritability and correlation among the milk production traits.

	MPKED	MPEK	DMY/CI	DMY/LL	CI	LL	300 DMY	WFC	AFC
MPKED	a	0.89	0.80	0.77	-0.03	-0.14	-0.04	-0.40	-0.03
MPEK	0.42	**0.71±0.12**	0.98	0.62	0.05*	0.18	-0.06*	-0.18	0.02
DMY/CI	0.18	0.20	**0.14±0.08**	0.80	-0.29	0.30	-0.17	-0.03	-0.09**
DMY/LL	0.25	0.19	0.39	**0.46±0.10**	-0.13	-0.14	-0.07*	-0.08**	-0.05*
CI	-0.01	0.04	-0.16	-0.02	b	0.29	-0.02	-0.04	0.01
LL	-0.04	0.09**	0.04	-0.06*	0.21	**0.34±0.09**	-0.11	0.15	-0.05*
300DMY	-0.01	-0.02	-0.01	-	0.01	-0.02	a	-	-0.01
WFC	-0.20	-0.14	0.02*	0.01	0.04	0.03	-	**0.63±0.12**	-0.03
AFC	-	0.01	-0.01	-0.01	-	-0.01	-	-	a

The value above and below the diagonal are genotypic and phenotypic correlations respectively and heritability values at diagonal itself. a = heritability was greater than one, b = sire component value were negative. *P<0.05, **P<0.01.

obtained by Bhoite (1996) in FJG, 1FJG, JFG and IBFG groups of triple crosses and Tate (1986) in FJG triple crosses. However, non-significant effect was obtained by Bhoite (1996) in JG and FG groups of halfbreds.

Effect of season of calving : The effect diielo season of calving was non-significant in PT synthetic cow. The summer (20.75 ± 1.46) season born cows had highest MPEKD than winter calvers (20.03 ± 1.44). The cows born during summer and rainy season had small difference for MPEKD in PT cow. Similar results obtained by Bhoite (1996) in JG, FG, FJG, JFG, IJFG groups and contradictory results in IFG triple crossbreds.

Heritability : Heritability estimates for lactation length, DMY/LL, DMY/C1, MPEK were 0.34 ± 0.09, 0.46 ± 0.10, 0.14 ± 0.08, 0.71 ± 0.12, respectively. However estimated h^2 for 300 days milk yield, MPEKD and AFC were not precised.

The heritability estimates for production traits revealed that in PT synthetic cow the values were moderate to high. Herbert and Bhatnagar (1989) in Karan Swiss cows showed the similar estimates for h^2. Whereas, Gupta *et al*. (1986) reported the higher value of h^2 for lactation length in Friesian x Tharparkar halfbreds.

Correlation : Between reproduction and production traits : The genetic correlation of age at first calving with other production traits were negative and non-significant except only in case of MPEK (0.02) and calving interval (0.01). The significant (P0.05) relation observed in lactation length. These results resembled with Koul *et al*. (1985). These results indicated that age at first calving in Phule Triveni cow could be reduced without any detrimental effect on MPEK.

The genetic correlations of weight at first calving with other traits were negative and non-significant. The lactation length showed the positive (0.15) correlation and DMY/LL (0.08) showed the negative correlation with PO.01 significance. Phenotypic correlation was negative in MPEK and MPEKD production traits. These estimates resembled with Kulkarni (1985) and Tate (1986) in two and three breed crosses. The present results revealed that the milk production efficiency could be improved by selecting the animals which have higher body weight at first calving.

Milk yield in 300 days showed the negative and significant (PO.05) genetic correlation with MPEK (-0.06) and DMY/LL (-0.07). However, the positive phenotypic correlation was observed in calving interval. Similar results were obtained by Singh and Tomar (1988) and Kumar and Bhatnagar (1989) in various crossbred cows.

It was observed that lactation length have negative genetic correlation with MPEKD and DMY/LL in correlation and phenotypicaly correlated with MPEK ($P<0.01$) significantly positive. Also, negative and PO.05 significant showed with DMY/LL (-0.06) trait of milk production.

Calving interval showed the positive phenotypic (0.04) correlation and genetic (0.05) correlation with MPEK. The milk production efficiency traits i.e. MPEK, MPEKD, DMY/LL, DMY/CI showed the positive non-significant genetic and phenotypic correlation amongst them. However, in DMY/LL observed negative (-0.08), (-0.05) correlation with WFC $P<0.01$ levels of significance and with AFC PO.05 levels of significance respectively in reproductive traits.

In Phule Triveni triple cross the effect of period of calving was highly significant on age at first calving, 300 days milk yield, calving interval, MPEK, MPKED, daily milk yield per

lactation length and daily milk yield per calving interval while it had non-significant effect on lactation length and weight at first calving traits of milk production. The influence of season of calving showed non-significant effect on LL, CI, MPEK, MPKED, AFC, WFC, DMY/LL, DMY/CI traits except in 300 DMY ($P<0.05$). The lactation order significantly influenced on DMY/LL, DMY/CI and 300 DMY. The contradictory effect on LL, CI traits in Phule Triveni synthetic cow. The high estimates for heritability of WFC,LL,DMY/LL and MPEK were, obtained, however moderate heritability estimates were observed for DMY/CI, so improvement in herd may be brought through selection for the traits which are having high heritability estimates. The milk production efficiency traits i.e. MPEK, MPEKD, DMY/LL, DMY/CI showed positive and non-significant genetic and phenotypic correlation, the improvement in both traits could be made by making improvement in one trait.

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RESEARCH NOTES

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Effect of Housing and Management System on Growth Performance of Osmanabadi Kids

Osmanbadi goat is a promising breed of goats found in and around Osmanbad district. This is considered as an ideal breed of scarcity zone both for meat and milk production. These goats are reared either by grazing in the harvested field/road side bushes/hillrocks/or semi-grazing system. In the drought prone areas, the goats are mostly maintained on grazing. In recent years there were lot of quarries regarding a fully stall fed goat rearing system and its utility, economic gain etc. However, there was not an authentic research data on different system of rearing. With this background, the present research was carried out to observe comparative performance of different systems of management.

A flock of 120 Osmanabadi goats along with followers was purchased from breeding tract. These goats have been placed in three (grazing, stall feeding and semi-stall feeding) management system in equal number. The performance of the goats under three management groups was compared under three housing system *viz*., thatched with specious and close housing (H_1), well ventilated housing (H_2) and pucca housing with modern structure (H_3). In three management and housing systers fortnightly observations were recorded for growth observation at birth, 3

Table 1. Effect of housing and management system on growth performance of Osmanabadi goats.

Particulars		Birth weight (kg)		3 months weight (kg)		6 months weight (kg)	
		Male	Female	Male	Female	Male	Female
Grazing (M_1)	H_1	1.936 ± 0.039 (56)	1.784 ± 0.44	6.800 + 0.251	6.696 + 0.359	11.000 + 0.265	10.37 + 0.396
	H_2	2.041 ± 0.030 (34)	1.906 ± 0.035	7.644 + 0.211	6.944 + 0.242	11.825 + 0.534	11.764 + 0.551
	H_3	1.900 ± 0.040	1.936 ± 0.049	7.005 + 0.248	6.728 + 0.461	11.447 + 0.375	10.520 + 0.422
	Av.	1.960 ± 0.027	1.856 ± 0.026	7.110 + 0.152	6.780 + 0.205	11.270 + 0.206	10.873 + 0.267
Semi-stall (M_2)	H_1	2.014 ± 0.049	1.867 ± 0.048	5.808 + 0.245	5.478 + 0.210	10.720 + 0.464	9.857 + 0.277
	H_2	1.983 ± 0.059	1.843 ± 0.060	60487 + 0.354	5.906 + 0.288	10.788 + 0.457	8.921 + 0.371
	H_3	2.067 ± 0.036	1.925 ± 0.038	6.422 + 0.317	6.750 + 0.330	10.793 + 0.572	10.000 + 0.343
	Av.	2.017 ± 0.003	1.871 ± 0.032	6.317 + 0.191	6.031 + 0.174	10.578 + 0.313	9.464 + 0.213
Stall fed (M_3)	H_1	1.967 ± 0.027	1.900 ± 0.042	7.214 + 0.266	7.087 + 0.343	11.079 + 0.314	10.122 + 0.408
	H_2	1.867 ± 0.054	1.980 ± 0.050	6.200 + 0.306	5.547 + 0.262	10.700 + 0.475	9.611 + 0.358
	H_3	1.898 ± 0.076	1.827 ± 0.077	6.961 + 0.401	6.253 + 0.333	11.344 + 0.686	9.040 + 0.490
	Av.	1.916 ± 0.039	1.866 ± 0.040	6.910 + 0.214	6.333 + 0.200	11.133 + 0.329	9.528 + 0.260
H_1 mean		1.963 ± 0.024	1.833 ± 0.028	6.684 + 1.162	6.478 + 0.211	10.993 + 0.194	10.273 + 0.233
H_2 mean		1.985 ± 0.032	1.894 ± 0.032	6.866 + 0.196	6.209 + 0.170	10.778 + 0.304	9.948 + 0.287
H_3 mean		1.954 ± 0.040	1.886 ± 0.038	6.813 + 0.211	6.547 + 0.213	11.171 + 0.360	9.784 + 0.265
Mean		1.970 ± 0.020	1.870 ± 0.019	6.782 + 0.180	6.406 + 0.114	10.996 + 0.166	10.020 + 0.151

H_1 = Close housing, H_2 = Well ventilated thatched structure, H_3 = modern structure.

month, 6 months, 12 months and adult body weight (kg).

The mean highest birth weigh (Table 1) was recorded in the male kid (2.017 ± 0.003 kg) under semi-stall feeding system followed by that of grazing (1.960 ± 0.027 kg) and stall feeding (1.916 ± 0.039 kg) systems. In females, the highest birth weight was recorded in stall feeding system (1.866 ± 0.040 kg) followed by semi stall fed groups (1.871 ± 0.032 kg) and grazing group (1.856 ± 0.026 kg). In the grazing group, the male kids gave higher birth weight in H_2 housing, while for the female kids H_3 housing gave higher values. In semi stall fed group, both males and females kids weighed heavier at birth in H_3 type housing. In case of stall fed group, males weighed heavier (1.967 ± 0.027 kg) at birth in H_1 housing while, the females did so in the H_2 housing (1.980 ± 0.050 kg).

When housing effect was considered irrespective of management, H_2 type housing gave highest birth weight in the male and female kid. At 3 month's age both male (7.110 ± 0.152 kg) and female (6.780 ± 0.205 kg) kids from grazing management gave the highest body weight followed by stall fed group (6.910 ± 0.214 and 6.333 ± 0.200 kg) and semi stall fed group (6.317 ± 0.191 and 6.031 ± 0.174 kg), respectively. The body weight at 3 month's for three types of housing indicated the highest weight in the male (6.866±0.196 kg) from H_2 type housing while, in the females the highest (6.547 ± 0.213 kg) weight was noticed in the H_3 type housing.

At three month's age the overall body weight in the male kids averaged 6.782 ± 0.180 kg and in the females 6.406 ± 0.1 14 kg. The body weight in the males from grazing group (11.270 ± 0.206 kg) were the highest followed by that in stall fed group (11.133 ± 0.329 kg) and semi stall fed group (10.578 ± 0.313 kg) at age of six month body weight. In

Table 1. Contd.

Particulars		12 months weight (kg)		Adult weight (kg)	
		Male	**Female**	**Male**	**Female**
Grazing (M_1)	H_1	15.178 + 0.781	14.633 + 0.255	22.700 + 0.000	18.133 + 1.618
	H_2	15.400 + 0.917	14.750 + 0.505	-	21.450 + 0.967
	H_3	14.866 + 1.113	16.667 + 0.695	-	20.764 + 1.045
	Av.	15.170 + 0.781	15.300 + 0.305	22.700 + 0.000	20.478 + 0.742
Semi-stall (M_2)	H_1	14.220 + 0.892	15.294 + 0.523	16.408 + 1.020	20.500 + 0.000
	H_2	14.617 + 0.735	13.609 + 0.410	17.800 + 1.159	20.178 + 1.048
	H_3	14.698 + 0.000	14.615 + 0.315	18.340 + 0.000	15.647 + 0.291
	Av.	14.417 + 0.133	14.344 + 0.348	17.600 + 0.310	19.214 + 0.931
Stall fed (M_3)	H_1	16.248 + 0.612	14.278 + 0.127	18.728 + 1.028	19.000 + 0.503
	H_2	18.198 + 0.426	15.229 + 0.485	20.147 + 0.816	18.891 + 0.795
	H_3	16.194 + 0.999	13.229 + 0.600	19.743 + 1.713	15.867 + 0.333
	Av.	17.094 + 0.896	14.229 + 0.425	19.743 + 1.713	18.550 + 0.603
H_1 mean		15.170 + 0.781	14.854 + 0.287	19.630 + 1.300	19.050 + 0.930
H_2 mean		16.117 + 0.735	14.332 + 0.290	18.400 + 1.159	20.284 + 0.542
H_3 mean		15.294 + 0.648	14.815 + 0.563	18.743 + 1.213	17.492 + 0.829
Mean		15.480 + 0.540	14.759 + 0.208	18.940 + 0.990	19.396 + 0.434

H_1 = Close housing, H_2 = Well ventilated thatched structure, H_3 = modern structure.

the female at 6 months age the highest weight recorded in the grazing group (10.873 ± 0.267 kg) followed by stall fed (9.528 ± 0.260 kg) and semi-stall fed (9.464 ± 0.213 kg) groups.

The overall 6 month's weight averaged 10.996 ± 0.166 kg in the- males and 10.020 ± 0.151 kg in the females. However, the body weight at 6 month's according to housing types indicated variable trends. At 12 month's age the average weight for the males from stall fed management were highest (17.094 ± 0.896 kg) followed by grazing group (15.170 ± 0.781 kg) and semi-stall fed group (14.417 ± 0.153 kg).

Amongst the females, the highest weight at 12 month's was recorded in the grazing group (15.300 ± 0.305 kg) followed by semi-stall fed (14.344 ± 0.305 kg) and stall fed group (14.229 ± 0.425 kg). The average adult weight recorded in grazing management were the highest for males (22.700 ± 0.000 kg) and the females (20.478 ± 0.742 kg) followed by semi-stall fed group (19.743 ± 1.713 kg and 18.550 ± 0.603 kg respectively). The males from stall fed management however, weighed heavier than the semi-stall fed males.

The overall adult weight irrespective of housing and management system averaged 18.940 ± 0.990 kg in the males and 19.396 ± 0.434 kg in the females.

All the results are in agreement with Ulmek (2003) and Ray and Raut (2003).

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Effect of Types of Birth and Management System on Growth Performance of Osmanabadi Kids

Goat is an important meat producing species of ruminant livestock which contribute about one third of the total meat production in India. Osmanabadi has been classified meat breed (Acharya, 1992). The information of goat rearing is scanty and hence attempt was made to study the effect of management system on Osmanabadi goat.

The flock of 120 Osmanbadi goats along with followers was purchased from breeding tract. These goat have been placed in three (grazing, stall feeding and semi stall feeding) management system in equal number. In three management system fortnightly observation recorded for growth observation at birth, 3 months, 6 months, 12 months and adult body weight (kg).

The two types of birth *viz*., single and multiple were considered for study. The twins and triplet born have been considered as multiple birth. In all the three systems of management the average highest birth weight

(Table 1) for male and female kids were in the single born kid so also the weight were higher in the male than the female except the females in the stall fed group.

The overall highest birth weight for both sexes was observed in semi-stall feeding system. The single and multiple born kids in all the three management indicated the most similar

Table 1. Effect of types of birth and management system on body weight of Osmanabadi goats.

Particulars		Birth weight (kg)		3 months weight (kg)		6 months weight (kg)	
		Male	Female	Male	Female	Male	Female
Grazing (M_1)	T_1	2.129 ± 0.049 (34)	2.032 ± 0.044 (38)	7.753 ± 0.284	7.663 ± 0.294	11.378 ± 0.336	11.097 ± 0.396
	T_2	1.888 ± 0.030 (80)	1.765 ± 0.026 (69)	6.830 ± 0.171	6.346 ± 0.254	11.212 ± 0.263	10.737 ± 0.358
	Av.	1.960 ± 20.027 (114)	1.856 ± 0.026 (108)	7.110 ± 0.152	6.780 ± 0.205	11.270 ± 0.206	10.873 ± 0.267
Semi-stall (M_2)	T_1	2.164 ± 0.052 (44)	2.076 ± 0.038 (37)	7.318 ± 0.352	6.881 ± 0.315	11.693 ± 0.571	10.323 ± 0.347
	T_2	1.914 ± 0.031 (63)	1.728 ± 0.037 (53)	5.731 ± 0.183	5.498 ± 0.167	9.884 ± 0.328	8.978 ± 0.244
	Av.	2.017 ± 0.003 (107)	1.871 ± 0.032 (90)	6.317 ± 0.191	6.031 ± 0.174	10.5787 ± 0.313	9.464 ± 0.213
Stall fed (M_3)	T_1	1.973 ± 0.051 (30)	2.000 ± 0.067 (32)	7.067 ± 0.369	6.815 ± 0.392	11.542 ± 0.593	10.573 ± 0.358
	T_2	1.886 ± 0.053 (58)	1.804 ± 0.046 (49)	6.830 ± 0.265	6.061 ± 0.215	10.920 ± 0.397	8.938 ± 0.318
	Av.	1.916 ± 0.039 (88)	1.886 ± 0.040 (81)	6.910 ± 0.214	6.333 ± 0.200	11.122 ± 0.329	9.528 ± 0.260
Overall		1.970 ± 0.020 (309)	1.870 ± 0.019 (279)	6.782 ± 0.108	6.406 ± 0.114	10.996 ± 0.166	10.020 ± 0.151

T_1 = single birth, T_2= multiple birth

Table 1. Contd.

Particulars		12 months weight (kg)		Adult weight (kg)	
		Male	Female	Male	Female
Grazing (M_1)	T_1	16.233 ± 1.087	15.613 ± 0.443	25.000 ± 0.000	19.900 ± 1.152
	T_2	14.714 ± 1.012	15.096 ± 0.415	20.400 ± 0.000	21.200 ± 0.859
	Av.	15.170 ± 0.781	15.300 ± 0.305	22.700 ± 0.000	20.478 ± 0.742
Semi-stall (M_2)	T_1	16.000 ± 1.154	14.892 ± 0.722	15.950 ± 1.170	18.378 ± 0.878
	T_2	13.573 ± 0.895	14.069 ± 0.377	18.260 ± 1.537	20.720 ± 2.058
	Av.	14.417 ± 0.153	14.344 ± 0.348	17.600 ± 0.310	19.217 ± 0.931
Stall fed (M_3)	T_1	15.533 ± 1.503	14.967 ± 0.792	20.120 ± 3.759	18.667 ± 0.810
	T2	17.945 ± 1.284	14.027 ± 0.496	19.533 ± 1.865	18.375 ± 0.955
	Av.	17.094 ± 0.999	14.229 ± 0.425	19.743 ± 1.713	18.550 ± 0.603
Overall		15.478 ± 0.527	14.659 ± 0.208	18.940 ± 0.990	19.396 ± 0.434

T_1 = single birth, T_2 = multiple birth

trend of growth to that observed at birth i.e. singles giving highest body weight for all the traits over the multiple born kids.

The highest body weight was observed in grazing management system. At sixth month age single born males and females from the three system of management were heavier than the multiple born kids. In both the types of birth the males were heavier than the females. The grazing management system of rearing had highest 6 months body weight.

At age of 12 months also the single born males and females from three system of management gave higher body weight than their corresponding twins. In stall fed management, however, the twin born males (17.945 ± 1.284 kg) gave higher body weights than the corresponding singles (15.533 ± 1.503 kg). Further, in grazing system and semi stall fed system the multiple born males were higher than the twin females.

At maturity (adult weight) except the twin males and females from semi-stall fed group and twin born in female grazing group, the single born males and females gave higher weights over their corresponding multiples. So also the multiple born females grazing group (21.200 ± 0.859 kg) weighted heavier than their corresponding singles (19.900 ± 1.152 kg). Despande and Jahagirdar (2003) reported higher adult body weight for Osmanabadi goats under stall feeding however, they also reported higher body weights single and multiple births.

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Adoption ol Sugarcane Production Technology by Growers

The sugarcane production technology is being generated in the various research stations in India. But majority of the sugarcane growers do not know the importance of adoption of improved sugarcane production technology. It has been.observed that there is a wide gap in knowledge as well as in adoption ol sugarcane production technology of sugar cane growers. It is therefore necessary to study the present status of adoption of sugarcane production technology and factors affecting it. Keeping this in view the present study was carried with the objectives to study the personal and socio-economic characteristics of sugarcane growers, to know the extent of adoption of recommended practices of sugarcane production technology by the sugarcane growers and the relationship between the adoption level and personal characteristics of the sugarcane growers.

The study was carried out in the area of Vaidyanath Sahakari Sakhar Karkhana Ltd. in Parali Vaijnath, Taluka of Beed district in Maharashlra State. From the command area of Vaidyanath Sugar Factory, ten villages were purposively selected randomly for the purpose of the study. From each village fifteen farmers cultivating sugarcane at least for last three years were selected randomly. Thus a total sample of 150 respondents was selected for the present study. Keeping in view the objectives of the study interview schedule was developed, and used for interviewing the respondents personally. During study, the variables namely age, education, land holding, annual income, social participation, sources of information, sources of irrigation, risk orientation etc. were studied as independent variable and adoption as dependent variable. The scores were given to each practice like 0, 1 and 2 for non-adoption, partial adoption and complete adoption respectively. Based on the total adoption score obtained, the respondents were categorized under high, medium and low adopter category. Further, the data were analyzed using statistical tools *viz*., mean, percentage, standard devialion and correlation co-efficient.

It is observed from Table 1 that 96 per cent of the respondents were literate while only 4 per cent were illiterate. Where as 80 per cent of the respondents were above age of 35 years. More than half of the respondents (56.66%) were having medium land holding, with medium social participation (66.66%), medium sources of information (68%) and medium risk orientation (58%). These findings are in line with the findings of Warghade (2000). Only 10 per cent respondents were having annual income upto Rs. 20,000/- whereas about 60 per cent respondents were having annual income in between Rs. 20,000-80,000. These findings are in line with the findings of Hadole (2003), Khandikar (1996) and Borse (2003). It was also been observed that 42.66 per cent respondents depended upon well as a source of irrigation. This was followed by river and canal irrigation 29.33 and 28 per cent respectively.

Table 1. Personal, socio-economic and psychological characteristic of sugarcane growers (n=150).

Characteristics	Frequency	Percentage
Age (years) :		
Upto 35	30	20.00
36 to 50	70	46.66
Above 50	50	33.34
Education :		
Illiterate (No formal education)	06	04.00
Primary education (Upto VIIth Std)	48	32.00
Secondary education (VIIIth to XIIth)	61	40.66
College education (Above XIIth)	35	3.34
Land holding :		
Small land holding (Up to 2 hectares)	30	20.00
Medium land holding (2.1 to 6.0 ha)	85	56.66
Large land holding (6.1 ha. and above)	35	23.34
Annual income :		
Upto Rs. 20,000/-	15	10.00
Rs. 20,001/- to 40, 000/-	31	20.66
Rs. 40.001/- to 60.000/-	35	23.34
Rs. 60.001/- to 80,000/-	24	16.00
Rs. 80.001/- to 1,00,000/-	20	13.34
Rs. 1,00,001/- and above	25	16.66
Social participation :		
Low	15	10.00
Medium	100	66.66
High	35	23.34
Source of information :		
Less	22	14.66
Medium	1.02	68.00
More	26	17.33
Sources of irrigation :		
Canal	42	28.00
River	44	29.34
Well	64	42.66
Risk orientation :		
Low	40	26.66
Medium	87	58.00
High	23	15.34

Table 2. Distribution of respondents according to adoption.

Adoption level	Respondents	
	Number	Percentage (n=150)
Low	16	10.66
Medium	84	56.00
High	50	33.33
Total	150	100

The data presented Table 2 revealed that 56.00 per cent of respondents had medium adoption level while 33.33 per cent of the respondents had high adoption level. Only 10.66 per cent of the respondent had low adoption level. The higher percentage of the resporrdents was the medium category may be due to clustering of respondents in medium level of annual income, social participation, source of information and risk orientation, These characteristics of the respondents had close relation with adoption. The finding is in line with the study conducted by Joshi (1985), Vekaria *et al*. (1987), Bhatkar *et al*. (1997) and Warghade (2000).

Adoption of sugarcane production

Table 3. Distribution of respondents according to their adoption of recommended practices of sugarcane cultivation.

Recommended practices	Adoption as per recommendation	
	Frequency (n=150)	Per-centage
Selection of land, heavy black well drained soil	135	90
Preparatory tillage operation deep ploughing, with 2-3 cross harrowing	126	84
Application of FYM	30	20
Green manuring	48	32
Use of improved varieties	142	94.66
Planting season :		
Adsali (15 July to 15 Aug.)	04	2.6
Pre seasonal (15Oct. to 15 Nov.)	31	20.66
Suru (15 Dec. to 31 Jan.)	115	76.66
Selection of cane sets, 8-9 months well nourished cane set from sugarcane farm and set having 1, 2 or 3 buds for planting	132	92.00
Seed treatment of deeping sets in bavistine solution and insecticide solution	20	13.33
Use of *Azotobactor* soluble phosphate treatment and bio fertilizer	10	6.66
Use of 25000-30000 sets ha^{-1}	130	86.66
Pressing the sets 3-4 cm deep in to the mud	150	100
Application of NPK fertilizer doses as per recommended	52	34.66
Giving irrigation properly	70	46.66
a) First irrigation after 4-5 days of planting		
b) Irrigation interval in summer 8-10 ays, 12-15 days in winter and rainy season according to need		
Use of drip/sprinkler irrigation system	15	10
Intercultivation 3-4 weeding and 2-3 hoeing	120	80
Use of weedicides	2	1.33
Use of plant protection measures to control insects and pests	4	2.66
Harvesting at proper time of maturity	118	78.66
No burning of sugarcane leaves after harvesting-previous crop	20	13.33
Ratoon crops taken for 2-3 years	150	100

lechnology was ascertained in respect of twenty important recommended practices and data have been reported in Table 3 which indicated that all respondents (100%) adopted pressing the sets 3-4 cm deep in to the mud and rotton crop taken for 2-3 years. Most of the respondents adopted the use of improved varieties (94.66%), selection of cane sets from 8-9 months well nourished sugar cane farm, and cane sets having 1, 2 or 3 buds (92%), selection of heavy black well drained soil (90%), using 25000-30000 sets hectare^{-1} (86.66%) deep ploughing with 2-3 cross harrowing (84.00%).

Majority of the farmers adopted recommended cultivation practices in sugarcane *viz*., inter cultivation, 3-4 weeding and 2-3 hoeing (80%), harvesting at proper time of maturity (78.66%) and plantation season in suru (76.66%). As much as 46.66 per cent of fanners followed the irrigation schedule, 34.66 per cent and 32.00 per cent farmers adopted recommended fertilizer dose and green manuring respectively. Twenty per cent respondents were found adopting well decomposed FYM and set treatment before planting. About 13 and 10 per cent farmers adopted no burning of sugarcane leaves after harvesting previous crop and use of drip sprinkler irrigation system respectively. Limited farmers i.e. 10, 4 and 2 per cent adopled the recommended use of bio fertilizer, pest control measures and use of weedicides respectively. This may be due to the lack of knowledge of farmers about recommended sugarcane practices.

The use of improved varieties, selection of land, application of NPK ferlilizer, plant protection control and use of weedicides etc. practices of sugarcane production technology are in conformity with the finding reported by Hadole and Dakhore (2003).

Table 4. Relationship of selected characteristics of respondents with adoption of sugarcane production technology.

Variables	r' value
Age	-0.537*
Education	0.288**
Land holding	0.565*
Annual income	0.267**
Social participation	0.248*
Source of information	0.244*
Source of irrigation	0.218 N.S.
Risk orientation	0.4.39*

*, ** Significant at 0.05 and 0.01 level of probability.

The data in Table 4 revealed that out of eight independent variables the six variables namely education, land holding, annual income, source of information, social participation and risk orientation were found positively related with adoption of sugurcane production technology. These findings are in conformity with the findings of Kharde and Nimbalkar (1996) and Warghade (2000). Age was negatively related at 0.01 level of significance. This indicates that as the age increases the adoption of sugarcane production technology decreases. The study is in line with the study of Adgale (1980). Sources of irrigation were having non-significant relationship with adoption of sugarcane production technology. This finding is in conformity with the findings reported by Wasnik (1995) and Warghade (2000).

It is concluded from the findings that sugarcane production technology *viz*., use of plant protection measures, set treatment, use of chemical weed control, dipping of set in insecticide solution before planting, use of biofertilizer was adopted by a few respondents. Overall adoption of sugarcane production technology was found to be at medium level. The relation analysis showed that among selected characteristic education, land holding, annual income, social participation, sources of

information and risk orientation were positive and significantly related and age was negatively related with adoption of recommended practices of sugarcane production technology.

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Stability Analysis in Grain Amaranthus (*Amaranthus hypochondriacus* L.)

Grain amaranthus (*Amaranthus hypochondriacus* L.) is an important psuedocereal that is widely cultivated in Sub-Himalayan ranges and the Nilgiri hills of South India under the common name "Rajgeera" (Singh, 1961). Amaranthus is dual purpose crop used for grains and vegetable (Willis, 1973). Amaranthus contain all essential amino acids, high protein, high fibre, it does not contain gluten protein. In India amaranthus is consumed during religious days of fast. The grains of amaranthus are consumed in various ways and it could be rightly described as a "poor man's vegetable".

In order to realize the best yield potential of this crop, it is necessary to identify the stable genotypes which respond to predictable environments. The present study was conducted with a view to assess the elite genotypes of amaranthus for their stability performance by growing in different environments.

The field experiment comprising of twelve genotypes of grain amaranthus (*Amaranthus hypochondriacus* L.) was sown in RBD with three replications during *rabi*, 2009 in four different environments as E_1 - (sowing done on 15th Oct.), E_2 - (sowing done on 30th Oct.), E_3

- (sowing done on 15^{th} Nov.) and E_4 - (sowing done on 30^{th} Nov.).

Observations were recorded on seven characters *viz*., days to 50 per cent flowering, days to maturity, plant height, length of inflorescence, grain yield, number of spikelets and seed volume weight. Pooled analysis of variance over four environments and stability parameters mean (μ) regression co-efficient (bi) and deviation from regression (S^2di) and environmental indices (Ij) were estimated as per the model suggested by Eberhart and Russell (1966).

Pooled analysis of variance over four environments showed that genotypic and environmental differences when tested against G x E were significant for all the characters except seed volume weight under study (Table 1) indicating the presence of genetic variability among the genotypes and environments, respectively.

Genotype x environment interaction was significant when tested against pooled error for all characters except seed volume weight indicating that major portion of interaction was linear in nature and prediction over environments was possible. Significant pooled deviation was observed for length of inflorescence, grain yield plant^{-1} and number of spikelets inflorescence^{-1} suggested that the prediction of genotypes performance across environments would be highly effective for these traits.

According to Eberhart and Russell (1966) the ideal genotype would be one which has high mean, regression coefficient equal to unity (bi=l) and low deviation mean square(S^2di=0). In the present study linear regression (bi) is treated as measures of response of a particular genotypes whereas deviation from the regression line (S^2di) is considered as a measure

Table 1. Analysis of variance for stability for different characters in amaranthus.

Source	d.f.	Days to 50% flowering	Days to maturity	Plant height (cm)	Length of inflores-cence	Grain yield plant^{-1} (g)	Spikelets inflores-cence^{-1}	Seed volume (g 10^{-1} ml)
Genotype (G)	11	11.906++,@@,**	56.329++,@@,**	154.772**	179.280++,@@,**	32.875++,@@,**	174.793++,@@,**	0.170++,@@,**
Environment (E)	3	243.383++,@@,**	215.685++,@@,**	5649.571++,@@,**	999.990++'@®'**	176.271++,@@,**	578.272++,@@,**	0.29++'®®-**
G x E	33	1.507**	3.543**	95.774**	20.817@**	9.518@**	33.522@@**	0.009
E + (G x E)	36	21.663	21.221	558.588	102.415	23.414	78.918	0.014
Environment (Linear)	1	730.150@@**	647.057@@**	16948.71@@**	2999.972@@**	528.814@@**	1734.818@@**	0.087@@**
G x E (Linear)	11	1.638**	2.951**	93.428**	42.895@@**	18.384@@**	72 382@@**	0.017@@**
Pooled deviation	24	1.322**	3.518**	88.865**	8.964**	4.662**	12.918**	0.007**
Pooled error	96	0.295	0.944	2.838	2.838	0.097	0.097	0.021

+, ++ = Significant at 5 and 1 per cent level, respectively against the G x E interaction, @, @@ = Significant at 5 and 1 per cent level, respectively against the pooled deviation, * , ** = Significant at 5 and 1 per cent level, respectively against the pooled error

of stability. Estimation of environmental indices (Ij) suggested E_3 environment (sowing on 15th November) was most favourable for the plant height (cm), length of inflorescence, grain yield plant^{-1} and number of spikelets inflorescence^{-1}. The environment E_4 (sowing on 30th November) was most favourable compared to as E_3 environment. The estimates of stability parameters i.e. mean (m), regression coefficient (bi) and deviation from regression (S^2di) for

Table 2. Estimation of stability parameters for different characters of amaranthus by Eberhart and Russell Model (1966).

Genotypes	Days to 50% flowering			Days to maturity			Plant height		
	Mean ($\bar{X}$)	bi	S^2di	Mean ($\bar{X}$)	bi	S^2di	Mean ($\bar{X}$)	bi	S^2di
RGAS-08-08	51.40	1.21*	1.73	97.85	0.71*	-0.40	99.89	0.63*	55.51**
RGAS-08-10	51.64	0.95	0.91	107.30	1.21	0.08	92.05	1.28*	92.37**
RGAS-08-11	52.89	1.08	1.89	101.90	0.98	2.77	105.10	1.10	39.97**
RGAS-08-12	53.37	0.83*	2.82*	103.76	0.81	0.15	103.51	1.09	50.84**
RGAS-08-13	52.94	1.13	0.15	106.44	1.32*	6.69	92.60	0.90	40.88**
RGAS-08-14	51.60	1.24*	0.77	104.32	1.04	7.36	99.75	1.27*	4.10
RGAS-08-15	50.43	0.83*	0.45	101.45	0.92	2.96	97.18	0.56*	409.94**
RGAS-08-16	48.13	0.73*	3.10*	97.49	0.56*	-0.52	98.05	1.01	49.82**
RGAS-08-19	52.44	1.02	0.09	109.76	1.11	1.42	84.10	1.28*	160.25**
RGAS-92-10-1	52.84	1.13	0.67	103.00	0.86	10.02*	105.71	0.98	2.64
GA-1 (check)	53.42	0.87	-0.10	106.02	1.29*	-0.52	102.14	1.17	127.66**
Suvarna (check)	54.93	0.94	-0.20	100.19	1.14	0.85	96.20	0.66*	-1.72
Mean	52.17			103.29			98.02		
S.E.±	0.66	0.14		1.08	0.25		5.44	0.25	

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

Table 2. Contd.

Genotypes	Length of inflorescence			Grain yield plant^{-1}			Spikelets inflorescence^{-1}		
	Mean ($\bar{X}$)	bi	S^2di	Mean ($\bar{X}$)	bi	S^2di	Mean ($\bar{X}$)	bi	S^2di
RGAS-08-08	56.00	0.36*	3.90	22.53	0.41*	14.69**	41.70	0.86	-0.08
RGAS-08-10	50.70	1.20*	5.95	17.10	1.31	3.73**	26.11	1.12	13.70**
RGAS-08-11	56.89	0.65*	18.83	23.25	1.01	2.16**	43.45	-0.36	25.92**
RGAS-08-12	54.74	0.88	-2.48	21.71	1.31	7.90**	39.97	0.80	14.98**
RGAS-08-13	48.44	0.98	-0.008	18.98	1.04	0.43	32.35	1.88	2.48**
RGAS-08-14	51.97	1.33*	-2.56	23.18	1.84*	2.17**	33.75	1.43	7.22**
RGAS-08-15	59.36	1.25*	6.19	22.84	1.00	0.84**	37.65	2.10	18.35**
RGAS-08-16	54.85	1.34*	10.49	21.13	0.73	9.48**	31.84	0.56	2.75**
RGAS-08-19	47.53	1.71*	25.32*	20.55	1.93*	8.52**	25.41	1.21	13.02**
RGAS-92-10-1	56.04	0.98	-0.02	24.15	1.52*	2.59**	34.85	0.93	6.09**
GA-1 (check)	51.00	0.98	10.51	15.99	0.39*	0.15	46.84	0.02	43.53**
Suvarna (check)	33.77	0.29*	-2.62	16.40	-0.36*	2.07**	39.15	1.41	5.82**
Mean	51.77			20.65			36.09		
S.E.±	1.72	0.18		1.24	0.32		2.07	0.29	

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

Table 3. Estimates of environmental indices (ij) under different sowing dates.

Name of characters	E_1	E_2	E_3	E_4
Days to 50 % flowering	-5.00	1.74	-5.60	-1.14
Days to maturity	3.82	3.48	-4.13	-3.16
Plant height (cm)	-28.30	-4.48	21.55	11.23
Length of inflorescences	-12.82	0.41	8.23	4.17
Grain yield plant^{-1} (g)	-4.72	-1.50	3.32	2.90
No. of spikelets inflorescence^{-1}	-10.06	1.39	5.72	2.93
Seed volume weight (g 10^{-1} ml)	0.004	0.06	-0.014	-0.05

different characters are presented in Table 2. None of the genotype was found to be stable for grain yield. The genotype RGAS-08-08 exhibited average stable for number of spikelets inflorescence^{-1}. The genotypes RGAS-92-10-1 and RGAS-08-12 exhibited stability for length of inflorescence, the genotype RGAS-92-10-1 stable for plant height. The genotypes RGAS-08-15 and RGAS-08-11 exhibited wider stable for early maturity. For the trait days to 50 per cent flowering, the genotype RGAS-08-10 exhibited average stability. Similar results were reported by Sharma *et al*. (2001) and Kishore *et al*. (2007) in their stability studies in amaranthus. While, the genotypes RGAS-08-14 and RGAS-08-08 exhibited below average stability for days to 50 per cent flowering i.e. suitable for favourable environments. The genotype RGAS-08-15 exhibited stability for poor/stress environment.

The genotypes which recorded above average stability for different characters can be used to mitigate the global warming challenges.

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Vaibhav - A Mungbean Variety for Maharashtra

Mungbean (*Vigna radiata* L. Wilczek) it is second important kharif pulse crop grown in Maharashtra after pigeonpea. Mungbean is short a duration grain legume grown in different seasons in India under varying climatic conditions. It is cultivated on an area of 34.40 and 6.57 lakh hectares producing 13.70 and 3.06 lakh tonnes with average productivity of 399 and 466 kg ha^{-1} in India (2007-08) and Maharashtra (2008-09), respectively.

Table 1. Performance of Phule M-9339 in various trials.

Year/location	Grain yield (kg ha^{-1})			
	PM 9339	**Koper-gaon**	**J-781**	**AKM-8802**
SVT (1996 *kharif*)				
Rahuri	1126	750	-	-
LSYT (*kharif* 1997)				
Rahuri	1056	901	938	-
RVT 1997 (Kh)				
Rahuri	511	-	-	-
Jalgaon	478	-	303	-
Mean (2)	495	-	303	-
RVT 1999 (Kh)				
Rahuri	1129	502	-	-
Kopergaon	807	619	-	-
Jalgaon	396	176	-	-
RVT 2000 (Kh)				
Rahuri	910	851	-	-
Kopergaon	603	400	-	-
Mean (2)	757	626	-	-
SMVT(B) 1997 (Kh)				
Rahuri	1208	1045	984	1065
Dhule	604	614	895	672
Jalgaon	602	523	306	640
Mean (3)	805	727	728	792
SMVT(B) 1998 (Kh)				
Rahuri	905*	656	142	511
Dhule	1071*	823	583	1005*
Akola	285	631	396	535
Washim	804	925	804	779
Nagpur	687	331	648	789
Badnapur	1481	1075	-	1517
Parbhani	1131*	895	-	972
Mean (7)	909(i)	762	490	844(ii)
SMVT(O) 1999 (Kh)				
Digraj	536	373	-	-
Jalgaon	911	382	-	668
Pune	1580	1003	-	1533
Rahuri	967	735	-	626
Mean (4)	999	623	-	942
SMVT (O) 2000 (Kh)				
Rahuri	609	458	-	557
Dhule**	234	139	-	93
Jalgaon**	314	274	-	196
Pune	930	569	-	73

Table 1. Contd

Year/location	Grain yield (kg ha^{-1})			
	PM 933P	**Koper-gaon**	**J-781**	**AKM-8802**
Mean (2)	770	514	-	647
SMVT(B) 1999(Kh)				
Rahuri	925	735	889	1053
Kopergaon	552	463	554	730
Jalgaon	386	299	350	399
Mean (3)	621	499	598	707
SMVT (B) 2000 (Kh)				
Rahuri	536	484	547	396
Dhule**	235	124	180	139
Jalgaon*	-	-	-	-
Kopergaon	720	690	419	730
Mean (2)	628	587	483	563
General Mean (30)	814.8	639.57 (28)	583.87 (17)	785.65 (20)
Mean % increase over		27.39	39.29	3.71
Performance of Phule M-9339 in Co-ordinated testing				
	PM-9339	**ML-5**	**ML-131**	**BM-4**
IVT 1998(Kh)				
Rahuri	996	1089	1174	-
Indore	810	746	627	-
Khargone	823	607	657	-
Mean (3)	876	814	819	-

** At Jalgaon and Dhule the data was not considered to work out the averages as the yield levels yet low due to severe water stress. * Vitiated due to severe water stress.

However, the present yield potential of improved varieties is not enough to attract the farmers. In addition to lower production potential and undesired smaller seed size, susceptibility of the almost all cultivated varieties to the powdery mildew disease which resulting into poor yield. Powdery mildew (*Erysiphe polygoni* D.C.) is the most devastating disease of mungbean. For effective and eco-friendly cheapest control of this disease a well thought breeding programme was initiated at the Pulse Improvement Project, MPKV, Rahuri to develop bold seeded, high

Table 2a. Reaction to powdery mildew disease at MPKV, Rahuri.

Strain	Per cent PM			Mean
	97-98	99-00	00-01	
Phule M-9339	8.00	4.00	5.66	5.89
Kopergaon (Ch)	60.00	75.00	100	78.33
J-781 (Ch)	80.00	70.00	-	75.00
AKM-8802	-	70.00	43.00	56.50
Phule M-2	100	100	100	100

yielding, powdery mildew resistant variety of mungbean.

The genotype Phule M-9339 (Vaibhav) was isolated from the cross between the widely adapted, bold seeded, resistance to pod shattering parent KDM-1 and powdery mildew resistant parent TARM-18, through pedigree selection method. At the advancement of each generation the segregating material was evaluated for its resistance to powdery mildew under artificial epiphytotic condition of disease as per 0 to 5 scale.

The culture Phule M-9339 was entered in small scale yield trial during the year 1996 and tested with check Kopergaon. The yield difference due to genotypes were significant for grain yield. It recorded grain yield of 1125 kg ha^{-1}, which was 50 per cent higher than the check Kopergaon (750 kg ha^{-1}) (Table 1). In the large scale yield trial Vaibhav (Phule M-9339) recorded 1055 kg ha^{-1} grain yield which was 17.09 and 12.47 per cent higher than the checks Kopergaon and J-781, respectively. In the varietal trial, conducted at three locations during 1997 to 2000, Phule M-9339 gave 63.37 per cent (J-781), 79.86 per cent (Kopergaon) and 20.92 (Kopergaon) higher grain yield than the respective checks, respectively.

The state multilocation trials (Bold) were conducted during 1997, 1998, 1999 and 2000 at 3, 7, 3 and 3 locations, respectively in which the genotype Phule M-9339 (Vaibhav) recorded 10.73 and 10.77 per cent (1997), 22.55 and 96.33 per cent (1998), 24.45 and 3.85 per cent (1999), 4.34 and 11.84 per cent (2000) higher grain yield than the checks Kopergaon and J-781, respectively. While in the state multilocation varietal trial (SMVT-0) conducted during 1999 and 2000 at 4 locations, recorded 60.35 and 49.81 per cent higher grain yield over the check Kopergaon (Anonymous, 2000a).

It was also tested in initial varietal trial of AICRP on MULLaRP during 1998. These trials were conducted at 3 locations in Central Zone. In these trials Phule M-9339 (Vaibhav) recorded the highest yield of 876 kg ha^{-1} as against 819 kg ha^{-1} of National check M-131.

The genotype Phule M-9339 recorded the 23.66 per cent higher grain yield over the Kopergaon in adaptive trials during kharif, 2000. The variety Phule M-9339 is resistant to powdery mildew showing 5.89 per cent incidence as against 100 per cent. susceptibility

Table 2b. Reaction to powdery disease of mungbean genotypes at different centers (0-5 scale).

Name of strain	1999-2000								2000-01 Badnapur
	Wara-ngal	Akola	Coimb-atore	Durga-pura	Juna-gadh	Khar-gone	Udaipur	Rahuri	
Phule M-9339	1.00	1.7	0.0	2.0	1.1	2.5	2.0	1.0	2.60
Kopergaon (Ch)	1.00	3.3	4.0	-	3.0	2.5	3.0	-	-
J-781 (Ch)	-	-	-	-	-	-	-	4.0	3.60

of check Phule M-2 (Table 2a and 2b), Phule M-9339 is also identified as donar for powdery mildew resistance (Anonymous, 2000b).

On an average of 30 trials conducted in MPKV, Rahuri, PKV, Akola and MAU, Parbhani jurisdiction gave 27.39 per cent higher grain yield over Kopergaon and 39.29 per cent over J-781. Because of high yield potential, bold seed size and resistance to powdery mildew the genotype Phule M-9339 was released under the name "Vaibhav" for kharif cultivation in Maharashtra state by the variety release committee meeting in Joint AGRESCO held at MKV, Parbhani on 17-19th June, 2001. This variety can be suitable substitute for the earlier released powdery mildew susceptible varieties Kopergaon and J-781. The cultivation of this variety will help in enhancing the production and productivity of this important pulse crop in the state.

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Biochemical Mechanism of Host Resistance to *Macrophomina phaseolina* (Tassi) Goid of Sorghum

Sorghum suffers from many fungal diseases. Among these charcoal rot caused by *Macrophomina phaseolina* (Tassi) Goid. (*Rhizoctonia bataticola* Taub) is one of the serious and potential disease causing heavy losses. This disease was reported in India by Uppal *et al*. (1936) and further in different sorghum states of India (Bhagwat, 1975). Several workers have reported the varying degree of phenols in resistant and susceptible varieties. Patil *et al*. (1978) studied role of phenols in charcoal rot resistance in sorghum. They observed that in tolerant genotypes phenol concentration was higher than in susceptible ones. Anahosur and Naik (1985) estimated high amount of phenols from root and first internode, in resistant genotypes at physiological maturity.

The experiment was conducted at research unite of department of Plant Pathology, Dr. PDKV, Akola during *kharif*, 2004. Before sowing, 10 g of inoculum of *Macrophomina phaseolina* was added in furrows and the seed was dibbled. The experiment was conducted in a randomized block design with six varieties and four replications. The phenol concentration was estimated by the method given by Bray and Thorpe (1954) using catechol as a standard. Intensity of the spectrophotometer chromato-

Table 1. Total phenol content (mg g^{-1}) in different sorghum genotypes.

Genotypes	Total phenol (mg g^{-1})					
	30 DAS		60 DAS		At physiological maturity	
	Root	Stem	Root	Stem	Root	Stem
CSH-9	17.25	18.25	10.25	11.88	4.88	5.38
CSH-14	17.00	16.13	7.75	10.63	3.75	3.88
CSH-16	14.25	11.50	5.88	9.00	3.38	2.63
CSN-15	20.38	21.38	11.38	12.88	7.63	6.63
PKV-801	17.38	18.13	10.13	12.50	6.13	5.75
IS-14332	20.75	21.13	15.50	14.75	9.25	8.13
S.E.(M)±	0.383	0.479	0.411	0.275	0.342	0.271
CD at 5%	1.318	1.646	1.411	0.945	1.174	0.932

graphy colour was measured at 650 nm wavelength.

The phenol was estimated from roots and stems at 30, 60 DAS and at physiological maturity.

The total phenol content from roots and stem at different stages of crop growth were significant. Out of six genotypes, IS-14332 recorded maximum (Table 1) total phenol i.e. 20.75 mg g^{-1} at 30 DAS followed by CVS-15 which showed 20.38 mg g^{-1} however, these treatments were at par with each other. The other genotypes *viz*., PKV-801, CSH-9 and CSH-4 recorded the root phenol content of 17.38, 17.25 and 17.00 mg g^{-1}, respectively but were at par with each other. The minimum total phenol (14.25 mg g^{-1}) was recorded in CSH-16 with decreasing trend at 60 DAS to physiological maturity.

The maximum total phenol in the stem was (21.38 mg g^{-1}) recorded in CSV-15 followed by IS-14322 (21.13 mg g^{-1}) but these treatments were at par with each other. However, CSH-9 and PKV-80 showed 18.25 and 18.33 mg g^{-1} receptively. The minimum total phenol (11.50 mg g^{-1}) was recorded in CSH-16 with decreasing trend at 60DAS to physiological maturity. Higher concentration of phenol was recorded in tolerant genotype IS-14332.

These results agree with the findings of Patil *et al*. (1978) and Anahosur *et al*. (1985). Higher concentration of phenol was recorded in tolerant genotypes than susceptible by Patil *et al*. (1978). Anahosur *et al*. (1985) estimated more phenol in resistant genotypes than susceptible genotypes.

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Induction of Host Resistance in Mustard (*Brassica juncea*) with Non-Conventional Chemicals Against *Alternaria* blight (*Alternaria brassicae*)

The "plant defense activators" or "plant activators" (Romero *et al.* 2001) salicylic acid mimic compound (acibenzolar-s-methyl, Bion), phosphorous salts (Foli-R-Fos 400, Nutri-Phite-P) and micronutrient potassium salts (Canon, Phytogard and Nutrol) have been developed as commercial plant activator Becot *et al*., 2000 and Graham and Leite, 2004.

Some biological plant defense inducers such as *Trichoderma*, *Pseudomonas*, *Bacillus*, *Serratra*, non-pathogenic strains of *Fusarium* and yeast have been developed as commercial product to manage various diseases Benhamon and Garand, 2001 and Droby *et al*. 2002. In the present studies efficacy of different chemicals in the control of mustard *Alternaria* blight was tested under glass house conditions.

Infected leaves exhibiting typical symptoms of *Alternaria* spot of *A. brassicae* (isolates A, C and D) were collected from the field-grown plants of *B. carinata* from Crop Research Centre, GBPUA and T., Pantnagar and isolated *A. brassicae* which were transferred on PDA slants.

The identified *A. brassicae* isolate cultures were purified by single spore isolation methods and were maintained on PDA. The cultures were further used for inoculation whenever necessary. The pots filled with soil compost mixture were first watered and left as such in the glass house for two days to ensure appropriate moisture for seed germination. Five seeds of mustered cv. Varuna were sown in each pot. Proper thinning was done and 2-3 seedling were maintained in each pot. Two-week-old culture of isolate "A" with 10^5 spores ml^{-1} was sprayed on the plant surface using automizer. Inoculated plants were incubated for 72 hr. in humid chamber at 90-100 per cent relative humidity. Post inoculated plants with non conventional chemicals were incubated for 72 hr. in humid chamber at 90-100 per cent relative humidity. The conc. Of $CaSO_4$, KCl and K_2SO_4 were 0.5, 1.0 and 1.5 per cent whereas $ZnSO_4$ and $Na_2B_4O_7$ were 0.25, 0.50 and 0.75 per cent maintaining distilled water sprayed check.

Spots were measured at 10 days interval with the help of a thin plastic scale and average size of spot was then calculated. The leaves were rated as per the 0-5 scale and disease index was calculated.

Alternaria leaf spot was increased from 30 to 50 DAS in cv. Varuna. Treatment $CaSO_4$ at all concentration showed significant minimum size of spot in the range of 1.76 mm to 1.82 mm followed by treatments KCl (2.21 mm) and K_2SO_4 (2.21 mm) at 1.5 per cent. $Na_2B_4O_7$ (2.21 mm) at 0.75 per cent which were at pat with each other in comparison to check (3.71 mm). The significant minimum size of spot was observed in $Na_2B_4O_7$ at 0.75 per cent at 30 and 40 DAS in treatment $CaSO_4$ with 1.0 per cent at 50 DAS. The interactions between different treatment and observations interval was found highly significant. It was interesting to note that all the inducers showed reduction in size of spot as compared to check. These findings indicate that non conventional chemical (plant defense activators) helps in reducing *Alternaria* blight severity by reducing size of spots. Similar results were also reported by Vishvanath *et al*. (1999).

The increase of the number of leaf spots was found to be highly significant among the treatments and observations interval. The

significant minimum number of leaf spots observed in $CaSO_4$ (2.05 to 2.95) at all concentrations followed by $Na_2B_4O_7$ (2.85) at 0.75 per cent and K_2SO_4 (3.05) at 1 per cent, $Na_2B_4O_7$ (3.10) at 0.25 per cent which was at par among themselves in comparison to check (5.28). The significant difference in minimum number of average size of leaf spot was observed in $CaSO_4$ at 0.5 per cent (0.60) and (1.54) at 30 and 40 DAS respectively. The interaction among different treatment and observation intervals was also found highly significantf. These findings suggest that minimum number of spots may be important criteria for finding source of resistance against *Alternaria* blight of mustard. These results are in accordance with Vishvanath *et al*. (1999) and Kaur and Kolte (2001) who reported that inducers previously inoculated prior to challenge inoculation provide protection against diseases.

All the chemicals showed significantly lower disease (Table 1) index in comparison to check. The significant minimum per cent disease index was observed in treatment $CaSO_4$ (10.15%) at 0.5 per cent followed by $Na_2B_4O_7$ (14.66%) at 0.75 per cent, $CaSO_4$ (14.80%) which were at par with each other. The significant minimum per cent disease index was also observed in treatment K_2SO_4 (14.85%), $Na_2B_4O_7$ (15.10%) in comparison to check (28.00%). Mustard plants acquire resistance against *Alternaria* blight and white rust by previous or subsequent inoculation with chemicals and biotic agents (Singh *et al.* 1999; Vishwanath *et al.* 1999; Howell *et al*. 2000, Kaur and Kolte 2001). The conventional chemicals represent a

Table 1. Effect of some non-conventional chemicals on disease severity of *Alternaria* blight at different stages of growth of mustard cv. Varuna under glasshouse conditions.

Treatments	Conc. (%)	Disease index (%)				Rduction over check (%)
		30 DAS	40 DAS	50 DAS	Mean	
$CaSO_4$	0.5	2.70 (9.43)	6.00 (14.17)	21.75 (27.83)	10.15 (17.14)	63.75
$CaSO_4$	1.0	2.95 (9.88)	7.75 (16.16)	38.2 (37.97)	16.30 (21.34)	41.78
$CaSO_4$	1.5	2.35 (8.81)	6.30 (14.53)	35.75 (36.76)	14.80 (20.03)	47.14
KCl	0.5	5.80 (13.90)	11.75 (20.01)	40.05 (39.42)	19.20 (21.41)	31.42
KCl	1.0	4.00 (11.47)	15.00 (12.89)	41.40 (40.04)	16.80 (21.47)	40.00
KCl	1.5	8.00 (16.40)	23.00 (28.65)	38.10 (38.10)	22.70 (27.72)	18.92
K_2SO_4	0.5	5.90 (14.13)	14.00 (21.93)	27.8 (31.80)	15.90 (22.62)	43.21
K_2SO_4	1.0	5.55 (13.62)	12.00 (19.65)	27.00 (31.27)	14.85 (21.51)	46.96
K_2SO_4	1.5	5.30 (13.29)	13.00 (21.11)	27.30 (31.47)	15.20 (21.96)	45.71
$ZnSO_4$	0.25	8.20 (16.63)	18.50 (25.47)	39.00 (38.63)	21.90 (26.91)	21.78
$ZnSO_4$	0.50	6.00 (14.14)	16.40 (23.87)	30.94 (33.78)	17.78 (23.95)	36.50
$ZnSO_4$	0.75	7.80 (16.21)	20.00 (26.55)	32.05 (34.47)	19.95 (25.74)	28.75
$Na_2B_4O_7$	0.25	5.00 (11.47)	14.50 (22.36)	26.25 (30.81)	15.25 (21.55)	45.53
$Na_2B_4O_7$	0.50	6.50 (14.76)	13.80 (21.80)	26.00 (30.64)	15.10 (22.40)	46.07
$Na_2B_4O_7$	0.75	4.90 (12.78)	10.25 (18.66)	28.83 (32.46)	14.66 (21.30)	47.64
Check		9.00 (17.45)	28.8 (32.26)	46.20 (42.81)	28.00 (30.84)	-
CD at 5%						
Treatment		-	-	-	1.08	-
Interval		-	-	-	0.46	-
Interaction		-	-	-	1.87	-

Values in parenthesis are angular transformed values, DAS = Days after sowing.

new group of plant defense activator capable of protecting mustard plants against *Alternaria* blight in glass house conditions. However, more studies are required to find out mechanism of action and the role of environmental factors on the efficacy and formulations of these plant defense activators in managing *Alternaria* blight and plant health.

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Effect of Integrated Weed Management on Growth and Yield of Garlic (*Allium sativum*)

A most troublesome problem faced by garlic growers is the control of weed particularly during the early stage of crop growth. Because of higher plant density and slow growth of the plants having erect tubular leaves the interculturing is practically difficult and the crop suffers heavily from weed competition during establishment of seedlings. The weeds compete for the nutrients, moisture, space, light and affect growth and development. Weed reduces the bulb yield to the extent of 40-80 per cent (Verma and Singh, 1996), therefore, it is essential to keep the field weed free in critical period of crop growth.

An integrated weed management consists of two or more weed control methods at low input levels in order to reduce weed competition in a given cropping system below an economic threshold level and helpful for producing the higher yield. It is therefore, necessary to develop as appropriate and economical integrated weed management practices for garlic crop consisting of herbicide use and hand

weeding during *rabi* season. Hence, the present investigation was undertaken to study the effect of integrated weed management on quality parameters of garlic.

An experiment was conducted during *rabi* season of 2008-09 at the field of Horticulture Section, College of Agriculture, Nagpur (M.S.) in a randomized block design with three replications and with eleven treatment combinations *viz*., Pendimethalin (1 kg ha^{-1}, pre-emergence), Pendimethalin (0.75 kg ha^{-1}, pre-emergence) + 1 hand weeding at 45 DAP, Pendimethalin (0.5 kg ha^{-1} , pre-emergence) + 2 hand weeding at 30 and 60 DAP, Oxyfluorfen (0.2 kg ha^{-1}, pre-emergence), Oxyfluorfen (0.15 kg ha^{-1}, pre-emergence) + 1 hand weeding at 45 DAP, Oxyfluorfen (0.1 kg ha^{-1}, pre-emergence) + 2 hand weeding at 30 and 60 DAP, Oxyfluorfen (0.1 kg ha^{-1}, post-emergence), Oxyfluorfen (0.075 kg ha^{-1}, post-emergence) + 1 hand weeding at 45 DAP, Oxyfluorfen (0.05 kg ha^{-1}, post-emergence) + 2 hand weeding at 30 and 60 DAP. Hand weeding at 20, 40 and 60 DAP and control (no weeding). The most dominant dicot weeds were *Chenopodium album*, *Phasalis minima* and *Amarantus viridis* and the monocot weeds were *Cynodon dactylon*, *Cyprus rotundus* and *Dinebra retroflexa*. Uniform cloves of garlic were selected and planted at a spacing of 10 x 10 cm keeping the growing point upwards. Recommended dose of fertilizer, plant protection and all other operations were timely fallowed for better growth of the crop. The data were recorded for plant population, height of plant, days required for maturity, diameter and length of garlic bulbs, weight, number of cloves, bulb yield and economics of weed control and subjected to statistical analysis as per Panse and Sukhatme (1978).

Table 1. Effect of integrated weed management on number of monocot and dicot weeds and dry matter of weed in garlic.

Treatments	**Plant population**		**Height of plant (cm) 120 DAP**	**Days for maturity**	**Yield (q ha^{-1})**	**Bulbs dia. (cm)**	**Length of bulb (cm)**	**Wt. of bulb (g)**	**No. of cloves**
	Initial unit	**Final unit**							
Pendimethalin (1 kg ha^{-1}, pre-em)	292.33	241.33	66.02	157.00	94.66	3.81	2.72	13.13	17.26
Pendimethalin (0.75 kg ha^{-1}, pre-em) + 1 HD at 45 DAP	293.00	249.6.6	67.35	156.33	102.66	3.78	2.87	14.17	17.80
Pendimethalin (0.5 kg ha^{-1}, pre-em) + 2 HD at 30 and 60 DAP	294.33	252.00	68.79	155.00	113.66	3.89	3.32	15.69	18.43
Oxyfluorfen (0.2 kg ha^{-1}, per-em)	291.66	232.00	64.45	157.33	91.00	3.53	2.72	13.08	15.73
Oxyfluorfen (0.15 kg ha^{-1}, per-em) + 1 HD at 45 DAP	293.00	238.33	65.73	157.66	95.33	3.60	2.84	1.3.52	15.95
Oxyfluorfen (0.1 kg ha^{-1}, per-em) + 2 HD at 30 and 60 DAP	294.00	242.33	68.12	156.66	109.00	3.84	3.11	15.26	18.12
Oxyfluorfen (0.1 kg ha^{-1}, post-em)	291.33	236.00	65.16	158.66	86.00	3.44	2.66	12.26	15.43
Oxyfluorfen (0.075 kg ha^{-1}, post-em) + 1 HD at 45 DAP	291.33	237.66	65.71	158.00	86.33	3.48	2.70	12.35	16.74
Oxyfluorfen (0.05 kg ha^{-1}, post-em) + 2 HD at 30 and 60 DAP	292.33	246.66	66.96	157.33	104.00	3.78	3.04	12.39	17.91
Hand weeding at 20, 40 and 60 DAP	291.66	232.00	65.55	155.66	97.66	3.75	3.02	13.82	16.86
Control (no weeding)	291.33	212.66	65.15	159.00	62.00	3.29	2.65	09.65	14.00
SE(m)±	0.52	2.11	0.86	1.16	1.28	0.13	0.03	0.34	0.79
CD at 5 %	N.S.	6.32	2.53	3.44	3.78	0.38	0.10	1.00	2.34

There was no significant variation in respect of initial plant population at 20 DAP however, it was significantly affected during subsequent growth period. The significant reduction in plant population upto stage of harvest was observed in all the treatments but maximum reduction was found in the treatment control (No wedding). This might be due to overcrowding of weeds. Similarly, comparable plant population was reduced in the treatments oxyfluorfen pre emergence @ 0.2 kg ha^{-1} to Oxy-post-em @ 0.05 kg ha^{-1} + 2 HW which might be due to the phytotoxic effect of Oxyfluorfen application. The results are in the conformity with the findings of Magyar (1985) in onion. The effect of different weed control treatments on height of garlic plant was found to be significant at all the stages of observation except 30 and 60 DAP. At 90 and 120 DAP, an integrated treatment Pendi-pre-em @0.5 kg ha^{-1} + 2 HW produced maximum plant height (62.63 and 68.79 cm respectively). An increase in height of plant in all the herbicidal treatments including cultural treatments might be due to minimum weed competition led to favoured maximum utilization of light and nutrients by crop and thereby more metabolic activities resulted into maximum height of garlic. Similar results were also reported by Singh *et al*. (2002) and Warade (2004) in garlic and onion respectively.

The minimum days required for maturity (155.00) were observed in the treatment Pendi-pre-em @ 0.5 kg ha^{-1} + 2 HW which was at par with the treatments three hand weeding at 20, 40 and 60 DAP (155.66), Pendi-pre-em @ 0.75 kg ha^{-1} + 1 HW (156.33), Oxy-pre-em @ 0.1 kg ha^{-1} + 2 HW (156.66), Pendi-pre-em @ 1 kg ha^{-1} (157.00), Oxy-pre-em @ 0.2 kg ha^{-1} (157.33), Oxy-post-em @ 0.05 kg ha^{-1} t 2 HW (157.33) and Oxy-pre-em @ 0.15 kg ha^{-1} + 1 HW (157.66). The maximum days required for maturity (159.00) were recorded in the control treatment and was at par with the treatments Oxy-post-em @ 0.1 kg ha^{-1} (158.66) and Oxy-post-em @0.075 kg ha^{-1} + 1 HW (158.00). Similar results were recorded by Muhammod *et al*. (2001) and Warade (2004) in garlic and onion respectively.

The data presented in Table 1, revealed that the maximum diameter (3.89 cm) and length

Table 2. Economics of weed control in garlic.

Treatments	Total expenditure (Rs.)	Yield (q ha^{-1})	Gross return (Rs.)	Net return (Rs.)	B:C ratio
Pendimethalin (1 kg ha^{-1}, pre-em)	70387	94.66	1893,20	118933	2.68
Pendimethalin (0.75 kg ha^{-1}, pre-em) + 1 HD at 45 DAP	73520	102.66	205320	131800	2.79
Pendimethalin (0.5 kg ha^{-1}, pre-em) + 2 HD at 30 and 60 DAP	76148	113.66	227320	151172	2.98
Oxyfluorfen (0.2 kg ha^{-1}, per-em)	70316	91.00	182000	111684	2.58
Oxyfluorfen (0.15 kg ha^{-1}, per-em) + 1 HD at 45 DAP	74115	95.33	190660	116545	2:57
Oxyfluorfen (0.1 kg ha^{-1}, per-em) + 2 HD at 30 and 60 DAP	76625	109.00	218000	141375	2.84
Oxyfluorfen (0.1 kg ha^{-1}, post-em)	69425	56.33	172660	103235	2.48
Oxyfluorfen (0.075 kg ha^{-1}, post-em) + 1 HD at 45 DAP	75250	56.00	172000	96750	2.28
Oxyfluorfen (0.05 kg ha^{-1}, post-em) + 2 HD at 30 and 60 DAP	79300	104.00	208000	129700	2.65
Hand weeding at 20, 40 and 60 DAP	79300	97.66	195320	116020	2.46
Control (no weeding)	68500	62.00	12400	55500	1.81

FYM - Rs. 750 ton^{-1}, Pendimethalin - Rs. 504 $liter^{-1}$, Nitrogen - Rs. 11 kg^{-1}, Oxyfluorfen - Rs. 189 100^{-1} ml, $P_2 0_5$ - Rs. 25 kg^{-1}, Labour cost - Male - Rs. 80/- day^{-1}, Female - Rs. 60/- day^{-1}, Common expenditure - Rs. 68520/-

(3.32 cm) of bulb produced by the treatment Pendi-pre-em @ 0.5 kg ha^{-1} + 2 HW followed by the treatment Oxy-pre-em @ 0.1 kg ha^{-1} + 2 HW, which recorded the diameter 3.84 cm and length of 3.11 cm respectively. The maximum diameter and length of garlic bulbs recorded in these treatments might be due to maximum growth achieved due to least weed competition during bulb development stage. Similar results under the treatment Pendimethalin along with hand weeding for increasing diameter and length of bulbs were reported by Singh and Singh (1993), Ved Prakash *et al*. (2000) and Warade (2004) in onion.

An integrated treatment Pendi-pre-em @ 0.5 kg ha^{-1} + 2 HW recorded significantly the maximum weight of bulbs (15.59 g) and it was at par with the treatment Oxy-pre-em @ 0.1 kg ha^{-1} + 2 HW (15.26 g) (No weeding). This mainly due to the lowest weed population throughout the critical crop growth period reducing the competition and the hand weeding loosen the soil and promotes proper environment for development of bulbs thus resulted into maximum weight of garlic bulbs. However, significantly lowest weight of bulbs (9.65 g) was noted with control. Similar finding by using Pendimethalin plus hand weeding were reported by Singh and Singh (1993) and Ahmed and Khanded (1991). Increasing weight of bulbs due to oxyfluorfen plus hand weeding was also reported by Tewari *et al*. (1999) and Shekar *et al*. (2002). An application of Pendi-pre-em @ 0.5 kg ha^{-1} + 2 HW recorded maximum number of cloves per bulb (18.43) which was at par with the treatment Oxy-pre-em @ 0.1 kg ha^{-1} + 2 HW (18.12), Oxy-post-em @ 0.05 kg ha^{-1} + 2 HW (17.91) and Pendi-pre-em @ 0.75 kg ha^{-1} + 1 HW (17.80). This might be due to higher size and weight of bulb obtained in these treatment ultimately produced maximum number of cloves per bulb. However, minimum number of cloves per bulbs (14.00) was recorded in control treatment. Similar results were reported by Ahmed and Khanded (1991) and Singh *et al*. (2002) in garlic.

The data indicated that an integrated treatment Pendi-Pre-em + 2 HW recorded significantly the highest hectare-1 yield of bulbs (113.66 q) which was followed by the treatment Oxy-Pre-em + 2 HW (104.00 q) might be due to the better weed control, higher plant population and other characters *viz*., diameter and weight of bulbs which in turns resulted into the higher $hectare^{-1}$ yield of garlic bulbs, Superiority of Pendimethalin alongwith one or two hand weeding for increasing yield of garlic bulbs were reported by Pandey *et al.* (1991), Singh and Singh (1993), Tewari *et al*. (V999) and Warade *et al*. (2008). It also revealed that (Table 2) the treatment Pendi-pre-em @ 0.5 kg ha^{-1} + 2 HW proved to be most profitable over all other treatments in terms of net profit (Rs. 51172) and benefit-cost ration (2.98). The other treatments Oxy-pre-em @0.1 kg ha^{-1} + 2 HW and Pendi-pre-em @ 0.75 kg ha^{-1} + 1 HW were found to be most beneficial in terms of net profit (Rs. 141375 and Rs. 131800 respectively) and benefit cost ratio (2.84 and 2.79), respectively.

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Tolerance of Sugarcane Cultivars in Sodic Soil

The salt affected soils have been grouped into two broad classes *viz*., saline and sodic soil. Soil degradation by salinization and/or sodiflcation is of major concern in arid and semiarid regions. Out of 14.62 m ha of salt affected soils in India 7.74 m ha is saline and 6.88 m ha is sodic in nature (Bhargawa and Kumar, 2004). In Maharashtra the most of the area of sugarcane crop comes under canal irrigation system in which majority of the farmers having tendency to give excess irrigation to sugarcane crop. This situation might have resulted into salinization and/or sodiflcation of soil. About 60 lakh hectares area under salinity and alkalinity falls in sugarcane growing tract. Saline soils contain excess neutral soluble salts, mainly chlorides and sulphates of sodium, calcium and magnesium in quantities sufficient to affect plant growth adversely. Sodic (alkali) soils are those salt affected soils, which are predominant salts capable of alkaline hydrolysis, *viz*., sodium carbonate, sodium bicarbonate and sodium silicate. The sodicity influence agricultural production due to deterioration of physical conditions, moisture relation and excess sodium which lead to high pH and nutritional disorder. These factors are responsible for reduction in yield of sugarcane crop. As such yield reduction in sodic soil can be minimized through selection of sodicity tolerant cultivars of sugarcane crops. Keeping such aspects in mind the present investigation was under taken to study the tolerance of different sugarcane cultivars along with high yielding recently released sugarcane cultivar CoM 0265 (Phule 265) in sodic soils.

A field experiment was conducted during 2007-08, 2008-09, and 2009-10 for seasonal sugarcane on sodic soils at Central Sugarcane

Research Station, Padegaon (M.S.) in randomized block design, with five treatments (cultivars) and four replications. The sugarcane planting and harvesting were done in three successive crops in three years. The recommended cultivation practices were followed as setts of sugarcane were planted at one side and 15 cm above from the bottom of furrow which is adopted for problematic soils.

Soil samples before planting and after harvest of each crop were collected and used for determination of available N,P and K with other chemical properties using standard procedures. Soil samples were analyzed for pH and EC from saturation paste extract, organic carbon were estimated as per Nelson and Sommers (1982), available N by alkaline permanganate method (Subbiah and Asija, 1956), available P as per method Olsen *et al*. (1954) and available K determined by flame photo metrically as described by Knudeson *et al*. (1982). Plant samples were analyzed for total nutrient uptake as per method given by Parkinson and Alien (1975). Cane juice quality was determined by using procedure outlined by Spencer and Meade (1964) and commercial cane sugar (CCS) was calculated. The data obtained on chemical properties of soil, uptake of nutrient, juice quality and yield of sugarcane were analyzed statistically by using procedure laid down by Panse and Sukhatme (1978).

The cultivar CoM 0265 recorded significantly higher cane yield (111.4 t ha^{-1}) which was on par with Co 62175 (94.32 t

Table 1. Yield parameters and economics of sugarcane cultivars grown in sodic soils (Mean of three years).

Treatment	Yield (t ha^{-1})	CCS (t ha^{-1})	ACW (kg)	NMC (000 ha^{-1})	CCS %	Monetary returns (Rs. ha^{-1})	Net profit (Rs. ha^{-1})	B:C ratio
Co 86032	83.15	11.72	1.60	45.39	14.21	114827	16744	1.28
Co 94012	69.06	9.89	1.25	53.00	14.34	99095	2210	1.10
CoM 0265	111.36	15.54	1.93	54.81	13.97	156436	59552	1.62
Co 62175	94.32	11.87	1.62	54.38	12.61	131622	34737	1.38
CoC 671	58.64	8.63	1.07	52.44	14.72	85733	11152	1.00
SE(m)±	5.68	0.75	0.073	0.72	0.06	5.67	-	-
CD 5%	18.55	2.45	0.24	1.45	0.20	18.52	-	-

Table 2. Soil chemical properties (Mean of three years).

Treatment	pH	EC (dSm^{-1})	OC (%)	Avail. Nutrients in soil (kg ha^{-1})			Nutrient uptake					
							kg ha^{-1}			kg t^{-1}		
				N	P	K	N	P	K	N	P	K
Co 86032	9.33	0.97	0.30	133	09.73	142.0	219	30.7	293	2.63	0.37	3.52
Co 94012	9.35	1.00	0.30	143	11.76	146.7	166	24.7	213	2.40	0.36	3.08
CoM 0265	9.33	0.85	0.40	176	15.34	150.7	300	37.7	354	2.69	2.69	3.18
Co 62175	9.35	0.81	0.36	163	15.49	150.7	277	24.3	309	2.93	2.94	3.28
CoC 671	9.37	1.02	0.28	134	09.43	145.3	148	25.0	159	2.52	2.52	2.71
SE(m)±	0.0084	0.0798	0.018	0.054	1.36	6.65	6.33	3.49	10.9	-	-	-
CD 5%	0.0275	NS	0.059	0.18	4.46	NS	20.69	NS	34.9	-	-	-
Initial	9.39	0.97	0.24	134.7	14.3	171.7						

CCS : Commercial Cane Sugar, ACW : Average Cane Weight and NMC: Number of Millable Canes.

ha^{-1}). Similar type of trend was also observed in case of number of millable canes $hectare^{-1}$. Whereas in case of commercial cane sugar (CCS) yield and average cane weight cultivar CoM 0265 were recorded 15.54 t ha^{-1} and 1.93 kg respectively which were found significantly superior over all the varieties. Further, Co 62175 showed significantly lower CCS yield (11.87 t ha^{-1}) and CCS per cent (12.61) than all cultivars. However, the cultivars CoC 671(14.72 %), Co 94012 (14.34%) and Co 86032 (14.21%) were statistically equal and higher than the other cultivars (Table 1). Vijay Kumar *et al*., (1999) also showed the cane yield as well as yield attributing characters decreased significantly with increase in RSC of irrigation water (sodic) to 6.5 and 12.0 me L^{-1} (35 and 51% decline in average cane yield for plant crop and for ratoon crop the corresponding decrease in average cane yield was less than the plant crop (only 14 and 21%). These results are also in agreement with findings of Choundhary *et al*. (2004). Considering the observations of three years, it was observed that the cultivar CoM 0265 recorded significantly higher cane and CCS yields and it was superior over all the cultivars. Results, indicated that the CoM 0265 (Phule 265) was found to be better in sodic soil for getting higher cane and CCS yields. The highest cane yield by CoM 0265 was associated with the genetical ability of this cultivar to produce higher number of millable canes and average cane weight as compared to other cultivars. Similar type of observations were also recorded by Singh *et al*. (2003). Kadlag *et al*. (2011) also observed that the sugarcane varieties *viz*., Co 86032 and CoM 9516 recorded the highest cane and CCS yield than the variety Co 8014.

The soil pH, organic carbon, Avail. N and P (Table 2) were significantly influenced due to different cultivars grown in sodic soils, however, the B.C. and available K were not influenced significantly. The significantly higher available N and P was noticed in soil at harvest where the CoM 0265 was grown indicating that this cultivar survives better in sodic soil with improvement in soil fertility. Kadlag *et al*., (2011) observed the better performance of Co 86032 in saline sodic soil having pH 8.7 and electrical conductivity 4.2 dSm^{-1}. While the sugarcane varieties namely CoSe 93232,CoS 97264 and CoSe 95422 were found suitable for growing under sodic soil having 20 ESP (Tiwari *et al*., 2006).

The cultivar CoM 0265 recorded significantly higher N and K uptake than the other cultivars which might be because of better availability of NPK nutrients in soil. he genetical potentials reflected in increased uptake of N and K thereby resulted into increasing the average cane weight and cane yield per hectare. Similar type of observations were also reported by Kadlag *et al*. (2011).

The comparatively maximum CCS per cent (sugar recovery) was observed in CoC 671 followed by Co 94012,Co 86032 and CoM 0265 in periodical analysis from 10^{th}, 11^{th} and 12^{th} month interval. The least sugar recovery was observed in Co 62175 in all the period.

The CoM 0265 recorded higher monetary returns (Rs. 1,56,436 ha^{-1}), net profit (Rs. 59,552 ha^{-1}) and B:C ratio (1.62) than the other cultivars. Considering higher yields of cane and commercial cane sugar with maximum monetary returns, the cultivar CoM 0265 showed better performance in sodic soil as compare to other cultivars.

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An Assessment of Adoption Pattern of IPM Technologies by Farmers in Chickpea

Gram pod borer, *Helicoverpa armigera* (Hubner) is the most serious insect pest causing substantial yield losses to the large number of crops. It has emerged as one of the most difficult insect pests in the history of pest management. The management tools available for combating this pest have so far been less effective.

Productivity of pulse is low because some farmers not follow proper recommended packages of practice. Hence, it is necessary to know the adoption pattern of recommended practices which was followed by farmers with a view to plan for IPM technology dissemination amongst the farmers. Present study was therefore, undertaken with the objective, to assess the adoption pattern on integrated pest management (IPM) technologies in chickpea by the chickpea growing farmers.

An extensive survey was carried out regarding adoption and non adoption of IPM technology by farmers in chickpea during 2010- 2011. Four villages were selected from Rahuri tahsil of Ahmednagar district in

Table 1. Adoption and non adoption of IPM technologies by farmers in chickpea (Based on 61 of farmers).

IPM component	Adoption of technology		Non-adoption of technology	
	No. of farmers (N=61)	Adoption (%)	No. of farmers (N=61)	Adoption (%)
Lack of technical knowledge	42	69	19	31
Proper suggestion regarding plant protection by input centre	39	64	22	36
Wanting of quick result	52	85	9	15
Knows the infestation after beyond control measures	49	80	12	20
Result of IPM is slow	16	26	45	74
Deep ploughing of soil	16	26	45	74
Pheromone kit available in market	15	26	46	75
HaNPV is available in market	12	20	49	80
NSE available in market	17	28	44	72
Unawareness of pests and diseases	26	43	35	57
Unawareness of cropping pattern	21	34	40	66
Self implementation without subsidy	21	34	40	66

Maharashtra. The information were collected from 61 farmers with the help of questionnaire made on 12 component of pest management and the data subjected to analysis on number of farmers and their percentage of adoption and non-adoption basis.

The information collected from chickpea growing farmers is presented in Table 1. Out of 12 IPM technologies, only 4 IPM technologies were adopted by the farmers more than 50 per cent. Out of 61 farmers, 52 farmers adopted IPM technology of wanting of quick result having 85 per cent followed by 80 per cent who knows the infestation after beyond control measures, lack of technical knowledge (69%) and proper suggestion regarding plant protection by input centre (64%).

Among the 12 IPM technology, 8 IPM technology were not adopted by more than 50 per cent chickpea growing farmers. It revealed that 74 per cent farmers do not get sufficient time for deep ploughing as they want to use residual moisture. It was noticed that 75, 80 and 72 per cent chickpea growers do not get pheromone kit, HaNPV and NSE from market, respectively. Fifty seven per cent chickpea growers were unaware of pest and diseases. Whereas 66 per cent chickpea growers were unknown about cropping pattern, 69 per cent chickpea growers don't have technical knowledge like role of trap crop, bird perches etc.

At the same time 64 per cent chickpea growers have got proper suggestion regarding plant protection from input centres like, State Agriculture Department, Zilha Parishad and Panchayat Sammittee. Eighty five per cent chickpea growers want quick result at the same time 74 per cent chickpea growers thought that IPM gave slow result. Eighty per cent chickpea growers have opinion that they know the pest infestation aftet beyond control measures. It was also observed that 66 per cent chickpea growers do not adopt IPM technology without subsidy. They depend on subsidy because with subsidy scheme they easily get technical knowledge. Earlier Alam, (2000) reported similar findings.

The findings of the study revealed that non adoption of IPM technology by chickpea growers were found to be the major constraints

to increase the adoption of IPM technology of the farmers which is very low. To improve this situation it is necessary to increase the participation of farmers in extension education programme.

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Aspiration of Post Graduate Girls Student of Marathwada Krishi Vidyapeeth

The present investigation was conducted in Marathwada Krishi Vidyapeeth, Parbhani during the year of 2011-12 to know the aspiration of the girls student toward the agriculture and to find out the relationship between personal characteristics of the girls student and their aspiration towards education. The information pertaining to the objectives of the study was collected from 100 Agricultural and other faculty post graduating girls student at College of Agriculture, Parbhani, College of Agriculture, Latur, College of Home Science, Parbhani, College of Food Technology Parbhani, College of Agricultural Engineering and Technology Parbhani, College of Agricultural Bio-technology, Latur, College of Agricultural Business Management, Latur and with a view to know the aspirations of the student.

It is observed that 32.06 per cent of the agricultural and other faculty post graduating girls student had aspired to start biofertilizer production, 26 per cent agricultural and other faculty post graduating girls student had aspired to start nursery, 24 per cent of the agricultural and other faculty post graduating girls student had aspired to start fruit processing unit, 21 per cent of the agricultural and other faculty post graduating girls student had aspired to start vermicompost, 14 per cent of the agricultural and other faculty post graduating girls student had to aspired to start dairy, 11 per cent of the agricultural and other faculty post graduating girls student had aspired to start sericulture unit, 10 per cent of agricultural and other faculty post graduating girls student had aspire to start agro-service centre, 9 per cent agricultural and other faculty post graduating girls student had aspired to become dealer of agricultural input, 9 per cent of the agricultural and other faculty post graduating girls student had to aspired to start mushroom production, 7.8 of the aericultural and other faculty post graduating girls student has aspired to start own poultry enterprise.

The 19 per cent of agricultural and other faculty post graduating girls students had aspired for farming of irrigated orchards crops. 9 per cent of the agricultural and other faculty post graduating girls student had aspired for farming rain fed/dry land horticultural crops. 8 per cent of the agricultural and other faculty

post graduating girls student had aspired to grow field crops.

Further 27 per cent of the agricultural and other faculty post graduating girls student had aspired to start the marketing services. 12 per cent of the agricultural and other faculty post graduating girls student had aspired to start horticultural-services, 6 per cent of the agricultural and other faculty post graduating girls student had aspired to start the consultancy service of land scaping and 5 per cent of the agricultural and other faculty post graduating girls student had aspired to start the pest control services.

Overall level of aspiration of girls students toward the business was higher in bio-fertilizer production that is (32%) of the Agricultural and other faculty post graduating girls students had to start bio-fertilizer production.

Aspiration towards the farming higher in irrigated orchards that is 19 per cent of agriculture other girls had aspired the faming of irrigated orchards crops overall level of aspiration of girls student towards consultancy service higher in horticulture that i.e. 12 per cent agricultural and other faculty post graduating girls student had aspired to horticulture.

As regards overall aspiration, it was observed that majority (84%) of the Agricultural post graduating girls student had medium level of aspirations, while 10 per cent of Agricultural post graduating girls student had high level of aspiration and 6 per cent of Agricultural and other faculty post graduating girls student had low level of aspirations, respectively.

It is observed from the Table 1 that, family income, social participation, family type, parents occupations, academic performance, scholarship were positively and significantly related with the aspirations of the agricultural post graduating girls student. Family income and academic performance of the student highly influence their aspiration and family income is high then the student get more facilities from parent, which leads to increase level of aspiration and academic performance of the student as they highly influence the aspiration. If the student had good academic performance his thinking will be positive and which may be lead to higher aspiration. Similar results were also reported by Iswalkar (2001), Jondhale and Wattamwar (2004), More (2004) and Hande (2009).

It is concluded that majority of the agricultural and other faculty post graduating girls student had aspired to start biofertilizer production, nursery, fruit processing unit, vermicompost, dairy, sericulture, agro-service, aspired to become dealer of agricultural input, mushroom production and own poultry.

From the above findings it is noteworthy that majority of the agricultural and other faculty post graduating girls student were interested to develop their own business, specially biofcrtilizer production, followed by nursery. Chole and Fatak (2007) also reported empowerment of rural women in agro based enterprises.

Table 1. Correlation between personal and socio-economic characteristics of the respondents and their aspirations (N = 100).

Characteristics	'r' values
Family income	0.763**
Social participation	0.492**
Family type	0.552**
Land holding	0.075
Family size	0.135
Family background	0.149
Parents occupation	0.208**
Academic performance	0.659**
Scholarship	0.204**

** Significant at 0.01 level of probability.

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Correlation and Path Coefficient Analysis in Rice (*Oryza sativa* L.) Under Shadenet Condition

The association of yield components with yield forms a pre-requisite for making selection effective, when two or more characters are simultaneously considered in selection programme. Character association is of great significance to breeders, when they have to exercise selection for simultaneous improvement of more than one character. However, correlation alone does not provide the information on the contribution of related character which necessitates the study of cause and effect relationship of different characters among themselves. The path analysis depicts the exact relationship of characters and there by providing more information than correlation.

The experiment was conducted at the farm of Department of Agricultural Botany, College of Agriculture Dapoli, Dist. Ratnagiri, Maharashtra state during *kharif*, 2007. The soil of the experimental site was laterite type and well drained with acidic reaction (pH 5.6). The experiment comprised of sixteen varieties of rice laid out in a randomized block design with three replications in artificial shading. The plots were artificially shaded by using 50 per cent shade net, such that 50-60 per cent of natural light was only received by the crop canopy. The experimental material for the present investigation comprised twelve varieties and four hybrids of rice. Ten plants were selected randomly from each variety in each replication in shade and open condition for recording observations.

At phenotypic level grain yield plant^{-1} indicated positive and highly significant positive correlation with dry matter plant^{-1} (0.702), 1000-grain weight (0.617), plant height (0.608) and panicle length (0.396). Grain yield plant^{-1} also showed positive but non-significant correlation with number of filled spikelets panicle^{-1} (0.187), tillers plant^{-1} (0.154), number of spikelets panicle^{-1} (0.103), fertile tillers plant^{-1} (0.100), days to maturity (0.0784), days to 50 per cent flowering (0.037). Days to 50 per cent flowering had

positive and highly significant correlation with days to maturity (0.854) and also positively significant correlation was noticed with plant height (0.296) and number of tilled spikeiets panicle^{-1} (0.293). Days to maturity had positive and significant correlation with plant height (0.315). Number of tillers plant^{-1} showed positive and highly significant correlation with number of fertile tillers plant^{-1} (0.931). Number of fertile tillers plant^{-1} showed positive but non-significant correlation with dry matter plant^{-1} (0.025), panicle length (0.017). Number of spikelets panicle^{-1} had positively and highly significant correlation with number of filled spikelets panicle^{-1} (0.912) and panicle length (0.384). Number of filled spikelets panicle^{-1} had positive and significant correlation with panicle length (0.311), dry matter (0.311), plant height (0.348). Panicle length had positive and highly significant correlation with plant height (0.621), 1000-grain weight (0.530), dry matter plant (0.439). Plant height had positively and highly-significant correlation with dry matter plant^{-1} (0.815) and 1000-grain weight (0.603). 1000-grain weight had positively and highly significant correlation with dry matte plant^{-1} (0.506).

At genotypic level, grain yield plant^{-1} showed positive and highly significant correlation with dry matter plant^{-1} (0.848), 1000-grain weight (0.792), plant height (0.686), panicle length (0.599). While positive significant correlation was found with number of tillers plant^{-1} (0.307). It also showed positive but non-significant correlation with number of filled spikelets panicle^{-1} (0.200), number of fertile tillers plant^{-1} (0.136), days to maturity (0.103), number of spikelets panicle^{-1} (0.059) and days to 50 per cent flowering (0.041). Days to 50 per cent flowering had positive and highly significant correlation with days to maturity (0.861) and dry matter plant^{-1} (0.409), also positive significant correlation was noticed with plant height (0.399) and number of filled spikelets panicle^{-1} (0.348). Days to maturity had positive and highly significant correlation with plant height (0.359), number of filled spikelets panicle^{-1} (0.340) and dry matter plant^{-1} (0.367). Number of tillers plant^{-1} showed positive and highly significant correlation with number of fertile tillers plant^{-1} (1.018). Number of fertile tillers plant^{-1} showed positive but non-significant association with panicle length (0.042). Number of spikelets panicle^{-1} had positive and highly significant correlation with number of filled spikelets panicle^{-1} (0.978) and panicle length (0.471). Number of filled spikelets panicle^{-1} had positive and highly significant correlation with panicle length (0.445), plant height (0.440) and dry matter (0.473). Panicle length had positive and highly significant correlation with plant height (0.812). 1000-grain weight (0.585) and dry matter plant^{-1} (0.744). Plant height had positive and highly significant correlation with 1000-grain weight (0.674) and dry matter plant^{-1} (0:912). 1000-grain weight had positive and highly significant correlation with dry matter plant^{-1} (0.659).

In the present study, days to maturity, number of fertile tillers plant^{-1}, number of spikelets panicle^{-1}, number of filled spikelets panicle^{-1}, 1000-grain weight, dry matter plant^{-1} had positive effect at phenotypic level and days to 50 per cent flowering, number of fertile tillers plant^{-1}, number of filled spikelets panicle^{-1}, panicle length and dry matter plant^{-1} at genotypic level under shade net condition. The positive effect of days to 50 per cent flowering, number of fertile tillers plant^{-1} with grain yield plant^{-1} also reported by Yogameenakshi *et al*. (2004). The direct positive effect of number of filled spikelets panicle^{-1} and 1000-grain weight with yield plant^{-1} at genotypic and phenotypic level reported by Shivani and Sree Rama Reddy

(2000). Days to 50 per cent flowering had negative direct effect on grain yield at phenotypic level, while it had positive direct effect at genotypic level. While it's indirect effect through number ol tillers plant^{-1}, number of tilled spikelets panicle^{-1}, dry matter plant^{-1} was positive at phenotypic and genotypic level under number of spikelets panicle^{-1} was positive at phenotypic and negative at genotypic level under shade condition. These results were in conformity with the results reported by Krishna Naik (2005).

Number of tillers plant^{-1} had negative direct effect at both the levels on grain yield while its indirect effect via number of fertile tillers plant^{-1}, number of spikelets panicle^{-1}, plant height, dry matter plant^{-1} was positive at phenotypic and genotypic level under shade condition. Positive indirect effect through plant height, straw yield also reported by Chitra *et al*. (2005) with positive direct effect. Number of fertile tillers plant^{-1} had positive direct effect on grain yield while its indirect effect through the character plant height was positive at both phases and days to 50 per cent flowering, dry matter plant^{-1} in genotypic level and days to maturity, number of spikelets panicle^{-1}, panicle length, 1000-grain weight at phenotypic level. Positive direct effect of number of fertile tillers plant^{-1} with positive indirect effect via panicle length also reported by Yogameenakshi *et al*. (2004).

Number of spikelets panicle^{-1} had positive direct effect on grain yield at phenotypic level and it had negative direct effect at genotypic level. Its indirect effect via number of tillers plant^{-1}, number of filled spikelets panicle^{-1}, dry matter plant^{-1} was positive at both phenotypic level and negative at genotypic level under shade condition. Negative direct effect at both phenotypic and genotypic level recorded by Shivani and Sree Rama Reddy (2000). Panicle length had negative direct effect on grain yield at phenotypic level and positive direct effect at genotypic level, while its indirect effect via fertile tillers plant^{-1}, number of filled spikelets plant^{-1} and dry matter plant^{-1} at phenotypic level and at genotypic level were positive under shade condition. Direct positive effect through panicle length and indirect negative effect via days to 50 per cent flowering also reported by Chitra *et al*. (2005). Plant height had negative direct effect while indirect effect via number of tillers plant^{-1} and number of filled spikelets panicle, dry matter plant^{-1} was posivite at both genotypic and phenotypic level. Dry matter plant^{-1} had positive direct effect on grain yield plant^{-1} at both phenotypic and genotypic level. Its indirect effect via days to 50 per cent flowering, days to maturity, number of fertile tillers plant^{-1}, number of spikelets panicle^{-1}, 1000 grain weight was positive at both phenotypic level and negative at genotypic level under shade condition. Similar result with positive direct effect of dry matter production plant^{-1} on grain yield plant^{-1} at both phenotypic and genotypic levels also reported by Shivani and Sree Rama Reddy (2000.)

The correlation study revealed that dry matter plant^{-1}, one thousand grain weight, plant height, panicle length showed highly significant positive correlation with grain yield. It indicated that tall genotypes having more panicle length along with high 1000 grain weight and dry matter may contribute to higher yield plant^{-1} under shade condition. The grain yield showed positive and significant correlation with 50 per cejnt flowering, days to maturity, number of tillers plant^{-1}, number of fertile tillers plant^{-1}, number of spikelets panicle^{-1}, number of filled spikelets panicle^{-1}. It is to be stated that the varieties having low reduction or higher per cent increase under shade condition over open in the yield and yield contributing character are suitable for shady conditions or under agro-forestry system. Variety Karjat-3 showed increased in yield in shade condition while

lower reduction showed by Karjat-5. Karjat-5, Karjat-3 and Sahyadri showed better yield performance while varieties Sahyadri-3, Karjat-3, Karjat-5, and Palghar-1 showed better overall performance under shade condition.

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Effect of Storage Conditions on Quality and Shelf Life of Kokum (*Garcinia indica* Choisy) Fruit

Kokum (*Garcinia indica* Choisy) belongs to the genus Garcinia, which is large genus of polygamous evergreen trees and shrubs native of Asia, Southern Africa and Polynesia (Anthony, 1997). The scientific name Garcinia is derived from Garcias, who described it in 1974 (Subash Chandran, 1996). The genus belongs to a botanical family clusiaceae, which consists of tropical trees, lianes (vines) and herbs.

The experiment was conducted in a factorial randomised design with three replications. The treatments included were T_1 - Ambient storage, T_2 - Ambient temperature + Fruits packed in perforated polythene packaging, T_3 - Ambient storage + Waxol 12 per cent, T_4 - Cool chamber, T_5 - Cool chamber + Fruits packed in perforated polythene packaging, T_6 - Cool chamber + Waxol 12 per cent, T_7 - Cold storage (13 ± °C and 86% R. H.), T_8 - Cold storage + Fruits packed in perforated polythene packaging and T_9 - Cold storage + Waxol 12 per cent. The observations on daily temperature and humidity were recorded at all storage conditions, physiological loss in weight and chemical changes in weight. The number of fruits shriveled and spoiled due to disease incidence and extent of PLW and spoilage up to 15 per cent at 2 days interval were observed.

The moisture content (Table 1) decreased under all the storage treatments through respiration and the transpiration. Similar findings were also reported by Shinde and Raut (1999) in sapota. The moisture content showed non-significant variation within the treatments. The moisture content of the kokum fruits was lower (less loss as compared to the original value of the fruit) at various treatments of cold storage than at ambient temperature. This

could be owing to the lower temperature and the high humidity at both the cool and cold storage, as compared to ambient temperature. The observations are in line with the findings reported by Naik (1985) at cool chamber and Joshi (1994) at cold storage of Alphonso mango fruit and Raut (1999) in sapota.

The storage treatments differed significantly with respect to moisture content of the kokum fruits. The higher moisture content in kokum fruits stored at T_9 treatment closely followed by T_8 and T_7 treatments of cold storage could be attributed to low temperature and high humidity at cold storage which could have been responsible for lower rate of respiration and the transpiration leading to higher retention of the moisture. Similar observations were also reported by Joshi (1994) and Raut (1999) in mango and sapota fruits respectively at cold storage.

The kokum fruits stored at ambient temperature (T_1) exhibited significantly maximum T.S.S. (14.17°B) followed by cool chamber (1405°B) (T_4) and cold storage (13.61°B) (T_7). The significantly maximum (12.08°B) T.S.S. was observed in treatment T_2 which was at par with the treatment T_3, T_5, T_6, T_8 and T_9. The maximum T.S.S. content of the kokum fruits at ambient temperature conditions might be due to the favourable temperature and the humidity levels leading to the maximum hydrolysis of the starch into sugars. The observations also confirmed to the findings reported by Shinde (1993) and Raut (1999) in sapota. Moreover, the perforated polythene wrapping, waxol and the lower temperature at cool and cold storage might have slightly hindered the process of hydrolysis of starch into sugars. These observations are in accordance with the reports of Gole (1986) in mango and Joshi (1994) in kokum fruits.

The titrable acidity of the kokum fruit was found to decline continuously upto the end of shelf life, irrespective of storage treatments and the years of study. The observations in accordance with these findings were also reported by Raut (1999) in sapota and Mali (1999) in papaya. The acidity of the kokum fruits stored in the cold storage (T_7, T_8 and T_9) were maximum, as compared to their storage in ambient temperature. This could be attributed to the low temperature and the high humidity, which could have been responsible for reduction in the rate of respiration leading to less utilization and degradation of organic

Table 1. Chemical changes after storage in kokum (*Garcinia indica* Choisy) fruits stored at different storage.

Treatments	Moisture (%)	Total soluble solids (°B)	Acidity (%)	Asorbic acid (mg 100^{-1} g)	Reducing sugar (%)	Total sugar (%)
T_1	77.51	14.17	3.18	2.86	6.53	14.23
T_2	77.86	12.08	3.20	3.21	6.25	14.02
T_3	78.91	12.30	3.34	3.73	6.13	14.62
T_4	78.44	14.05	3.45	3.97	4.38	14.09
T_5	78.90	13.38	3.43	4.19	4.87	13.18
T_6	79.24	12.20	3.53	4.78	4.48	13.58
T_7	79.68	13.61	3.38	4.87	4.60	14.05
T_8	80.60	12.95	3.30	4.92	4.75	14.50
T_9	80.44	12.86	3.35	5.34	4.42	14.05
Before storage	81.41	13.11	3.50	12.43	5.22	12.42
S.E.±	0.62	0.347	0.362	0.036	0.293	0.272
C.D. at 5%	1.72	0.960	N.S.	0.101	0.810	N.S.

acids during storage. The identical observations were also reported by Joshi and Roy (1983) in mango.

The slower decrease in the acidity during cool and cold storage fruits wrapped in perforated polythene and the wax coated fruits, as compared to the ambient temperature could possibly due to low temperature and the high humidity prevalent at these conditions, which slowered down the rate of degradation of organic acids.

Ascorbic acid content of kokum fruits declined throughout the storage period, irrespective of storage conditions treatments and the years of study. The ascorbic acid content of the kokum fruits stored at T9 treatment was significantly maximum (5.94). The treatments T_7 and T_8 were found at par with each other. The treatments T_3 and T_4 were found at par with each other. The decline in ascorbic acid content at ambient temperature storage condition could possibly be due to its degradation during this period. The similar results were also reported by Mali (1999) in papaya and Raut (1999) in sapota. Treatment T_9 at cold storage accorded the best retention of ascorbic acid, followed by T_8 and T_7 treatments which appeared due to low temperature and high humidity prevalent at these conditions resulting in minimum degradation of ascorbic acid.

The content of reducing sugars and the total sugars was less at initial which increased during storage period, irrespective of storage treatments. The increase in sugar content appeared due to conversion of starch into sugars during storage. The sugars in kokum fruits did not show much variation, when stored at different storage conditions with different treatments. However, the cold storage conditions have shown better retention of the sugars and at the ambient temperature storage, sugars were maximum.

Faster the rate of conversion of starch into sugar more will be the hydrolysis of starch into sugar. The minimum reducing and the total sugar content were recorded in kokum fruits stored at T_9 treatment, followed by T_8 and T_7. This could be due to prevailing low temperature and high humidity lowering the rate of respiration and transpiration. The observations are in conformation with the reports of Mali (1999) in papaya, Sawant (2000) in jackfruit and Asagekar (2002) in pineapple.

Physiological loss in weight increased continuously till the end of storage period, irrespective of storage conditions due to loss of moisture from the fruits through respiration and the transpiration. T_9 treatment showed the minimum physiological loss in weight and maximum shelf life of kokum fruits than cool chamber and ambient temperature storage. The low temperature and high humidity prevalent in cold storage and the wax coating treatment might have brought about the reduction in PLW by reducing the moisture loss through decrease in respiration and transpiration rate. Gole (1986) reported similar observations in cold storage with Alphonso mango and Joshi (1994) with wax treated kokum fruits.

The shrivelling and the spoilage was found to be the fastest at ambient temperature. This could be due to the maximum temperature (28.30°C) and the minimum humidity (77%) at ambient temperature storage, which could have been at the optimum level for the fastest shrivelling. The accelerated rate of moisture loss must have been responsible for the shrivelling. The favourable temperature and the humidity at ambient temperature storage might have also been responsible for the rotting of ripe kokum fruits resulting into low shelf life.

The fruits stored at treatment T_9 showed the slowest rate of shrivelling and the spoilage. This

could be due to the minimum biosynthesis of ethylene because of low temperature and the wax layer resulting into slowest rate of ripening of the kokum fruits. The spoilage of kokum fruits was the minimum at cold storage and in wax layered fruits. Similar observations were also reported by Shinde (1993) and Raut (1999) in sapota and Joshi (1994) in kokum.

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Knowledge Level of Farm Women Engaged in Floriculture

The area under floriculture increased from 53,000 ha in the year 1993-94 to 1,61,000 ha during 2007-08, which is more than 300 per cent increase in the span of 15 years. Tamil Nadu, Karnataka, Andhra Pradesh, West Bengal and Maharashtra states account for about 71 per cent area under flowers in the country. Keeping in view the facts, an attempt had been made to study the role performance of farm women engaged in floriculture.

The present study was planned to analyze role performance of farm women engaged in floriculture in Patur tahsil of Akola district. Initially a detail village wise list of women farmers was obtained from the Taluka Agriculture Office, Deptt. of Agriculture, Patur and it was confirmed with Extension Officer (Agri.) in Patur Panchayat Samiti. As per the list, cultivation of flower crops was mostly undertaken in 10 villages namely, Shirla, Deulgaon, Khanapur, Babulgaon, Agikhed, Asola, Jamb, Alegaon, Karla and Patur. An exploratory research design of social research was used for present investigation.

It was seen from the above villages that marigold (*Tagetes* species) and Rose (*Rosa indica*), were the major flower crops grown on large area in selected villages and hence these two crops were selected for the study as major flower crops. Thus, 10 farm women from each selected village were drawn by adopting proportionate random sampling method. In all, 100 farm women constituted the sample for the present study. The total score of knowledge test was utilized for computation of knowledge index of an individual respondent by adopting formula Knowledge index = Sum of knowledge scores obtained by respondent for all items / Sum of obtainable knowledge scores for all items x 100.

The 42 per cent of marigold growers (Table 1) were found in category of medium level of knowledge about improved cultivation practices of marigold followed by 34 per cent respondents who were in high category of knowledge level. Less than one forth (24.00%) of the respondents had low knowledge level.

Exactly one-half of the respondents had medium level of knowledge about improved cultivation practices of rose. One-third (30.00%) and One-fifth (20.00%) of rose growers had high and low knowledge level respectively about rose cultivation practices.

This indicated that the floriculturists had medium to high knowledge level. The similar trend ofknowledge level was observed in marigold as well as rose floriculturists. The present finding are supported by Pathak (1992), Pandya and Vekaria (1994).

High proportion of respondents were found to have knowledge about soil type (96.00%), preparatory tillage (94.00%), preparation of beds for nursery (92.00%), time for sowing seeds on beds (94.00%), FYM application on beds (96.00%), method of transplanting (92.00%), irrigation management (96.00%) and weeding/hoeing (92.00%).

Thus, it may be inferred that majority of marigold growers in study area had knowledge about major improved practices for cultivation of marigold crop except few practices namely seed rate, fertilizer dose for top dressing, control measures for diseases and grading and packaging practices of flowers for proper marketing. The present findings are supported by Sadanshiv (2006) and Goyal and Solanki (2007).

Majority of the rose floriculturists had

Table 1. Distribution of the respondents according to their overall knowledge.

Sr. No.	Knowledge level	Frequency (n=50)	Per-centage
A	**Marigold**		
1	Low (Upto 33.33)	12	24.00
2	Medium (33.34 to 66.66)	21	42.00
3	High (Above 66.66)	17	34.00
	Total	50	100.00
B	**Rose**		
1	Low (Upto 33.33)	10	20.00
2	Medium (33.34 to 66.66)	25	50.00
3	High (Above 66.66)	15	30.00
	Total	50	100.00

knowledge about preparatory tillage (96.00%), soil type (94.00%), depth of planting (94.00%) and preparation of rose beds in November and December at budding stage (92.00%). Regarding plant protection 84 per cent of the rose floriculturists had knowledge about diseases and use of chlorpyriphos (0.1%) and malathion and systematic fungicides (80%). Majority of the rose growers had knowledge about irrigation management and irrigation schedule (82%), FYM application (84%) and different varieties of rose (80%) followed by manuring and fertilizers (72%), top dressing of fertilizers (68%) and planting distance (70%) and season of planting (68%). Half of the respondents had knowledge about grading of flowers and only one tenth of respondents had knowledge about packaging of flowers as cut flowers. This indicates that there is a scope to provide technical know how about marketing of flowers through scientific extension functionaries to the floriculturists farmers growing rose crop. Pathak (1992) and Adharpur (1989) supported the above findings.

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Yield, Economics and Energetics of Soybean as Influenced by Integrated Nutrient Management and Genotypes

Among the yield contributing factors of soybean, nutrient management have been pivotal since the nutrient turnover in soil - plant system is considerably high under intensive cropping, Neither the chemical fertilizer nor the organic/ biological sources alone can achieve production sustainability. Thus, for sustainable soil fertility and productivity of soybean, it becomes imperative to adopt the strategies which are of low cost, eco-friendly, high viable and efficient in managing the crop production with no adverse effect on the environment. Therefore, the integrated nutrient management (INM) now -a- days is the only concept which needs to be adopted in agriculture. Similarly, crop genotypes may very in their ability to produce economic yield in a given set of agro - climatic condition. Considering the above facts the present study was under taken.

A field experiment on soybean was conducted at instructional cum research farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) under rainfed condition during *kharif*

Table 1. Yield, economics and energetic values of soybean as influenced by integrated nutrient management and genotypes.

Treatment	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Total cost (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	Benefit: cost ratio	Energy input (MJ x 10^{-3} ha^{-1})	Energy output (MJ x 10^{-3} ha^{-1})			Energy output: input ratio	Energy efficiency (MJ x 10^{-3} ha^{-1})	
								Seed	Stover	Total		Seed	Stover
Nutritional schedule :													
75% of RDF	12.68	18.19	11244	26280	15036	1.33	4.18	18.65	22.75	41.40	9.90	3.03	4.35
75% of RDF + *Rhizobium* + PSB	13.48	17.69	11914	27855	15941	1.34	4.19	19.82	22.12	41.94	10.00	3.22	4.22
75% of RDF + FYM	14.67	19.41	12874	30321	17447	1.36	5.68	21.57	24.27	45.84	8.07	2.58	3.42
100% of RDF	15.98	21.22	13524	33031	19507	1.44	4.92	23.50	26.53	50.03	10.17	3.25	4.31
100% of RDF + *Rhizobium* + PSB	16.27	22.29	13564	33654	20090	1.48	4.93	23.92	27.86	51.78	10.50	3.30	4.52
100% of RD + FYM	17.02	24.45	14524	35262	20738	1.43	6.43	25.02	30.56	55.58	8.64	2.65	3.80
125% of RDF	18.60	25.39	15174	38470	23296	1.54	5.66	27.34	31.74	59.08	10.44	3.29	4.49
125% of RDF + *Rhizobium* + PSB	18.86	25.38	15114	38999	23885	1.58	5.67	27.73	31.73	59.46	10.49	3.33	4.48
125% of RDF + FYM	20.08	26.24	16174	41472	25298	1.56	7.16	29.52	32.80	62.32	8.70	2.80	3.66
Rhizobium + PSB	9.40	16.64	6963	19642	12679	1.82	1.98	13.83	20.81	34.64	17.49	4.75	8.40
FYM	10.52	16.94	7923	21887	13964	1.76	3.47	15.46	21.18	36.64	10.56	3.03	4.88
Absolute control	9.09	16.21	6923	19001	12078	1.74	1.97	13.37	20.26	33.63	17.07	4.61	8.23
SE±	0.37	0.67	-	734	736	0.06	-	0.54	1.21	1.31	0.45	0.09	0.37
CD (5%)	1.15	2.05	-	2308	2317	0.20	-	1.69	3.81	4.13	1.43	0.30	1.17
Genotype :													
JS-93-05	12.05	17.26	8573	26746	18173	2.11	3.07	17.72	21.58	39.30	12.80	3.92	5.62
JS-97-52	17.39	24.42	8573	35719	27146	3.16	3.07	25.57	30.52	56.09	18.27	5.66	7.95
SE±	0.17	0.46	-	346	347	0.03	-	0.25	0.57	0.62	0.21	0.04	0.18
CD (5%)	0.54	1.67	-	2020	2028	0.17	-	1.48	3.34	3.61	1.25	0.26	1.03

Note : RDF = 30:60:40:20 kg ha^{-1} N, P_2O_5, K_2O and S, respectively and FYM dose = 5 t ha^{-1}.

2009 in clay soil having low in available nitrogen (217 kg ha^{-1}), medium in available phosphorous (13 kg ha^{-1}) and high in available potassium (371 kg ha^{-1}) contents. The reaction of the soil was neutral (7.1 pH). Trial was laid out in factorial randomized block design with three replications under a gross plot size of 6.0 x 3.6 m. Crop was sown on 5th July, 2009 adopting 30 x 10 cm spacing and harvested on 14th October, 2009. All recommended cultural practices were followed. The treatments comprised of 12 nutritional schedules (Table 1) and two varieties of soybean (JS-93-05 and JS-97-52). The basal dose of organic and inorganic nutrients (as per the treatments) was given in furrows. However, *Rhizobium* (*Bradyrhizobium japonicum*) and phosphate solubilising bacteria (PSB) were seed dressed before sowing of soybean.

Seed yield : Significantly higher seed yield (20.08 q ha^{-1}) was recorded with the application of 125 per cent of RDF + farm yard manure (5 t ha^{-1}) as compared to other nutrient combinations which was at par with the application of 125 per cent of RDF + *Rhizobium* + PSB (18.86 q) and 125 per cent of RDF (18.60 q). These three nutrient schedules produced 121, 107 and 104 per cent higher seed over absolute control (9.09 q ha^{-1}). The absolute control and combination of *Rhizobium* + PSB produced similar yield under study. Maximum seed yield was recorded by the application of 125 per cent of RDF + FYM was due to nutrient supply by inorganic and organic fertilizer combination which resulted in better development of growth and yield attributes of soybean. Similar results were also obtained by Gajbhiye and Mali (2009). Soybean variety JS-97-52 produced significantly more (44.32%) seed yield (17.39 ha^{-1}) than JS -93-05 (12.05 q ha^{-1}). The possible explaination of higher seed yield with JS-97-52 was the production of maximum yield attributes compared to variety JS-93-05. Yield variation among varieties was also observed by Mehasen and Saeed (2005).

Stover yield : The application of 125 per cent of RDF + farm yard manure produced significantly more stover yield (26. 24 q ha^{-1}) over other treatments. However, it was on par with 125 per cent of RDF (25.39 q), 125 per cent of RDF + Rhizobium + PSB (25.38 q) and 100 per cent of RDF + FYM (24.45 q ha^{-1}) nutrient management system. Similarly, the stover yield was significantly less under lower level of chemical fertilizers and with bio-fertilizers (75% of RDF alone and in combination of *Rhizobium* + PSB), combination of *Rhizobium* + PSB, FYM alone and absolute control treatments and was at par with each other. These results corroborate the findings of Sarawagi *et al*. (2007). Soybean variety JS-97-52 produced statistically higher stover yield (24.42 q ha^{-1}) than JS-93-05 (17.26 q ha^{-1}) under study due to higher growth parameters. The results are in agreement with the observations of Gupta *et al.* (2003).

Economics : The cost of cultivation, gross return and net return was higher in all nutrient management system as compared to absolute control (Table 1). Application of 125 per cent of RDF + farm yard manure (5 t ha^{-1}) incurred the maximum cost of cultivation (Rs. 16174 ha^{-1}), gross (Rs. 41472 ha^{-1}) and net (Rs. 25298 ha^{-1}) return. However, it was statically at par with 125 per cent of RDF + *Rhizobium* + PSB and 125 per cent of RDF treatment in respect of net returns. The benefit cost ratio was more in *Rhizobium* + PSB (1.82) followed by 5 t ha^{-1} farm yard manure (1.76) and it was minimum in 75 per cent of RDF (1.33) treatment. Soybean variety JS-97-52 recorded statistically higher gross (Rs. 35719 ha^{-1}) and net (Rs. 27146 ha^{-1}) return as well as benefit cost ratio (3.16) compared to JS-93-05 under study. The increased values of economic characters may be ascribed to higher level of

grain and stover yields with the respective nutritional schedule and crop variety. Similar types of findings were observed by Paikra et al. (1988) and Vyas *et al*. (2006).

Energetics : The energy input and total output values were minimum under absolute control (1.97 and 33.63 MJ x 10^{-3} ha^{-1}) and maximum in 125 per cent of RDF + farm yard manure (7.16 and 62.32 MJ x 10^{-3} ha^{-1}). However, the energy input:output ratio was higher with *Rhizobium* + PSB (17.49) followed by absolute control (17.07) treatment. Similarly, the value of energy use efficiency was maximum under *Rhizobium* + PSB (4.75 MJ x 10^{-3} ha^{-1} in seed and 8.40 in stover) followed by absolute control and it was minimum in 75 per cent of RDF + 5 t ha^{-1} farm yard manure (2.58 MJ x 10^{-3} ha^{-1} in seed and 3.42 in stover). Significantly higher value of total energy output (56.09 MJ x 10^{-3} ha^{-1}), energy input:output ratio (18.27) and energy use efficiency in seed (5.66 MJ x 10^{-3} ha^{-1}) and stover (7.95 MJ x 10^{-3} ha^{-1}) were recorded with JS-97-52 as compared to soybean variety JS-93-05. The results obtained were in accordance with the findings of Deshmukh *et al*., (2005).

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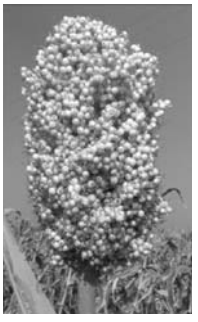
Varieties of Field Crops and Farm Machinery Implements Released During 2012

I. Mahatma Phule Krishi Vidyapeeth, Rahuri

A. Released varieties :

1. *Rabi* sorghum : Phule Suchitra (RSV-1098/SPV-2048)



Medium maturity - 120 to 125 days. Average grain yield - 21.2 q ha^{-1}. Average fodder yield - 67.1 q ha^{-1}. Medium bold grain with pearly white colour. Better *roti* and fodder quality. Tolerant to drought, shootfly, charcoal rot and foliar diseases like leaf rust and leaf blight. Released for *rabi* season under rainfed condition on medium soils of Western Maharashtra.

2. Pearl millet : ICTP- 8203-FE 10-2 (Dhanshakti)

Grain yield - 21.99 q ha^{-1}. Higher Iron content - 81 ppm (9.4% higher than ICTP 8203, 74 ppm). Early maturity - 78 to 83 days. Globular, bold grain with grey colour. Resistant to downy mildew and blast. Released for drought prone areas of Maharashtra.

3. Sugarcane : VSI-434

Early maturity - 10 months (suitable for early crushing period). Higher cane yield - 128.39 t ha^{-1}. Higher sugar yield (CCS) - 20.93 t ha^{-1}. Good ratooning ability. Tolerant to drought. Less susceptible to internode borer. Moderately resistant to smut, grassy shoot, pokkah boeng and red rot. Released for pre-season and suru in Maharashtra.

4. Paddy : Phule RDN-6

Midlate - 125 to 130 days. High yield - 44 q ha^{-1}. Long, slender grain. Resistant to bacterial leaf blight and moderately resistant to leaf blast. Released for Western Maharashtra.

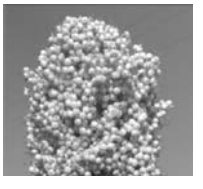
5. Pigeon pea : Rajeshwari (Phule Tur-12)

Maturity - 133 days. Yield - 2254 kg ha^{-1}. Bold seeds (11.3 g 100^{-1} seeds) with red colour. Higher protein content - 20.42%. Moderately resistant to *Fusarium* wilt, sterility mosaic, pod borer, pod fly and nematode. Released for *kharif* season in Maharashtra.

6. Groundnut : Phule Unnati (RHRG - 6083)

Dry pod yield : Summer- 39.90 q ha^{-1} *Kharif* - 28.54 q ha^{-1}. Resistant to leaf spot (Tikka), stem rot, rust, spodoptera and thrips. Released for summer and *kharif* season in Maharashtra.

7. Safflower : Phule SSF-733



Maturity - 120 to 125 days. Seed yield - 1329 kg ha^{-1}. Oil content - 28.2%. Good response to fertilizer. Resistant to aphids. Released for drought prone area of Maharashtra.

8. Grass : Phule Marvel-06-40

Green forage yield - 431.30 q ha^{-1}. Dry matter yield - 116.81 q ha^{-1}. Resistant to leaf spot and rust. Less susceptible to jassids. Better fodder nutritional quality (crude protein - 6.41%). High leaf : stem ratio and high tillering ability. Released for pasture land of Maharashtra under rainfed condition.

B. Released farm machinery and implements :

1. Phule Multi-crop Ridger Planter

Tractor drawn. Recommended for planting soybean, chickpea on ridges and furrows.

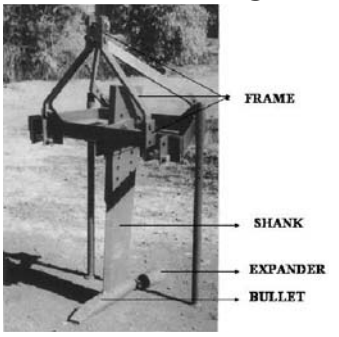
2. Phule Sugarcane Interculturing Machine

Low hp (18.5 hp) tractor drawn. Recommended for earthing up and application of granular fertilizers in sugarcane crop planted at 120-150 cm row spacing.

3. Phule Sheti Yantra

Multipurpose. Recommended for harrowing, cultivating and sowing of different crops.

4. Phule Mole Plough



Tractor operated. Recommended for drainage of excess water from ill-drained deep black soils.

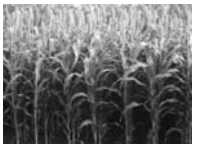
II. Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

A. Released varieties :

1. Paddy Var : PKV Kisan (SKL-22)

Dwarf, non-lodging, duration 130-145 days, medium size grain and good cooking quality, yield 40-50 q ha^{-1}, resistant to leaf blast, bacterial leaf blight.

2. Sorghum Hybrid : SPH-1635



GMS based hybrid, grain yield - 45 q ha^{-1} and fodder yield - 130 q ha^{-1}, easy for seed production

B. Released farm machinery and implements :

1. PKV BBF planter cum inter row cultivator

Useful for preparation of broad bed furrow

TABLES - Type tables in double-space on separate pages, each one referred to in the text and numbered with Arabic numerals (e.g. Table 1). The title of each table should identify its contents so that reference to the text is not necessary. Title and column heading should be brief. Unnecessary descriptive matter should be avoided. Column and row heading with footnotes should be self explanatory. Capitalize only the first letter of the first word of each column and row heading. Use lower case letter from the end of alphabet (x,y,z) to identify tabular footnotes. Use lower case letters from the beginning of alphabet (a,b,c) or asterisks with explanatory footnotes at 5% level, capitals for significance at 1% level.

FIGURES - Identify graphs, line drawings and photographs with consecutive Arabic numbers, as Fig. 1, Fig. 2. Place figures after tables. Photographs must be clear, glossy prints. Original graphs and drawings must be in Indian ink or equivalent on plain, white drawing paper. Letter in Indian ink with a lettering guide large and bold enough to permit reduction. Each figure should be referred to in the text. The title of paper and fig. number should be placed in pencil on the back of each fig. for identification.

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ABBREVIATION - In both text and tables except for the first word in a sentence long words or terms used repeatedly should be abbreviated usually without a period (e.g. a.m. ppm. m. °C, N, P, K, K_2SO_4). Use standard abbreviations. Names of organic chemicals and other terms, abbreviated for the reader's convenience should be spelled out first with parenthetical abbreviation used.

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Dorsey, M.J. and Bushnall, J.W. 1920. The hardiness problem. Proc. Amer. Soc. Hort. Sci. 17:210-224.

Snedecor, G.W. 1956. Statistical Methods. 5th Edn. Iowa State Univ. Press, Ames, Iowa, pp.534.

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