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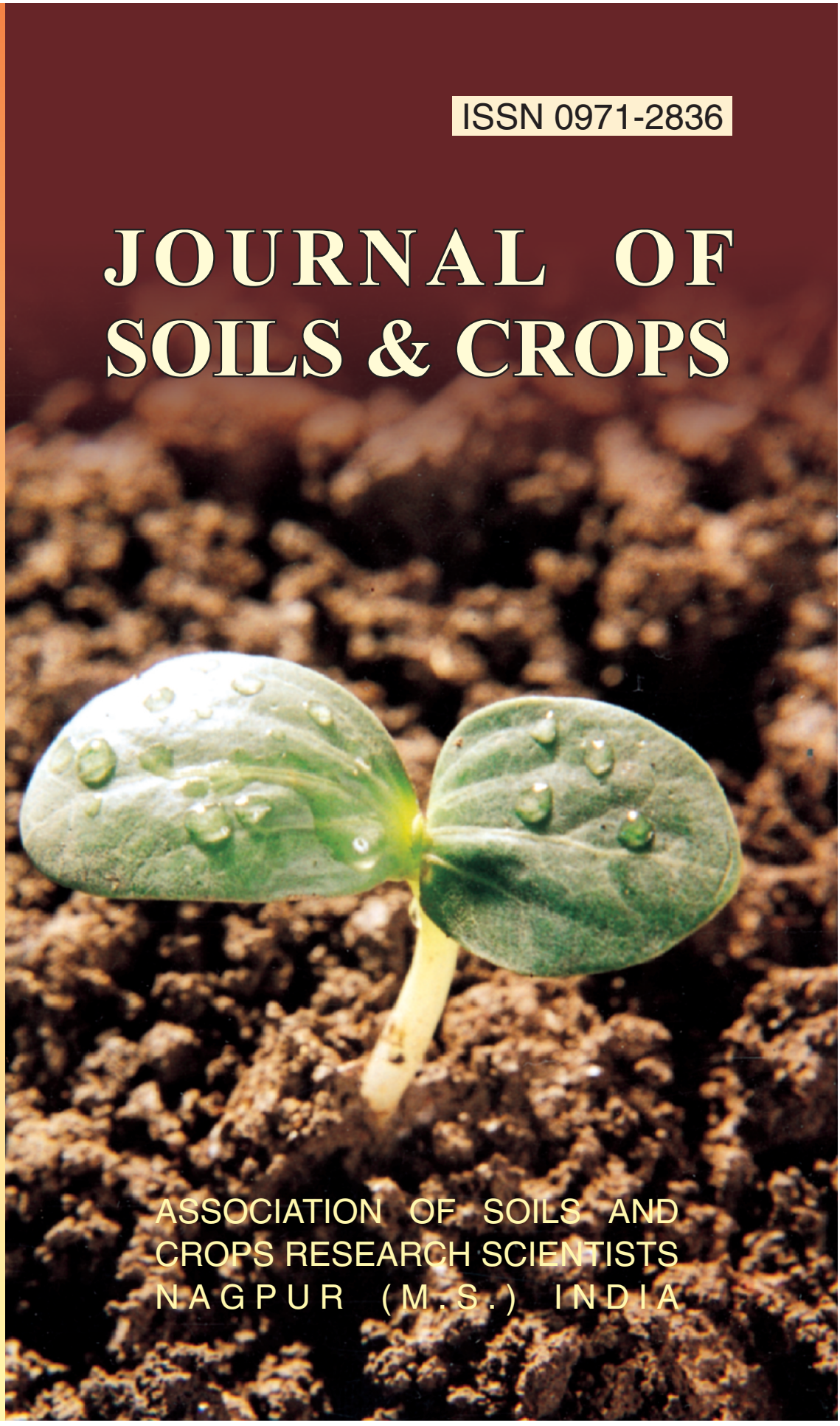

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EFFECT OF PHOSPHORUS, MOLYBDENUM AND COBALT ON GROWTH, YIELD AND NUTRIENT CONTENT OF MUNGBEAN (*Vigna radiata* L. Wilczek) AND SOIL FERTILITY

T. Alben Awomi, A. K. Singh, A. P. Singh and L. J. Bordoloi

ABSTRACT

Growth, yield and quality of mungbean (*Vigna radiata* L. Wilczek) with concomitant changes in soil fertility in response to graded doses of phosphorus (P), molybdenum (Mo) and cobalt (Co) were studied in a field experiment carried out during 2008-09 with mungbean Cv. 'K- 851'. The crop was treated with different combinations of P, Mo and Co besides having common applications of FYM, *Rhizobium*, N and K. Boost in mungbean growth and yield was realised with increase in P application upto 60 kg ha^{-1} in different combinations with Mo and Co. Increase in application of Mo (from 0.75 to 1.50 kg ha^{-1}) and Co (from 0.5 to 1.00 kg ha^{-1}) at a particular level of P could improve growth and yield performance of the crop, thereby denoting beneficial impacts of these micronutrients. The improvement in seed and stover yield was noticed with every increment in Mo application and significantly better nodulation with every increment of Co was noteworthy. Maximum seed yield (4.46 q ha^{-1}) and stover yield (4.50 q ha^{-1}) were recorded with P applied @ 60 kg ha^{-1} along with Co and Mo applied @ 1.00 and 1.50 kg ha^{-1}, respectively. The maximum seed protein content (27.75%) was also recorded under the same treatment. Marked improvement in soil residual nutrients, particularly N and P was recorded with combined application of P, Mo and Co. Strong positive correlations of nodule number with seed yield (r = 0.972; p=0.01) and seed N content (r = 0.883; p= 0.01) are testimony to benefits of proper nodulation in legumes.

(Key words: Cobalt, molybdenum, mungbean, phosphorus, growth, quality, soil fertility and yield)

INTRODUCTION

Mungbean/ green gram contributes 14% in total pulses area and 7% in total pulses production in India. It is an excellent source of easily digestible high quality protein. Sprouted mungbean contains ascorbic acid (vitamin C) and the amount of riboflavin and thiamine are also increased. Being a short duration crop, it fits well in many intensive crop rotations, prevents soil erosion, fixes atmospheric nitrogen and helps in improving soil fertility. Green gram can be grown from sea level to an elevation of 2000 metres in well-drained loamy to sandy loam soils. Like other leguminous crops, requirements of nitrogen are substantially fulfilled from symbiotic nitrogen fixation through *Rhizobium*. Phosphorus is the most important nutrient limiting pulse production. The deficiency of phosphorus appears to be the major cause of low yield. It is essential for all types of N-fixing microbes in general and *Rhizobium* in particular. An adequate supply of phosphorus in early plant life is important for well development of roots as well as for seed formation and yield. The soils of North Eastern India are acidic in nature. Acid soils are low in available phosphorus and molybdenum and have high phosphate fixation capacity. At low pH values, the $HMoO_4$ is adsorbed by silicate clays and more especially by oxides of iron and aluminium through ligand exchange with hydroxide ions on the surface of the colloidal particles. Molybdenum is structural component of nitrogenase, the enzyme which is actively involved in nitrogen fixation by *Rhizobium* bacteria in the root-nodules of leguminous crops. Molybdenum is also reported to be essential for absorption and translocation of iron in plants as well as yield. Significant increase in nodulation, nitrogen content and yield was reported by Laltlanmawia *et al*. (2004) by the application of molybdenum in soybean in acid soils of Nagaland.

Cobalt is constituent of cobalamine coenzyme and required for formation of leghaemoglobin in nitrogen fixation. Under condition of cobalt deficiency, methionine synthesis is depressed which leads to lower protein synthesis of heme (iron porphyrins) in the bacteriods. Cobalt seed treatment along with *Rhizobium* culture increased the

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yield of legumes to a great extent (Singh and Singh, 2010). Keeping in view the above, the present investigation was undertaken to study the effect of different levels of P, Mo and Co application on growth, yield and quality of mungbean along with concomitant changes in soil fertility.

MATERIALS AND METHODS

Field experiment was carried out in the Experimental Research Farm of School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema, Nagaland. The farm is located at an altitude of 310 m with the geographical location of $25^0 45' 45''$ N latitude and $93^0 53' 04''$ E longitude. The soil of the experimental farm is sandy loam in texture with pH 4.5 and 13.0 g kg^{-1} organic carbon. The N, P_2O_5 and K_2O content were 250.8, 17.9 and 165.3 kg ha^{-1}, respectively. The treatments comprised of P, Mo and Co applied at various doses and combinations along with common application of FYM, *Rhizobium*, N and K except in absolute control which was devoid of any application of these nutrient sources. There were 14 treatments as follows: -

T_1: Absolute control
T_2: Control (devoid of P, Mo and Co only)
T_3: $P_{20}Mo_{0.75}Co_{0.5}$
T_4: $P_{20}Mo_{0.75}Co_{1.0}$
T_5: $P_{20}Mo_{1.50}Co_{.5}$
T_6: $P_{20}Mo_{1.50}Co_{1.0}$
T_7: $P_{40}Mo_{0.75}Co_{0.5}$
T_8: $P_{40}Mo_{0.75}Co_{1.0}$
T_9: $P_{40}Mo_{1.50}Co_{0.5}$
T_{10}: $P_{40}Mo_{1.50}Co_{1.0}$
T_{11}: $P_{60}Mo_{0.75}Co_{0.5}$
T_{12}: $P_{60}Mo_{0.75}Co_{1.0}$
T_{13}: $P_{60}Mo_{1.50}Co_{0.5}$
T_{14}: $P_{60}Mo_{1.50}Co_{1.0}$

The treatments were replicated thrice and the experiment was laid out in Randomised Block Design (RBD). Mungbean Cv. "K- 851" was used as the test crop. Farm Yard Manure (FYM) was applied @ 2 tonnes ha^{-1} before two weeks of sowing. Different levels of phosphorus (P_2O_5) i.e. 20, 40 and 60 kg ha^{-1}; molybdenum i.e. 0.75 and 1.50 kg ha^{-1} and cobalt i.e. 0.50 and 1.00 kg ha^{-1} were applied as treatment combination through Single super phosphate (SSP), ammonium molybdate and cobalt chloride. Nitrogen @ 20 kg ha^{-1} and potassium @ 40 kg ha^{-1} were applied at the time of sowing through urea and muriate of potash (MOP), respectively. *Rhizobium* culture was also applied as soil treatment at the time of sowing @ 10 kg ha^{-1}. Seeds were sown during April 2008 and harvested at physiological maturity.

Five plants were selected randomly from each plot and tagged for recording plant height, number of leaves and branches $plant^{-1}$, root length, number of nodules $plant^{-1}$, number of seeds pod^{-1}, number of pods $plant^{-1}$ and filled pods $plant^{-1}$, seed yield and stover yield. Seed and stover samples were dried in oven and grinded in Willey mill. In the plant samples (seed and stover) nitrogen was determined through steam distillation using micro Kjeldahl method, phosphorus was estimated through vanado molybdate yellow coloured method and potassium content was estimated through flame photometry (Jackson, 1973). Protein content was calculated by multiplying the nitrogen content with the factor 6.25.

Surface soil samples (0-15 cm) were collected from each plot at the start of the experiment and also after harvest of the crop. The samples were air dried, ground to powder form and sieved through 2 mm sieve. In the prepared samples, soil texture was determined through International Pipette Method (ISSS 1929) as described by Baruah and Barthakur (1999). The ready soil samples, hence subjected to analysis of pH, organic carbon, available nitrogen, phosphorus and potassium content were determined using standard procedures (Jackson, 1973).

RESULTS AND DISCUSSSION

Growth and yield of mungbean

Growth and yield response of mungbean under various combinations of P, Mo and Co are presented in table 1. Data revealed that increase in P levels (irrespective of Mo and Co) had significant positive effect on the crop growth and yield. Plant height increased significantly reaching a maximum of 68.40 cm with increase in P dose from 20 to 60 kg P_2O_5 ha^{-1}, while the rates of other nutrients remained constant. This result is in agreement with the findings of Singh and Hiremath (1990) who observed that application 50 kg P_2O_5 ha^{-1} increased the plant growth in *Vigna radiata*. The significant influence of phosphorus on plant height was also observed by Mandal and Sikder (1999). Number of leaves, number of branches and root length also increased, although not significantly,

with every increment in P. Nodule numbers were enhanced significantly with every increase in P level. Maximum nodule number (43.68) was attained with the combination of 60- 1.50- 1.0 kg ha^{-1} of P_2O_5, Mo and Co. No significant enhancement in number of seeds pod^{-1} could be recorded with increase in P level. Significant improvement in number of filled pods plant^{-1} was recorded only when P level was raised to 60 from 20 kg P_2O_5 ha^{-1}. Seed and stover yield got significant boost with every increment in P level recording maximum of 4.46 and 4.50 q ha^{-1} with application of 60 kg P_2O_5 ha^{-1}, respectively. Basu *et al.* (2003) and Bhattacharya and Pal (2001) also observed significant increase in yield by increased application of phosphorus in groundnut and green gram, respectively.

At each level of P, differential effects of varying doses of Mo and Co were recorded. At a particular P level, increase in Mo application (keeping Co constant) resulted in greater improvement in all the parameters except nodule number in comparison to the results obtained from increasing Co application (keeping Mo constant). On the contrary, nodule number was found to be affected more by variation in Co level than in that of Mo. Such effects of Mo and Co were, of course, overshadowed by the variations stemmed from changing levels of P. However, Mo and Co combined at their highest rates (1.50 and 1.00 kg ha^{-1} for Mo and Co, respectively) with a particular P level was found to perform best in terms of all the growth and yield traits of the crop.

Nutrient contents in mungbean

N, P, K and protein contents in seeds and stover of mungbean are presented in table 2. Raising the P levels from 20 to 60 kg ha^{-1} significantly influenced seed N contents, while the stover N content did not show much variation. Maximum content of N in seed (4.44%) was recorded with application of 60-1.50- 1.00 kg ha^{-1} of P_2O_5, Mo and Co, respectively, which was 0.23% higher than application of 20 kg P_2O_5 ha^{-1} with similar levels of Mo and Co. This increase in N content might be due to the vigorous growth of root and increased uptake of N by the application of phosphorus fertilizer. Similar observations have been reported by Singh *et al.* (1993). As with seed N, seed protein content also showed marked improvement reaching a maximum of 27.75% owing to increase in P level upto 60 kg P_2O_5 ha^{-1} applied along with Mo and Co @ 1.50 and 1.00 kg ha^{-1} , respectively. Sharma *et al.* (2001) reported similar observations with application of 60 kg P_2O_5 ha^{-1}. Sharma and Minhas (1986) observed that Molybdenum application significantly increased nitrogen and protein content of soybean grains. The contribution of Co, although not comparable in magnitude to that of Mo, is also too crucial to be ignored. Significant increase in N and protein content of green gram due to seed treatment with Co was reported by Pattanayak *et al.* (2000). Maximum N (1.41%) in stover was recorded with 60-1.50-1.00 kg ha^{-1} of P_2O_5, Mo and Co, respectively. Seed and stover P contents showed significant improvement with every increment in P application at similar levels of Mo and Co. As anticipated, maximum P contents in seed (0.56%) and stover (0.31%) were recorded with 60 kg P_2O_5 ha^{-1} applied with 1.50 and 1.00 kg ha^{-1} of Mo and Co, respectively. Similar result was observed by Khan *et al.* (2002) who reported that P uptake in inoculated mungbean increased with increasing rates of P_2O_5 upto 75 kg ha^{-1}. Jain *et al.* (2007) reported that application of phosphorus in P deficient soil increased the concentration in soil solution resulted in greater utilization of P by mungbean. Marked improvement in seed and stover P was also recorded with the increase in Mo application at a particular level of P and Co. This was in conformity with Laltlanmawia *et al.* (2004) wherein enhancement in P content of soybean with increasing levels of molybdenum was reported. Increasing P application from 20 to 60 kg P_2O_5 ha^{-1} with 1.50 and 1.00 kg ha^{-1} of Mo and Co yielded the maximum K contents in seed (1.87%) and stover (2.50%). At any particular level of P and Co, increase in Mo application from 0.75 to 1.50 kg ha^{-1} was found to enhance remarkably the K contents in seed and stover. The significant influence of molybdenum on the potassium content of soybean was observed by Laltlanmawia *et.al.* (2004).

Residual soil fertility

Effects of different combinations of P, Mo and Co on residual soil fertility are presented in table 3. A steady increase in residual soil N (RSN) with every increment in P application was noticeable. Mo and Co combined at their highest doses with P resulted in maximum RSN at any particular P level. Increasing the level of either Mo or Co keeping the other nutrients constant could not bring much improvement in RSN. Maximum RSN (260.66 kg ha^{-1}) was recorded with P applied @ 60 kg P_2O_5 ha^{-1} along with 1.50 and 1.00 kg ha^{-1} of Mo and Co, respectively. Residual soil P (RSP) was significantly increased with the increase in P application from 20 to 60 kg P_2O_5 ha^{-1}. Increase in Mo and/or Co within a

Table 1. Effect of different levels of phosphorus, molybdenum and cobalt on growth and yield parameters of mungbean

Treatment No.	Treatments	Plant height (cm)	No. of Leaves plant^{-1}	No. of Branches plant^{-1}	Root length (cm)	No. of nodules (45 DAS)	No. of seeds pod^{-1}	No. of filled pods plant^{-1}	seed yield (q ha^{-1})	Stover yield (q ha^{-1})
T_1	$P_0Mo_0Co_{0\ (absolute\ control)}$	39.24	30.44	13.77	19.44	21.33	8.66	11.66	2.40	2.60
T_2	$P_0Mo_0Co_{0\ (control)}$	42.28	34.33	15.66	19.62	25.66	9.36	11.78	2.72	2.78
T_3	$P_{20}Mo_{0.75}Co_{0.5}$	46.60	36.24	17.52	21.33	27.00	8.78	13.00	3.20	3.25
T_4	$P_{20}Mo_{0.75}Co_{1.0}$	48.20	36.82	16.82	21.85	31.16	8.64	14.10	3.36	3.42
T_5	$P_{20}Mo_{1.50}Co_{0.5}$	49.50	39.66	18.14	22.20	30.42	8.92	13.86	3.55	3.60
T_6	$P_{20}Mo_{1.50}Co_{1.0}$	51.60	41.87	18.95	24.65	33.45	9.11	14.72	3.70	3.77
T_7	$P_{40}Mo_{0.75}Co_{0.5}$	53.50	39.84	19.66	26.51	34.56	9.56	16.22	3.86	3.88
T_8	$P_{40}Mo_{0.75}Co_{1.0}$	54.30	39.72	19.54	26.82	37.94	8.95	17.24	3.96	3.92
T_9	$P_{40}Mo_{1.50}Co_{0.5}$	56.00	42.20	20.35	27.10	36.12	9.21	17.19	3.90	3.97
T_{10}	$P_{40}Mo_{1.50}Co_{1.0}$	59.40	44.54	22.47	27.76	38.88	9.66	18.35	4.04	4.10
T_{11}	$P_{60}Mo_{0.75}Co_{0.5}$	62.25	43.10	24.56	28.50	39.35	9.82	19.46	4.10	4.18
T_{12}	$P_{60}Mo_{0.75}Co_{1.0}$	63.80	44.25	24.32	28.72	42.19	9.68	19.62	4.18	4.22
T_{13}	$P_{60}Mo_{1.50}Co_{0.5}$	66.20	46.12	26.15	29.15	40.57	10.12	20.37	4.30	4.35
T_{14}	$P_{60}Mo_{1.50}Co_{1.0}$	68.40	48.62	29.32	32.44	43.68	12.10	23.15	4.46	4.50
	SE m ±	0.127	2.90	4.13	4.60	0.168	0.44	1.76	0.036	0.090
	CD at 5%	0.37	8.47	12.04	–	0.49	1.305	5.135	0.105	0.264

Table 2. Effect of different levels of phosphorus, molybdenum and cobalt on N, P, K and protein contents in seed and stover of mungbean

Treatment No.	Treatments	N (%)		P (%)		K (%)		Protein (%)
		Seed	Stover	Seed	Stover	Seed	Stover	Seed
T_1	$P_0Mo_0Co_0$ (absolute control)	3.28	0.89	0.24	0.11	1.55	2.13	20.50
T_2	$P_0Mo_0Co_0$ (control)	3.56	1.02	0.27	0.13	1.68	2.20	22.25
T_3	$P_{20}Mo_{0.75}Co_{0.5}$	4.04	1.21	0.33	0.18	1.71	2.23	25.25
T_4	$P_{20}Mo_{0.75}Co_{1.0}$	4.13	1.20	0.36	0.19	1.70	2.23	25.81
T_5	$P_{20}Mo_{1.50}Co_{0.5}$	4.15	1.26	0.34	0.21	1.72	2.24	25.94
T_6	$P_{20}Mo_{1.50}Co_{1.0}$	4.21	1.28	0.38	0.21	1.72	2.27	26.31
T_7	$P_{40}Mo_{0.75}Co_{0.5}$	4.17	1.31	0.40	0.24	1.74	2.32	26.06
T_8	$P_{40}Mo_{0.75}Co_{1.0}$	4.18	1.29	0.42	0.26	1.76	2.34	26.13
T_9	$P_{40}Mo_{1.50}Co_{0.5}$	4.20	1.33	0.43	0.26	1.77	2.35	26.25
T_{10}	$P_{40}Mo_{1.50}Co_{1.0}$	4.32	1.37	0.46	0.27	1.79	2.39	27.00
T_{11}	$P_{60}Mo_{0.75}Co_{0.5}$	4.30	1.30	0.48	0.29	1.81	2.41	26.88
T_{12}	$P_{60}Mo_{0.75}Co_{1.0}$	4.33	1.36	0.49	0.29	1.81	2.42	27.06
T_{13}	$P_{60}Mo_{1.50}Co_{0.5}$	4.36	1.34	0.51	0.31	1.83	2.45	27.25
T_{14}	$P_{60}Mo_{1.50}Co_{1.0}$	4.44	1.41	0.56	0.31	1.87	2.50	27.75
	SE m ±	0.018	0.295	0.005	0.017	0.007	0.088	0.79
	CD at 5%	0.053	0.859	0.017	0.049	0.022	0.256	2.314

Table 3. Effect of different levels of phosphorus, molybdenum and cobalt on residual soil fertility

Treatment No.	Treatments	Available nutrients (kg ha^{-1}) in soil		
		N	P_2O_5	K_2O
T_1	$P_0Mo_0Co_0$ (absolute control)	234.15	11.20	148.36
T_2	$P_0Mo_0Co_0$ (control)	241.52	13.12	160.55
T_3	$P_{20}Mo_{0.75}Co_{0.5}$	243.62	23.57	164.12
T_4	$P_{20}Mo_{0.75}Co_{1.0}$	243.18	24.12	164.36
T_5	$P_{20}Mo_{1.50}Co_{0.5}$	244.12	24.66	165.47
T_6	$P_{20}Mo_{1.50}Co_{1.0}$	246.65	26.20	167.32
T_7	$P_{40}Mo_{0.75}Co_{0.5}$	248.18	30.86	169.54
T_8	$P_{40}Mo_{0.75}Co_{1.0}$	248.87	31.42	171.82
T_9	$P_{40}Mo_{1.50}Co_{0.5}$	250.62	32.87	170.95
T_{10}	$P_{40}Mo_{1.50}Co_{1.0}$	253.12	33.50	172.88
T_{11}	$P_{60}Mo_{0.75}Co_{0.5}$	257.46	37.16	173.86
T_{12}	$P_{60}Mo_{0.75}Co_{1.0}$	257.24	37.64	174.12
T_{13}	$P_{60}Mo_{1.50}Co_{0.5}$	259.15	37.56	174.45
T_{14}	$P_{60}Mo_{1.50}Co_{1.0}$	260.66	38.15	175.72
	SEM ±	0.254	1.00	0.692
	CD at 5%	0.741	2.94	2.02

Table 4. Coefficients of correlation (*r*) amongst relevant parameters

	Seed yield (q ha^{-1})	Residual N (kg ha^{-1})	Seed N (%)	Seed P (%)	Seed K (%)
Nodule number	0.972*	0.959*	0.883*	ND**	ND**
Seed yield (q ha^{-1})	-	ND**	0.939*	0.958*	0.938*

* *r* significant at 1%** ND Not determined

particular P level failed to bring significant enhancement in RSP. At every level of P, maximum RSP was, however, recorded with higher doses of both Mo and Co together. Of all the treatments, 60-1.50-1.00 kg ha^{-1} of P_2O_5, Mo and Co, respectively recorded the maximum RSP content of 38.15 kg ha^{-1}. Residual soil K (RSK) also showed steady increase with increasing levels of P application. Within a particular P level, not much variation in RSK was however recorded even with changes in rates of Mo and Co application. Maximum RSK (175.72 kg ha^{-1}) was recorded with application of P_2O_5, Mo and Co @ 60, 1.50 and 1.00 kg ha^{-1}, respectively.

Correlation study

The linear correlations computed amongst the relevant parameters are presented in table 4. A strong positive correlation (r= 0.972; p= 0.01) of nodule number with seed yield highlights the importance of proper nodulation for ensuring optimum productivity of the crop. Nodule number also showed strong positive correlation with residual soil N (r= 0.959; p= 0.01) and seed N (r= 0.883; p= 0.01) content. Strong positive correlations of seed yield were also recorded with seed N, P and K content.

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PRODUCTIVITY, ECONOMICS, NUTRIENT STATUS AND WEED STUDIES IN INTERCROPPING IN *RABI* CEREAL, LEGUME, OILSEEDS AND SPICES ON *INCEPTISOLS* IN CHHATTISGARH PLAIN

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ABSTRACT

Field experiment was conducted on different intercropping under irrigated condition during rabi season of 2009-10 at Indira Gandhi Krishi Vishwavidyalaya, Raipur to evaluate the yield, economics and to undertake weed studies of intercropping in *rabi* cereal, legume, oilseeds and spices in rice based cropping system in *inceptisols*. Maximum wheat equivalent yield, (65.55 q ha^{-1}) of *rabi* crops was recorded in onion + coriander system over all the other intercropping treatment. Wheat + fenugreek intercropping was next in order which has also recorded significantly higher WEY (36.58 q ha^{-1}) over wheat followed by rice, the existing cropping system (30.61 q ha^{-1}), castor + lentil (32.78 q ha^{-1}) and wheat + lentil (28.18 q ha^{-1}). The highest net returns (Rs.65,292 ha^{-1}) from *rabi* crops were recorded with onion + coriander because of higher value of the produce. The highest B:C ratio of *rabi* intercrops was recorded in onion + coriander (1.98) followed by mustard + lentil (1.90) and wheat (1.89). On the other hand, the highest weed population (172.33 and 147.00 m^{-2}) and dry matter production (7.8 and 194 g m^{-2}) was observed in mustard + lentil at 30 and 60 DAS. The lowest weed dry production was found in onion+ coriander (1.8 g m^{-2}) at 30 DAS, and under wheat + fenugreek (82.07 g m^{-2}) at 60 DAS. On an average, the available N, P, K and organic carbon content were increased by 6.1, 3.6, 11.8, and 4.2%, respectively over initial values in soil after the harvest of the *rabi* crop.

(Key words: Economics, nutrient status, productivity, *rabi* intercropping, weed studies, wheat equivalent yield)

INTRODUCTION

Diversification of crops with inter-cropping can give higher yields than sole crops (Mandal *et al.,*1986*)*. Thus, selecting compatible combination of crops is necessary for the maximum utilization of growth resources, *viz*. solar energy, and water unit^{-1} area unit^{-1} time that will also keep the soil in a better physical condition with improvement in yield. Hence, choice of the component crops in intercropping needs to be suitably maneuvered to harvest the synergism among them towards efficient utilization of resource base and to increase overall productivity (Anderson, 2005). In order to generate useful information for such type of potential areas, an investigation was undertaken to study growth resource use and yield complementary of intercroppings during *rabi* season *viz.*, wheat + lentil, mustard + lentil, sunflower + lentil, wheat+ fenugreek, onion + coriander, castor + lentil under irrigated condition.

MATERIALS AND METHODS

Field experiment was conducted on different intercropping under irrigated condition during *rabi* season of 2009-10 at Indira Gandhi Krishi Vishwavidyalaya, Raipur to evaluate and identify the yield attributes, economics, weed studies and available nutrient status of soil after intercropping in *rabi* cereal, legume, oilseeds and spices on *inceptisols* in Chhattisgarh plain. Seven intercropping viz., sole wheat (′GW-273′), Castor (′DCS-9′) + lentil (′K-75′) in 1:3; mustard (′Pusa bold′) + lentil in 1:2; sunflower (′Jwalamukhi′) + lentil in 1:3; wheat+ fenugreek (′PEB′), wheat in furrows and fenugreek (seed purpose) on beds in 1:1 skip row; wheat + lentil (1:1 skip row), wheat in furrows and lentil on ridges in 1:1 skip row; Onion (′Nasik red′) + coriander (′Hariyali′) for green leaf and seed in 1:3 ratio were tested in randomized block design with three replications with a plot size of 14.5 x 6.0 m. Recommended dose of N, P and K were supplied through urea, single super phosphate and murate of potash as per recommended dose of the crops i.e. for wheat -100:60:40, castor - 80:50:30, lentil - 30:50:30, sunflower -80:50:30, mustard - 80:50:30, onion - 80:60:100, coriander-60:40:30 and fenugreek - 40:40:30 kg ha^{-1}. Crops were sown on 20.11.2009 and harvested during 2nd fortnight of March 2010. The soil was silty clay (*Inceptisol*) in texture and neutral in reaction, medium in organic carbon (0.49%), medium in available N (248 kg ha^{-1}),

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medium in available P (18.6 kg ha^{-1}) and medium in available K (262 kg ha^{-1}). The total rainfall received was 1054.6 mm during 2009-10. The experiment was conducted under irrigated condition as per recommended practices of different crops. Yield obtained from *rabi* crops was converted into wheat equivalent yield by multiplying yield of respective crop with prevailing farm gate price of produce and divided by price of wheat during 2009-10. Net return was calculated by deducting the cost of cultivation from the gross return. Benefit: cost ratio was obtained by dividing the net return with cost of cultivation. Weed count and dry weight of weeds were recorded at 30 and 60 DAS. Weeds present in quadrate of 0.25 m^2 were uprooted along with their roots. The root portion was cut and detached. Only shoot portion of the weed plants were oven dried at 60^0C for 36 hours. After complete oven drying, dry weight of weeds was recorded for different treatments. The values were subjected to square root transformation.

RESULTS AND DISCUSSION

Maximum wheat equivalent yield, (65.55 q ha^{-1}) of *rabi* crops was recorded from onion + coriander system (Table1). This was significantly superior over all the intercropping treatments including sole wheat. Wheat + fenugreek cropping system was next in order which was also recorded significantly higher WEY (36.58 q ha^{-1}) over wheat, the existing cropping system (30.61 q ha^{-1}), castor + lentil (32.78 q ha^{-1}) and wheat + lentil (28.18 q ha^{-1}). The WEY was maximum due to the higher yield and price of intercrops. Systems having intercropping of lentil produced lower WEY, because lentil is a poor competitive crop due to very slow growth and low plant height compared to sunflower, wheat and mustard which resulted in low yield under intercropping with these crops. The results are in agreement with Singh and Rana (2006) who reported that lentil seed yield was reduced significantly under mustard-lentil intercropping mainly due to reduced plant population $unit^{-1}$ area and lower values of growth parameters.

The cost of cultivation, net return and B:C ratio of *rabi* crops are presented in table 1. The economic analysis showed that the highest cost of cultivation (Rs.33,033 ha^{-1}) was incurred in onion + coriander cropping system, as this system required heavy fertilization and irrigation. Cost of seed of onion also increased the cost. The system involving wheat + lentil and wheat + fenugreek also hiked the cultivation cost considerably (Rs.19,568 and Rs.19,386 ha^{-1}, respectively) because of higher labour requirement for weeding etc. The lowest cost of cultivation (Rs.15,883 ha^{-1}) was noticed in wheat, the existing cropping system.

However, the highest net returns (Rs.65,292 ha^{-1}) from *rabi* intercrops were recorded with onion + coriander because of higher value of the produce (Table 1) . It was proved to be the most remunerative cropping system and gave almost double profit and remained significantly superior over all the other treatments. Wheat + fenugreek gave considerable net returns (Rs.35,484 ha^{-1}). Whereas, owing to lower grain yield, wheat + lentil system provided the lowest net return (Rs.22,707 ha^{-1}) among *rabi* crops. The highest B:C ratio of *rabi* crops was recorded in ′onion + coriander (1.98) followed by mustard + lentil (1.90) and wheat (1.89). The lowest B:C ratio of *rabi* crops (1.16) was obtained in wheat + lentil. Mehta *et al*. (2010) also reported appreciable B:C ratio of coriander+ onion intercropping with 2:2 ratio.

The data regarding total weed population and dry matter production of weeds at 30 and 60 DAS are presented in table 2. Perusal of data indicated that significant variation in total weed population and total dry matter production of weeds was noticed among different cropping systems. The highest weed population (172.33 and 147.00 m^{-2}) and dry matter production (7.8 and 194 g m^{-2}) were observed in mustard + lentil at 30 and 60 DAS, respectively because of slower growth of mustard and lentil during initial stages and weed competed for light, water and nutrients for quick growth. The lowest weed dry production was found in onion+ coriander (1.8 g m^{-2}) at 30 DAS, and under wheat + fenugreek (82.07 g m^{-2}) at 60 DAS, due to uprooting of weeds during intercultural operation of onion + coriander and faster growth of wheat and fenugreek during earlier stage which did not allow weeds to grow.

Lower weed density and dry matter of weeds in vegetable intercropping (onion + coriander and wheat + fenugreek) cropping sequences were due to smothering effect of wheat and due to repeated

Table 1. Grain yield and wheat equivalent yield of *rabi* crops as influenced by different cropping systems

Tr.	Intercropping	Grain yield (q ha^{-1})		Wheat equivalent yield (q ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
	Rabi	Main crop	Intercrop				
T_1.	Sole wheat	30.61	-	30.61	15,883	30,032	1.89
T_2.	Castor + Lentil (1:3)	4.97	9.11	32.78	18,126	31,049	1.71
T_3.	Mustard +Lentil (1:2)	13.44	4.48	33.17	17,113	32,637	1.90
T_4.	Sunflower + Lentil (1:3)	16.64	2.25	33.14	18,731	30,984	1.65
T_5.	Wheat +Fenugreek (1:1 skip row)	16.70	8.52	36.58	19,386	35,484	1.83
T_6.	Wheat + Lentil (1:1 skip row)	19.06	3.80	28.18	19,568	22,707	1.16
T_7.	Onion + Coriander (3:1)	97.77	2.92 (seed) 31.04 (leaf)	65.55	33,033	65,292	1.98
	SEm±	-	-	1.25	-	1,876	-
	CD at 5%	-	-	3.79	-	5,690	-

Table 2. Total weed population and dry matter of *rabi* season weeds as affected by different cropping systems

Tr	Intercropping	Weed population (m^{-2})		Weed dry weight (m^{-2})		OC (%)	Available nutrient content (kg ha^{-1})		
	Rabi	30 DAS	60 DAS	30 DAS	60 DAS		N	P	K
T_1	Wheat	11.71 (136.67)	11.45 (130.67)	2.59 (6.2)	12.85 (164.6)	0.51	261	20.8	274
T_2	Castor + Lentil (1:3)	12.67 (160)	11.91 (141.33)	2.77 (7.2)	12.99 (168.2)	0.50	252	20.8	274
T_3	Mustard +Lentil (1:2)	13.15 (172.33)	12.14 (147)	2.88 (7.8)	13.95 (194)	0.51	256	20.4	270
T_4	Sunflower + Lentil (1:3)	11.67 (135.67)	11.39 (129.33)	2.61 (6.3)	13.18 (173.3)	0.52	255	20.4	268
T_5	Wheat +Fenugreek (1:1 skip row)	7.27 (52.33)	8.48 (71.33)	1.70 (2.4)	9.09 (82.07)	0.52	257	21.1	274
T_6	Wheat + Lentil (1:1 skip row)	11.29 (127)	10.98 (120)	2.54 (5.96)	12.65 (159.6)	0.53	259	20.4	283
T_7	Onion + Coriander (3:1)	6.52 (42)	8.53 (72.33)	1.52 (1.8)	9.15 (83.2)	0.54	263	21.6	270
	SEm±	0.09	0.05	0.02	0.06	0.01	5.27	1.03	6
	CD at 5%	0.28	0.17	0.06	0.18	–	–	–	19

intercultural operations in vegetables which did not provide conducive environment for weed growth (Tripathi and Singh, 2008).

The fertility status in soil was influenced by various treatments after completion of one cycle of intercropping system. Available organic carbon ranged from 0.50 - 0.54 g kg^{-1} and remained non significant. However, it was found 10.2% higher (0.54 g kg^{-1}) in onion + coriander cropping systems over initial value (0.49 kg ha^{-1}) and lower (0.50 g kg^{-1}) in castor + lentil system. At the time of *rabi* harvest, available N in soil ranged from 252 – 263 kg ha^{-1} under intercropping and was also found non significant due to rabi intercrops and remained at par with sole wheat. Though, owing to the higher dose of fertilizer it was higher in onion + coriander (263 kg ha^{-1}) over other intercropping systems. Even N was much higher (261 kg ha^{-1}) under wheat than those of other intercrops (Table 2). Whereas, the lowest N content (252 kg ha^{-1}) was recorded in castor + lentil cropping sequence. Similar trend was observed in case of available P content. Available K content was not influenced by different intercropping systems. However, higher K (283 kg ha^{-1}) was determined under wheat + lentil cropping sequence and lower in sunflower+ lentil) (268 kg ha^{-1}). The reduction in N as compared to sole wheat due to inclusion of oilseeds intercrops might be due to the higher uptake and lower addition of nutrient in soil in particular treatment. The observations conform the results of Singh *et al*. (2004). The available N, P, K and organic carbon content were increased in soil after the harvest of the *rabi* crops. This might be due to inclusion of pulse crop in intercropping system owing to addition of nutrient by biological N-fixation by these crops. Increase in available N, P, K and organic carbon content in intercropping involving vegetable pea, green gram were reported by Gangwar and Ram (2005).

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PERFORMANCE OF VESICULAR ARBUSCULAR MYCORRHIZAE UNDER DIFFERENT LEVELS OF PHOSPHORUS IN STRAWBERRY (*Fragaria annanassa,* Duch)

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ABSTRACT

The experiment was conducted during 2004-06 in SKUAST-K, Srinagar (J&K) to study the performance of vesicular arbuscular mycorrhizae (VAM) under different levels of phosphorus in strawberry. Inoculation of VAM alone significantly exhibited higher root colonization (52%) and spore density (5 spores g^{-1} soil) over all other treatments. The root colonization showed significantly positive correlation (r=0.851 and r=0.461) with spore density and phosphorus uptake. Application of VAM+ 50 kg P_2O_5 ha^{-1} recorded significantly higher plant height (34.20 cm), plant spread (28.40 cm^2), number of fruits $plant^{-1}$ (16.40) and fruit weight (18.45 g). Significantly higher plant fresh weight (76.80 g) and available phosphorus (18.19 kg ha^{-1}) were observed by the application of VAM+100 kg P_2O_5 ha^{-1} and VAM+50 kg P_2O_5 ha^{-1} respectively. Maximum per cent soil phosphorus utilization (311.09) was observed by VAM inoculation alone. Application of 50 kg P_2O_5 ha^{-1}, 100 kg P_2O_5 ha^{-1} and VAM+ 100 kg P_2O_5 ha^{-1} recorded uniformly maximum apparent phosphorus recovery of 40.40%. The VAM fungi had shown better performance either alone or in combination with lower levels of inorganic phosphorus.

(Key words : VAM, Phosphorus levels, strawberry)

INTRODUCTION

Phosphorus, being one of the important macro nutrients, is in short supply in many agricultural soils, thereby limits the crop production. At present 49.3% of Indian soils are under low available P_2O_5 category (Pattanayak *et al*., 2009). Soluble phosphates have a low mobility in soil and their uptake creates a depletion zone around root (Hoffland *et al*., 1989). Much of the inorganic P applied to soils as fertilizer is rapidly converted into unavailable forms with low solubility. As about 50% of Indian soils are low in available P and require a large amount of phosphatic fertilizer, of which only 10-15% is available to plants and also the utilization rate of P in mineral fertilizer is merely 10-25% (Finck,1992). Precipitation of inorganic native and applied P is another important factor responsible for poor availability of P to crops. The arbuscular mycorrhizal(AM) symbiosis is an association between the roots of higher plants and soil fungi that promote plant development especially under suboptimal growth conditions. Under mineral depletion conditions AMF enhances plant ability to bridge over the depletion zone and decreases the mineral concentration in close proximity to the root surface. This bridging is mediated by AMF hyphae especially by providing a greater root surface area, which can exploit larger volumes of soil and hence, increase the amount of nutrients being in reach to the roots. Also external fungal hyphae promote absorbance of phosphate (Pi) by the host plant. This promoted Pi absorbance is thought to be attributed to the presence of specific Pi transporters, either plant originated or fungal originated (Benedetto *et al*.,2005). A very scanty information with respect to the use of VAM under temperate conditions is available. Therefore, the present investigation was carried out to study the performace of Vesicular arbuscular mycorrhizae under different levels of phosphorus in strawberry.

MATERIALS AND METHODS

The present experiment was conducted during 2004-06 in Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar. The soil was silty clay loam in texture, neutral in reaction (pH 6.9), non saline (EC 0.65 dSm^{-1}), high in organic carbon (0.75%), low in available nitrogen (99.20 kg ha^{-1}), medium in available phosphorus (10.18 kg ha^{-1}) and potassium (212.16 kg ha^{-1}). The treatments consist of control, VAM inoculation, 50 kg P_2O_5 ha^{-1}, VAM+50 kg P_2O_5 ha^{-1}, VAM+100 kg P_2O_5 ha^{-1}. The plot size for each replication was 3 m x 3 m in a randomized block design with 3 replications. Locally isolated Glomus mosseae (VAM) culture was applied around the root zone of each plant @ 100 kg ha^{-1} after one month of

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application of basal fertilizer doses. The strawberry runners were planted in the last week of November at a distance of 60 x 25 cm. Recommended dose of nitrogen @ 100 kg ha^{-1} (1/2 as basal and ½ just before full bloom) was supplied through urea after adjusting the quantity of N already supplied through di-ammonium phosphate and potassium @ 100 kg K_2O ha^{-1} in the form of muriate of potash which were applied as basal. Farmyard compost @ 10 tones ha^{-1} was mixed at the time of preparation of field. All the cultural practices were adopted as per the standard package of practices. Plant and soil samples were collected at the time of harvesting consisting of 500 g of each rhizosphere soil with roots for determination of root infection and spore density of VAM. The picking of mature fruits was done at alternate days early in the morning. The yield and fruit parameters were recorded as per standard practices. The root colonization was determined by root slide technique in which roots were cut into 1 cm segment and cleared in KOH solution (10%, KOH w/v:30 min, 90^0C) and stained in trypan blue in lacto glycerol (0.05%, 10 min: 90^0C) (Phillip and Hayman, 1970). Mycorrhizal spores were counted after removing them from the soil by wet sieving and decanting (Gerdemann and Nicoloson, 1963). The plant samples were processed, oven dried and digested with HNO_3 : $HClO_4$ (9:4) mixture. Digested materials were used for determination of phosphorus by spectrophotometer as per standard procedure. The soil samples were processed and analyzed for available phosphorus as per the procedure given by Olsen *et al.*(1954). The per cent soil phosphorus utilization was computed by the formula given below.

$$\text{Per cent soil phosphorus utilization (PSPU)} = \frac{U_t}{P_a + A_p} \times 100$$

Where U_t-Uptake of phosphorus in the test treatment: P_a - Phosphorus applied to the test treatment (kg ha^{-1}) and A_p - available soil phosphorus (kg ha^{-1}).

RESULTS AND DISCUSSION

Root colonization and spore population :

Inoculation of VAM fungi alone exhibited significantly higher root colonization (52%) and its spore density (5 g^{-1} soil) over all the treatments, it was followed by root colonization of 45% and 38% with spore densities of 3 and 2 recorded from the treatments VAM + 50 kg P_2O_5 ha^{-1} and VAM+50 kg P_2O_5 ha^{-1} respectively. The latter treatment was at par with control with respect to the spore density. The increasing levels of phosphorus with or without VAM inoculation resulted in significant decrease in the per cent root colonization and its spore density (Table 1). It is clear from these results that high phosphorus levels can inhibit spore germination and growth. These results are in agreement with the findings of Singh and Singh (2008). They reported that inoculation of VAM alone showed significantly higher root colonization (24.80 and 35.86%) and its spore density (118.0 and 240.0 spores 50 g^{-1} soil) but increasing levels of phosphorus with or without VAM inoculation reduced it at tillering and harvest stages of wheat.

The correlation studies revealed that per cent root colonization exhibited significantly positive correlation with spore densities and phosphorus uptake having correlation coefficient values of r=0.851 and r=0.46 respectively. These findings are in agreement with those of Mohan *et al*. (2005) who reported that a positively significant correlation r=0.835 existed between per cent root colonization and spore population of AM fungi.

Plant growth and yield attributes :

Application of different levels of phosphorus with or without VAM inoculation significantly increased the plant growth and yield attributes over control (Table 1). The maximum plant height (34.2 cm) was recorded with the application of VAM+50 kg P_2O_5 ha^{-1}, followed by VAM+100 kg P_2O_5 ha^{-1}, and VAM+50 kg P_2O_5 ha^{-1}, 100 kg P_2O_5 ha^{-1}. Similarly maximum plant spread (28.40 cm^2) was observed by the application of VAM+50 kg P_2O_5 ha^{-1}, followed by 100 kg P_2O_5 ha^{-1}, and VAM+100 kg P_2O_5 ha^{-1}. Significantly highest plant fresh weight (76.80g) was recorded by the use of VAM+100 kg $P_2O_5$$ha^{-1}$,this was followed by 100 kg P_2O_5 ha^{-1} (16.40) was recorded with the addition of VAM+50 kg P_2O_5 ha^{-1}, followed by VAM+100 kg P_2O_5 ha^{-1} were statistically at par with each other with respect to the recorded observations like plant height, spread, fresh weight, number of fruits and fruit weight. Similarly maximum fruit weight (18.45g) was recorded with VAM+100 kg P_2O_5 ha^{-1}, followed by 100 kg P_2O_5 ha^{-1} (18.0) and VAM+100 kg P_2O_5 ha^{-1} (17.96g). From the

Table 1. Effect of VAM and various levels of phosphorus on yield and yield attributes in strawberry (*Fragaria ananassa*, Duch)

Treatments	Plant height (cm)	Plant spread (cm^2)	Plant fresh weight(g)	No. of fruits $plant^{-1}$	Fruit weight(g)
Control	23.3	19.01	66.84	8.00	10.10
VAM	27.8	23.25	70.45	13.00	13.00
50 kg P_2O_5 ha^{-1}	28.0	24.00	71.30	14.00	14.30
VAM+50 kg P_2O_5 ha^{-1}	34.2	28.40	75.40	16.40	18.45
100 kg P_2O_5 ha^{-1}	33.8	28.20	76.00	16.00	18.00
VAM+100 kg P_2O_5 ha^{-1}	34.00	27.90	76.80	16.10	17.96
SE±	0.50	0.35	0.75	0.47	0.54
C D (P=0.05)	2.0	1.4	3.0	1.9	2.18

Table 2. Effect of VAM and various levels of phosphorus on availability and use efficiency indices of phosporus

Treatments	Root colonization (%)	No. of spores (g^{-1} soil)	Phosphorus Uptake (kg ha^{-1})	Available "P" after harvest (kg ha^{-1})	Increase or decrease over initial level of P(kg ha^{-1})	PSPU (%)	APR (%)
Control	8.0	2	15.72	10.00	-0.18	157.20	--
VAM	52.0	5	17.92	10.12	-0.06	311.09	--
50 kg P_2O_5 ha^{-1}	6.0	1	17.92	13.20	+3.02	28.35	4.40
VAM+50 kg P_2O_5 ha^{-1}	45.0	3	35.84	15.80	+5.62	54.46	40.24
100 kg P_2O_5 ha^{-1}	5.0	1	20.16	17.30	+7.12	17.18	4.40
VAM+100 kg P_2O_5 ha^{-1}	38.0	2	20.16	18.10	+7.92	17.07	4.40
SE±	0.9	0.06	0.38	0.70	-	-	-
C D (P=0.05)	1.8	0.23	1.53	2.82	-	-	-
Initial value	-	-	-	10.18	-	-	-

aforementioned results, it is quite evident that VAM had performed better in combination with lower levels of inorganic phosphorus (Table 1). Koltai *et al.* (2010) also reported that low to moderate fertility favours AM symbiosis and most AM spores readily germinate on medium with low nutrient content.

Uptake and availability of phosphorus:

All the treatments showed significantly higher uptake of phosphorus (Table 2) by the strawberry mother plants over control. The highest P uptake of 35.84 kg ha^{-1} was recorded from the treatment combination of VAM + 50 kg P_2O_5 ha^{-1}. Inoculation of VAM fungi alone increased the uptake of P by strawberry mother plants which was at par with the sole application of 50 kg P_2O_5 ha^{-1}. This imporved P uptake by the VAM inoculation may be due to its active involvement in mineral cycling particularly in mobilizing and translocation of P to host plants. The interpretation of this phenomenon is that the mycelia have a high affinity for soluble phosphates (Lanfranco *et al.,* 1999).

Barring the sole inoculation of VAM fungi, all other treatments significantly increased the available P content in soil over control. The highest value (18.10 kg ha^{-1}) for available P was recorded from the plot that received VAM + 100 kg P_2O_5 ha^{-1}. Application of 50 kg P_2O_5 ha^{-1}, VAM+50 kg P_2O_5 ha^{-1}, VAM + 100 kg P_2O_5 ha^{-1} and VAM + 100 kg P_2O_5 ha^{-1} increased the available status to the tune of 29.66,55.20, 69.94 and 77.79% over initial status, respectively. Inoculation of VAM along with 50 kg P_2O_5 ha^{-1} was at par with the application of 100 kg P_2O_5 ha^{-1} with respect to the increase in available P status (Table 2). Pattanayak *et al*. (2009) also reported that improvement in available P status by VAM inoculation may be due to the production of sidrophores by VAM fungi which chelate Fe and release phosphorus for plant availability, beside VAM also secrete phosphatases which mobilize organic P compounds.

Phosphorus use indices :

Maximum per cent soil phosphorus utilization of 311.09% was recorded with inoculation of VAM fungi alone followed by control (157.20%) and VAM + 50 kg P_2O_5 ha^{-1} (54.46%). These results clearly indicate that the increasing levels of P alone decreased by per cent soil P utilization. Further inoculation of VAM fungi alone or in combination with lower levels of inorganic P registered higher per cent of soil P utilization over higher levels of P (Table 2). These results are in agreement with the findings of Singh and Singh (2008), who reported that phosphatases and organic acid production capacity of VAM fungi increased with lower levels of P application, that act as a starter dose of P which help the plants in establishing the strong root system to enter into the symbiotic relationship with VAM fungi. The maximum apparent phosphorus recovery of 40.24% was observed by application of VAM + 50 kg P_2O_5 ha^{-1}, while as a uniform value of 4.4% was recorded by the application of 50 kg P_2O_5 ha^{-1}, 100 kg P_2O_5 ha^{-1} and VAM + 100 kg P_2O_5 ha^{-1}. It is quite evident from these findings that inoculation of VAM fungi may effectively mobilize insoluble fraction of P from the soil only when lower levels of P are used along with VAM fungi. Singh and Singh (2008) also reported that the application of higher levels of P adversely affects the performance of VAM fungi. It can be inferred that VAM fungi has shown better performance either alone or in combination with lower levels of inorganic P with respect to per cent colonization, spore density, yield and yield attributes, phosphorus uptake and P use efficiency indices over no inoculation and in combination with higher doses of P.

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IN VITRO EFFICACY OF VARIOUS INHIBITORS AGAINST SPORE GERMINATION OF *Curvularia andropogonis* INCITING LEAF BLIGHT OF LEMON GRASS (*Cymbopogon flexuosus*)

N. Lakpale[1]

ABSTRACT

Lemon grass (*Cymbopogon flexuosus*) is one of the important aromatic plants attacked by *Curvularia andropogonis* inciting leaf blight disease. In the present laboratory study, inhibitors of various origins were tested for their efficacy against spore germination of the causal organism during the year 2009-10. Findings revealed that systemic fungicides – Propineb (500 ppm), Hexaconazole (500 ppm) and Epoxiconazole (500 ppm), botanicals – neem based Achook (5 ml l^{-1}) and Tricure (5 ml l^{-1}), medicinal plant leaf aqueous extracts of *Kalanchoe heterophylla* (10%), *Curcuma amada* (10%) and *Adhatoda vasica* (10%) and isolates of bio agents – *T. viride* 4 (5%) and *P. fluorescens* 1 (5%) were found very effective i.e. complete inhibition of spore germination.

(Key words : Spore germination, *Curvularia andropogonis,* Lemon grass *(Cymbopogon flexuosus))*

INTRODUCTION

The importance of plants as major source of therapeutic and other agents has assumed greater importance throughout the world. The tribal state Chhattisgarh is very rich in medicinal and aromatic herbs. These herbs are being used from centuries and generations together for therapeutic and other uses. Lemon grass (*Cymbopogon flexuosus*) is one of the important aromatic plants, its leaves having Citral α & β essential oil, which is being used in preparation of perfumes, cosmetics and soaps. Like other crop plants, this crop is also attacked by biotic and abiotic factors. Among biotic factors, diseases have always been considered as a scourge and limiting factors for plant growth and production of quality products (active ingredients having medicinal and aromatic values). Lemon grass is primarily suffered by leaf blight disease incited by *Curvularia andropogonis* (Zimm.) Boedijn.

The typical symptoms are isolated bluish green water soaked lesions found on sheaths and leaves. The lesions are broad in the centre and narrow elongation on tips. The centre of lesion is grey in colour and surrounded by dark brown margin. In later stages, lesions increase in number, coalesce and give blighted appearance leading to drying of leaves.

In the present study, an attempt was made to know the efficacy of fungicides, botanicals, plant extracts and bio-control agents on spore germination of causal organism under laboratory condition (*in vitro*) in order to screen out the effective inhibitors and resultant may be used in field conditions.

MATERIALS AND METHODS

I. Fungicides

Unless and otherwise mentioned, in general spores of causal organism were taken from the infected leaves. Spore suspension was prepared in sterile water in culture tubes and standardized, so as to have above 20-25 spores microscopic field $^{-1}$ under 100 X magnification of compound microscope. One ml standardized spore suspension was mixed with one ml spore germination stimulant i.e. glucose (0.1%). Thereafter, 0.5 ml of this suspension was mixed with 2 ml solution of each fungicide individually. Two drops of this suspension were placed in each cavity of cavity slides (Anonymous, 1947). Cavity slides containing spore suspension without adding fungicidal solution served as control. All these cavity slides were incubated at 25±1^{0}C temperature in BOD incubator. Four replications for each treatment were maintained and observations were recorded for spore germination after 24 hrs of incubation.

II. Botanicals

To know the comparative efficacy of seven botanicals viz., Achook (5 ml l^{-1}), Neem azal T/S (3 ml l^{-1}), Neem gold (20 ml l^{-1}), Tricure (5 ml l^{-1}), Wanis (5 ml l^{-1}), Biotos (2.5 ml l^{-1}) and Neem oil (4 ml l^{-1}) were tested for spore germination. The standard procedure was employed as in case of fungicidal

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testing, in which fungicide was substituted by botanical. A suitable control was maintained without adding botanical. Incubation and observations were done as described earlier.

III. Medicinal plant leaf extracts

In vitro aqueous leaf extracts of different medicinal plants were evaluated for their antifungal activity against spores of the causal organism. The fresh leaves of 25 medicinal plants (Table 3) were collected from medicinal plants garden of IGKV, Raipur (C.G.). The extract of each plant species was prepared in water by taking leaf tissues and distilled water in 1:1 ratio (w/v), boiled for 30 minutes and extracted material was filtered through muslin cloth and filtrate was then passed through Whatman′s filter paper number 42. This filtrate was considered as stock solution. One ml of stock solution was mixed in 9 ml of distilled water to make extract of 10% concentration of each plant species. For evaluation of these extracts, standard procedure was followed as described previously in fungicidal testing and fungicides were replaced by plant extracts. A control was kept without adding plant extract. Incubation and observations were followed as described earlier.

IV. Bio- agents

For this study, isolates of two bio-control agents like *Trichoderma viride* (Tv 1,Tv 3,Tv 4,Tv 5 and Tv 7) and *Pseudomonas fluorescens* (Pf 1 and Pf2) were evaluated against spores of causal organism. Isolates of *T. viride* were multiplied on potato dextrose broth for 7 days and isolates of *P. fluorescens* were multiplied on King′s B medium broth for 48 hrs, individually. Both agents were separated from broth through filtration and centrifugation. Thereafter, supernatant of individual isolate was further diluted to 5% concentration in sterilized water and used separately. Standard procedure was followed as described in fungicidal testing. Different isolates of bio-agents were used individually, in place of fungicides. Proper control was maintained without adding isolates of bio-agent. Incubation and observations were followed as described earlier.

RESULTS AND DISCUSSION

Comparative efficacy of fungicides on spore germination of causal organism :

Data presented in table 1 revealed that all the fungicides were found effective as they inhibited the germination of spores of causal organism as compared to that of control. Fungicides found very effective against spore germination of *C. andropogonis* were Propineb, Hexaconazole and Epoxiconazole (no spore germination) followed by Saaf (Carbendazim + Mancozeb) (2.19%), Propiconazole (3.13%), Mancozeb (3.78%) and Carboxin (4.43%). All these fungicides significantly reduced the spore germination over control. Efficacy of various groups of fungicides conform the findings as reported by earlier worker against *Curvularia* sp. Sahu and Agrawal (2003) found Captafal and Mancozeb; Pathan *et al.* (2003)- Carboxin, Benomyl and Captan; Lasca *et al.* (2004)- Carbendazim + Thiram and captan; Saravanan and Karuppiah (2005)- Mancozeb and Thiram; Khare and Kumar (2006)- Carboxin and Carbendazim; Arshad *et al.* (2009)- Mancozeb and Metalaxyl and Koche *et al.* (2009) found Thiram + Carbendazim effective against *Curvularia* sp.

Efficacy of botanicals on spore germination of causal organism :

Data presented in table 2 clearly showed that all the botanicals tested were found to inhibit the germination of spores of causal organism as compared to that of control. Botanicals found very effective against spore germination of *C. andropogonis* were Achook and Tricure (no spore germination) followed by neem gold (2.63%) and neem azal (17.82%). Effectiveness of *Azadirachta indica* against *Curvularia* sp. was also reported by earlier workers. Saha *et al.* (2005) reported that aqueous extract of *A. indica* and other plant species recorded 100% inhibition of spore germination of *Curvularia* sp. Chakraborty *et al.* (2005) observed that extract of *A. indica* provided more effective protection against the *Curvularia* sp. than the extract of *C. roseus*. Kohli and Diwan (2007) found griseofulvin, Topsin M and neem as best treatment against *Curvularia* sp., Kadam *et al*. (2008) and Enikuomehin (2010) reported spores of *Curvularia* sp. were most sensitive to *A. indica* and *M. paradisiaca*. Result of present study was in agreement with the findings of earlier workers.

Table 1. Comparative efficacy of fungicides on spore germination of causal organism

S.N.	Fungicides	Dose	Spore germination (%)
1	Triadimenfon	100	30.13 (33.27)
2.	Propineb	500	0.00 (0.57)
3.	Carbendazim	500	25.61 (30.40)
4.	Hexaconazole	500	0.00 (0.57)
5.	Propiconazole	500	3.13 (10.14)
6.	Ediphenphos	500	34.47 (35.91)
7.	Epoxiconazole	500	0.00 (0.57)
8.	Carboxin	500	4.43 (12.11)
9.	Chlorothalonil	500	43.19 (41.09)
10.	Tricyclazole	500	39.41 (38.88)
11.	Flusilazole	500	14.19 (22.14)
12.	Mancozeb	1000	3.78 (11.24)
13.	Captan	1000	31.78 (34.33)
14.	Copper oxychloride	1000	10.15 (18.63)
15.	Saaf (Carbendazim + Mancozeb)	1000	2.19 (8.53)
16	Control	-	85.90 (67.94)
	SEm±	-	1.13
	CD (P=0.05)	-	3.16

* Average of four replications
* Data in parenthesis are arc sin transpormed values

Table 2. Efficacy of botanicals on spore germination of causal organism

S.N.	Botanicals	Spore germination (%)
1.	Achook	0.00 (0.57)
2.	Neem-azal	17.82 (24.95)
3	Neem-gold	2.63 (9.28)
4.	Tricure	0.00 (0.57)
5.	Wanis	30.92 (33.77)
6.	Biotos	29.77 (33.02)
7.	Neem-oil	32.41 (34.70)
8.	Control	85.90 (67.94)
	SEm±	2.07
	CD (P = 0.05)	5.29

* Average of four replications
* Data in Parenthesis are arc sin transformed values

Table 3. Effect of medicinal plant leaf extracts on spore germination of causal organism

S.N.	Medicinal plants	Spore germination (%)
1.	Vidhara (*Argyreia speciosa*)	62.81 (52.42)
2.	Bawchi (*Psoralea corylifolia*)	45.60 (42.48)
3.	Patchouli (*Pogostemon patchouli*)	30.31 (33.40)
4.	Bhasmpatti (*Kalanchoe heterophylla*)	0.00 (0.57)
5.	Ghritkumari (*Aloe-vera*)	73.80 (59.21)
6.	Amahaldi (*Curcuma amada*)	0.00 (0.57)
7.	Tikhur (*Curcuma angustifolia*)	35.68 (36.69)
8.	Jangali-onion (*Alium cepa*)	20.13 (26.64)
9.	Lemon-grass (*Cymbopogon flexuosus*)	66.17 (54.45)
10.	Khas (*Vetiveria zizanoides*)	70.19 (56.91)
11.	Roja grass (*Cymbopogon martinil*)	81.09 (64.23)
12.	Tulsi (*Ocimum sanctum*)	16.10 (23.66)
13.	Sadabahar (*Catharantus pusillum*)	80.32 (63.65)
14.	Aswagandha (*Withania somnifera*)	73.19 (58.82)
15.	Brahmi (*Bacopa monnieri*)	59.78 (50.65)
16.	Sarpagandha (*Rauvolfia serpentina*)	54.91 (47.81)
17.	Satawar (*Asparagus racepentina*)	81.04 (64.23)
18.	Kiwach (*Mucuna pruriens*)	72.09 (58.12)
19.	Neem (*Azadirachta indica*)	7.92 (16.32)
20.	Chitrak (*Plumbago zeylanica*)	78.92 (65.65)
21.	Kalmegh (*Andrographis paniculata*)	29.71 (33.02)
22.	Adusa (*Adhatoda vasica*)	0.00 (0.57)
23.	Pudina (*Mentha arvensis*)	33.87 (35.61)
24.	Citronella (*Cymbopogon winterianus*)	46.93 (43.22)
25.	Datura (*Datura stramonium*)	19.46 (26.21)
26.	Control	85.90 (67.94)
	SEm±	1.95
	CD (P=0.05)	4.96

* Average of four replications
* Data in parenthesis are arc sin transformed values

Table 4. Effect of bio-agents on spore germination of causal organism

S.N.	Boi-agents	Spore germination (%)
1.	Tv 1	33.91 (35.61)
2.	Tv 3	39.73 (39.06)
3.	Tv 4	12.19 (20.44)
4.	Tv 5	46.87 (43.17)
5.	Tv 7	59.13 (50.24)
6	Pf 1	19.39 (26.13)
7.	Pf 2	37.18 (37.58)
8.	Control	85.90 (67.94)
	SEm±	2.94
	CD (P=0.05)	7.58

* Average of four replications
* Data in parenthesis are arc sin transformed values

Effect of medicinal plant leaf extracts on spore germination of causal organism :

Data presented in table 3 clearly showed that all the tested medicinal plant leaf extracts were more or less able to inhibit the germination of spores of causal organism as compared to that of control. Medicinal plant leaf extracts found very effective against spore germination of *C. andropogonis* were *Kalanchoe heterophylla, Curcuma amada* and *Adhatoda vasica* (no spore germination) followed by *Azadirachta indica* (7.92%) and *Ocimum sanctum* (16.10%). Effectiveness of extracts of *Azadirachta indica* and *Ocimum* sp. against *Curvularia* sp. were also reported by various workers. Saha *et al.* (2005) reported that aqueous extract of *A. indica* and other plant species recorded 100% inhibition of spore germination of *Curvularia* sp. Chakraborty *et al.* (2005) reported that extract of *A. indica* provided more effective protection against the *Curvularia* sp. than the extract of *C. roseus*. Kohli and Diwan (2007) recorded griseofulvin, Topsin M and neem as best treatment for *Curvularia* sp. Kadam *et al*. (2008) found that extract of *A. indica* inhibited the growth of *Curvularia* sp. and Enikuomehin (2010) found spores of *Curvularia* sp. were most sensitive to *A. indica* and *M. paradisiaca.* Ghante *et al.* (2006) recorded the maximum germination percentage of seeds in *Ocimum* treatment due to lowest infection of mould including *Curvularia* sp. Amadi *et al.* (2010) recorded the impairment of radial growth causal organism by the addition of *Ocimum* aqueous extract in the culture medium. Findings of these researchers were support the present findings.

Effect of bio-agents on spore germination of causal organism :

Data presented in table 4 clearly indicate that all the tested isolates of bio-agents succeeded more or less in inhibiting the germination of spores of causal organism as compared to that of control. Isolates of bio-agents found very effective against spore germination of *C. andropogonis* were *Trichoderma viride* 4 and *Pseudomonas fluorescence* 1. Several other workers also reported the effectiveness of both the organisms. Singh *et al.* (2003) found *T. harzianum* and *P. fluorescence;* Naik and Hiremath (2003) - P. *fluorescence;* Indira and Muthusubramaniam (2003) - *Trichoderma* sp. and *Pseudomonas* sp.; Saravanan and Karuppiah (2005) - *P. fluorescence;* Trujillo *et al*. (2007) and Gawade *et al*. (2009) reported *P. fluorescence* and *T. viride* were very effective against *Curvularia* sp. Thus, theonfirm the findings of these workers.

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ASSESSMENT OF FARMERS PARTICIPATION AND BENEFITS PERCIEVED FROM VARIOUS AGRICULTURAL TECHNOLOGIES DISSEMINATION IN CHHATTISGARH

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ABSTRACT

Increase in productivity and production could only be achieved by adopting new technological interventions in the farming. Various efforts from government as well as non-government organizations are regularly applied but the results are still not satisfactory in accordance with potential of the sector important extension programs being implemented in Chhattisgarh state were assessed to know the participation and benefits received by the farmers with a sample size of 144 farmers equally contributed by marginal, small and big farmers. The data were personally collected in the year 2008. The findings show that most of the farmers were middle to old age and having medium socio-economic status. Farmers' participation were not found much in the selected programs however, higher participation were recorded in the IPM, oilseed and pulse related programs and big farmers were having more participation. In other hands majority of the respondents perceived that they were acquired maximum benefits from rice, oilseed-pulse and IPM related programs. The benefits expressed by few respondents in terms of new implements, time saving, training and cost effectiveness. The marginal, small and big farmers expressed benefits in varying manners. Taking all the programs in to consideration, it is revealed that benefits were more in rice, oil seeds and pulses, IPM sugar cane and farm machanization. These findings may be considered as beacon of light for the extension functionaries to intensify their efforts, seeking higher participation of farmers in every stage of each program implementation so that the outcome can be realized by the farmers up to the satisfaction level.

(Key words : Farmers' participation, technology dissemination, extension programmes)

INTRODUCTION

The impact of extension programmes are broadly based on the reliability and sustainability of the technology dissemination system. The sustainability of extension system has been discussed at many levels. Shortage of human resources in agricultural extension, inadequate knowledge level and differential work load and budget allocation if taken together we may find that present system is not as sustainable as desired. In the state like Chhattisgarh, out of the total population of above 2 crores, about 80% of them depend on agriculture. Rice is the principal crop, and other crops are, pulses, oilseeds, sugarcane and some horticultural crops under cultivation. In the agricultural map of India, the position of Chhattisgarh is not much encouraging in terms of productivity. So far as sustainability of extension is concerned, the government does invest a significant amount for field activities like demonstrations, inputs and incentives as required. But after the input is taken out, the same feeling towards adoption does not exist. To make the dissemination programmes successful, effective participation of farmers is essentially required. Marketing credit, processing and value addition, product planning, marketing information alterative marketing, and linkage with research and developing agencies would enrich our system of approaching farm families to a considerable extent. To make the dissemination programmes successful, effective participation of farmers is essentially required.

Market led extension system provides authentic, broad based and need based information about tested technologies, quality inputs, and dependable markets, considering the resources of the farmers and infrastructure available in the area for holistic development, irrespective of their socio-economic conditions. Poor involvement of farmers, short supply of extension workers, lack of adequate technical knowledge, loaded with more work with inadequate time and money, the extension system has not been able to deliver expected services at the door step of the farmeres particularly in crucial times. The extension density in terms of number of farmers per extension worker varies considerably through out the globe. It was commonly felt that evaluation of on-going extension projects in the light of awareness and participation and the status of clientele be given priority. The study was selected to add into the domain of tansfer of technology. No such studies were undertaken for assessing the effectiveness of such programmes. Keeping the above-mentioned status, an attempt was made to investigate into the

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analysis of farmers′ participation and benefits received from the important agricultural extension programmes implemented which may be the key for the success of any program as reported by Singh and Prasad (2000) that IRDP programme has contributed for improving the standard for living (72.5%), increase in dietary standard (66.5%) and consciousness about education of children (61.5%). However, the changes perceived by the respondents above 25 per cent emerged as, status in caste and communities have improved (44%), able to maintain social relation (30%), and habit of small savings developed (29%).

MATERIALS AND METHODS

Chhattisgarh sate comprising of three Agro-climatic Zones i.e. Chhattisgarh plains, Bastar Plateau and Northern Hills having 18 districts. For this investigation, Raipur, Durg, Dhamtari and Mahasamund districts of Chhattisgarh plain zone were considered purposively because this patch of the districts have homogenous characteristics in implementing the technology extension program. By applying random sampling technique, two blocks from each of the four selected districts (total 8 blocks) were identified. From each selected block two villages (total 16 villages) were selected for this study randomly. From each selected village, equal number of respondent belonging to marginal small and big farm families were selected. The final selection thus consisted of 48 marginal, 48 small and 48 big farmers with total 144 respondents. The study was designed within the farmework of ex-facto research. Five important extension programmes related to rice, sugarcane, oilseeds and pulses, integrated pest management (IPM) and agricultural implements were taken into consideration for this study. The data were collected for socio-economic profile, participation and benefit perceived from the selected programme. The respondents were personally interviewed using pre-tested interview schedule in hindi during the year 2008 for Ph.D. degree of Pt. Ravishankar University, Raipur.

RESULTS AND DISCUSSION

Socio-economic characteristics of respondents :

Most of the respondents belonged to middle age group and educated upto the middle school level (Table 1). The percentage of higher/college educated respondents were more in big farmers than the marginal and small farmers. Other backward castes were dominating among all categories of respondents followed by general caste respondents. A total of about 52,50 and 42 per cent of marginal, small and big respondent respectively were having less than 6 members in their families. A considerable number (35.42%) of joint families were also residing in the study area. Regarding annual income of respondents, more than 47 per cent marginal and 41 per cent small farmers earned less than Rs. 40000 annum^{-1} family^{-1}. In case of big farmers the distribution was mostly varied from Rs. 40000 to Rs. 1.2 lacks annum^{-1}. The finding concludes that the marginal and small farmers were involved in more occupations to sustain their livelihood because small size of holdings can not produce enough to cater the needs of whole family round the year. Contrast to that big farmers were engaged in agriculture as primary occupation followed by animal husbandry and some other businesses. The investigation revealed that all the respondents were taking short term credits especially for agricultural inputs i.e. seeds, fertilizers, pesticides etc. The big farmers were also taking short term credit mostly for the labour payment. The marginal and small farmers were reluctant to acquire medium and long term credit, may be because of their poor economic base and repaying capacity. Khan (2002) also reported that the farm credits were mostly utilized by the big farmers due to their better repaying capacity. About 25 and 6 per cent of the big respondents respectively had also borrowed medium and long term credit from various institutions. This loan was mostly taken for buying implements and other farm machinery items. In all about 21 per cent of the respondents did not take loan as also reported by Singh and Bhagat (2002). Non repaying capacity was due to low returns from and lack of remunerative crop were the major factors for non repayment of agricultural loans (Virk *et al.,* 2003).

Participation in rice programme :

Participation of farmers on ten specific areas related with rice cultivation observed to be in great variations (Table 2). Maximum respondents were taking up new varieties of rice. The other areas of

participation were contact with extension personnel, harvesting, demonstration and trainings. The minimum participation was observed in the activities like planning and group action. In short program on rice has not been able to register impact on educational aspect. Comparing three groups of farmers it is observed that marginal and small farmers were much behind of the big farmers. Similarly Helen *et al.* (2004) reported that high yielding varieties of rice created a greater impact among the participating farmers. Chaudhary *et al.* (2008) and Prakash *et al.* (2005) pointed out that technological gap exist in adoption of rice cultivation practices.

Participation in surgarcane programme :

Data contained in table 3 revealed that participation in case of attending meetings on surgarcane was highest followed by more production and contact with extension agencies. The other areas of participation were found to be technical guidance, demonstration, harvesting, use of new varieties and group action. The participation in case of group action and planning the program was found minimum. Again, samll and marginal farmers were lagging much behind compared to big farmers in all activities of sugarcane improvement programmes. Experiences revealed that the farmers need to be trained in the activities so that their contribution can be ensured by imparting knowledge as suggested by Arya *et al.* (2003).

Participation in oilseeds and pulses programme :

The country is paying more attention to boost up productivity of oilseeds and pulses. The major oilseeds are goundnut, soybean, mustard, sesame, niger and linseed where as important pulses include gram, mung, urid, pigeonpea, lentil and peas. Taking all these crops into consideration, the participation of respondents was considered as given in table 4. The program has been able to register good impact as evidenced from participation in meeting demonstration more production and trainings. There has been good response for technical guidance and contact with extension agencies. The marginal and small farmers were much behind than big farmers for participation in many activities. As per results planning at village level and introduction of new varieties are two important aspects which appear to be neglected. It needs close relation with research unit to take up breeding programmes on pulses keeping the location specific requirements. Similarly, Rathore *et al.* (2003) suggested for regular training capacity building and method demonstration to achieve higher participation and production from mustard crop.

Participation in Intergrated Pest Management (IPM):

IPM is of greater importance from ecological and cost of production point of views. To create interest in the mind of farmers about IPM the Government had made a number of attempts. Information contained in table 5 shows that the extent of participation of respondents was in progress. A look at the table reveals that participation in case of contact with extension agencies looking for technical guidance training and meeting were found in descending order. Among three groups participation was the highest in case of big farmers. The overall picture reveals that IPM had not registered good impact on the farmers. So far as participation in various activities is concerned. The concept of IPM should be carried out to the farmers effectively.

Participation in farm mechanization :

Mechanization is one of the answers to reduce cost of labour. The study of participation of sample farmers in farm mechanization revealed (Table 6) that the participation of farmers in farm implements was very poor. There was some response in case of attending meeting demonstration visiting exhibits and sale centres The marginal and small farmers were not involved in the programme as evidenced from their poor participation. The poor response as reflected above may be due to a variety of reasons. The introduction of high-tech and skill proved to be of major concern not only in the field of agriculture but also in all other cases. Dadheech *et al.* (2008) reported that the exposure to reliable source of information was one of the important factors for farmer′s participation in agriculture programmes.

Overall participation in 5 important programmes

Again within the framework of the study an attempt was made to investigate into the differential participation of three categories of farmers in farm

mechanization as given in table 7. Data analysis reveals that participation was highest in cases of IPM followed by oilseeds and pulses sugarcane and rice in order. However minimum participation was observed in case of Farm Mechanization. Further farmer group wise the participation was found to be the highest with big farmer followed by small and marginal farmers.

Correlation between attitude towards programme and overall participation :

Further, attempt was made to correlate attitude with participation in different programmes. The attitude towards program was measured in three-point scale like Agree, Disagree and Neutral. The correlation value is given in table 8. The correlation value indicates that at all levels the attitude and participation was found to be significantly correlated. In case of farm implements the farmers have not developed positive attitude and therefore, their participation was low. The 'r' value of significance revealed that farmers have not yet given adequate attention in case of sugarcane and mechanization.

Benefits perceived from rice development programme :

Rice development programme is operating in Chhattisgarh to provide technical back up, subsidized input and marketing support through price policy. In finding out benefits derived from the programme the responses were compiled in the tabel 9. The table reveals that farmers expressed benefits in terms of new varieties, more production, training, exposure and profit in that order. In our society the small and marginal farmers always remain at the end. Their poor standing in society, limited resources, non-contact and traditional ways of living have not made them capable of taking benefits. In all cases, the benefits are less than 50%. Again in terms of benefits a clear-cut difference is marked among three groups of farmers. Prakash *et al.* (2003) rightly pointed out that knowledge plays important role in rice production.

Benefits perceived from sugarcane imporvement programme :

Data contained in table 10 reveals that programme on sugarcane has benefited farmers in terms of exposure to technology, training, new varieties, production and profit. The big farmers have gained more than marginal and small farmers. The profit in case of sugarcane is market linked and processing linked and varied time to time. Attempts to mere increase in production did not help the situation without ensuring profit to the farmers because of high fluctuation of market price. The farmers, market, government policy have to move at the same direction. It is not surprising that many of the good farmers are closing their farm business owing to uncertainty in price structure.

Benefits perceived from oilseeds and pulses :

The state covers 8.7 and 2.8 lacks hectares under pulses and oilseeds. The participation of marginal and small farmers was more in oilseeds and pulses. A look at the table 11 reveals that sample farmers have obtained benefits from the programmes of oilseeds ad pulses in the counts of exposure to new technology, training, more of products profit and new varieties. Programmes on oilseeds and pulses have covered good numbers of marginal small and big farmers. The crops under oilseeds and pulses are close to the farmers because these crops are grown mostly in rainfed areas. These crops ensure some benefits even at the worst situation. More profits depend upon more production and good market. The government agencies have not correlated these aspects for which farmers have to bear loss. Rathore *et al.* (2002) rightly pointed out that training and contact with extension agents is helpful in improving productivity of mustard crop.

Benefits perceived from integrated Pest Management (IPM) :

There has been a constant effort to reduce chemical pesticides because of its adverse residual effects. The benefits derived from IPM are recorded in table 12. Reactions of respondents revealed that they perceived these in terms of less use of chemical pesticides decrease in investment in farming reduction in cost and training. The gap exists between marginal small and big farmers in perceiving benefits of IPM. It is interesting to note that pest control was not achieved to greater extent in case of IPM. It may be due to fact that adoption of recommendations has not increased or the correct adoption has not been

Table 1. Percentage distribution of respondents according to their socio-economic characteristics

Characteristics	Percentage distribution of respondents			
	Marginal (N=48)	Small (N=48)	Big (N=48)	Pooled (N=144)
Age				
Young (<35 years)	27.08	29.17	18.75	25.00
Middle (35 to 50 years)	39.59	43.75	35.42	39.58
Old (<50 years)	33.33	27.08	45.83	35.42
Education				
lliterate	4.17	6.24	0.00	3.48
Primary	33.33	25.00	20.83	26.39
Middle school	35.42	41.67	37.50	38.19
High school	25.00	22.92	29.17	25.69
College and above	2.08	4.17	12.50	6.25
Caste				
Scheduled Caste	12.50	4.17	8.33	8.33
Scheduled Tribe	8.33	6.25	2.08	5.56
Other Backward Class	62.50	81.25	64.59	69.44
General	16.67	8.33	25.00	16.67
Family size				
Small (up to 5 members)	52.08	50.00	41.66	47.92
Medium (6 to 8 members)	16.67	22.92	18.75	19.44
Big (9 to 12 members)	22.92	20.83	29.17	24.31
Very Big (> 12 members)	8.33	6.25	10.42	8.33
Family type				
Nuclear	66.67	70.83	56.25	64.58
Joint	33.33	29.17	43.75	35.42
Annual Income				
Upto Rs. 40,000	47.92	41.67	18.75	36.10
Rs. 40,001 to Rs. 80,000	22.92	25.00	25.00	24.31
Rs. 80,001 to 1,20,000	20.83	27.08	31.25	26.39
Rs. 1,20,001 to Rs 1,60,000	8.33	6.25	14.58	9.72
Rs. 1,60,001 and above	0.00	0.00	10.42	3.47
Occupation				
Agriculture alone	0.00	2.08	4.17	2.08
Agri.+Animal husbandry	8.33	12.50	43.75	21.53
Agri.+Service/labour	70.84	56.25	12.50	46.53
Agriculture+Business	12.50	22.92	25.00	20.14
Agri.+other occupations	8.33	6.25	14.58	9.72
Credit acquistion *				
Nil	29.17	20.83	12.50	20.83
Short term credit	70.83	85.42	83.33	79.86
Medium term credit	0.00	2.08	25.00	9.03
Long term credit	0.00	0.00	6.25	2.08

*Multiple responses

Table 2. Participation in rice development programme

(N=144)

Areas of participate	**MF**	**SF**	**BF**	**Pooled**	
				No.	**Per cent**
1. Attending meetings	15	16	20	51	39.41
2. Attending training	6	6	8	20	13.88
3. Attaining more production	14	15	19	48	33.33
4. Group action	3	8	7	18	12.50
5. Demonstration	2	10	12	24	16.66
6. Harvesting	3	12	14	29	20.13
7. Program planning	0	2	8	10	6.94
8. Use of new varieties	15	20	25	60	41.66
9. More of technical guidance	8	9	11	28	19.44
10 Contact with extension agencies	10	15	18	43	29.86

Table 3. Participation iin sugarcane development programme

(N=144)

Areas of participate	MF	SF	BF	Pooled	
				No.	Per cent
1. Attending meetings	15	16	20	51	35.41
2. Attending training	13	13	18	44	30.93
3. Attaining more production	12	16	18	46	31.94
4. Group action	8	10	12	32	22.22
5. Demonstration	10	12	15	37	25.89
6. Harvesting	4	11	21	36	25.00
7. Program planning	2	8	13	23	15.97
8. Use of new varieties	6	12	15	33	22.91
9. More of technical guidance	6	15	16	37	25.59
10 Contact with extension agencies	8	18	20	46	31.94

Table 4. Participation in the programmes of oilseeds and pulses

(N=144)

Areas of participate	MF	SF	BF	Pooled	
				No.	Per cent
1. Attending meetings	23	28	40	91	63.19
2. Attending training	12	15	18	45	31.25
3. Attaining more production	10	17	19	46	31.94
4. Group action	8	10	12	30	20.83
5. Demonstration	10	22	28	60	41.66
6. Harvesting	9	12	19	40	27.77
7. Program planning	3	2	6	11	7.63
8. Use of new varieties	8	8	10	26	18.05
9. More of technical guidance	89	12	14	35	24.30
10 Contact with extension agencies	10	10	15	35	24.30

Table 5. Participation in IPM

(N=144)

Areas of participate	MF	SF	BF	Pooled	
				No.	Per cent
1. Attending meetings	5	6	20	31	21.52
2. Attending training	6	7	18	31	4.52
3. Demonstration	3	9	8	20	13.88
4. Technical guidance	10	10	12	32	22.22
5. Contact with extension agencies	12	10	13	3	24.36
6. Field visit	3	2	8	13	5.55

Table 6. Participation in farm mechanization

(N=144)

Areas of participate	MF	SF	BF	Pooled	
				No.	Per cent
1. Attending meetings	5	8	13	26	18.05
2. Attending training	0	2	5	7	4.86
3. Demonstration	2	6	8	16	11.11
4. Implement exhibition	0	2	10	12	8.33
5. Visit to sale centre	0	0	0	8	5.55

Table 7. Differential participation in all five important programmes (Average)

Programmes related with	MF	SF	BF	Pooled
1. Rice	16.66	22.91	29.16	22.91
2. Sugarcane	16.66	27.08	25.41	23.61
3. Oilseed and pulses	20.53	29.16	37.50	27.10
4. IPM	12.50	14.58	27.08	33.33
5. Farm mechanization	2.08	4.16	18.75	9.72
Average	**13.68**	**19.58**	**29.58**	**23.74**

Table 8. Correlation ('r' value) between attitude and over all participation

Programme related with	MF	SF	BF
1. Rice	0.56*	0.78*	0.79*
2. Sugarcane	0.44*	0.69	0.89*
3. Oilseed and Pulses	0.67*	0.68*	0.70*
4. IPM	0.24	0.46*	0.65*
5. Farm Mechanization	0.21	0.14	0.25**

** & ** Significant at 5% and 1% level*

Table 9. Benefits perceived from rice development programmes

Benefits	MF	SF	BF	Pooled	
				No.	Per cent
1. New varieties	20	21	27	68	47.22
2. More production	16	17	25	58	40.27
3. More profit	12	13	18	43	29.86
4. Training & skill	15	18	20	53	38.80
5. Exposure to technology	15	19	22	56	38.88

Table 10. Benefits perceived from sugarcane imporvement programme

Areas of participate	MF	SF	BF	Pooled	
				No.	Per cent
1. New varieties	12	12	16	40	27.77
2. More production	11	10	8	29	20.13
3. More profit	6	7	9	22	15.27
4. Training & skill	15	18	23	56	38.88
5. Exposure to technology	20	25	25	70	48.61

Table 11. Benefits perceived from oilseeds and pulse programme

Benefits	MF	SF	BF	Pooled	
				No.	Per cent
1. New varieties	15	16	17	48	33.33
2. More production	12	14	21	49	34.02
3. More profit	10	18	23	51	35.41
4. Training & skill	18	20	25	63	43.75
5. Exposure to technology	19	23	25	67	46.52

Table 12. Benefits perceived from Integrated Pest Management programme

Benefits	MF	SF	BF	Pooled	Percentage
1. Less use of chemical pesticides	25	25	36	86	59.72
2. Decrease in investment	19	22	27	68	47.22
3. Reduction in labour cost	18	20	22	60	41.66
4. Better control of pests	12	18	23	50	34.72
5. Training and skill	15	18	21	54	37.50

Table 13. Benefits perceived from Farm Mechanization

Benefits	MF	SF	BF	Pooled	
				No.	Per cent
1. New implements	0	0	3	3	2.08
2. Labour saving	3	5	8	16	11.11
3. Cost effective	0	0	5	5	3.47
4. Time saving	0	0	10	10	6.94
5. Training and skill	3	2	5	10	6.94

Table 14. Overall benefits perceived from all selected programmes

Programme	Benefits (Average)
1.Rice Development	38.84
2. Sugarcane improvement	30.13
3. Oilseeds and pulses	38.60
4. Integrated Pest Management	37.22
5. Farm Mechanization	6.10

MF= Marginal Farmers SF= Small farmers BF= Big farmers

achieved so far, may be because of poor economic status of farmers as stated by Chander and Singh (2003), that economic constraints were most serious in adoption of IPM technologies. The attempt to increase adoption of IPM practices should be given increased attention and support.

Benefits perceived from farm mechanization :

Modern farming system needs use of farm machineries like tractor, power tiller, harvester and electricity in farming. Results reveal that some respondents were benefitted from the programmes on farm implements. However, big farmers expressed benefits in labour and time saving and training. As the use of costly implement is limited and the farmers have yet to receive skill for operation, it is obvious to observed result as shown above. There have been a number of studies on these aspects but the results have not been very encouraging.

Overall benefits perceived :

Comparing the benefits of all the five programmes to the respondents, the following results were obtained. The results reveal that rice, sugarcane, oilseeds and pulses and IPM have been perceived equally in giving benefits to farmers. However, farm mechanization is yet to play role and hence needs more extension efforts. The farmers of Chhattisgarh have yet to imbibe the ideas of mechanization. Kumar and Arya (2003) studied the rice growers of Meghalaya and Arunachal Pradesh and they reported that involvement of farmers in rice cultivation will enhance the production and benefit.

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CORRELATION AND PATH ANALYSIS IN DOLICHOS BEAN (*Dolichos lablab* L.) FOR CHHATTISGARH PLAINS

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ABSTRACT

Correlation and path coefficient analysis for sixty three genotypes of Dolichos bean were evaluated during *kharif* and *rabi* seasons of 2009-10. The studies revealed that number of pods plant^{-1} had highly significant and positive association with pod width, pod length and leaf length at phenotypic and genotypic level. Among the component traits, significant and positive correlation was observed among the pair of traits *viz*., pod width, pod length, leaf length, number of seeds pod^{-1}, number of flowers inflorescence^{-1}, number of pods inflorescence^{-1} and number of seeds pod^{-1} at both genotypic and phenotypic levels. Studied IS-32 genotype was the earliest to flowering in 44 days and pods matured in 58 days. IS-02 recorded average maximum pod length (15.30 cm) and also had average highest length of inflorescence (27.30 cm). Maximum pod yield was recorded in IS-02 (0.279 kg plant^{-1}). The highest green pod yield (155.09 q ha^{-1}) recorded in genotype IS-02, however the genotype IS-48 recorded the lowest green pod yield (66.78 q ha^{-1}). Path coefficient analysis revealed that among the developmental characters *viz*., green pod yield plant^{-1} (kg), hundred seed weight, number of pods plant^{-1}, number of pods inflorescence^{-1}, pod length, leaf width and inflorescence length showed high direct effect and significant positive correlation except number of flowers inflorescence^{-1} and leaf length.

(Key words: Path analysis, correlation, dolichos, genetic diversity)

INTRODUCTION

Dolichos bean or Hyacinth bean or Egyptian bean or Sem (*Dolichos lablab* L.) is an important vegetable crop throughout India and especially in Chhattisgarh due to its local acceptability by the people. Chhattisgarh has a wide range of genetic variability in Dolichos bean with variable plants type (determinate / indeterminate), pod characteristics for shape (small, medium, long etc.) and colour (dark green, light green, maroon, red etc.). It is primarily grown for green pods, which are cooked as vegetable like other beans. The foliage of the crop provides hay, silage and green manure. It contains 30% protein on dry weight basis, out of which albumin, globulin, prolamin and glutein accounted for approximately 20%, 48%, 1% and 31% respectively of the total proteins.

In Dolichos bean, correlation studies of yield and its components characters are useful in developing an effective basis of phenotypic selection and path analysis further helps to elucidate the intrinsic nature of the observed association and impact confidence in the selection of breeding programme. Considering these points, a study was undertaken at Department of Horticulture, I.G.K.V., Raipur (C.G.), to study about relationship among green pod yield and its components and determines the correlation and path analysis, on which selection can be used for genetic improvement in the green pod yield and promote Dolichos bean cultivation in Chhattisgarh plains.

MATERIALS AND METHODS

The experimental material comprised of sixty three diverse genotypes of Dolichos bean. The trials were conducted during *kharif* and *rabi* seasons of 2009-10 at Department of Horticulture, Horticulture Farm, under All India Coordinate Research Project on Vegetable Crops, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The experiment was conducted in Randomized Block Design with four replications. Each entry was sown in 3.6 m x 3.0 m plot area with a spacing of 60 cm x 30 cm in between row and within row respectively. All the standard agronomical practices and plant protection measures were followed timely to raise a crop successfully. Five plants were selected randomly from each plot for recording different yield attributing and quality related traits *viz*., days to first flowering, days to last pod harvest, inflorescence length, number of flowers inflorescence^{-1}, number of pods inflorescence^{-1}, pod length, pod width, number of pods plant^{-1}, hundred seed weight, plant growth habit, stem colour, leaf vein colour, flowering behaviours, pod colour, pod suture colour, pod shape,

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pod curvature, pod surface, parchment layer, seed shape and biotic stress susceptibility. However , green pod yield, days to first picking, days to last picking and other quality related traits *viz*., plant growth habit, stem colour, leaf vein colour, flowering behaviours, pod colour, pod suture colour, pod shape, pod curvature, pod surface, parchment layer, seed shape and biotic stress susceptibility were recorded on plot/plant basis. The date of sowing of sixty three genotypes was 9th July 2009, with the first earliest flowering date recorded on 22 August 2009, whereas last pod harvest date noticed on 5 February 2010. After recording yield attributing traits data, the genotypic and phenotypic correlation coefficient were partitioned into direct and indirect effects by path analysis as suggested by Dewely and Lu (1959).

RESULTS AND DISCUSSION

Analysis of variance revealed significant difference among the genotypes under study. The mean performance of tested genotypes for different yield and yield traits are presented in table 1. In the present study, genotype IS-02 recorded significantly higher green pod yield (155.09 q ha^{-1}) than all the other genotypes. However, the genotype IS-54 ranked 2nd for green pod yield (152.31 q ha^{-1}) followed by IS-18 (151.85 q ha^{-1}), though the lowest green pod yield (66.78 q ha^{-1}) was recorded in IS-48. The genotype IS-02 also recorded longest pod length (15.30 cm) followed by IS-33 (15.22 cm) whereas least pod length was recorded in IS-08 (4.12 cm). The maximum pod width was recorded in IS-37 (3.76 cm) followed by IS-53 (3.63 cm) and the least pod width was recorded in IS-19 (1.10 cm).The largest inflorescence length was recorded in IS-02 (27.30 cm) followed by IS-01 (27.00 cm) whereas, minimum length of inflorescence was recorded in IS-53 (8.90 cm). The highest number of pods inflorescence^{-1} was recorded in genotype IS-08 (11.75) though the average number of pods inflorescence^{-1} was the least in IS-57 (4.50). Maximum leaf length was recorded (14.45 cm) in IS-33, followed by IS-55 (14.17 cm), whereas, minimum leaf length was recorded in IS-08(9.37 cm). Maximum leaf width was recorded in IS-33 (13.51 cm) followed by IS-57 (13.37 cm) whereas, minimum leaf width was recorded in IS-30 (8.35 cm). Maximum number of seeds pod^{-1} was counted 6.25 in IS-50 which was followed by IS-12 (5.50) whereas, national check Swarna Utkrishti recorded 3.75 number of seeds pod^{-1}.

The correlation coefficient at phenotypic and genotypic levels for green pod yield and developmental characters are presented in table 2. Characters like leaf length, pod length and pod width showed significant and positive correlation with green pod yield plant^{-1} (kg) at phenotypic and genotypic levels. Among the component traits highest significant and positive correlation was observed by the character pod width followed by pod length and leaf length at phenotypic level. Whereas at genotypic level highly significant and positive correlation was recorded by the character pod width followed by pod length and leaf length. While number of pods plant^{-1} did not show significant and positive correlation at genotypic level. The above results supported the revelations of Baswana *et al.* (1980) who reported that plant height had positive significant association with seed yield. Pandita *et al.* (1980) reported that length of inflorescence and pod length were highly and positively correlated with yield. Golani *et al*. (2007) found that pod width had positive and strong correlation with yield.

Path analysis at genotypic level (Table 3) revealed that number of pods plant^{-1} (0.547) showed the highest positive direct effect on green pod yield, though it had negative indirect contribution of leaf width, number of flowers inflorescence^{-1}, pod length , pod width , respectively. Hundred seed weight (0.461), number of pods inflorescence^{-1} (0.178) and pod length (0.176) showed the highest positive direct effect on green pod yield. The character number of flowers inflorescence^{-1} had highly significant correlation with green pod yield, although it showed negative direct effect (- 0.107) due to higher positive indirect effect of leaf length and inflorescence length. The above results agree with Baswana *et al.* (1980) and Bendale *et al.* (2008) who reported that the developmental characters *viz*., plant height, primary branches plant^{-1}, number of leaves plant^{-1}, leaf area plant^{-1}, days to flower appearance and first pod maturity had direct effect on seed yield plant^{-1} at phenotypic level, while the characters plant height, primary branches plant^{-1}, days to flower appearance and first pod maturity had direct effect on seed yield plant^{-1} at genotypic level.

Table 1. Mean values for various green pod yield and yield attributing characters of Dolichos bean

Character No. →		1	2	3	4	5	6	7	8	9	10
Sr. No.	Genotype ↓	Leaf length (cm)	Leaf width (cm)	Inflorescence length (cm)	No. of flowers inflorescence^{-1}	No. of pods inflorescence^{-1}	Number of pods plant^{-1}	No. of seed pod^{-1}	Pod length (cm)	Pod width (cm)	Marketable Green pod yield plant^{-1} (kg)
01	**IS-01**	11.82	10.21	27.00	26.50	11.5	49.75	4.25	6.22	1.58	0.256
02	**IS 02**	11.42	11.63	27.30	24.50	8.50	45.75	5.25	15.30	1.46	0.279
03	**IS 03**	12.55	11.22	22.30	23.25	6.00	40.75	4.75	07.15	1.41	0.202
04	**IS-04**	12.42	11.07	21.15	24.75	7.50	35.00	4.75	10.00	1.59	0.252
05	**IS 05**	12.45	11.50	20.25	24.50	6.00	28.75	4.75	07.62	1.56	0.173
06	**IS 06**	12.00	11.28	21.65	21.75	6.75	39.50	4.75	06.62	1.87	0.203
07	**IS 07**	11.75	11.31	19.70	25.50	8.50	36.75	5.00	06.82	1.65	0.245
08	**IS 08**	9.375	09.30	15.00	21.50	11.75	33.25	4.00	04.12	1.68	0.141
09	**IS 09**	10.76	10.87	18.45	28.25	8.50	36.25	5.00	06.5	1.70	0.211
10	**IS 10**	09.75	09.04	21.52	27.00	9.50	33.50	4.75	07.33	1.66	0.196
11	**IS 11**	12.12	11.52	21.00	27.50	7.25	34.00	5.00	12.70	1.54	0.271
12	**IS-12**	11.05	10.62	24.90	28.75	9.75	33.50	5.50	12.50	1.62	0.263
13	**IS-13**	12.70	12.60	21.20	27.00	9.25	28.00	4.75	08.96	2.17	0.163
14	**IS-14**	12.75	11.26	17.00	22.25	7.25	33.50	5.00	09.77	1.72	0.269
15	**IS-15**	12.94	11.58	22.55	23.50	9.50	24.25	4.50	07.68	2.23	0.137
16	**IS 16**	10.95	09.90	22.35	22.75	7.50	27.50	4.50	06.72	2.23	0.163
17	**IS-17**	11.57	10.94	22.20	24.00	9.25	31.50	5.25	12.87	1.47	0.253
18	**IS-18**	11.11	10.28	22.35	25.50	9.00	34.00	4.75	07.42	1.45	0.273
19	**IS-19**	10.23	08.74	15.20	16.50	11.25	27.25	4.25	09.56	1.10	0.161
20	**IS-20**	12.27	11.95	20.75	26.00	7.25	46.50	4.75	09.85	1.33	0.257
21	**IS-21**	10.15	10.39	25.15	25.75	5.25	42.50	3.25	08.47	1.35	0.175
22	**IS-22**	11.75	10.84	16.40	22.00	7.00	34.00	4.25	07.70	1.37	0.211

Contd....

Table-1. Mean values for various green pod yield and yield attributing characters of Dolichos bean

Character No. →		1	2	3	4	5	6	7	8	9	10
S. No.	Genotype ↓	Leaf length (cm)	Leaf width (cm)	Inflorescence length (cm)	No. of flowers inflorescence^{-1}	No. of pods inflorescence^{-1}	Number of pods plant^{-1}	No. of seeds pod^{-1}	Pod length (cm)	Pod width (cm)	Marketable Green pod yield plant^{-1} (kg)
23	**IS-23**	12.87	13.06	23.70	27.00	9.00	38.00	5.00	09.00	1.41	0.211
24	**IS-24**	12.10	11.81	20.20	23.75	7.75	22.50	3.75	07.57	1.90	0.198
25	**IS-25**	12.55	11.01	16.75	18.00	5.75	32.75	5.25	10.35	1.73	0.253
26	**IS-26**	10.45	11.06	16.85	23.50	9.00	26.75	4.25	10.20	1.69	0.201
27	**IS-27**	11.03	09.98	24.20	20.75	8.50	22.00	5.00	08.55	1.76	0.166
28	**IS-28**	12.40	12.03	26.40	24.75	7.00	39.00	4.75	09.25	1.40	0.271
29	**IS-29**	12.24	12.04	13.25	17.75	5.75	21.00	4.75	10.47	2.36	0.206
30	**IS-30**	12.28	08.35	08.95	16.50	6.00	32.50	4.50	12.57	2.53	0.226
31	**IS-31**	12.58	11.39	19.45	18.00	6.50	30.50	4.25	08.83	1.55	0.213
32	**IS-32**	09.67	08.97	20.80	25.25	9.00	44.75	4.75	07.92	1.20	0.158
33	**IS-33**	14.45	13.51	20.15	22.00	6.50	25.75	4.75	15.22	1.42	0.257
34	**IS-34**	12.61	11.90	10.70	17.50	5.50	40.00	4.75	07.49	2.14	0.240
35	**IS-35**	12.25	12.27	17.10	25.25	5.75	28.50	4.25	09.00	1.56	0.229
36	**IS-36**	10.71	09.60	24.40	27.75	6.00	35.00	4.25	07.29	1.75	0.140
37	**IS-37**	11.87	11.55	19.45	23.50	7.25	41.75	4.25	09.40	3.76	0.209
38	**IS-38**	12.82	11.77	20.00	29.00	6.75	39.00	5.25	09.85	2.26	0.262
39	**IS-39**	11.80	11.22	17.15	20.00	8.50	26.75	4.00	05.70	1.50	0.212
40	**IS-40**	12.57	12.63	18.97	24.00	5.75	35.00	4.25	05.92	1.52	0.220
41	**IS-41**	12.85	12.65	16.85	17.50	5.50	29.50	4.50	10.67	2.30	0.244
42	**IS-42**	14.00	11.04	20.20	23.75	7.00	26.50	4.75	11.65	1.40	0.224
43	**IS-43**	12.13	11.80	11.10	22.75	5.25	26.50	5.25	15.15	1.35	0.240

Cont…..

Table-1. Mean values for various green pod yield and yield attributing characters of Dolichos bean

Character No.		1	2	3	4	5	6	7	8	9	10
Sr No.	Genotype	Leaf length (cm)	Leaf width (cm)	Inflorescence length (cm)	No. of flower inflorescence^{-1}	No. of pod inflorescence^{-1}	Number of pods plant^{-1}	No. of seeds pod^{-1}	Pod length (cm)	Pod width (cm)	Marketable Green pod yield plant^{-1} (kg)
44	**IS-44**	14.00	12.32	15.65	22.00	6.50	43.50	4.25	09.65	2.31	0.133
45	**IS-45**	12.50	11.98	11.00	15.50	5.75	29.00	5.00	07.10	1.25	0.203
46	**IS-46**	11.68	09.59	18.80	21.00	6.25	25.50	3.75	06.65	1.25	0.189
47	**IS-47**	11.89	11.06	15.95	23.00	5.00	28.00	4.25	08.02	1.55	0.180
48	**IS-48**	12.82	12.21	17.20	14.75	5.75	28.25	4.25	13.07	1.46	0.134
49	**IS-49**	11.30	11.85	16.15	17.00	6.00	29.25	4.25	07.27	1.56	0.196
50	**IS-50**	13.30	12.04	13.05	10.50	6.00	23.75	6.25	14.10	1.54	0.247
51	**IS-51**	11.72	10.93	18.60	23.00	7.25	38.75	3.75	09.38	1.60	0.170
52	**IS-52**	12.42	11.17	25.15	26.00	7.25	38.25	4.50	10.27	1.97	0.187
53	**IS-53**	12.10	11.90	08.90	13.00	5.75	31.50	4.25	10.02	3.63	0.185
54	**IS-54**	10.27	09.50	16.80	21.50	9.00	38.25	4.25	11.20	2.83	0.274
55	**IS-55**	14.17	10.57	16.95	22.25	6.00	45.25	4.75	11.95	2.74	0.188
56	**IS-56**	10.30	09.64	20.30	21.00	6.00	41.50	4.75	09.57	1.38	0.207
57	**IS-57**	10.22	13.37	14.50	14.00	4.50	31.25	4.00	09.00	1.69	0.170
58	**IS-58**	11.76	10.48	23.65	26.00	8.00	24.25	4.75	11.12	1.40	0.146
59	**IS-59**	10.54	08.52	13.20	17.75	5.50	20.50	4.75	11.27	1.46	0.188
60	**IS-60**	13.25	12.32	12.25	15.75	5.25	25.00	4.75	10.66	3.33	0.228
61	**IS 61**	12.20	11.65	14.95	20.50	9.00	22.50	3.75	6.45	2.35	0.157
62	**IS-62**	12.54	12.19	17.85	22.25	5.00	38.50	4.25	8.55	2.00	0.191
63	**IS 63**	11.29	11.22	17.65	24.75	4.75	34.00	4.25	8.85	1.45	0.204
Mean		**11.95**	**11.15**	**18.73**	**22.36**	**7.18**	**32.86**	**4.57**	**9.33**	**1.79**	**0.200**
SEm ±		**0.413**	**0.375**	**0.614**	**0.525**	**0.439**	**1.543**	**0.257**	**0.203**	**0.055**	**0.007**
C D (P=0.05)		**1.143**	**1.041**	**1.701**	**1.454**	**1.217**	**4.275**	**0.713**	**0.562**	**0.151**	**0.020**

Table 2. Phenotypic and genotypic correlation of green pod yield and its components characters in Dolichos bean

Sr. No.	Characters		Leaf length (cm)	Leaf width (cm)	Length of inflorescence (cm)	Number of flowers inflorescence^{-1}	Number of pods inflorescence^{-1}	Number of pods plant^{-1}	Number of seeds pod^{-1}	Pod length (cm)	Pod width (cm)	Marketable green pod yield plant^{-1} (kg)
1.	Leaf length (cm)	P	0.322*	0.347**	-0.091	-0.031	0.087	-0.061	0.178	-0.014	0.217	0.308*
		G	0.433	0.428	0.089	0.030	0.085	0.063	0.272	0.015	0.232	0.343
2.	Leaf width (cm)	P		0.459**	-0.098	-0.068	-0.271	-0.088	0.184	0.276*	0.188	0.186
		G		0.715	-0.138	-0.103	-0.402	-0.056	0.293	0.358	0.241	0.209
3.	Length of inflorescence (cm)	P			-0.070	-0.079	-0.315	-0.060	0.084	0.140	0.125	0.128
		G			-0.078	-0.095	-0.387	-0.059	0.109	0.178	0.128	0.199
4.	Number of flowers inflorescence^{-1}	P				0.679**	0.349**	0.333**	0.053	-0.088	-0.310	0.080
		G				0.730	0.425	0.365	0.054	-0.089	-0.332	0.088
5.	Number of pods inflorescence^{-1}	P					0.375**	0.297*	0.013	-0.167	-0.179	0.060
		G					0.430	0.340	0.038	-0.174	-0.187	0.066
6.	Number of pods plant^{-1}	P						0.049	0.040	-0.187	-0.106	0.009
		G						0.096	0.045	-0.218	-	-0.011
7.	Number of seeds pod^{-1}	P							-0.001	-0.076	0.021	0.249
		G							-0.002	-0.090	0.027	0.229
8.	Pod length (cm)	P								0.350	-0.061	0.332**
		G								0.564	-0.131	0.599
9.	Pod width (cm)	P									0.055	0.355**
		G									0.056	0.378
10.	Marketable green pod yield plant^{-1} (kg)	P										-0.048
		G										0.052

***: Significant at 5%, **: Significant at 1%, P=Phenotypic; G=Genotypic**

Table 3. Direct and indirect effect of green pod yield and its components at phenotypic level in Dolichos bean

Characters	Leaf length (cm)	Leaf width (cm)	Inflorescence length (cm)	Number of flowers Inflorescence^{-1}	Number of pods Inflorescence^{-1}	Pod length (cm)	Pod width (cm)	Number of pods plant^{-1}	Hundred seed weight (g)	Green pod Yield plant^{-1} (kg)
Leaf length (cm)	**0.017**	-0.012	0.003	0.002	0.007	-0.006	-0.004	0.001	-0.006	0.213
Leaf width (cm)	0.074	**0.103**	-0.008	-0.008	-0.040	0.018	0.013	-0.006	0.034	0.202
Inflorescence length (cm)	0.006	-0.003	**0.047**	0.047	0.020	-0.004	-0.015	0.017	-0.008	0.088
Number of flowers inflorescence^{-1}	0.014	0.008	-0.107	**-0.107**	-0.045	0.009	0.035	-0.039	0.019	0.089
Number of pods inflorescence^{-1}	0.071	-0.069	0.076	0.075	**0.178**	-0.039	-0.021	0.017	-0.048	-0.013
Pod length (cm)	0.063	0.031	-0.016	-0.015	-0.038	**0.176**	0.009	-0.016	0.084	0.371
Pod width (cm)	0.018	-0.009	0.025	0.025	0.009	-0.004	**-0.076**	-0.002	0.001	-0.052
Number of pods plant^{-1}	0.025	-0.027	0.169	0.168	0.044	-0.041	0.012	**0.547**	-0.174	0.226
Hundred seed weight (g)	0.201	0.180	-0.100	-0.099	-0.148	0.261	-0.006	-0.206	**0.461**	0.449

Residual value: 0.0839, Diagonal and bold underline figures shows direct effect on pod yield

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STUDY ON ANTIBIOSIS MECHANISM OF RESISTANCE TO BPH *Nilaparvata lugens* (Stal.) ON RESISTANT RICE GENOTYPES

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ABSTRACT

Antibiosis mechanism of resistance ot *Nilaparvata lugens* (Stal.) was studied by nymphal survival and developmental periods at glass house, IGKV, Raipur during 2009-2010. All the resistant genotypes exhibited average nymphal survival values varied from 35.00 to 63.33 per cent which was significantly lower than the susceptible check TN 1, whereas developmental period values ranged between 13.22 and 19.17 days. It was also significantly higher than the susceptible check TN 1. In TN 1, the susceptible check variety, Nymphal survival value was maximum (86.67 %) and corresponding developmental period was 11.12 days. The nymphal survival value was significantly higher and devlopmental periods were significantly lower on susceptible check TN 1 than on all the resistant genotypes. The growth index of BPH was low on genotype R 1723-1411-2-356-1 followed by MR 1523, Rathu Heenati, MO 1, R 1244-1246-1-605-1 and INRC 3021 than PTB 33.

(Key words : Rice, antibiosis, *Nilaparvata lugens* (Stal.), BPH)

INTRODUCTION

The brown planthopper *Nilaparvata lugens* (Stal.) had occupied the status of a major pest of rice since the era of green revolution. In order to control this pest, over reliance on highly toxic, hazardous pesticides has given rise to many problems *viz.,* resurgence effect, resistance to insecticides, outbreaks of new biotypes due to high selection pressure, destruction of natural enemies etc. Moreover, towards the maturity stage of crop growth, application of insecticides causes presence of their residues in rice bran and straw above tolerance level (Rajukannu *et al*., 1988).

In addition, excess use of insecticides causes high residual effect in the environmnet and become a more dangerous pollutant. Due to these reasons human health status is going on diminishing. Therefore, taking an account on economic losses, pesticidal hazards, environmental pollution and human health, development and use of resistant variety is an effective tool in pest management.

Painter (1951) grouped mechanisms of host plant resistance into three main categories viz., non-preference, antibiosis and tolerance. Out of which, antibiosis is the most effective way to control the insect. Antibiosis refers to the adverse effect of the host plant on the biology (survival, development or reproduction) of the insect and their progeny infesting it. The insect feeding on resistant plants may manifest antibiotic symptoms varying from acute or lethal to vary mild. The most commonly observed symptoms in insect include immature death in first few instars, abnormal growth rates etc. These symptoms may occur due to various physiologics processes viz., presence of toxic substances, nutrient imbalances, presence of antimetabolites and enzymes adversely affecting food digestion and utilization of nutrients.

Host plant resistance has played an important role in the management of pests successfully during past two decades. Several resistant varieties have been developed and grown in different areas of India (Mathur *et al.,* 1999 and Krishnaiah *et al.,* 1999). As a result it contributed towards the suppression of the pest for nearly last fifteen years. Therefore, 16 resistant rice genotypes along with susceptible (TN 1) and resistant (Ptb 33) check were evaluated for antibiosis mechanism of resistance to BPH at glass house, Deptt. of Entomology, IGKV, Raipur during 2009-10.

MATERIALS AND METHODS

The sixteen resistant rice genotypes viz., R1576-538-1-167, R1576-570-1-182, R1723-1411-2-356-1, R1723-1413-3-357-1, R1600-1124-2-618-1, 1R64, R 1519-773-3-581-1, R 1473-521-249-1-1, R1243-1224-578-1, R 1244-1246-1-605-1, MO1, MR 1523, Rathu Heenati, Sinna Sivappu, INRC 3021 and ARC 10550 along with standard checks (Ptb 33 and TN1) were used for the study.

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The well germinated seeds of resistant rice genotypes were sown in 500 ml plastic/earthen pots filled with fertilizer enriched puddled soil. After 30 days, the plants were covered by the Mylar tube with ventilating windows. Then 10 nymphs (First and second instar) were released in such tubes and then the open end of the tube was covered by the muslin cloth and tied with rubber band. For each variety six replications were maintained. The plants were observed daily for the emergence of the adult. These emerged adults were removed from the tubes and observation on sex and winged form of the adults were noted down. The data on different forms of winged adults i.e. brachypterous and macropterous were reported in per cent on the basis of total adults.

The unhatched BPH eggs were counted by dissecting out the plant tissues with the help of microscope then from this data fecundity and % unhatched eggs were calculated. (Alagar and Suresh, 2007b).

The per cent nymphal survival was calculated by using following formula (Heinrichs *et al.,* 1985).

$$\text{Per cent nymphal survival} = \frac{\text{Number of adult emerged}}{\text{Number of nymphs released}} \times 100$$

Developmental period was studied by counting the days taken by nymphs to reach the adult stage (Pongprasert and Weerapat, 1979). Growth index (GI) of BPH on each genotype was computed from the data obtained from the experiments on nymphal survival and developmental period as below (Pablo, 1977 and Panda and Heinrichs, 1983).

$$\text{Growth Index (GI)} = \frac{\text{Per cent of nymphs survived}}{\text{Mean developmental period}}$$

The BPH female or male sex per cent on different genotypes was calculated by following formula.

$$\text{Sex \% (Male/Female)} = \frac{\text{Number of Male/Female insects}}{\text{Total number of insects}} \times 100$$

RESULTS AND DISCUSSION

In all the resistant genotypes average nymphal survival values varied from 35.00 to 63.33 per cent which was significantly lower than the susceptible check TN 1, whereas developmental period values ranged from 13.22 to 19.17 days. It was also significantly higher than the susceptible check TN 1 (Table 1). In TN 1 (susceptible check variety) nymphal survival value was maximum (86.67 %) and corresponding developmental period was 11.12 days. The nymphal survival value was significantly higher and developmental periods were significantly lower on susceptible check TN 1 than all the resistant genotypes including check Ptb 33.

Resistant check Ptb 33 showed nymphal survival of 53.33 per cent, which was significantly higher than R 1723-1411-2-356-1, Rathu Heenati, MO 1 and MR 1523 genotypes but significantly lower than R 1576-570-1-182 and susceptible check TN 1. Whereas, the developmental period on Ptb 33 was 18.16 days, which was significantly higher than 13 resistant genotypes and also than the susceptible check TN 1 (Table 2). The genotype R1723-1411-2-356-1 had the lowest nymphal survival (35.00%) followed by Rathu Heenati (38.33%), MO 1 (40%) and MR 1523 (41.67), which was significantly lower than the susceptible check TN 1. The genotype MR 1523 had the highest value of developmental period (19.17 days) followed by R 1723-1411-2-356-1 (17.92 days) and MO 1 (17.17) which was also significantly higher than susceptible check TN 1.

Among all the resistant genotypes studied for antibiosis mechanism of resistance exhibited growth index (GI) values ranging from 1.95 to 4.75, although it was 2.94 in resistant check Ptb 33 and it was maximum i.e. 7.79 in susceptible check TN 1. The results revealed that the genotype R 1723-1411-2-356-1 had the lowest growth index (1.95) followed by MR 1523 (2.17), Rathu Heenati (2.32) and MO 1 (2.33).

Among the resistant genotypes tested, the percentage of female population ranged from 30.56 to 58.34 per cent, which was significantly lower than the susceptible check TN 1, whereas the percentage of male population ranged from 41.66 to 69.44 per cent, which was significantly higher than susceptible check TN 1. The susceptible check TN 1 showed the highest percentage of female population (72.5 per cent) and the lowest percentage of male population (27.5 per cent). The resistant check Ptb 33 exhibited the female population of 47.5 per cent which was significantly higher than the genotype Rathu Heenati

and R 1244-1246-1-605-1, but it was significantly lower than the genotype MO 1 and susceptible check TN 1. The contribution of male sex in population build up on resistant check Ptb 33 was 52.5 per cent, which was significantly higher than the genotype MO1 and susceptible check TN 1, but it was significantly lower than the genotypes Rathu Heenati and R 1244-1246-1-605-1.

Among all the resistant genotypes tested, the genotype Rathu Heenati had the lowest female sex population and highest male population followed by R 1244-1246-1-605-1 and R 1576-538-1-167. The genotype MO 1 had the highest population of female sex and lowest population of male sex followed by ARC 10550, IR 64 and R 1723-1413-3-357-1.

The insect population of adults with brachypterous and macropterous wing form were not significantly different in all the rice genotypes including resistant and susceptible check, although the genotype R 1723-1411-2-356-1 had the lowest population of brachypterous form and the highest population of macropterous form.

The results were in conformity to the work done by following scientists. Gao *et al.* (1990) studied the antibiotic effects of resistant and reported that insect survival on Xiu-Shui 620 and IR64 was 50 per cent of that on Xiu-Shui 48. Also Velusamy *et al.* (1995) evaluated wild rice against *N. lugens* and found that insect caged on resistant wild rice had low fecundity and low egg hatchability as compared to *N. lugens.* Similarly Alagar and Suresh (2007a) studied antibiosis mechanism of resistance to BPH and stated that among the genotypes tested, ARC 10550 supported significantly the lowest nymphal survival of 50.0 per cent followed by ADT 45 (52.0%), ASD 7(54.0%), ARC 6650 (58.0%) and Jeeraga samba (60.0%), as compared to 82.0% on TN1. They also observed that ARC 10550 recorded the lowest growth index of *N. lugens* (2.71).

Insect Growth index (IGI) provides additional information on antibiosis mechanism of resistance. These indicated unsuitability of the resistant genotypes and suitability of the susceptible genotypes to BPH (Alagar and Suresh, 2007a). The genotype R 1723-1411-2-356-1 with lower insect growth index value (IGI, 1.95) exhibited the high level of antibiosis than resistant check Ptb 33 followed by MR 1523 (2.71), Rathu Heenati (2.32), MO 1 (2.33), R 1244-1246-1-605-1 (2.79) and INRC 3021 (2.94). As the wing dimorphism is density dependent factor, it shows the non significant results. Due to adequate nutrition providing ability or absence of harmful biochemicals, the susceptible variety favours the development of more females and vice versa. Lower nymphal survival and slow growth rate reflects the antibiosis (Alarn and Cohen, 1998).

The results on the reduction in the survival rate of BPH on resistant genotypes might be due to presence of antibiosis factors i.e. presence of feeding deterrents such as soluble salicylic acid, malic acid, itaconic acid and benzoic acid in the resistant genotypes as reported by Soundararajan *et al.* (2002). Greater nymphal survival and low developmental period on susceptible TN 1 proved the availability of good quality food and reverse can be found in resistant genotypes.

Table 1. Per cent surival and developmental period of BPH on resistant rice genotypes

Sr. No.	Designation	Nymphal Survival (%)	Developmental period (Days)	Insect growth index (IGI)	Female (%)	Male (%)	B* (%)	M* (%)
1.	R 1576-538-1-167	51.67	13.22	3.91	38.61	61.39	96.67	3.33
		(45.96)			(38.12)	(51.87)	(82.19)	(7.80)
2.	R 1576-570-1-182	63.33	13.33	4.75	41.19	58.81	92.20	7.80
		(52.81)			(39.80)	(50.19)	(76.39)	(13.60)
3.	R 1723-1411-2-356-1	35.00	17.92	1.95	38.89	61.11	75.00	25.00
		(36.22)			(38.37)	(51.62)	(63.51)	(26.48)
4.	R 1723-1413-3-357-1	51.67	14.88	3.47	54.45	45.55	97.22	2.78
		(45.96)			(47.77)	(42.22)	(82.60)	(7.39)
5.	R 1600-1124-2-618-1	53.33	15.48	3.45	52.78	47.22	78.33	21.67
		(46.92)			(46.62)	(43.37)	(65.67)	(24.32)
6.	IR 64	48.33	15.62	3.09	55.00	45.00	82.22	17.78
		(44.03)			(48.07)	(41.92)	(66.45)	(23.54)
7.	R 1519-773-3-581-1	60.00	13.24	4.53	49.48	50.52	78.67	21.33
		(50.85)			(44.63)	(45.36)	(66.08)	(23.91)
8.	R 1473-521-249-1-1	50.00	15.44	3.24	50.00	50.00	82.22	17.78
		(45.00)			(45.00)	(45.00)	(68.09)	(21.90)
9.	R 1243-1224-578-1	53.33	16.39	3.25	51.67	48.33	95.83	4.17
		(46.92)			(45.96)	(44.03)	(81.62)	(8.37)
10.	R 1244-1246-1-605-1	46.67	16.73	2.79	35.00	65.00	82.33	16.67
		(42.49)			(35.72)	(54.27)	(69.09)	(20.90)

Cont...

Table 1. Per cent surival and developmental period of BPH on resistant rice genotypes

Sr. No.	Designation	Nymphal Survival (%)	Developmental period (Days)	Insect growth index (IGI)	Female (%)	Male (%)	B* (%)	M* (%)
11	MO 1	40.00	17.17	2.33	58.34	41.66	87.50	12.50
		(39.14)			(49.80)	(40.19)	(73.07)	(16.92)
12	MR 1523	41.67	19.17	2.17	48.33	51.67	82.22	17.78
		(40.00)			(44.03)	(45.96)	(69.91)	(20.08)
13.	Rathu Heenati	38.33	16.50	2.32	30.56	69.44	93.33	6.67
		(38.22)			(33.38)	(56.61)	(78.44)	(11.55)
14	Sinna Sivappu	55.00	16.29	3.38	53.02	46.98	93.89	6.11
		(47.92)			(46.62)	(43.37)	(78.85)	(11.14)
15.	INRC 3021	48.33	16.42	2.94	39.76	60.24	88.73	11.27
		(43.99)			(38.73)	(51.26)	(72.48)	(17.51)
16.	ARC 10550	51.67	14.79	3.49	57.22	42.78	87.78	12.22
		(45.96)			(49.20)	(40.79)	(73.40)	(16.59)
17	PTB 33	53.33	18.16	2.94	47.50	52.50	86.94	13.06
		(46.92)			(43.46)	(46.53)	(71.18)	(18.81)
18	TN 1	86.67	11.12	7.79	72.50	27.50	88.66	11.34
		(68.85)			(58.37)	(31.62)	(72.57)	(17.42)
	SEm±	2.39	0.49		3.54	3.54	5.46	5.46
	CD at 5%	6.71	1.37		9.97	9.97	15.35	15.35

*** Average of six replications**
*** Figures in the parentheses are arc sine transformed values**
B* Brachypterous wing form
M* Macropterous wing form

Table 2. Ovicidal effect of resistant rice genotypes on BPH

Sr. No.	Designation	No.of nymph emerged	No. of unhatched eggs	Fecundity	% unhatched eggs	Days to wilt
1.	R 1576-538-1-167	65.33 (54.11)	29.83 (32.97)	95.16	31.35	12.67
2.	R 1576-570-1-182	64.50 (54.91)	35.33 (36.34)	99.83	35.39	14.17
3.	R 1723-1411-2-356-1	15.17 (22.80)	70.00 (56.98)	85.17	82.19	15.67
4	R 1723-1413-3-357-1	49.17 (44.51)	48.50 (44.13)	97.67	49.66	13.50
5.	R 1600-1124-2-618-1	71.50 (58.00)	34.00 (35.48)	105.50	32.23	12.67
6.	IR 64	36.00 (36.03)	40.83 (39.45)	76.83	53.15	15.00
7.	R 1519-773-3-581-1	51.00 (45.84)	25.83 (29.92)	76.83	33.62	11.50
8.	R 1473-521-249-1-1	38.33 (38.01)	25.83 (30.45)	64.17	40.26	14.50
9.	R 1243-1224-578-1	40.50 (39.16)	42.00 (40.12)	82.50	50.91	16.50
10.	R 1244-1246-1-605-1	16.00 (23.32)	38.33 (38.12)	54.33	70.55	16.50
11.	MO 1	23.33 (28.72)	59.50 (50.52)	82.83	71.83	14.83
12.	MR 1523	31.00 (33.66)	48.00 (43.83)	79.00	60.76	16.00
13.	Rathu Heenati	45.67 (42.48)	65.83 (54.33)	111.50	59.04	16.17
14.	Sinna Sivappu	26.33 (30.63)	46.00 (42.68)	72.33	63.59	14.67
15.	INRC 3021	34.83 (35.82)	27.50 (31.53)	62.33	44.12	15.33
16.	ARC 10550	40.00 (39.15)	30.67 (33.47)	70.67	43.40	14.00
17.	PTB 33	20.17 (26.38)	56.67 (48.88)	76.84	73.75	18.17
18.	TN 1	107.33 (85.94)	9.50 (17.46)	116.83	8.13	8.50
	SEm±	3.51	2.31	--	–	0.86
	CD at 5%	9.87	6.49	--	–	2.42

* Average of six replications
* Figures in the parentheses are arc sine transformed values

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EFFECT OF *RHIZOBIUM* INOCULATION, LIQUID FERTILIZERS MICRONUTRIENTS AND GROWTH STIMULANT ON GROWTH AND YIELD OF COWPEA (*Vigna sinera*)

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ABSTRACT

The field experiment was conducted at the Agronomy Farm, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (M.S.) during *rabi*-hot weather seasons of 2008-09. Growth and yield of cowpea are greatly influenced by soil moisture, nutrient, environmental condition and management practices. Absence of relevant information on these aspects adversely affected the productivity of cowpea. In present case various sources of nutrients were tried along with recommended dose of fertilizer. Results revealed that, treatment (Sujala) 13:40:13 kg NPK ha^{-1} (2% spray) + R.D.F. 25:50 kg NP ha^{-1} was found significant in producing grain yield of cowpea (13.51 q ha^{-1}) over all the treatments. The dry matter plant^{-1} after harvest was maximum in the treatment, *Rhizobium* inoculation + R.D.F. 25:50 kg NP ha^{-1} which was at par with Urea (2% spray) and R.D.F. 25:50 kg NP ha^{-1} treatment, which produced 12.83 g and 11.70 g dry matter plant^{-1}, respectively. The data on number of pods plant^{-1} indicated that, at harvest, the highest number of pods plant^{-1} were recorded in the treatment *Rhizobium* inoculation + R.D.F. 25:50 kg NP ha^{-1} and liquid seaweed spray + R.D.F. (25:50 kg NP ha^{-1}) recorded significantly more number of pods (8.60). It was observed that, *Rhizobium* inoculation + R.D.F. (25:50 kg NP ha^{-1}) recorded the maximum net returns of Rs. 26174.37 ha^{-1} with highest B : C ratio of 1.84 followed by DAP spray + R.D.F. (25:50 kg NP ha^{-1}) with net returns of Rs. 21459.61 ha^{-1} and B : C ratio of 1.70 over the control.

(Key words : Cow pea, *Rhizobium*, micronutrients, growth stimulant, yield, yield attributes, dry matter, net return)

INTRODUCTION

Importance of pulses is relatively more in our country as their contribution in nutrient supply is far more in Indian diet than rest of Asia and the whole world. Each plant of pulse crops in virtually nature′s mini nitrogen fertilizer factory, which enables to meet its own requirement as well as that of the succeeding cereal crop. Area under cowpea in Maharashtra and Konkan was 11,800 ha and 1200 ha with an average productivity of 400 kg ha^{-1} (Apte and Jadhav, 2002). Out of total acreage, 54% is occupied by *kharif* pulses contributing about 38 per cent of total pulse production. The *rabi* pulses contribute 46 per cent in total area and about 62 per cent in production. Increasing fertilizer prices and high requirement of nutrients compel the farmers to deviate from using the recommended doses of inorganic fertilizers. However, pulses can harvest more than synthetically produced nitrogen from atmosphere saving huge quantity of costlier energy. Hence, it becomes imperative to judiciously utilize the inorganic fertilizers and integrate with locally available all possible alternative sources of plant nutrients like organic manures, suitable pulse crop and bio fertilizers to improve fertility and productivity of soil.

The only way to improve the yield of the pulse crop lies in the use of bio fertilizers. In case of cowpea, groundnut and green gram, inoculation of *Rhizobium* increases the yield by 55.04, 20.99, and 44.04 per cent over uninoculated crops, respectively (Kadam *et al*., 2007). The micronutrients like Cu, Zn, Mn, Mo are known to play an important role in the enzymatic process in plants, synthesis of chlorophyll, carbohydrate production, respiration and other like Fe, Mn, Cu, CI and Zn are found to activate a number of biochemical processes in plant. Application of nutrients through foliar spray demand less quantity of nutrients. With rapid and efficient absorption, foliar nutrients usually penetrate the cuticle of the leaf and enter the cells. Hence, foliar nutrition is recognized as an important method of fertilization in modern agriculture. Panchagavya is used for soil application along with irrigation water, seed or seedling treatment. Panchagavya is a single organic input, which can act as a growth-promoter and immunity booster. It has a significant role in providing resistance to pests, diseases and increases the overall yield. Therefore, it is necessary to study the effect of *Rhizobium* inoculation, liquid fertilizers, micronutrients and growth stimulant on growth and yield of cowpea.

MATERIALS AND METHODS

The field experiment was conducted at the Agronomy Farm, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (M.S.) during *rabi*-hot

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weather seasons of 2008-09. The experimental plot was well levelled and uniform in topography. The soil of experimental plot was sandy clay loam in texture and slightly acidic in reaction with medium in organic carbon content (0.91). It was low in available nitrogen (220.12 kg ha^{-1}) and medium in available phosphorus (15.19 kg ha^{-1}) and low in available potassium (142.38 kg ha^{-1}) with pH 6.43.

The experiment was conducted in randomized block design with three replications. The treatments tried were T_1- Control, T_2 - *Rhizobium* inoculation + R.D.F.(25:50 kg NP ha^{-1}), T_3 Recommended dose of fertilizers (25:50 kg NP ha^{-1}), T_4 - Liquid 'Seaweed' + R.D.F. (25:50 kg NP ha^{-1}), T_5 - Microla + R.D.F. (25:50 kg NP ha^{-1}), T_6 -(Sujala) 13:40:13 kg NPK ha^{-1} (2% spray) + R.D.F. (25:50 kg NP ha^{-1}), T_7 - DAP (1% spray) + R.D.F. (25:50 kg NP ha^{-1}), T_8 - Urea (2% spray) +R.D.F. (25:50 kg NP ha^{-1}), T_9 - Cow urine (2% spray)+R.D.F. (25:50 kg NP ha^{-1}), T_{10} - Spray of water + R.D.F. (25:50 kg NP ha^{-1}) and T_{11} - "Panchagavya" (3% spray) + R.D.F. (25:50 kg NP ha^{-1}).

Thus, there were 11 treatments replicated thrice. Hence, total 33 plots were arranged randomly in a field of 45 x 45 m size with gross plot size of 4.50 m x 4.50 m. The buffer of 1m and 0.5 m was left between two successive replications and treatments respectively, in order to avoid movement of water from one plot to another. Well-decomposed farm yard manure was applied in each plot @ 5 t ha^{-1} and mixed thoroughly into the soil after the layout. The seed of cowpea cultivar "Konkan Sadabahar" was used in present investigation. The quantity of fertilizer dose for each plot was calculated as per the treatments. The quantity of FYM and single super phosphate was applied as a basal dose by band placement and urea was applied in two split doses i.e. 1st dose at the time of sowing and 2nd dose at the time of flowering. Required quantity of healthy, unbroken and fully developed seeds of variety Konkan Sadabahar for one treatment i.e. T_2 was inoculated with *Rhizobium*. The culture of *Rhizobium* was used for seed treatment @ 250 g 10 kg^{-1} seeds, a night before sowing of the crop. Then the seeds of all treatment plots were treated with thirum @ 3 g kg^{-1} of seed before sowing in order to protect them against seed and soil borne fungal diseases.

The following ingredients were used to prepare Panchagavya stock solution. First, 7 kg of fresh cow dung was added into 5 litres of cow urine and 5 litres of water and kept in a suitable container in the shade. The container was kept open for aeration and to allow the gas produced during fermentation process to escape. Cow dung urine mixture was mixed thoroughly and was stirred twice daily for about fifteen days. On 16th day, rest of the ingredients were added (Ghee - 1 kg + Milk -2 lit, + Curd -2 kg) and continue of the stirring twice daily. On the 22nd day the Panchagavya was ready to use. By stirring regularly, stock solution can be kept for 6 months. It contains about 302 mg kg^{-1} of total nitrogen, 218 mg kg^{-1} of total phosphorus and 355 mg kg^{-1} of total potassium (Asangla *et al*. 2005). Liquid sea-weed contains cytokinins, which promote the cell division and expansion and are linked to increase the crop yields and overall plant growth. It contain 0.75% N, 0.15% P, 1.2% K, 1.4% Ca, 1.0% Mg, 0.82% S, 70 ppm Bo, 800 ppm Fe, 30 ppm Zn and 6 ppm Cu. Nutrient content in microla was Zn-3%, Fe-2.5%, B-0.5%, Cu-1%, Mo-1% and Mn-1% (Gatut-Suprjadji,1985).

For dry matter, one plant was randomly selected from each net plot at the time of every periodical observation. These plants were uprooted and their roots were cut. Then the plant was chopped into small pieces and kept in a brown paper bag, suitably labelled and then dried in a thermostatically controlled oven at a temperature of 60^0C. The samples were dried till constant weight was obtained, and it was considered as dry matter $plant^{-1}$. The pods of five plants at harvest were counted and then the average number of pods $plant^{-1}$ was worked out. The weight of mature pods from the five observation plants in each net plot was measured and then average was worked out. The pods with fully developed grains were considered as mature pods. The plot wise grain and straw yield data was recorded after proper drying, threshing and cleaning of cowpea grains and straw. The plot wise data was then converted on hectare basis (q ha^{-1}).

RESULTS AND DISCUSSION

Dry matter $plant^{-1}$

The data pertaining to dry matter production $plant^{-1}$ as influenced by different treatments from 20 DAS to final harvest stage i.e. 100 DAS are presented in table 1. The dry matter content is an indication of the amount of photosynthetic material produced by the plant in it's complete life or during a certain period of time. The data from table 1 indicated that dry matter accumulation rate was increased between 40 DAS, 60 DAS, 80 DAS and also at harvest. The different treatments did not affect the dry matter production significantly at 20 DAS. At 40 DAS

significantly maximum dry matter production was observed in the treatment 13:40:13 kg NPK ha^{-1} (2% spray)and R.D.F. followed by *Rhizobium* inoculation + R.D.F. (3.58 g) and urea (2% spray) + R.D.F. (3.30 g) treatment. At peak harvest stage (80 DAS), the significantly maximum dry matter production (15.22 g) was observed in treatment *Rhizobium* inoculation + R.D.F., which was at par with the treatments urea (2% spray) + R.D.F., cow urine (2% spray) + R.D.F. and recommended dose of fertilizers which produced 14.26 g, 13.96 g and 13.33 g dry matter $plant^{-1}$, respectively. At 100 DAS i.e. final harvest stage dry matter production (13.21 g) was significantly higher in *Rhizobium* inoculation + R.D.F. which was at par with urea (2% spray)+R.D.F. and recommended dose of fertilizers treatment, which produced 12.83 g and 11.70 g dry matter $plant^{-1}$ respectively. These results are in line with Dhage and Kachhave (2007) who reported that, *Rhizobium*+PSB treatment was significantly superior over all other biofertilizer treatments. The highest dry weight (13.9 g $plant^{-1}$) was recorded in *Rhizobium*+PSB and lowest in no biofertilizer treatment.

Mean number of pods and pod weight $plant^{-1}$ at harvest :

The data in respect of number of pods $plant^{-1}$ and weight of pods $plant^{-1}$ as influenced by combinations organic manures and chemical fertilizers are presented in table 2. The results indicated that the treatment *Rhizobium* inoculation + R.D.F. and liquid seaweed spray + R.D.F. recorded significantly more number of pods $plant^{-1}$ (8.60). The minimum number of pods were observed in the treatment control (5.40). This was mainly due to interaction of these fertilizers and biofertilizers in cowpea. With respect to weight of pods $plant^{-1}$ the treatment *Rhizobium* inoculation + R.D.F. recorded significantly more weight of pods $plant^{-1}$ (9.77g).

However, The Treatment Liquid ′seaweed′ + R.d.f. (9.58 G), Cow Urine (2% Spray) + R.d.f. (9.17 G), Recommended Dose Of Fertilizers (8.16 G), Panchagavya 3% Spray + R.d.f. (7.60 G), Urea (2% Spray) + R.d.f. (7.56 G) And 13:40:13 Kg Npk Ha^{-1} (2% Spray) + R.d.f. (7.36 G) Were At Par With Each Other. The Minimum Weight Of Pods Were Observed In The Treatment Control (5.30 G). This Was Mainly Due To Interaction Of These Fertilizers And Biofertilizers In Cowpea. These Results Are In Close Conformity With Dhage And Kachhave (2007). They Reported That, Yield Attributing Characters Of Cowpea Viz, Length Of Pod, Number Of Pods $Plant^{-1}$, Weight Of Pods $Plant^{-1}$, Number Of Grains Pod^{-1} Were Significanly Superior In *Rhizobium* + Psb Treatment.

Grain And Stover Yield Of Cowpea :

From The Data Presented In Table 3, Treatment 13:40:13 Kg Npk Ha^{-1} (2% Spray) + R.d.f. Was Found Significant In Producing Grain And Stover Yield Of Cowpea (13.51 And 26.25 Q Ha^{-1}) Over All The Treatments But It Was At Par With Treatment *Rhizobium* Inoculation + R.d.f. (12.15 And 24.94 Q Ha^{-1}). The Treatments T_3, T_4, T_5, T_7, T_8, T_9, T_{10} And T_{11} Did Not Show Any Significant Effect Among Themselves.

Increase In The Grain Yield Of Cowpea Due To Treatment 13:40:13 Kg Npk Ha^{-1} (2% Spray) + R.d.f. Was In The Tune Of 38.04<26.05>25.53>25.01>24.35 >20.57 > 18.80 > 18.72 > 18.28 > 10.06 Over The Treatments, Control, Spray Of Water + R.d.f., Recommended Dose Of Fertilizers, Microla + R.d.f, Panchagavya 3% Spray + R.d.f., Liquid ′seaweed′ + R.d.f., Cow Urine (2% Spray) + R.d.f., Urea (2% Spray) + R.d.f., Dap (1% Spray) + R.d.f., *Rhizobium* Inoculation+ R.d.f., Respectively. The Highest Grain Yield Obtained In Treatment 13 : 40 : 13 Kg Npk Ha^{-1} (2% Spray) + R.d.f. Was Mainly Due To Foliar Spray Of 13 : 40 : 13 Kg Npk Ha^{-1} And Recommended Dose Of Fertilizer Which Played Important Role In Availability Of Nutrients Through Chemical Fertilizers. Similar Findings Were Reported By Kadam *Et Al.* (2007). According To Them, The Grain Yield Of Soybean (15.6 Q Ha^{-1}) Was Significantly Increased With Increasing Solubility Of Phosphorus In Fertilizer And Application Of These Fertilizer Together With Fym @ 5t Ha^{-1} And Seed Inoculation With Bio Fertilizer (*rhizobium Japonicum* And Psb Culture @ 25 G Kg^{-1} Of Seed) Over Control. Seed Inoculation With Biofertilizers Might Have Increased The N And P Availability To The Crop Which As A Result Increased The Soybean Yield.

Economics of treatments :

The parameters for economic analysis of cowpea viz., cost of cultivation, gross returns, net returns and benefit: cost ratio as influenced by the *Rhizobium* inoculation, fertilizers, micronutrients, liquid fertilizers and growth stimulant were calculated. The data was furnished in the table 4. The 13:40:13 kg NPK ha^{-1} (2% spray + RDF produced the highest gross returns of Rs. 63420 ha^{-1}, which was followed by *Rhizobium* inoculation + RDF of Rs. 57169 ha^{-}

The minimum gross return of Rs. 39549 ha^{-1} was recorded under control. Application of both the

Table 1. Dry matter plant^{-1} as influenced by different treatments

Treatment details	Days after sowing (DAS)				
	20	40	60	80	AT harvest
T_1 - Control	0.43	1.06	6.26	8.36	6.22
T_2 - *Rhizobium* inoculation +R.D.F.	0.83	3.38	11.96	15.22	13.21
T_3 - Recommended dose of fertilizer	0.73	2.16	10.66	13.33	11.70
T_4 - Liquid 'Seaweed' + R.D.F.	0.63	2.10	7.86	10.86	9.09
T_5 - Microla + R.D.F.	0.53	2.73	10.13	12.40	10.32
T_6 - 13:40:13 kg NPK ha^{-1} (2% spray)+R.D.F.	0.63	3.56	8.06	10.50	9.30
T_7 - DAP (1% spray) + R.D.F.	0.63	2.43	9.06	10.13	9.34
T_8 - Urea (2% spray) + R.D.F.	0.70	3.30	10.56	14.26	12.83
T_9 - Cow urine (2% spray) + R.D.F.	0.66	2.66	10.46	13.96	11.04
T_{10} - Spray of water + R.D.F.	0.50	1.86	7.26	8.53	6.47
T_{11} - Panchagavya 3% spray + R.D.F.	0.70	2.80	7.63	11.13	9.41
SEm±	0.08	0.38	1.00	0.79	0.53
CD at 5%	-	1.13	2.96	2.34	1.58

Table 2. Mean number of pods plant^{-1} and pods weight plant^{-1} at harvest as influenced by different treatments

Treatment details	Number of pods plant^{-1}	Weight of pods plant^{-1}
T_1 - Control	5.40	4.50
T_2 - *Rhizobium* inoculation +R.D.F.	8.60	8.01
T_3 - Recommended dose of fertilizer	6.60	5.55
T_4 - Liquid 'Seaweed' + R.D.F.	8.60	6.32
T_5 - Microla + R.D.F.	6.53	5.32
T_6 - 13:40:13 kg NPK ha^{-1} (2% spray) +R.D.F.	6.60	5.68
T_7 - DAP (1% spray) + R.D.F.	5.80	5.81
T_8 - Urea (2% spray) + R.D.F.	7.20	5.74
T_9 - Cow urine (2% spray) + R.D.F.	5.66	5.04
T_{10} - Spray of water + R.D.F.	6.20	4.56
T_{11} - Panchagavya 3% spray + R.D.F.	7.66	5.80
SEm±	0.73	0.61
CD at 5%	2.18	1.81

Table 3. Grain and straw yield of cowpea at harvest as influenced by different treatments

Treatment details	Grain yield (q ha^{-1})	% increase in grain yield w.r.t. treatment T_6
T_1 - Control	8.37	38.04
T_2 - *Rhizobium* inoculation +R.D.F.	12.15	10.06
T_3 - Recommended dose of fertilizer	10.06	25.53
T_4 - Liquid 'Seaweed' + R.D.F.	10.73	20.57
T_5 - Microla + R.D.F.	10.13	25.01
T_6 - 13:40:13 kg NPK ha^{-1} (2% spray) +R.D.F.	13.51	-
T_7 - DAP (1% spray) + R.D.F.	11.04	18.28
T_8 - Urea (2% spray) + R.D.F.	10.98	18.72
T_9 - Cow urine (2% spray) + R.D.F.	10.97	18.80
T_{10} - Spray of water + R.D.F.	9.99	26.05
T_{11} - Panchagavya 3% spray + R.D.F.	10.22	24.35
SEm±	0.73	-
CD at 5%	2.18	-

Table 4. Cost economics as influenced by different treatments

Treatments	Yield (q ha^{-1})		Gross Returns	Total cost	Net Returns	B:C ratio
	Grain	Straw				
T_1 - Control	8.37	18.84	39549	26350.73	13198.27	1.50
T_2 - *Rhizobium* inoculation + R.D.F.	12.15	24.94	57169	30994.63	26174.37	1.84
T_3 - Recommended dose of fertilizer	10.06	23.95	47665	29390.95	18274.05	1.62
T_4 - Liquid 'Seaweed' + R.D.F.	10.73	21.45	50430	96271.29	-45841.3	0.52
T_5 - Microla + R.D.F.	10.13	24.5	48035	82588.62	-34553.6	0.58
T_6 - 13:40:13 kg NPK ha^{-1} (2% spray) +R.D.F.	13.51	26.25	63420	44058.49	19361.51	1.43
T_7 - DAP (1% spray) + R.D.F.	11.04	23.39	52019	30559.39	21459.61	1.70
T_8 - Urea (2% spray) + R.D.F	10.98	25.40	51950	30652.47	21297.53	1.69
T_9 - Cow urine (2% spray) + R.D.F.	10.97	21.62	51527	30144.09	21382.91	1.70
T_{10} - Spray of water + R.D.F.	9.99	19.63	46918	29266.45	17651.55	1.60
T_{11} - Panchagavya 3% spray + R.D.F.	10.22	24.05	48395	30742.62	17652.38	1.57
SEm±	0.73	0.97	-	-	-	-
CD at 5%	2.18	2.88	-	-	-	-

treatment i.e. 13:40:13 kg NPK ha^{-1} (2% spray) + R.D.F. and *Rhizobium* inoculation+ R.D.F. increased the cost of cultivation in comparison with control. The *Rhizobium* inoculation + R.D.F. recorded the maximum net returns of Rs. 26174.37 ha^{-1} with the highest B : C ratio of 1.84 followed by DAP spray + R.D.F. with net returns of Rs. 21459.61 ha^{-1} and B :C ratio of 1.70. Treatment Liquid ′Seaweed′ + R.D.F. recorded the minimum net profit of Rs. -45841.3 ha^{-1} with B : C ratio of 0.52 only.

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COST ECONOMICS OF SWEET CORN (*Zea mays Saccharata*) AS INFLUENCED BY IRRIGATION AND FERTIGATION LEVELS

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ABSTRACT

The field experiment was conducted with four irrigation and five fertigation levels at ASPEE Agriculture Research and development Foundation, Tansa Farm, At, Met/Nare, Dist.- Thane (Maharashtra) during *rabi* season of the year 2008-09.The maximum green cob yields (17.10 and 18.06 t ha^{-1}, respectively) was obtained with fertigation levels 100 per cent RD and irrigation at 1.0 PE. The yield was 30.50 and 50.66 per cent higher in fertigation and irrigation levels respectively as compared to control and surface irrigation method. Also, their interaction effect was significant. The maximum cost of production was observed in treatment combination of 1.0x P.E. through drip with 100% RDF through fertigation (1, 56,882.92) and minimum in case of treatment combination of surface irrigation with control or no fertigation (77535.75). The maximum net income was obtained in treatment combination of 1.0 x P.E. through drip with 75% RDF through fertigation (Rs.102023.95) that is irrigation at 1.0 PE with 75 per cent RD whereas, minimum reported in case of treatment combination of 0.6 x P.E. through drip with control or no fertigation (-2515.43). The B: C ratio (1.75) was found maximum in treatment combination of 1.0 PE. with 100 per cent RD as soil application.

(Key words: Sweet corn, fertigation, irrigation, net income, yield)

INTRODUCTION

In Maharashtra, the area and productivity of sweet corn is very low which need to be increased substantially by way of developing suitable improved package of practices. The cultural practices coupled with balanced use of fertilizer and optimum use of irrigation water play vital role in enhancing the productivity of sweet corn. Among the various natural resources, which are governing agricultural crop production, water is the most important resource for exploiting yield potential of selected crop. Water is essential for all the biological activities and now a day's water has been recognized more precious than any other input in agriculture. It is necessary to have proper planning for optimal use of water to maximize production of food production. This can be achieved by additional development, conservation and efficient management of available water resources. Fertigation refers to the combined application of water and soluble fertilizer through an irrigation system. Normally many soils in India are coarse textured with low organic matter content and are inherently low in fertility. Such soils often require replenishment of nutrient deficit by application of manures and fertilizers to increase crop yield. Fertigation is timely application of small amount of fertilizer through drip tubes directly to the root zone. Compared to conventional soil application, fertigation improves fertilizer use efficiency. Subsequently, comparable or better yields and quality can be produced with 20 – 50 % less fertilizers.

Considering the commercial demand of sweet corn its productivity needs to be increase. This can be easily possible through manipulation of major input factor like irrigation and fertigation. Hence, there is need to have information about irrigation scheduling in respect of sweet corn and therefore, present investigation was undertaken.

MATERIALS AND METHODS

The experiment was conducted at the ASPEE Agriculture Research and development Foundation, Tansa Farm, At, Met/Nare, Dist.- Thane (Maharashtra) during *rabi* season of the year 2008-09. During the period of experimentation mean maximum temperature varied from 28.6^{0}C to 39^{0}C and mean minimum temperature varied from 11.3^{0}C to 20.8^{0}C and minimum pan evaporation was 2.1 mm day^{-1} and maximum was 7.5 mm day^{-1}.

The experimental plot soil was well drained and levelled and uniform in topography having medium black colour with good drainage. The soils of experimental field was medium black, clay loam in texture and having porosity and maximum water

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holding capacity were 44.12 and 64.11 per cent respectively. The bulk density was 1.20 g cc^{-1}. It could be concluded from the initial soil analysis of the experimental plot that the soil was medium black and clay loam in texture. It was uniform in depth with a fairly good water holding capacity. Studies regarding the initial soil fertility status indicated that it was moderately high in available nitrogen (445.53 kg ha^{-1}) and phosphorus (25.54 kg ha^{-1}) and very high in available potassium (424.10 kg ha^{-1}) with high content of organic matter (1.98%).

The experiment was laid out in spilt plot design with four main plot irrigation treatments I_0: surface irrigation, I_1: 0.6 x P.E. through drip, I_2: 0.8 x P.E through drip and I_3: 1.0 x P.E. through drip. Where 0.6, 0.8 and 1.0 were the integrated factors derived from crop coefficient (K_c), pan factor (K_p) and wetted area (W_a).

Five sub plot fertigation treatments were F_0: control, F_1: 100% RDF through fertigation, F_2 : 75% RDF through fertigation, F_3 : 50% RDF through fertigation and F_4 : 100% RDF as soil application. Thus, there were in all 20-treatment combinations, replicated 3 times.

The experiment was laid out with twenty treatment combinations arranged randomly in a field of 45 m x 45 m size with gross plot size of 4.50 m x 3.20 m. The buffer of 1 m was left between two successive treatments plots in order to avoid movement of water from one plot to another. Water soluble fertilizer of grade 19:19:19 and urea used for treatment with fertigation levels from F_1 to F_3 i.e. from 100% RDF through fertigation, 75% RDF through fertigation and 50% RDF through fertigation while urea (46% N), single super phosphate (16% P) and murate of potash (60% K) were used for the treatments F_4 i.e. 100% RDF as soil application. Water soluble fertilizers were applied weekly as per different fertigation treatments. Fertigation was given through the venturi of 0.75 inches. The basal dose was divided into four splits of 10,20,30,40 per cent and was applied weekly after sowing, whereas the dose of top dressing was divided into four equal splits of 25,25,25,25 per cent and was applied weekly in the next month. After 60 DAS no any fertigation was given. For treatment F_4 i.e. 100% RDF as soil application of solid fertilizers were used in which 100 per cent P, K and 1/3rd quantity of N was applied as a basal dose and remaining 2/3 dose of N was applied at 30 and 60 DAS as top dressing. The N, P, and K were supplied through urea, SSP and MOP respectively. For F_0 treatment no fertigation was allowed.

The cobs were harvested at late milk stage from each net plot were weighed in kg net^{-1} plot and then were converted on hectare basis. Economics of the different treatments was worked out taking into account the cost "C" and income of total produce. The prevailing prices during the crop season were used for working out gross returns. The cost: benefit ratio (CBR) was calculated by dividing the gross return by the total cost of cultivation of each treatment.

RESULTS AND DISCUSSION

Green cob yield of sweet corn:

Irrigation levels significantly influenced the green cob yield of sweet corn. Drip irrigation at 1.0 x P.E. (I_3) registered significantly higher green cob yield (Table 1). Increase in green cob yield of sweet corn due to treatment I_3 (1.0 x P.E. through drip) was in tune of 30.50, 25.02 and 13.27 per cent over the treatments, surface irrigation (I_0), 0.6 x P.E. through drip (I_1) and 0.8 x P.E. through drip (I_2) respectively. This clearly revealed that the crop experienced soil moisture stress due to varying amount of irrigation water applied. Similarly, the frequency of irrigation caused significant variation in green cob yield of sweet corn.

Significantly superior green cob yield (t ha^{-1}) was obtained in treatment F_1 (100% RDF through fertigation), which was on par with F_2 (75% RDF through fertigation) over the rest of fertigation treatments under study. Increase in the green cob yield of sweet corn due to treatment 100% RDF through fertigation (F_1) was in the tune of 1.17, 27.57, 15.28 and 50.66 per cent over the treatments 75% RDF through fertigation (F_2), 50% RDF through fertigation (F_3), 100% RDF as soil application (F_4) and Control (F_0), respectively. This data on green cob yield (t ha^{-1}) indicated the saving of 25 per cent nutrients with increase of green cob yield with 15-20 per cent with considerable labour saving in the

Table 1. Average green cob yield of sweet corn as influenced by different treatments

Treatments	Yield (t ha^{-1})	Treatments	Yield (t ha^{-1})
Irrigation levels		Fertigation levels	
I_0-Surface irrigation	12.30	F_0- Control	8.91
I_1- 0.6 x P.E through drip	13.27	F_1- 100% RDF through fertigation	18.06
I_2- 0.8 x P.E through drip	15.35	F_2- 75% RDF through fertigation	17.85
I_3- 1.0 x P.E through drip	17.70	F_3- 50% RDF through fertigation	13.08
SE ±	0.25	F_4- 100% RDF as soil application	15.30
CD at 5%	0.86	SE	0.57
	CD at 5%		**1.64**

Table 2. Interaction effect of irrigation and fertigation levels on green cob yield (t ha^{-1}) of sweet corn

Treatments	Fertigation levels				
Irrigation levels	Green cob yield (t ha^{-1})				
	F_0	F_1	F_2	F_3	F_4
I_0	7.80	15.21	15.07	11.36	12.23
I_1	8.70	15.71	15.62	11.86	13.94
I_2	9.45	19.04	18.93	13.12	16.24
I_3	9.69	22.27	21.78	15.97	18.77
S.E.±			0.610		
CD at 5%			1.756		

Table 3. Input cost, total cost, yield of cob (t ha^{-1}), gross income, net income, and B: C ratio of different treatment combinations

Treatment combination	Input cost (Rs ha^{-1})	Total cost (Rs ha^{-1})	Yield of cob (t ha^{-1}	Yield of green fodder (t ha 1)	Gross income (Rs ha^{-1})	Net income (Rs ha^{-1})	B:C ratio
I_0F_0	49906	77535.75	7.80	9.67	87,670	10134.25	1.13
I_0F_1	80846	127165.58	15.21	21.49	1,73,590	46424.42	1.36
I_0F_2	60076	103103.55	15.07	21.00	1,71,700	68596.45	1.66
I_0F_3	65676	101771.56	11.36	13.75	1,27,350	25578.40	1.25
I_0F_4	54423	90907.55	12.23	15.00	1,37,300	46392.45	1.51
I_1F_0	44606	95333.43	8.70	10.18	97,180	-2515.43	0.97
I_1F_1	75546	144715.57	15.71	21.49	1,81,910	37194.43	1.25
I_1F_2	67811	135587.82	15.62	23.32	1,79,520	43932.18	1.32
I_1F_3	60061	122016.99	11.86	17.57	1,36,170	29243.01	1.23
I_1F_4	53597	115622.13	13.94	17.83	1,57,230	41607.87	1.35
I_2F_0	44606	96623.41	9.45	10.42	1,04,920	7485.51	1.06
I_2F_1	75546	153906.47	19.04	27.04	2,17,440	63533.53	1.41
I_2F_2	67811	141686.15	18.93	26.81	2,16,110	74423.85	1.53
I_2F_3	60061	126791.99	13.12	20.06	1,51,260	53118.01	1.41
I_2F_4	53597	120088.77	16.24	21.63	1,84,030	63941.23	1.53
I_3F_0	44606	97165.08	9.69	11.27	1,08,170	11004.92	1.11
I_3F_1	75546	156882.92	22.27	31.53	2,54,230	97347.08	1.62
I_3F_2	67811	147206.05	21.78	31.43	2,49,230	102023.95	1.69
I_3F_3	60061	126791.99	15.97	20.21	1,79,910	53118.01	1.41
I_3F_4	53597	119935.72	18.77	23.28	2,10,980	91044.28	1.75

treatment 75% RDF through fertigation when compared with application of straight fertilizers as in case of the treatment 100% RDF as soil application.

Interaction effect:

The data on interaction effect of irrigation and fertigation on green cob yield of sweet corn are presented in table 2. The statistical analysis revealed the treatment combinations I_3F_1 (1.0x P.E. through drip with 100% RDF through fertigation) recorded significantly superior green cob yield than rest of the treatment combinations. However, the former treatment was at par with the treatment combination I_3F_2 (1.0x P.E. through drip with 75% RDF through fertigation) and the lowest yield was recorded by treatment combination I_0F_0 (surface irrigation with control or no fertigation). This might be due to application of water soluble fertilizer through fertigation because such fertilizers are become readily available to crop and also fertigation is scheduled at weekly interval instead of applying fertilizers at a time or twice in crop growth period. Similarly straight fertilizers were leached out or get fixed on soil colloids and due to this their availability gets reduced and hence yield of crop was less. Also, Ponnuswamy and Santhi (2008) clearly indicated that drip fertigation with 125 per cent recommended dose of fertilizer recorded more grain yield of maize (6852 and 6933 kg ha^{-1}), but it was at par with 100 per cent of RDF. Surface irrigation with soil application of 100 per cent RDF recorded lowest grain yield of 3661 and 5627 kg ha^{-1} during 1st and 2nd year.

Cost economics of sweet corn:

The highest total cost of production of sweet corn was observed by treatment combination I_3F_1 (1.0x P.E. through drip with 100% RDF through fertigation). This highest total cost was associated in case of drip irrigation treatment was due to the depreciation on irrigation system, materials and highest initial investment. In addition to that it may be due to higher cost of water soluble fertilizer used in the treatment combination (Table 3).The highest gross income was recorded by the treatment combination (I_3F_1) 1.0 x P.E. through drip with 100% RDF through fertigation (Rs. 2, 54,230 ha^{-1}) and lowest gross income was recorded by treatment combination surface irrigation with control or no fertigation (I_0F_0) (Rs. 87,670 ha^{-1}). The highest B: C ratio (1.75) was observed in the treatment combination I_3F_4 (1.0x P.E. through drip with 100% RDF through soil application) followed by the treatment combination I_3F_2 (1.0 x P.E. through drip with 75% RDF through fertigation) (1.69). This was mainly due to low cost of solid form of fertilizer as compared to high cost (4 times) of water soluble fertilizer. The B: C ratio was significantly higher in the conventional method of fertilizer application due to its low cost of production compared to all drip fertigated treatments. Similar findings were reported by Satpute *et al*. (2008) in case of cucumber, according to them fertigation of water soluble fertilizers through drip attributed to 25 per cent of fertilizer saving and high cost of liquid fertilizers significantly reduces the net profit and B: C ratio.

The treatment combination I_3F_2 (1.0 x P.E. through drip with 75% RDF through fertigation) recorded maximum net profit (Rs. 1, 02,023 ha^{-1}) followed by treatment combination I_3F_1 (1.0 x P.E. through drip with 100% RDF through fertigation) of Rs. 97,347.08 ha^{-1}.

The negative net income of Rs.-2515.43 was recorded by the treatment combination I_1F_0 (0.6 x P.E. through drip with control or no fertigation). This might be due to low green cob and green fodder yield (t ha^{-1}) with higher cost of production.

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EVALUATION OF MUSTARD GENOTYPES ON THE BASIS OF BIOCHEMICAL AND MOLECULAR TRAITS

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ABSTRACT

Thirteen genotypes belonging to five species *Brassica rapa, Brassica juncea, Brassica carinata, Brassica napus and Eureca sativa* were evaluated for biochemical and molecular traits to study the diversity among the genotypes and to identify the desirable and potential parents in mustard breeding programme during 2008-2009 in Agril Botany Section, College of Agriculture, Nagpur. The biochemical (seed protein SDS-PAGE and isozyme) and molecular markers (RAPD with 18 primers) were found to be effective in diversity like that of the genetic diversity. However,in mustard molecular markers like RAPD can be used as more effective supplementary test to screen the germplasm more reliably than genetic and biochemical markers. Drought tolerant genotype RTM-314 and T-27 deviated from all other genotypes on the basis of biochemical and molecular markers. The two genotypes showed unique bands for drought tolerance as compared to other genotypes. The cultivated genotypes ACN-9 and Pusa Bold showed enough dissimilarity from the RTM-314 and T-27. Hence, these two cultivated genotypes ACN-9 and Pusa Bold of *Brassica juncea* can be further improved for yield along with drought tolerance by crossing with RTM-314 and T-27 (*Eureca sativa*).

(Key words: *Brassica* species, biochemical and molecular analysis)

INTRODUCTION

Indian mustard (*Brassica juncea* L. Czern and Coss) is an important oil seed crop which has received attention of geneticist and breeders for it genetic improvement. It has exhibited greater production potential under varying environments. The important species of Brassica that are extensively cultivated commercially are *Brassica juncea*, *Brassica campestris* and *Brasica napus* out of which *Brassica campestris* and *Brassica juncea* are largly cultivated in Asia (India, China, Pakistan, Bangladesh and Nepal) while *Brassica napus* in Sweden, Germany, France, Canada and Australia.Indian mustard is mostly grown on light textured soil as it conserves moisture from monsoon rains thus, it invariably suffers from moisture stress during reproductive phase of growth. Genetic variability within a species offers valuable for studying the mechanism of drought tolerance. The analysis of genetic variation and relatedness in germplasm are of great value for genetic resources conservation and plant breeding programme over the years. Methods for assessing genetic diversity have ranged from classical strategies such as morphological analysis, biometrical analysis to biochemical strategies and molecular techniques (Demissie *et al.*, 1998).

Several biochemical and molecular approaches have been used to identify, diagnose and delimit species and access phylogenetic relationship between different species. Biochemical methods like seed protein, banding pattern, isozyme banding pattern and molecular methods like RAPD, RFLP etc, have been the most extensively applied technique for screening mustard species. Biochemical and molecular markers are the best tools for determining genetic relationships. Different types of marker system have been used for biodiversity analysis. Seed storage protein is useful tool for studying genetic diversity of wild and cultivated species of different crops eg. Rice (Kumar and Gupta,1985). However, the information of the SDS-PAGE on different species of *Brassica* for genetic diversity is still limited. *Brassica juncea* is a cultivated species of Vidarbha region having high yielding capacity. However, as it is grown with the conserved moisture from monsoon rain it invariably suffers from moisture stress during different phases of growth. The unpredictable rainfall received also results in unfavorable residual moisture. This affects the yielding potential of the mustard varieties grown in the Vidarbha region. Therefore, there is a need for identifying high yielding and early maturing mustard varieties along with the drought tolerant trait. In an attempt to fulfill this need partly this experiment was taken up to screen the available mustard species on the basis of biochemical and molecular technique.

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MATERIALS AND METHODS

The study of evaluation of mustard genotypes for biochemical and molecular traits was conducted in College of Agriculture, Nagpur during 2008-2009.Thirteen genotypes viz., Bhawani,PT-303,T-9,YST-151,Ragini, Pusa Bold, ACN-9, BSH-1,KBS-3,RTM-314,T-27, PC-5 and GSL-1 belonging to five Brassica species viz., *Brassica rapa, Brassica juncea, Eureca sativa, Brassica carinata and Brassica napus* were used for biochemical and molecular analysis. Seed storage protein was extracted from cotyledon of single seed and used for SDS-PAGE analysis as method suggested by Shapiro *et al*.(1967). Banding pattern were scored from atleast two electrophorograms for each stain. Where ambiguous pattern were obtained, electrophoresis was further carried out by changing the gel concentration and or electrophoresis time to determine the protein type. Seed protein banding pattern were evaluated for polymorphism. Bands were scored as '+' for the presence or boldly exhibited and '-'for the absence or weekly exhibited across the genotypes. These scores were then used to estimate the genetic similarity index and genetic distance as per the method described by Nei and Li (1979). As toria *Eureca sativa* have been reported as drought tolerance it was used as a marker genotype to identify drought tolerant species.

For molecular (DNA) data analysis the isolation of genomic DNA was done by the method given by Krishna and Jawali (1997). The isolated genomic DNA was verified for size, intactness, homogeneity and purity. Amplification of genomic DNA through polymerase chain reaction was done by the method suggested by Saiki *et al.*(1988). Seperation of DNA fragments was done by agarose gel electrophoresis was done by the method given by Sambrook *et al*. (1989). The gel was viewed in an alpha amager (alpha imager 1200, alpha innotech corporation) and the image was documented. All the electromorphs observed from the electrophoretic field were scored for their presence or absence of bands using binary codes as 1 and 0 respectively. The similarity indices were calculated using the formulae,

$$\text{Similarity index} = \frac{2 \times n11}{(2 \times n11)+(2 \times n11)}$$

Where,
N= Total numbers of bands
Nx= Total number of bands present in x
Ny= Total number of bands present in y
N^{11}= Total number of occurrences where x=1 and y=1
N^{oo}= Total number of occurrences where x=0 and y=0
N^{o1}= Total number of occurrences where x=0 and y=0
N^{10}= Total number of occurrences where x=1 and y=0

Based on these co-efficients UPGMA clustering was carried out and a cluster dendogram was constructed for the Brassica genotypes using nearest neighbourhood joining method. The entire analysis was performed by using "RAPDistance" 1.04, a computer soft ware developed by Amstrong *et al*. (2003).

RESULTS AND DISCUSSION

The electrophoresis of seed storage proteins is a method used to investigate genetic variation and to classify plant varieties. Seed protein is not sensitive to environmental fluctuation, its banding pattern is very stable which advocated for cultivars identification purpose in crop. It has been widely suggested that such banding patterns could be an important supplemental method for cultivar identification, particularly when there are legal disputes over the identification of cultivars or when cultivars are to be patented. However, the information on the SDS-PAGE on different species of Brassica for genetic diversity is still limited.

The seed protein banding pattern showed polymorphism among the genotypes studied, (Figure 1). The SDS-PAGE protein banding pattern exhibited a maximum of 18 bands out of which one was monomorphic and other seventeen bands were polymorphic for one and the other genotype. Genetic similarity index of the thirteen genotypes of mustard studied based on seed protein SDS-PAGE are presented in table 1. The similarity index ranged from 0.22 to 0.89 showing wide variation among the genotypes used in the study. *Brassica juncea* consisting of Pusa Bold and ACN-9 showed similarity index ranging from 0.31 to 0.67 with that of *Eureca sativa* group which indicates that there is a wide scope to improve these varieties for drought resistance. Genotypes belonging to yellow sarsan showed high similarity index with that of *Eureca*

sativa group ranging from 0.71 to 0.82. Genotypes belonging to brown sarson also showed high similarity index with that of toria group ranging from 0.80 to 0.75.

Genetic similarity index of the thirteen genotypes based on seed protein SDS-PAGE revealed that wide variation among the genotypes were prevalent, among them, as the similarity index ranged from 0.22 to 0.89. Genotypes belonging to *Brassica juncea* showed very less similarity indicating that Pusa Bold and ACN-9 were deviating from one another at high rate. But species belonging to *Brassica rapa* genotypes showed high similarity. Genotypes of *Eureca sativa* (drought tolerance) i.e. RTM-314 and T-27 showed the similarity index from 0.37 to 0.67 with that of genotypes of *Brassica juncea* i.e. Pusa Bold and ACN-9, which indicates that there is a wide scope of improving Pusa Bold and ACN-9, for drought tolerance by crossing with RTM-314 and T-27. A unique band marked (Figure 1) was observed only in RTM-314 and T-27 but not in any other genotypes of any species indicating that this band may be correlated with drought tolerance trait expressed by the two genotypes.

In accordance to this study Kour and Singh (2004) also distinguished certain mustard genotypes based on seed protein. Seed protein electrophoresis was proved to be useful in identifying genotypes of *Brassica juncea* species and characterizing them for identifying the promising genotypes for different traits, which may serve as good genetic donors for exploitation in further breeding programme. Attempt was also made to study the genetic diversity among thirteen genotypes taken from five different species by scanning the entire genome using arbitrary primers (Table 2) through RAPD analysis. All the eighteen primers revealed polymorphism between the thirteen genotypes taken for study. The amplified products varied in number and intensity among the selected genotypes. The RAPD profiles of thirteen genotypes for eighteen primers were presented in plate 1 to 2. A total of 279 scorable bands were identified as a result of amplification by eighteen random primers out of which 275 were polymorphic for the thirteen genotypes studied (Table 2).

In accordance to this study, usefulness of RAPD in *Brassica* species has been demonstrated for the variety identification by Saha *et al*. (2008). They studied genetic diversity and relationship among nine Brassica varieties of four different species using RAPD markers. In total, 59 reproducible DNA bands were generated by four arbitrarily selected primers of which 58 bands were proved to be polymorphic. This bands had ranged from 212 to 2272 bp in size.

Among eighteen primers tested, the number of RAPD bands generated were more for the primer E07, E09 and IOP700 (19) followed by A07 and B09 (18). Amplification with the primer D07 yielded the least number of amplified fragments (9). When the primers A07, D18, E07, E09, D07, D08, E06, E08, A08, B09, C07, G02, IOP576 and IOP700 were used for amplification, all the fragments identified 18, 16, 19, 19, 9, 14, 13, 18, 17, 17, 18, 17, 15, 13 and 19 respectively were polymorphic. The genomic DNA samples amplified with D09, IPI178 and IPI701 gave varying number of polymorphic bands. In D09, 12 out of 13, in IPI178, 11 out of 12 and in IPI701, 10 out of 12 were polymorphic and the remaining were monomorphic in nature. The degree of polymorphism detected by different primers varied and thus, there was considerable variation in the ability of individual primers to detect DNA polymorphism. Gosh *et al.* (2009) studied genetic diversity analysis and relationship among 9 *Brassica* varieties namely BARI Sharisha-12, Agrani, Sampad, BINA Sharisha-4, BINA Sharisha-5, BINA Sharisha-6, Daulat, Rai-5, Alboglabra using RAPD markers. In total 59 reproducible DNA bands were generated by arbitrary selected primers of which 58 (98.03%) bands were proved to be polymorphic. This bands ranged from 212-30686 bp in size.

The binary data obtained from 18 random primers for thirteen genotypes were analysed and the similarity index between the genotypes was derived and are presented in figure 3. The maximum similarity coefficient values (0.61 to 0.70) were observed between BSH-1 with Bhavani, PT-303 with BSH-1, Ragini with BSH-1, T-27 with ACN-9. The least similarity coefficient value (<= 0.20) was observed between T-27 and YST-151. Based on the similarity index, a cluster dendrogram was constructed which is presented in figure 3. The thirteen genotypes were grouped into two major clusters, comprising Bhavani, BSH-1, YST-151, PT-303, Ragini, and KBS-3, in one cluster and Pusa Bold, T-9, GSL1, ACN-9 and PC-5 in the other. Genotypes RTM314 and T-27 were observed to fall

in a separate minor cluster which was found to be distinct from that of the other two groups. The first major cluster was further partitioned into two subclusters one including Bhavani, BSH-1, and the other included YST-151, PT-23, Ragini, and KBS-3. Similarly the second major cluster comprised of two subclusters one including Pusa Bold, T-9, and GSL-1 and the other subcluster included ACN-9 and PC-5.

Variation in the intensity of the same band in different genotypes were noticed which might be due to the fact that specific site choosen by the primer could have been found in abundance when compared with other genotypes. 28 reproducible bands were used by Ali *et al*. (2010) for cluster analysis and with the help of these bands genetic diversity was estimated. Out of 28, four major bands were observed. Dendrogram was constructed and the accessions were divided into two main groups comprising 11 clusters. The result obtained from these cluster showed minimum genetic diversity in these accession on SDS-PAGE level. Due to low genetic diversity on SDS-PAGE level, it is suggested that two dimensional (2D) electrophoresis can be used for protein study. The analysis revealed that the variation in the similarity index ranged from 0.20 to 0.70 between the genotypes, the genotypes having maximum values being similar between them. The maximum similarity coefficient value ranged from 0.61 to 0.70 was observed between BSH-1 with Bhavani, PT-303 with BSH-1, Ragini with BSH-1, T-27 with ACN-9. The similarity index between the drought tolerant genotypes RTM-314 and T-27 belonging to *Eureca sativa* with the cultivated genotypes Pusa Bold and ACN-9 belonging to *Brassica juncea* were found to be in the range of 0.21 to 0.30 which indicates a high level of dissimilarity and diversity among these two species. Dendrogram obtained from the data of molecular data analysis revealed that the thirteen genotypes were distributed in two major and one minor cluster. Interesting thing observed from this study is that the drought tolerant genotypes RTM314 and T-27 fell in a separate minor cluster which was found to be distinct from that of the other two groups. The cultivated genotypes Pusa Bold and ACN-9 even though belonging to *Brassica jucea* grouped in two different subgroups of the second major cluster which indicates that these two varieties were distinct from one another in some aspects.

In accordance to this study, usefulness of RAPDs in *Brassica oleracea* has been demonstrated for variety identification (Hu and Quiros, 1991), gene bank management (Kresovich *et al*., 1992), taxanomic studies (Demek *et al*., 1992) and gene diversity evaluation (Margale *et al*., 1995). Liu and Furnier (1993) demonstrated that RAPD markers are very useful for discriminating individual genotypes. The utility of the molecular markers for the establishment of genetic relationship among *Brassica oleracea* and its wild relatives has been demonstrated by Lizaro and Auginagalde (1998) and in barley cultivars by Hussein *et al*. (2005). Evaluation of mustard genotypes on the basis of biochemical and molecular techniques resulted in significant findings. Biochemical study like SDS-PAGE of seed protein and molecular analysis like RAPD in leaf DNA can be effectively used for identifying genotypes for their use in further improvement. As ACN-9, and Pusa Bold are high yielding and established variety and are deviating from RTM-314 and T-27 can be further improved for drought tolerance along with yield by crossing ACN-9 and Pusa Bold with RTM-314 and T-27.

Table 1. Genetic similarity index of thirteen genotypes of mustard studied based on seed protein SDS-PAGE

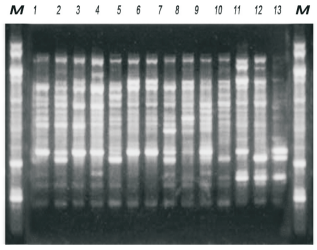
Genotypes	1	2	3	4	5	6	7	8	9	10	11	12	13
Brassica rapa													
1. Bhavani		0.77	0.67	0.63	0.31	0.50	0.36	0.80	0.75	0.53	0.53	0.47	0.47
2. PT-303			0.71	0.40	0.50	0.36	0.40	0.57	0.53	0.57	0.57	0.50	0.63
3. T-9				0.82	0.71	0.62	0.50	0.50	0.59	0.75	0.50	0.56	0.56
Brassica rapa (yellow)													
4. YST-151					0.80	0.43	0.46	0.71	0.67	0.71	0.47	0.63	0.63
5. Ragini						0.55	0.40	0.57	0.40	0.57	0.29	0.50	0.50
Brassica rapa (brown sarsan)													
6. BSH-1							0.22	0.62	0.57	0.46	0.31	0.40	0.27
7. KBS-3								0.33	0.46	0.67	0.50	0.43	0.43
Eureca sativa													
8. RTM-314									0.82	0.50	0.38	0.56	0.33
9. T-27										0.71	0.59	0.63	0.42
Brassica carinata 13													
10. PC-5											0.38	0.39	0.28
Brassica napus													
11. GSL-1												0.89	0.56
Brassica juncea													
12. Pusa Bold													0.50
13. ACN-9													

Table 2. RAPD products generated using 18 random primers in thirteen genotypes belonging to five mustard species

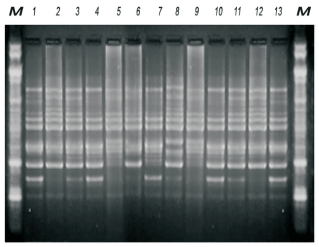
Sr. No.	Primer number	Prime sequence (5′ to 3′)	No. of polymorphic bands	No. of monomorphic bands	Total number of RAPD fragments
1	A07	GAAACGGGTG	18	-	18
2	D18	GAGAGCCAAC	16	-	16
3	E07	AGATGCAGCC	19	-	19
4	E09	AGGCATCTCD	19	-	19
5	D07	CGGGACCCGA	9	-	9
6	D09	GCCCAGGTCC	12	1	13
7	D08	CTAAAACGGC	14	-	14
8	E06	GGGCTGCTCA	13	-	13
9	E07	CCCGTACTGC	18	-	18
10	E08	ATTTGCCTCT	17	-	17
11	A08	CGTCGGGGCT	17	-	17
12	B09	CCCGTAGTGA	18	-	18
13	C01	CCCTCGTAGA	17	-	17
14	G02	CCCGTAGTCG	15	-	15
15	IOP576	CCCGCTGACC	13	4	13
16	IOP700	CGTAGGCTGA	19	-	19
17	IPI178	CCCGTAGCTG	11	1	12
18	IPI701	GTGCGAATGT	10	2	12
Total			275	4	279

PLATE 1. RAPD Banding pattern between genotypes for the primers

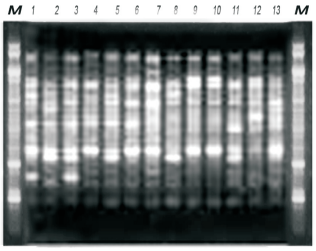
1. BHAVANI ,	2. YST -151,	3. BSH -1,	4. PT-303,
5. RAGINI,	6. KBS -3,	7. T-9	8. PC-5,
9. GSL -1,	10. PUSA BOLD,	11. ACN-9,	12. RTM -314.
13 T-27			



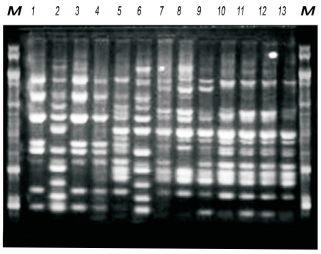
Primer A07



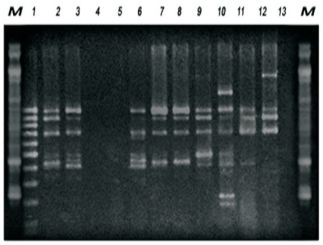
Primer D07



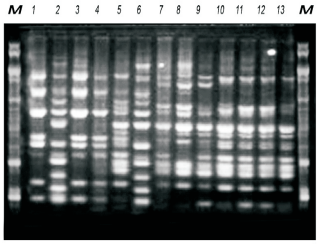
Primer D18



Primer E07



Primer E09



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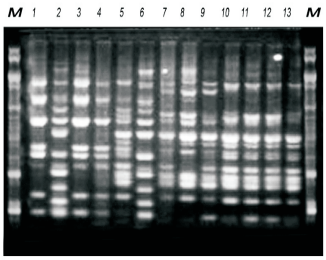
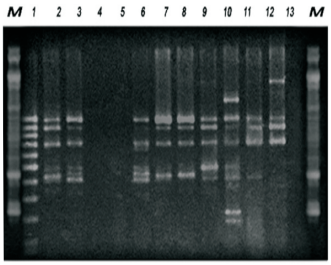
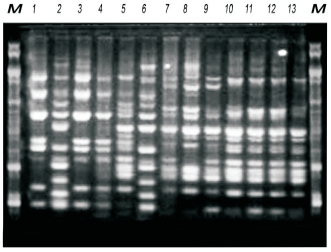


Primer D08



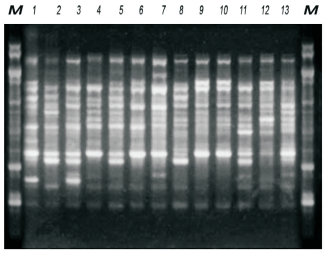
Primer E06



Primer E07

PLATE 2. RAPD Banding pattern between genotypes for the primers

1. BHAVANI ,	2. YST -151,	3. BSH -1,	4. PT-303,
5. RAGINI,	6. KBS -3,	7. T-9	8. PC-5,
9. GSL -1,	10. PUSA BOLD,	11. ACN-9,	12. RTM -314.
13 T-27			



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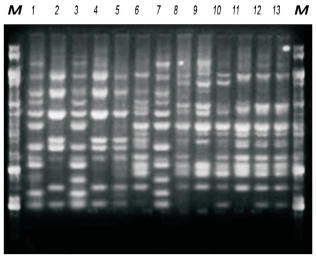
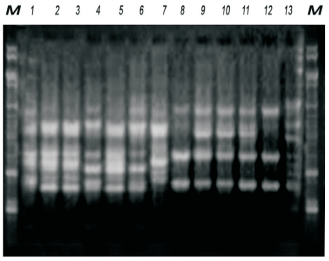
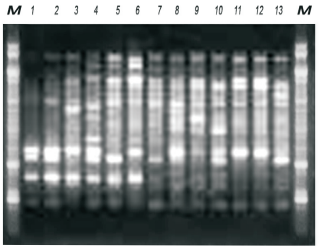


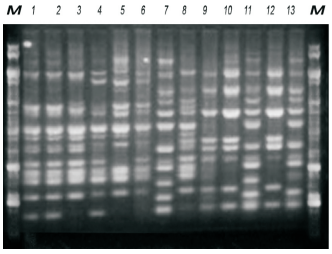
Primer A08



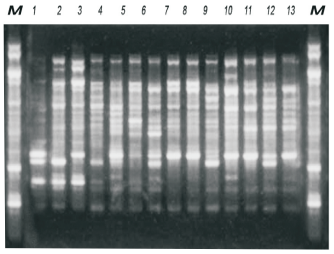
Primer B09



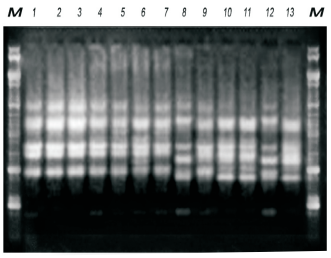
Primer C01



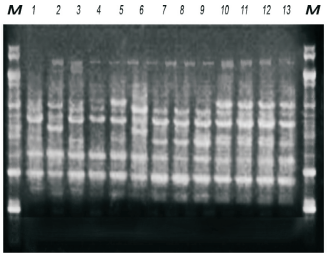
Primer G02



Primer IPI701



Primer IPI178



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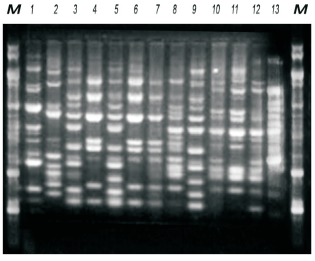
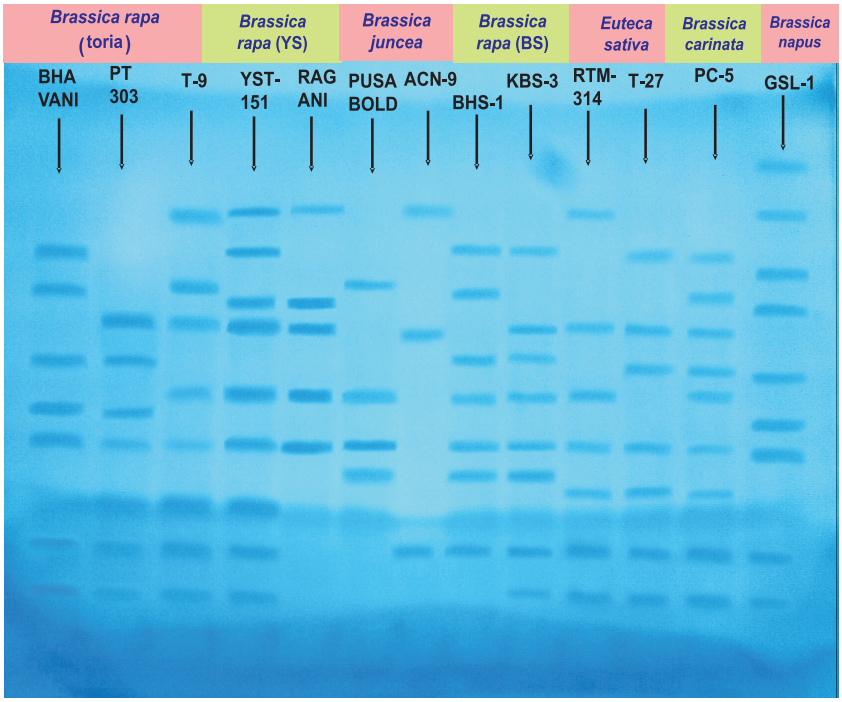


Primer IOP700

Fig.1 Seed protein banding pattern of 13 mustard genotypes



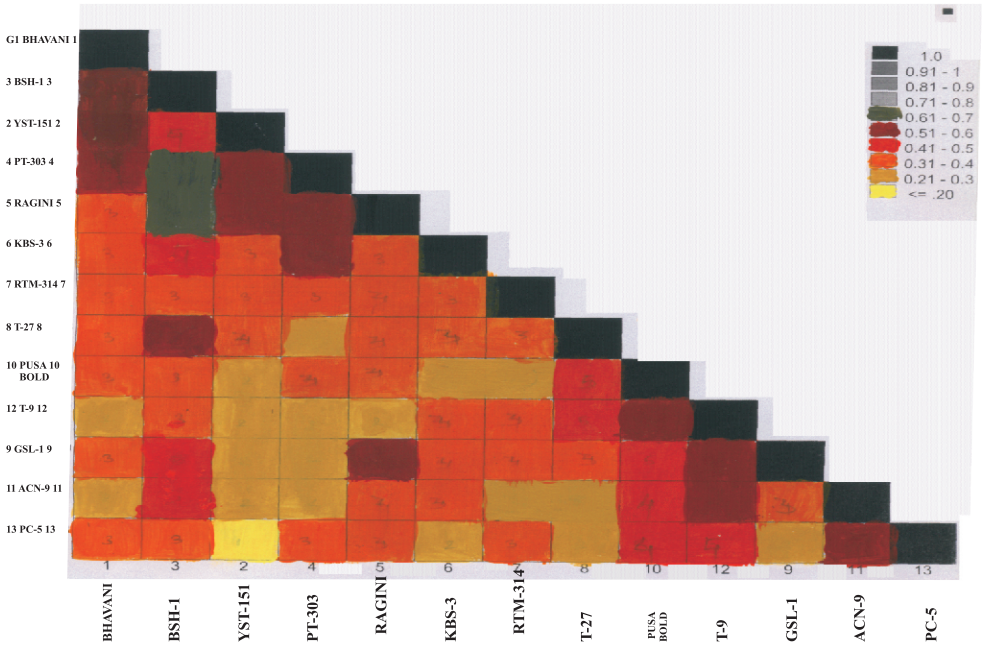


Figure 2. Similarity matrix of eighteen random primer for thirteen genotypes

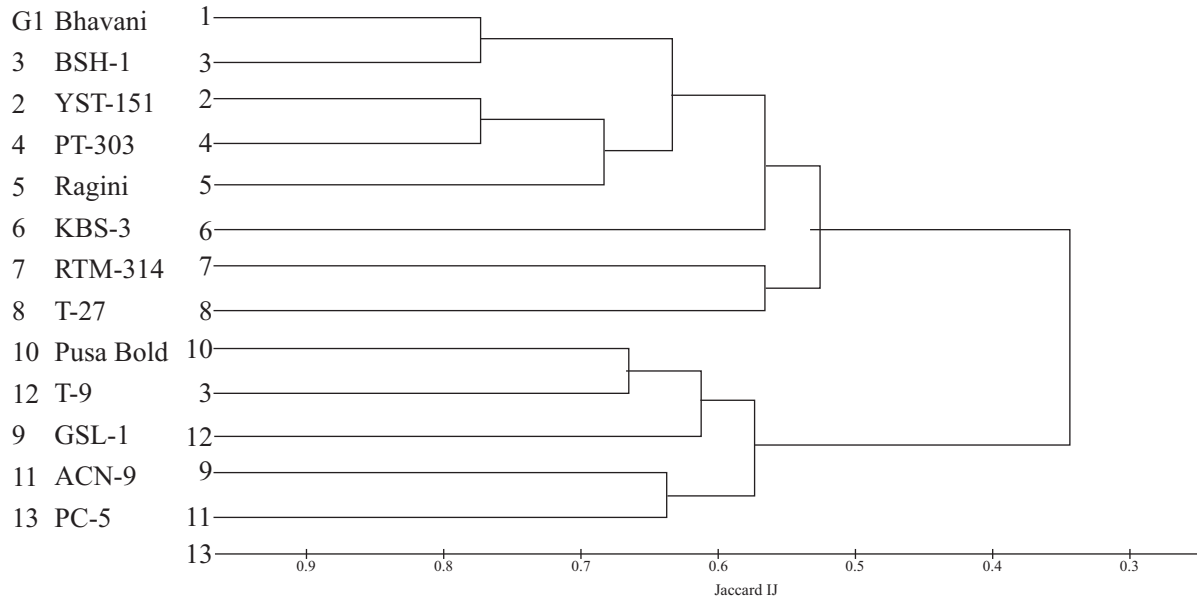


Figure 3. Dendrogram showing grouping of 18 random primer of thirteen mustard genotypes

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SURVEY OF SEED BORNE FUNGI OF ONION (*Allium cepa* L.) FROM VARIOUS LOCATIONS OF MAHARASHTRA

Swati Dumbre[1], Damayanti Guldekar[2] and S. R. Potdukhe[3]

An experiment was conducted during 2008-2009 in the Department of Plant Pathology, College of Agriculture, Nagpur. Seed samples (Local varieties) of onion were collected from five different geographical locations of Maharashtra viz., Pune, Nashik and Ahmednagar from *kharif* season and Akola and Nagpur from *rabi* season. Twelve different types of seed borne fungi were found associated with onion seeds. Five species of *Aspergillus*, two species of *Fusarium*, and one each from *Penicillium, Drechslera, Curvularia, Rhizopus* and *Alternaria* were identified. Among the twelve species of fungi, *Aspergillus niger* was the most prevalent fungi in all locations which was followed by *Drechslera australiensis, Fusarium oxysporum, Penicillium citirnum, Curvularia lunata, Rhizopus stolonifer* and *Alternaria alternata. Aspergillus oryzae* and *Alternaria alternata* were found only on the *rabi* variety from Nagpur region. Among the varieties grown at the five different locations, the variety grown in Nagpur region during the *rabi* season was found to be more susceptible. Also seeds collected from *rabi* season had more percentage of mycoflora than *kharif* season collected seeds.

(Key words: **Onion, Seed mycoflora, *Aspergillus*, *Drechslera, Penicillium, Fusarium, Curvularia, Rhizopus* and *Alternaria)***

INTRODUCTION

World′s onion production is steadily increasing because it is the second most important horticultural crop after tomatoes. Onion is the largest vegetable produced and consumed not only in India but also in the world. But onion seeds are considered to be notoriously short lived, as they lose their viability within one year. One of the reasons for this quick loss of viability is the infestation with seed-borne fungi (Chlvers toit du, 2006). Seed borne diseases are also seed transmissible. Seed transmitted pathogens cause disease at various stages of crop growth from seed germination to crop maturity and may cause heavy losses. Since, seed is a carrier of many diseases, it can transmit them to unknown areas. Seed borne-microorganisms are carried on the surface of seed or are embedded in seed tissues. Seed infection can affect germination resulting in reduction of plant population in field. Low germination capacity of vegetable seed is suspected to the external and internal association of different fungi with the seed (Kanjanasoon and Mathur, 1962). Kaul (1972) had made preliminary observations on seed–borne fungi of onion and their possible control. Viability of onion seeds generally decreases after a short period of storage and after a year the germination becomes uneconomical. This decrease in viability is governed by many factors which includes genetic, pathological, physiological and storage conditions. A pathological cause of reduction in viability is mostly due to seed borne mycoflora carried with the seeds (Puttoo, 1969).

Gupta *et al.* (1984) recorded the maximum number of seed-borne fungi of onion by blotter paper method. Koycii and Ozer (1997) determined in their experiment that seed borne fungi of onion viz; *Aspergillus alutaceous* , *Beauveria bassiana*, *Cladospoirium cladosporioides* , *Geotrichum* sp., *Humicola fuscoatra* ,*Trichoderma harzianum* and *T.pseudokoningii* in onion seeds, and *F.culmorum* , *F.graminearum* Schwabe and *F.sambucinum* in onion sets, were recorded for the first time. Among the several factors responsible for such a low yield, seed borne fungi also play important role by including pre and post emergence mortality, ultimately resulting in poor yields (Basak, 1994 and Kennewick, 2008). It was, therefore, thought necessary to study the seed borne fungi of onion from various locations of Maharashtra state.

MATERIALS AND METHODS

An investigation was carried out during 2008-2009 in department of Plant Pathology, College of Agriculture, Nagpur to identify the seed borne fungi of onion (*Allium cepa* L.) from various locations of Maharashtra. Seed samples of onion were collected from five different locations viz., Pune (Prashant), Ahmadnagar (Local Var), Nashik (Local Var) growing onion in *kharif* season and

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Akola (Akola safed) and Nagpur (White globe) growing onion in *rabi* season were used for study. Isolation of seed-borne mycoflora was carried by using blotter paper method suggested by International Seed Testing Association (Anonymous, 1976) under two heads.

a. Treated seed
b. Untreated seed

To isolate the seed-borne fungi, seeds were surface disinfected by dipping in mercuric chloride ($HgCl_2$) solution at 0.1 per cent concentration for one minute and washed subsequently in four changes of sterile distilled water in order to remove traces of mercuric chloride. The seeds were then dried and plated. The seeds as such without surface disinfection were also used for isolation of seed-borne mycoflora. The unsterilized (untreated) and surface sterilized (treated) 400 seeds of each were plated equidistantly on plastic plates of 90 mm diameter. Inoculated plates were incubated at room temperature (27 ± 1°C) in laboratory under 12 hours alternating dark and light cycle 8 days to develop the fungal flora.

The preliminary observations of fungal colonies were made on the basis of morphological and superficial characters like colony colour, colony texture, colony periphery and attachment of mycoflora to seed under stereoscopic binocular research microscope. The microscopic characters like conidiophores, conidia colour, conodia septation, shape of conodia, microconidia, macroconidia, sterigmata, mycelium colour, septation of mycelium, phialides, appendages etc. were identified under compound binocular research microscope. On the basis of observed characters under these microscopes, various cultures were isolated separately on Potato Dextrose Agar Medium (PDA). These fungi were further purified by hypal tip method. Sterilized PDA medium was poured @ 20 ml plate^{-1} and allowed to cool it. A bit or inoculum along with medium was transfer in the center of a plate with the help of sterilized inoculating needle. Then inoculated plates were incubated aseptically for 3-4 days at 27 ± 1°C. The growing tip of mycelium located under stereoscopic microscope was marked with permanent marker. This growing tip of mycelium was transferred on PDA slants. The pure culture of these isolated fungal flora from onion seeds were also sent to Agharkar Research Institute for fungus identification services, Mycology and Plant Pathology Group, Division of Plant Science, Pune for further confirmation of preliminary identification made at our level. The percentage of each fungus was calculated on the basis of 400 seeds of each variety.

RESULTS AND DISCUSSION

It was clearly observed from the data (Table 1 and plate 1) that there were 12 different fungi identified which belongs to five *Aspergillus* species, two from *Fusarium* and one each from *Penicillium*, *Drechslera*, *Curvularia, Rhizopus* and *Alternaria* respectively. In all the varieties seed treatment with $HgCl_2$ (0.1%) reduced percentage of all the fungus considerably in all the locations. The range of infection was from 2.60% to 58.88% in untreated and it was 0.80% to 33.55% in treated seeds. Our results are in line with the Saxsena *et al.* (1982) who reported that untreated seeds showed higher percentage of fungi as compared to the treated seeds in blotter paper method. Among the various fungi *Aspergillus niger* was dominating in all the location recording 58.88% in untreated and 33.55% in treated seeds. Koycii and Ozer (1997) obtained more frequency of *Aspergillus* and also Nagerbi and Abdalla (2004) detected that *Aspergillus* was the most prevalent genus among all the seed borne fungi of onion. Thus, their observations are supported by our findings.

Kharif season collected seeds had maximum percentage of *Aspergillus niger* both in treated and untreated sample ranging from (30.10% to 58.20%) as compared to *rabi* season collected seeds samples (33.41% to 62.28%). Seed samples collected in *rabi* season had more percentage of seed borne fungi as compared to seed samples collected in *kharif* season. It was observed from the data presented in table 1 that there was incidence of *Aspergillus oryzae* both in untreated (15.30%) and treated (7.77%) seeds at Nagpur location only. This may be attributed to agroclimatic situation varied in different location and variety grown for cultivation.

Similarly, it is clearly evident from the data that *Fusarium* species was recorded only in Ahmednagar (15.64% and 8.00%), Akola (22.2% and 8.70%) and Nagpur (20.70% and 7.54%) in

Table 1. Per cent incidence of seed borne mycoflora in untreated and treated onion seeds from different locations

Seed borne fungi	Association of seed borne fungi (%)										Total Seed borne mycoflora (%)	
	Kharif						*Rabi*					
	Pune		Ahmednagar		Nashik		Akola		Nagpur			
	UN	T	UN	T	UN	T	UN	T	UN	T	UN	T
Aspergillus niger	55.53	30.10	57.70	34.00	58.20	30.17	62.28	40.09	60.70	33.41	58.88	33.55
Aspergillus flavus	37.50	21.15	40.23	20.18	35.30	20.02	50.33	25.51	45.90	22.00	41.92	21.84
Aspergillus fumigatus	-	-	15.12	7.40	-	-	26.37	12.17	-	-	8.30	3.91
Aspergillus oryzae	-	-	-	-	-	-	-	-	15.30	7.77	3.06	1.55
Aspergillus nidulans	-	-	22.50	10.00	-	-	-	-	-	-	4.50	2.00
Penicillium citrinum	32.54	20.74	35.76	20.27	30.59	16.71	10.01	3.17	26.00	11.43	26.98	14.46
Fusarium sp.	-	-	15.64	8.00	-	-	22.20	8.70	20.70	7.54	11.71	4.85
Drechslera australiensis	40.47	12.64	10.37	2.30	25.02	9.30	45.38	22.11	45.69	20.70	33.39	13.41
Fusarium oxysporum	15.90	5.0	26.17	12.03	-	-	49.00	21.23	51.79	28.87	28.57	13.43
Curvularia lunata	5.30	1.25	-	-	30.91	10.21	40.87	12.10	35.54	13.67	22.52	7.45
Rhizopus stolonifer	-	-	20.59	-	34.47	16.37	25.29	12.00	30.00	11.9	22.07	8.05
Alternaria alternata	-	-	-	-	-	-	-	-	13.00	4.00	2.60	0.80
Total	187.01	91.24	244.08	114.18	214.49	102.78	331.72	56.48	344.0	161.32	264.50	125.30

Where, UN – Untreated, T - Treated

Plate 1. Association of different seed borne mycoflora on onion seed.

Aspergillus niger

Aspergillus flavus

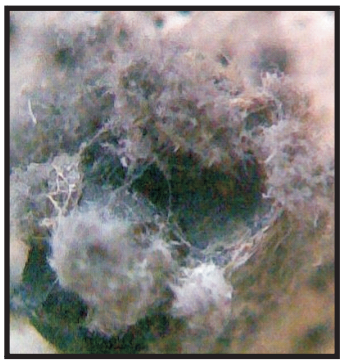
Aspergillus fumigatus

Aspergillus oryzae

Aspergillus nidulans

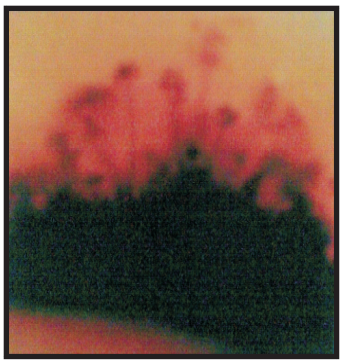
Penicillium citrinum

Fusarium sp.



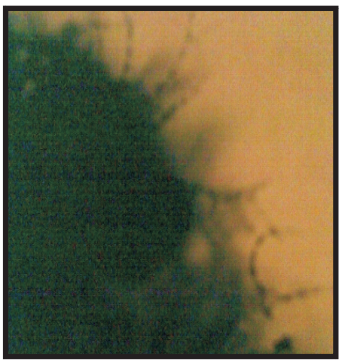
Drechslera australiensis

Fusarium oxysporum



Cuvularia lunata

Rhizopus stolonifer



Alternaria alternata

untreated and treated seeds respectively. This might have been occurred because of location specific varieties grown in particular season. The association of *Drechslera australiensis* was noticed across all the locations. The highest percentage in untreated seeds was 45.69% which reduced to 2.30% in treated lot. *Drechslera* reflected accordingly with 33.39% infection in untreated and 13.41% in treated lot of the total seed borne mycoflora under study. Nagerabi and Abdalla (2004) recorded 12.00% infection of *Drechslera* on onion seeds. It was observed from the data that onion seeds obtained from onion grown in *rabi* season in Akola and Nagpur had more total seed borne mycoflora ranging from 331.72 to 344.0 in untreated lot which reduced to 156.48 to 161.32 in treated lot. Similarly, when onion seeds grown in *kharif* season at Pune, Ahmednagar and Nashik were observed for mycoflora count, the seed borne mycoflora ranged from 187.01 to 244.08 in untreated seeds which reduced to 91.24 to 114.18 in treated seeds.

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EFFECT OF INTEGRATED USE OF INORGANIC AND ORGANIC MANURE ON YIELD AND MONETARY RETURNS OF MUSTARD – COWPEA – RICE CROPPING SEQUENCE IN LATERITIC SOILS OF KONKAN

Shilpa Babar[1] and J. H. Dongale[2]

ABSTRACT

The field experiments were conducted to study the effect of integrated use of inorganic and organic manure on yield and monetary returns of mustard – cowpea – rice cropping sequence in lateritic soils of Konkan during *rabi,* summer and *kharif* seasons during the year of 2005 - 06. The recommended dose of N, P_2O_5 and K_2O (kg ha^{-1}) for mustard, cowpea and rice crops were 90: 45: 45, 25: 50: 50 and 150: 50: 75, respectively. It is revealed from the study that the performance of mustard and cowpea crops in terms of grain yield productivity was the highest under the treatment application of 100 per cent recommended dose of NPK through inorganic fertilizers (IF), however in general its effects were statistically at par with those of integrated nutrient management treatment (50 % NPK, IF + 50 % N, FYM). The said effects due to above two treatments were much superior over to those of alone organic manure treatment 100 % N applied through FYM to both the crops. The performance of rice in terms of grain yield productivity was highest with the treatment where 50 per cent recommended dose of NPK was applied through chemical fertilizers plus 50 per cent dose of N was applied through glyricidia green leaf manuring to rice and its effects were significantly superior over to those of application of chemical fertilizer alone i.e. 100 per cent NPK (IF) and also over application of organic manure alone i.e. application of glyricidia green leaf manure @ 50 per cent recommended dose of N.

The economic benefits of mustard crop can not be increased only with the application of organic manure alone however, its integration with chemical fertilizers was helpful to increase the B: C ratio over that of B: C ratio of only organic manuring treatment. Thus for cowpea also the 100 per cent RDF through chemical fertilizers is best for profit maximization followed by INM (50: 50). The monitory returns from cowpea due to use of only organics are much low. In case of rice crop the integrated nutrient management through application of 50 per cent each of chemical fertilizers and glyricidia appeared most effective for maximizing yield of Sahyadri hybrid rice as well as for getting the highest gross returns and net profit on lateritic soil during *kharif* season. Thus the treatments *viz.*, 100 per cent RDF applied through chemical fertilizers and INM in 50: 50 proportion recorded higher gross returns, net returns and B: C ratio as compared to other treatments.

(Key words: Mustard, cowpea, rice, economic benefits, B:C ratio, net returns, gross returns)

INTRODUCTION

India has an agriculture driven economy. The Indian population has already crossed one billion and is increasing at the rate of 14 - 15 million every year. For feeding the population of 1.4 billion by 2020, India will need to produce 301 Mt of food grain in addition to other commodities. For producing this much food and other commodities at least 45 Mt of plant nutrients would be needed and the demand of chemical fertilizers would be 35 Mt. Thus, there will be a deficit of 10 Mt. of nutrients, which needs to be harnessed from organic manures, crop residues, recycling of organic waste and biofertilizers. (Tiwari, 2002). Thus, the food security in future is linked to fertilizer input and organic recycling. Therefore, there is need to develop more efficient and economic system of integrated nutrient management (INM) to sustain the productivity of different crops and cropping systems.

The lateritic soils of Konkan have poor soil fertility and are moisture non retentive. Soils are prone to nutrient losses through different mechanisms particularly during *kharif* season. The effects of organic and inorganic fertilizers are complementary to each other in terms of soil fertility improvement and sustainable agriculture. The cost of chemical fertilizers is also increasing in recent past. Therefore, it is necessary to use other manurial sources along with chemical fertilizers to minimize the dependence on chemical fertilizers. The manures are also in short supply and their application is required in bulk. Therefore, it is necessary to make their judicious use in right proportion for harvesting better yield of different crops in cropping sequence and for sustaining soil fertility. Therefore, the present study was undertaken to study the effect of INM on yield and monetary gain from the mustard – cowpea – rice cropping sequence .

MATERIALS AND METHODS

The field experiment entitled "Effect of integrated use of inorganic and organic manure on

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Table 1. Treatment Details

Treat. No.	Mustard (*Rabi*) RDF 90:25:150 NPK kgha^{-1}	Cowpea (Summer) RDF 45:50:50 NPK kgha^{-1}	Rice (*Kharif*) RDF 45:50:75 NPK kgha^{-1}
T_1	125% N (M)	Residual	Residual
T_2	100% N (M)	100% N (M)	50% N (M)
T_3	100% NPK (IF)	100% NPK (IF)	100% NPK (IF)
T_4	100%NPK(IF) +25%EN(M)	50% NPK (IF)	100%NPK(IF) +25%EN(M)
T_5	75%NPK (IF)	75% NPK (IF)	75% NPK (IF)
T_6	75%NPK (IF) +25% N (M)	75%NPK (IF) +25% N (M)	75% NPK (IF) +25 %N (M)
T_7	50% NPK (IF) +50% N (M)	50%NPK (IF) +50% N (M)	50%NPK (IF) +50 %N (M)
T_8	Control	Control	Control

Table 2. Treatmentwise fertilizers (g) and manures (kg) applied plot^{-1} in each crop

	Mustard				Cowpea				Rice			
Tr.No.	FYM	Urea	SSP	MOP	FYM	Urea	SSP	MOP	Gly.	Urea	SSP	MOP
T_1	19.6	-	-	-	-	-	-	-	-	-	-	-
T_2	15.7	-	-	-	3.4	-	-	-	22.7	-	-	-
T_3	-	317	455	122	-	100	577	154	-	600	577	231
T_4	3.9	317	455	122	-	50.1	288	76.9	11.3	600	577	231
T_5	-	238	342	92	-	75.2	432	115	-	450	433	173
T_6	7.8	238	342	92	0.9	75.2	432	115	11.3	450	432	173
T_7	7.8	159	228	61	1.7	50.1	288	77	22.3	300	288	115
T_8	-	-	-	-	-	-	-	-	-	-	-	-

yield and monetary returns of mustard – cowpea – rice cropping sequence in lateritic soils of Konkan" was conducted during *rabi,* summer and *kharif* seasons of 2005 -06 on Research Farm, Department of Agronomy, College of Agriculture, Dapoli,. The present investigation was conducted on lateritic soil. The soil was sandy clay in texture, slightly acidic in reaction and had low electrical conductivity. The status of soil organic carbon was high (1.14%), whereas the content of available N, P_2O_5 and K_2O in soil was 238.34, 17.23 and 100.8 kg ha^{-1}, respectively. Dapoli is located at 17.1^0 N latitude, 37.1^0 E longitudes and at an altitude 250 m above mean sea level. The climate is hot and humid. The region receives a very high rainfall (> 3000 mm annually) from June to September. Three crops were selected for three different seasons *viz;* oilseed: mustard (*rabi*), pulse: cowpea (summer) and the cereal: rice (*kharif*) and were grown on lateritic soil of Konkan. These three crops were grown by following standard package of cultivation practices recommended by Dr. BSKKV, Dapoli. For mustard, cowpea and rice the varieties used were Varuna**,** VCM – 8 i.e. Konkan Sadabahar and Sahyadri hybrid rice – 2, respectively. The field experiments were carried out in randomized block design comprising three replications and eight treatments. Out of eight treatment combinations; there were two treatments where only organic manures were used as a sources of nutrients (T_1 and T_2), where as in T_3 and T_5 treatments only chemical fertilizers were applied. In the other three treatments (T_4, T_6 and T_7) organic and inorganic fertilizers were applied together and treatment T_8 was absolute control where no manure or chemical fertilizer was applied.

Treatment wise manures were applied only on the basis of N supply. 125 % recommended dose (RD) of N through FYM to mustard and its residual effect was studied on next to crop (T_1); 100 % RD of N through FYM in mustard and cowpea and 50 % RD of N through glyricidia to rice (T_2); 100 % RDF through inorganic fertilizer (IF) to all the three crops (T_3); 100 % RDF through (IF) + 25 % RD of extra N through FYM to mustard and through glyricidia to rice, however 50 % RDF (IF) to cowpea (T_4); 75 % RDF (IF) to all the three crops (T_5); 75 % RDF (IF) + 25 % RD of N through FYM to mustard, cowpea and through glyricidia to rice (T_6),; 50 % RDF (IF) + 50 % RD of N through FYM to mustard, cowpea and through glyricidia to rice (T_7) and the absolute control (T_8). The N, P_2O_5 and K_2O were applied through urea, single super phosphate (SSP) and muriate of potash (MOP), respectively in treatments T_3, T_4, T_5, T_6 and T_7 to all the three crops. In case of mustard and cowpea crops the FYM was used as source of nitrogen supply and in case of rice, glyricidia green leaf manuring was used as a source of N supply. The treatment details and fertilizer applied to each crop are given in the table 1 and table 2, respectively. The data were processed statistically by following procedure of RBD i.e. randomized block design outlined by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

Grain and straw yield

Mustard:

The seed yield of mustard increased significantly from 2.67 to 11.01 q ha^{-1} among various treatments and the highest seed yield was contributed by treatment in which 100 per cent NPK (IF) was applied which was at par with those of 100 per cent NPK through IF + 25 per cent EN through FYM (10.95 q ha^{-1}), 75 per cent NPK through IF + 25 per cent N through FYM (10.12 q ha^{-1}) and 50 per cent NPK through IF + 50 per cent N through FYM (9.95 q ha^{-1}). Among various treatments, the chemical fertilizers treatments i.e.100 per cent NPK (IF) and 75 per cent NPK (IF) were most effective in boosting the seed yield of mustard by recording 249.06 per cent to 312.36 per cent increase over control followed by combination of organic + inorganic nutrient sources, whereas in which only organic sources were used (125 % and 100 % N through FYM) were observed to be least effective (Table 3). The stover yield of mustard also increased significantly from 6.23 to 27.92 q ha^{-1} due to various treatments compared to control. The inorganic sources of nutrients (100 % NPK and 75 % NPK through IF), INM treatments were at par with each other and all of them were significantly superior over organic treatments (125 % and 100 % through FYM). Tripathi *et al.* (2010) also found that yield obtained by the integrated use of 75 % RDF + 2t FYM ha^{-1} (1.31 t ha^{-1}) was at par with 100 % RDF (1.33 t ha^{-1})

indicated the saving of 25 per cent chemical fertilizers. Similarly, Sharma *et al.* (2005) reported that yield of mustard obtained by treatment receiving 100 per cent NPK (10.03 t ha^{-1}) was at par with the yield obtained by treatment receiving integrated use of 75 per cent NPK + 20 t FYM ha^{-1} (10.41 t ha^{-1}).

Cowpea :

In case of cowpea 100 % NPK through IF contributed the highest grain yield (15.61 q ha^{-1}) and straw yield (24.61 q ha^{-1}) which was closely followed by INM treatment (50:50) yielding 14.77 q ha^{-1} grain yield and 24.10 q ha^{-1} stover yield (Table 4). The effect of these two treatments was at par with each other and both of them were significantly superior over control and organic manuring treatments. Similar results were reported by the Bhikane *et al.* (2006) who showed that application of organic manures or vermicompost @ 4 t ha^{-1} along with recommended dose of fertilizers (N @ 25 + P_2O_5 @ 50 + K_2O @ 50 kg ha^{-1}) significantly increased the cowpea grain yield over the treatment receiving recommended dose of NPK.

Rice :

In case of rice the grain and straw yield increased significantly from 29.86 q ha^{-1} to 55.96 q ha^{-1} and from 31.18 q ha^{-1} to 56.95 q ha^{-1}, respectively due to different treatments compared to control (Table 5). The highest grain yield (55.96 q ha^{-1}) was contributed by INM (50:50) treatment. With respect to grain yield, the effect of this treatment was at par with the treatment in which 50 per cent N was applied through glyricida and 100 per cent NPK fertilizer through IF treatments. The treatment 50 per cent N through glyricidia to rice and the treatment 100 per cent NPK (IF) enhanced the grain yield of rice over control. In the present study the yield level with nutrient integration was higher compared to use of fertilizer alone. Bhoite (2005) also explained that substitution of 50 per cent N through green leaf manure gave the grain yield of rice 36.39 q ha^{-1} which was significantly superior over 100 per cent RDF (27.00 q ha^{-1}) and at par with the treatment in which 25 per cent N was substituted by green manure. Thus, green manure not only increased the yield of rice but also saved 25 to 50 per cent of chemical fertilizers.

Economic analysis of different treatments:

The economic analysis of different treatments consisting of inorganic fertilizers, manures and their integrated use with reference to mustard – cowpea –rice cropping sequence was calculated on the basis of gross returns and the total costs. The pertinent data have presented in table 3, 4, and 5.

Economic analysis of treatments: Mustard

From the data on economics of different treatments pertinent to mustard crop (Table 3) showed that the gross returns and net returns were in general highest with use of 100 per cent RDF dose, followed by INM treatments but net returns in case of organic manure treatments were negative.

The highest gross returns (Rs 33278/- ha^{-1}), net returns (Rs 18554/- ha^{-1}, Rs 10541/- ha^{-1}) and benefit : cost ratio (1:1.46) were obtained with treatment where 100 per cent recommended dose of nutrients was applied through chemical fertilizers. At this level of nutrient application the next best economic benefits were obtained with INM treatment (Rs 30596/- ha^{-1}, Rs 15567/- ha^{-1} and Rs 7961/- ha^{-1} 1:1.35) where 75 per cent NPK (IF) + 25 per cent N (FYM) were applied which was closely followed by INM treatment where chemical fertilizers and FYM were applied in 50:50 proportion (Rs 30072/- ha^{-1}, Rs 14731/- ha^{-1}, Rs 7171/- ha^{-1} and 1:1.31).

In case of organic treatments (125 % and 100 % through FYM) the total cost was higher than the gross returns obtained and therefore, the net returns obtained with these treatments were negative (Rs -2271/- ha^{-1}, Rs -4878/- ha^{-1}) and B: C ratio was very low (1:0.66, 1:0.54).

Thus, economic benefits of mustard crop can not be increased only with the application of organic manure alone. But its integration with chemical fertilizers was helpful to increase the B: C ratio over that of B: C ratio of only organic manuring treatment. However, for mustard highest dividends (1.46) was received by the application of 100 % RDF (N, P_2O_5 and K_2O @ 90: 45: 45 kg ha^{-1}).

Economic analysis of treatments: Cowpea

The economic analysis of treatments in cowpea crop showed that the highest gross returns (Rs 49291/- ha^{-1}) was recorded due to treatment receiving 100 per cent RDF dose (Table 4) followed by INM treatment receiving chemical fertilizer + FYM in 50: 50 proportion (Rs 46720/- ha^{-1}). The trend of net returns obtained due to application of above said two treatments was also consistent and the highest net returns (Rs 33420/- ha^{-1}, Rs 22586/- ha^{-1}) were contributed by 100 per cent NPK (IF) treatment closely followed by (50:50) INM treatments (Rs 31304/- ha^{-1}, Rs 20960/- ha^{-1}). The B: C ratio was also highest with 100 per cent RDF treatment (1.85) which was very closely followed by (50:50) INM treatment (1.81).

The residual treatment where 125 per cent N through FYM was applied to previous crop mustard and T_2 where 100 per cent N was applied through FYM to both the crops (mustard and cowpea) recorded somewhat similar B: C ratio (1.68, 1.67). However, the economic benefits due to 100 per cent N through FYM treatment in term of the net returns over total cost (Rs 16351/- ha^{-1}) and input cost (Rs 25631/- ha^{-1}) and gross returns (Rs 40651/- ha^{-1}) were higher as compared to the residual treatment i.e. Rs 15806/- ha^{-1}, Rs 24710/- ha^{-1} and Rs 38986/- ha^{-1}. The treatments *viz.*, 100 per cent RDF applied through chemical fertilizers, through INM in 50: 50 proportion and only organic manure i.e. 100 per cent N through FYM to both the crops yielded Rs 9988/- ha^{-1}, Rs 7872/- ha^{-1} and Rs 2199/- ha^{-1} higher net returns, respectively at input cost as compared to that of control treatment. Parasuraman *et al.* (2000) reported that in sorghum – horse gram cropping system, application of 75% RDF+ biofertilizers gave highest net income of Rs 5314 ha^{-1} and the B: C ratio was 2.6. In the fingermillet – horse gram cropping system the net income of Rs 4747 ha^{-1} was obtained with 2.2 B: C ratio under a treatment RIF + FYM which was followed by 75% RIF + biofertilizers (Rs 4057 ha^{-1} and B: C ratio was 2.0).

Thus, these trends clearly indicated that for profit maximization application of chemical fertilizers at recommended dose is very essential since gross returns (Rs 49291 ha^{-1}), net returns (Rs 33420/- ha^{-1}, Rs 22586/- ha^{-1}) and B: C ratio (1.85) were highest. However, under resource constraint the nutrient integration in 50: 50 proportion through inorganic and organic also yielded next best gross returns (Rs 46720/- ha^{-1}), net returns (Rs 31304/- ha^{-1}, Rs 20960/- ha^{-1}) and B:C ratio (1.81). Further it is to be noted that the use of only FYM @ 100 per cent N to both the crops although showed positive net returns over control however, they were 4.54 and 3.58 times less compared to the additional net returns obtained due to use of 100 per cent NPK (IF) treatment and 50: 50 per cent integration of organic + inorganic sources, respectively. Thus, for cowpea also the 100 per cent RDF through chemical fertilizers was best for profit maximization followed by INM (50: 50 %). The monitory returns from cowpea due to use of only organics were much low.

Economic analysis of rice

The economics data of different treatments in case of rice crop (Table 5) showed that the gross returns obtained due to 50:50 INM treatment was highest (Rs 38092/- ha^{-1}) which was followed by the treatment 100 per cent NPK (IF) + 25 per cent N (glyricidia) (Rs 35108/- ha^{-1}). The net returns over input cost was also highest in (50: 50) INM treatment (Rs 11733/- ha^{-1}) which was followed by 100 per cent NPK treatment (Rs 10849/- ha^{-1}). The B: C ratio of the said two treatments was almost equal (1.05, 1.06) to each other and they were higher than those of remaining treatments. The only organic manuring treatment also showed negative net returns at total cost (Rs – 3834/- ha^{-1} to Rs – 1349/- ha^{-1}).

Therefore, the integrated nutrient management through application of 50 per cent each of chemical fertilizers and glyricidia appeared most effective for maximizing yield of Sahyadri hybrid rice as well as for getting the highest gross returns and net profit on lateritic soil during *kharif* season.

These results are corroborative to Bajpai *et al.* (2006) who also reported the highest net returns with treatment receiving 50 per cent NPK (IF) + 50 per cent N through *Sesbania* green manure (Rs 28076/- ha^{-1}) followed by treatment 100 per cent NPK through chemical fertilizers (Rs 26767/- ha^{-1}) in case of rice. Powar (2004) also reported that the integration of the glyricidia @ 10 t ha^{-1} + 50 per cent N and full dose of P_2O_5 and K_2O for rice recorded highest B: C ratio (0.95) followed by treatment receiving 100 per cent recommended dose of fertilizers (0.88). Singh *et al.* (2006) reported that under rice – wheat cropping sequence the highest net profit was with treatment receiving 50 per cent NPK + 10 t FYM ha^{-1} (Rs 29798 ha^{-1}) with B: C ratio of 2.28. It was followed by the treatment 100 per cent NPK (IF) which gave net profit of (Rs 29529 ha^{-1}) with B: C ratio of 2.18.

Table 3. Economics of different treatments pertinent to mustard crop

Treat. No.	Yield (q ha^{-1})		Gross returns (Rs ha^{-1})						Net returns (Rs ha^{-1})			
	Grain	Straw	Grain	Straw	Total	Input cost (Rs ha^{-1})	Other cost (Rs ha^{-1})	Total cost (Rs ha^{-1})	Input cost	Total cost	B:C ratio	Cost q ha^{-1} (Rs)
T_1	4.81	9.86	14430	99	14529	16800	5162	21962	-2271	-7433	0.66	4545
T_2	3.66	9.35	10980	94	11074	15952	4474	20426	-4878	-9352	0.54	5555
T_3	11.01	24.83	33030	248	33278	14724	8012	22736	18554	10541	1.46	2042
T_4	10.95	27.92	32850	279	33129	15572	8100	23672	17557	9457	1.40	2136
T_5	9.32	22.71	27960	227	28187	14181	7092	21273	14006	6914	1.32	2258
T_6	10.12	23.62	30360	236	30596	15029	7606	22635	15567	7961	1.35	2213
T_7	9.95	22.17	29850	222	30072	15341	7560	22900	14731	7171	1.31	2279
T_8	2.67	6.23	8010	62	8072	12552	3523	16075	-4479	-8002	0.50	5997
SE±	0.49	0.99										
CD(0.05)	1.45	2.90										

Produce prices: i) Grain – Rs 3000 q^{-1}ii) Straw - Rs 10 q^{-1}

Table 4. Economics of different treatments pertinent to cowpea crop

Treat. No.	Yield (q ha^{-1})		Gross returns (Rs ha^{-1})			Net returns (Rs ha^{-1})						
	Grain	Straw	Grain	Straw	Total	Input cost (Rs ha^{-1})	Other cost (Rs ha^{-1})	Total cost (Rs ha^{-1})	Input cost	Total cost	B:C ratio	cost q ha^{-1} (Rs)
T_1	12.43	16.96	37290	1696	38986	14276	8904	23180	24710	15806	1.68	1728
T_2	12.83	21.61	38490	2161	40651	15020	9280	24300	25631	16351	1.67	1726
T_3	15.61	24.61	46830	2461	49291	15871	10833	26705	33420	22586	1.85	1553
T_4	13.46	21.64	40380	2164	42544	15044	9599	24642	27500	17902	1.73	1670
T_5	13.41	19.93	40230	1993	42223	15473	9602	25075	26750	17148	1.68	1721
T_6	12.67	18.16	38010	1816	39826	15661	9228	24888	24165	14938	1.60	1821
T_7	14.77	24.1	44310	2410	46720	15416	10344	25760	31304	20960	1.81	1581
T_8	12.04	15.88	36120	1588	37708	14276	8691	22967	23432	14741	1.64	1776
SE±	0.74	1.84										
CD (0.05)	2.19	5.43										

Table 5. Economics of different treatments pertinent to rice crop

Treat. No.	Yield (q ha^{-1})		Gross returns (Rs ha^{-1})						Net returns (Rs ha^{-1})			
	Grain	Straw	Grain	Straw	Total	Input cost (Rs ha^{-1})	Other cost (Rs ha^{-1})	Total cost (Rs ha^{-1})	Input cost	Total cost	B:C ratio	cost q ha^{-1} (Rs)
T_1	33.47	33.49	20082	2679	22761	19869	6726	26595	2892	-3834	0.86	715
T_2	46.34	56.95	27804	4556	32360	24785	8924	33709	7575	-1349	0.96	629
T_3	49.71	50.55	29826	4044	33870	23021	8961	31982	10849	1888	1.06	562
T_4	51.28	54.25	30768	4340	35108	25481	9467	34948	9627	160	1.00	597
T_5	42.85	43.34	25710	3467	29177	22233	8083	30316	6944	-1139	0.96	627
T_6	48.85	47.7	29310	3816	33126	24693	9040	33733	8433	-607	0.98	612
T_7	55.96	56.45	33576	4516	38092	26359	10071	36430	11733	1662	1.05	570
T_8	29.86	31.18	17916	2494	20410	19869	6334	26203	542	-5793	0.78	794
SE±	1.21	2.91										
CD (0.05)	3.55	8.56										

Produce prices: i) Grain – Rs 600 q^{-1} ii) Straw - Rs 80 q^{-1}

Input prices for all three crops i) Urea – Rs 5.02 kg^{-1} ii) SSP – Rs 3.00 kg^{-1} iii) MOP – Rs 4.62 kg^{-1} iv) Glyricidia – Rs 400 t^{-1}

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IMPACT OF FLY ASH ON PHYSICAL AND CHEMICAL PROPERTIES OF BLACK COTTON SOIL AND YIELD OF SUNFLOWER CROP

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ABSTRACT

To justify suitability of fly ash in agricultural applications, field investigation was conducted on sunflower (Var. EC 68415) during 2005-06 with seven levels of fly ash (0, 20, 40, 60, 80, 100 and 120 t ha^{-1}) along with recommended dose of NPK (60:60:00). An attempt was made to develop an integrated plant nutrition system. Application of 40 t ha^{-1}, 60 t ha^{-1} and 80 t ha^{-1} of fly ash in combination with recommended dose of NPK (60:60:00) were at par with each other and significantly superior over RDF and rest of the treatments and these three combi-treatments were found to be useful in increasing the seed and straw yield of sunflower and lower levels of fly ash application at the rate of 60 t ha^{-1} decreased bulk density, increased porosity marginally from 38.5 per cent in RDF to 39.6 per cent and increased in MWHC to 70.98 per cent as against 62.70 per cent in RDF, significant reduction of soil pH in alkaline soil, increased the organic carbon and the macro-nutrients in soil and plant. Further increase in rate of fly ash application did not show any advantage.

(Key words: Fly ash, soil properties, sunflower yield)

INTRODUCTION

Fly ash is produced as a result of coal combustion in thermal power station and discharge in ash ponds. Combustion of bituminous and sub-bituminous coal and lignite for generating electricity in thermal power plants produces solid wastes such as fly ash, bottom ash, boiler slag and Fuel Gas Desulphurization (FGD) material which are commonly known as coal combustion byproducts (CCPs) (Vom Berg, 1998). The material is produced in the fuel gas scrubber by reacting slurried limestone or lime with the gaseous SO_2 to produce $CaSO_3$. As a result of this, tonnes of fly ash are produced everyday at each of the thermal power station in India. The disposal of fly ash generated is and will continue to be a national problem.

It is expected that use of fly-ash instead of lime in agriculture can reduce net CO_2 emission and also reduce global warming (Kishor *et al*., 2010). Fly ash is alkaline, contains plant nutrients mostly Si, Al and Fe together with significantly percentage of Ca, K, Na and Ti (Tiwari *et al*., 2008) and containing 70 to 90 % silt size particles. Soil properties as influenced by fly-ash application have been studied by several workers (Inam, 2007) for utilizing this industrial waste as an agronomic amendment. Therefore, as an effort towards this direction, the present study on utilization of fly ash was undertaken to find-out the effect of fly ash application along with recommended dose of NPK on physical and chemical properties of soil as well as yield of sunflower in black cotton soil.

MATERIALS AND METHODS

The fly ash was brought from thermal power station, Paras, Tal. Balapur, Distt. Akola (Akola is situated at the latitude of 2242′ N and longitude of 7702′ E at an altitude of 307.42 m above mean sea level) for conducting the experiment at Central Research Station, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) on sunflower (Var. EC 68415), as a test crop.

The field experiment was carried out during 2005-06 with seven treatments of graded levels of fly ash and recommended dose of NPK (60:60:00). The experiment was laid out in RBD with four replications.

Treatments	Details
T_1	RDF (No fly ash)
T_2	20 t ha^{-1} Fly ash + RDF
T_3	40 t ha^{-1} Fly ash + RDF
T_4	60 t ha^{-1} Fly ash + RDF
T_5	80 t ha^{-1} Fly ash + RDF
T_6	100 t ha^{-1} Fly ash + RDF
T_7	120 t ha^{-1} Fly ash + RDF

The intercultural operation and plant protection measures were followed as and when required. The crop was harvested at maturity and

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grain and straw were harvested separately and yield was recorded on plot basis and then converted on hectare basis. Composite soil samples before sowing (without fly ash/ before fly ash application) and after harvest of crop from active root zone (0-15 cm) were collected separately from each plot and analyzed for different soil properties by following different standard procedures. The pH was measured with pH meter using 1:2.5 soil water suspension (Jackson, 1978). The clear supernatant extract obtained from suspension used for pH was also utilized for EC measurement using conductivity bridge (Jackson, 1978). Wet oxidation method for organic carbon content of soil given by Walkley and Black was adopted (Jackson, 1978). Total nitrogen was determined by alkaline permanganate method as described by Subbiah and Asija (1959). Available P was determined by Olsen′s method using 0.5 M sodium bicarbonate (pH 8.5) as an extractant Darco-G-60 free from soluble phosphorus was used to absorb the dispersed organic matter and make the filtrate colourless for further colorimetric analysis (Jackson, 1978). Available K was determined by flame photometer using 1 N neutral ammonium acetate (pH 7.0) as an extractant as described by Jackson (1978). Bulk density was determined by clod coating method (Black, 1965). Maximum water holding capacity was determined by Keen′s cup method (Sankaram, 1966).Di-acid was prepared as per method outlined by Jackson (1978) by using 9:4 mixture of HNO_3 : $HClO_4$. The pre-digestion of samples was done by using 10 ml HNO_3 $gram^{-1}$ of sample. Then di-acid extract was used for the determination of nitrogen by Kjeldahl′s method, phosphorus colorimetrically by vanadomolybdate phosphoric acid yellow colour method and potassium was recorded by using flame photometer as suggested by Jackson (1978).

RESULTS AND DISCUSSION

A relationship within the different intensity of fly ash and its effect on physical and chemical properties of soil are given in table 1 and yield response of sunflower in table 2.

1) Effect on soil properties:
i) Effect on Bulk Density:

The data (Table 1) revealed that fly ash addition decreased the bulk density of soil by application of lower levels of fly ash (20, 40 and 60 t ha^{-1}) and recommended dose of NPK significantly while higher doses of fly ash increased the bulk density of soil. Bhoyar (1998) reported that application of fly ash @ 15 t ha^{-1} in combination with NPK fertilizer to black soil significantly reduced the bulk density of soil whereas Yeledhalli *et al*. (2008) did not found any significant change in the bulk density with the application of 40 t ha^{-1} of fly ash. Thus our results agree with the results of Bhoyar (1998) for low doses of fly ash addition.

ii) Effect on maximum water holding capacity:

The data furnished in the table 1 revealed the significant effect of fly ash on maximum water holding capacity of soil and porosity of soil. Addition of fly ash improved the water holding capacity and porosity of soil. Soil porosity increased marginally from 38.5 per cent in RDF to 39.6 per cent in the treatment receiving 40 t ha^{-1} of fly ash + RDF and the treatment receiving 60 t ha^{-1} of fly ash + RDF. The maximum water holding capacity of black soil (70.98 %) increased significantly with the application of 60 t ha^{-1} of fly ash + RDF as against 62.70 per cent in RDF. With the increase in the dose of fly ash application above 60 t ha^{-1} and also below 40 t ha^{-1}, there was reduction in water holding capacity. Yeledhalli *et al*. (2008) reported that high water holding capacity was observed with the application of fly ash 40 t ha^{-1}. The Ca in fly-ash readily replaces Na at clay exchange sites and thereby enhances flocculation of soil clay particles, keeps the soil friable, enhances water penetration and allows roots to penetrate compact soil layers (Jala and Goyal, 2006).

iii) Effect on soil pH:

Data (Table 1) revealed the significant reduction of soil pH in alkaline soil due to addition of increasing level of fly ash and recommended dose of NPK. The results with the application of 20 t ha^{-1}, 40 t ha^{-1}, 60 t ha^{-1} and 80 t ha^{-1} of fly ash were at par with each other over RDF and rest of the treatments. Similar trend of decrease in soil pH by addition of fly ash was earlier reported by Matte and Kene (1995). Reduction in soil pH might be due to the fact that fly ash contained amorphous aluminium and iron complex which had undergone hydrolysis and released H^+ ions in the soil system.

iv) Effect on electrical conductivity of soil:

The data (Table 1) indicated significant reduction in electrical conductivity of soil due to addition of lower level of fly ash and recommended dose of NPK, while higher dose of fly ash and recommended dose of NPK gives the trivial effect on electrical conductivity of soil. Warambhe *et al*. (1992) reported that the reduction in electrical conductivity of soil might be due to acidic nature of fly ash which probably reduces the salt content of soil, whereas Vaggesh and Siddaramappa (2002) reported that analysis of soils (Alfisol and Inceptisol) at the end of the column leaching studies indicated that there were significant increase in EC of soils amended with fly ash compared to unamended soils.

v) Effect on organic carbon:

Data (Table 1) revealed that lower level of fly ash in conjunction with recommended dose of NPK increased the organic carbon content of soil while higher level decreased it. Applications of 40, 60 and 80 t ha^{-1} fly ash to the soil were statistically at par with each other but superior over RDF and rest of the treatments. Sarangi *et al*. (2001) observed gradual increase in organic carbon and organic matter with increased application rate of fly ash.

vi) Effect of fly ash on major nutrient content of soil:

a) Total nitrogen (N)

In soil, nitrogen is present as organic nitrogen, ammonical nitrogen, nitrate and nitrite nitrogen. Major portions of soil nitrogen exist in combination with the organic matter. Only a negligible fraction of soil-N, which is inorganic in form is available to plant. Therefore, organic-N mineralised to inorganic form is then available to plants (Maiti, 2003). 60 t ha^{-1} of fly ash and recommended dose of NPK recorded significantly highest total nitrogen (0.049%) while 120 t ha^{-1} of fly ash and recommended dose of NPK gave lowest total nitrogen (0.037%) (Table 2). Bhoyar (1998) reported that application of fly ash @ 15 t ha^{-1} in combination with NPK fertilizer to black soil had resulted in significant improvement in the content of total nitrogen, available phosphorus and potassium. Rani and Kalpana (2010) reported that application of fly ash to clay to loamy texture soil increased the nutrient availability such a nitrogen, phosphorus, potassium and other micronutrients. This might be due to fly ash application which increased the yield of crop.

b) Available phosphorus (P)

Data (Table 2) indicated that lower doses of fly ash @ 20 t ha^{-1}, 40 t ha^{-1} and 60t ha^{-1} increased available P content of soil significantly. Fly ash addition to soil considerably reduced the acid phosphate activity in soil and thereby increased available phosphorus content of soil. Chang Hoon Lee (2004) observed that the application of fly ash @ 0, 40, 80 and 100 Mg ha^{-1} in two paddy soils increased the available phosphorus significantly.

c) Available potassium (K)

The data in table 2 revealed increase in available K content of soil with lower level of fly ash as compared to RDF. The highest significant increase was observed in the treatment with 60 t ha^{-1} of fly ash and recommended dose of NPK (546.70 kg ha^{-1}) over RDF (359.40 kg ha^{-1}), whereas higher level of fly ash showed negative results. Similar trend of increase in available K content of soil was reported by Kuchanwar *et al.* (1997).

vi) Effect of fly ash on major nutrient content in seed and straw:

a) Nitrogen (N) content

The data in table 3 revealed that significantly highest per cent of nitrogen content was observed in treatment with 60 t ha^{-1} of fly ash over RDF in both seed and straw. Treatments with the application of 20, 40 and 60 t ha^{-1} of fly ash were at par with each other over rest of the treatments. Greenhouse experiments conducted by Sikka and Kansal (1994) showed that application of 2-4% fly ash significantly increased N content of rice plants.

b) Phosphorus (P) content

The data in table 3 revealed that significantly highest per cent of P content (0.25 per cent) was observed in seed and 0.29 per cent in straw was observed in treatment which received 60 t ha^{-1} of fly ash. However, rests of the treatments were found to be at par with each other. Warambhe *et al*. (1992) reported increase in N, P and K content in plant by the application of fly ash.

Table 1. Effect of fly ash on physical-chemical properties of soil

	Treatments	pH	EC (dSm^{-1})	Organic Carbon (%)	Bulk Density ($Mg\ m^{-3}$)	Porosity (%)	Maximum Water Holding Capacity (%)
T_1	RDF (No fly ash)	7.68	0.34	0.55	1.63	38.5	62.70
T_2	(20 t ha^{-1} fly ash + RDF)	7.66	0.33	0.61	1.60	39.6	66.88
T_3	(40 t ha^{-1} fly ash + RDF)	7.66	0.32	0.68	1.60	39.6	68.17
T_4	(60 t ha^{-1} fly ash + RDF)	7.65	0.32	0.69	1.64	38.1	70.98
T_5	(80 t ha^{-1} fly ash + RDF)	7.65	0.33	0.65	1.65	37.7	64.52
T_6	(100 t ha^{-1} fly ash + RDF)	7.64	0.37	0.62	1.65	37.7	66.70
T_7	(120 t ha^{-1} fly ash + RDF)	7.63	0.38	0.53	1.66	37.4	66.51
	SE (m) ±	0.0071	0.076	0.019	0.006	0.12	0.28
	CD at 5%	0.021	--	0.057	0.018	0.36	0.84

Table 2. Effect of fly ash on major nutrient content of soil

	Treatments	Total N (%)	Available P ($kg\ ha^{-1}$)	Available K ($kg\ ha^{-1}$)
T_1	RDF (No fly ash)	0.039	16.69	359.40
T_2	(20 t ha^{-1} fly ash + RDF)	0.043	22.77	476.52
T_3	(40 t ha^{-1} fly ash + RDF)	0.048	24.44	488.52
T_4	(60 t ha^{-1} fly ash + RDF)	0.049	25.21	546.70
T_5	(80 t ha^{-1} fly ash + RDF)	0.046	22.76	525.47
T_6	(100 t ha^{-1} fly ash + RDF)	0.044	20.29	467.16
T_7	(120 t ha^{-1} fly ash + RDF)	0.037	20.91	409.72
	SE (m) ±	0.00097	0.04	1.06
	CD at 5%	0.0029	0.122	3.15

Table 3. Effect of fly ash on nutrient content (%) in seed and straw of sunflower and seed and straw yield (q ha^{-1}) of sunflower

	Treatments	Nitrogen		Phosphorus		Potassium		Yield	
		Seed (%)	Straw (%)	Seed (%)	Seed (%)	Straw (%)	Straw (%)	Seed (q ha^{-1})	Straw (q ha^{-1})
T_1	RDF (No fly ash)	2.94	1.24	0.22	0.89	1.40	0.25	5.66	11.80
T_2	(20 t ha^{-1} fly ash + RDF)	3.36	1.33	0.23	0.98	1.48	0.26	6.31	12.03
T_3	(40 t ha^{-1} fly ash + RDF)	3.41	1.47	0.24	1.02	1.50	0.28	6.41	12.21
T_4	(60 t ha^{-1} fly ash + RDF)	3.72	1.48	0.25	1.10	1.54	0.29	6.54	12.51
T_5	(80 t ha^{-1} fly ash + RDF)	3.15	1.30	0.23	0.87	1.47	0.26	6.24	11.30
T_6	(100 t ha^{-1} fly ash + RDF)	3.02	1.29	0.23	0.84	1.39	0.26	6.24	11.10
T_7	(120 t ha^{-1} fly ash + RDF)	2.80	1.18	0.21	0.79	1.37	0.24	5.60	10.38
	SE (m) ±	0.14	0.12	0.007	0.012	0.0097	0.010	0.075	0.21
	CD at 5%	0.39	0.36	0.020	0.036	0.0270	0.030	0.220	0.60

c) Potassium (K) content

The treatment which received 60 t ha^{-1} of fly ash showed significantly superior K content over all treatments whereas increased levels of fly ash were found to be linear decrease in the K content in seed and straw. Warambhe *et al.* (1992) applied 5 to 15 t fly ash ha^{-1} to black soil and reported that application of 15 t fly ash ha^{-1} had beneficial effect on nutrient content of seed and straw.

vii) Effect on yield of sunflower:

Application of fly ash at increasing level in combination with recommended dose of NPK increased the grain and straw yield (Table 3). However application of 60 t ha^{-1} of fly ash and recommended dose of NPK recorded significantly highest yields of 6.54 q ha^{-1} and 12.51 q ha^{-1} seed and straw respectively as compared to RDF 5.66 q ha^{-1} and 11.80 q ha^{-1}. Application of 5-20 % fly ash on w/w basis in the plough layer (0-15 cm) increased both grain and straw yield of pearl millet followed by wheat (Grewal *et al*., 2001). The large-scale use of fly ash in agriculture and waste land development holds a potential to increase on an average 15 % yield of grains, oilseeds, sugarcane, cotton and about 25-30 % yield of vegetables (Kumar *et al*., 2005). Arivazhagan *et al*. (2011) concluded from NTPC-Vindhyachal field trials that the application of fly ash @ 50 t ha^{-1} increased the yield of maize from 36-40 %, red gram from 55-58 %, mustard from 28-32 % and potato from 25-37 % over control.

The study thus, revealed beneficial effect of fly ash @ 60 t ha^{-1} with recommended dose of NPK application on yield of sunflower crop, improvement in NPK status and physical and chemical properties of soil.

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EFFECT OF STEEL SLAG ON AGRICULTURAL TOP SOIL

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ABSTRACT

Agriculture occupies a prominent position in Indian policy-making not only because of its contribution to GDP but also because of the large proportion of the population that depends on this sector for its livelihood.This research was carried out during the academic year 2008 with the aim of studying the effect of Steel Slag on Agricultural Topsoil. Soil samples were collected from the agricultural fields adjoining a Steel Industry. The agricultural field was amended with steel slag. A detailed study was carried out to estimate the type and quantity of wastes from the industry and their effect on agricultural top soil under study. The results obtained through this research indicated that the soil samples have an alkaline pH (7.8) with high calcium and manganese content (2.44 and 2.07% respectively) with relatively lesser amount of sodium (0.36%). nitrate and organic carbon content was relatively lower (0.035 and 0.6% respectively). High aluminum (24.1%) and titanium value (0.09%) with traces of arsenic (0.003%), copper (0.011%) and zinc (0.016%) were also found at the agricultural setup. Laboratory and field tests also estimated the optimum dosage of Steel Slag as liming material for agricultural use and it was observed that a dose of 20% w/w is best suited for rice crop.

(Keywords: Steel slag, liming, rice, physico-chemical parameters, amelioration, acidic soil)

INTRODUCTION

Soil is the basis of agricultural production and its conservation and improvement must always be a first step in farming. Soils differ in their ability to supply nutrients to plants.

Solid wastes and chemicals have mainly caused land pollution. The main sources of land pollution have been the industries like, iron and steel plants, pulp and paper mills, oil refineries, power and heating plants, chemicals and fertilizer manufactures , plastic and rubber producing complexes and so on. Thousands and thousands of solid wastes have been either dumped or burnt or emptied into rivers.

Steel is an alloy of iron usually containing less than 1% carbon. It is produced by heating coke, iron ore and limestone in a blast furnace. It is used most frequently in the automotive and construction industries. Steel can be cast into bars, strips, sheets, nails, spikes, wire, rods or pipes as needed by the intended user.

The Steel Industry under study was Nippon Denro Ispat Industry in Kalmeshwar, which is located at a distance of about 25 kms from Nagpur city. The integrated steel plant uses the latest steel manufacturing technology to produce galvanized sheets and products, apart from cold rolled coils. It houses a total of three advanced plants –

(i) a 0.325 million tonne Galvanized Plain/Galvanized Corrugated plant,
(ii) a 0.33 million tonne Cold Rolled Coils plant and
(iii) a 60,000 tonne Color Coated Sheets plant. During the production process, a numerous kind of solid wastes are generated.

Iron and steelmaking slag is a by-product of the iron and steelmaking process. Slag has traditionally been used as a component of cement and construction aggregate. This has led the industry in promoting the effective use of slag.

Amelioration of acid soils with liming materials is a common practice. Some industrial by-products are also being used as liming agent. The most important by-product in amending acid soils is steelmaking basic slag. Slag compound contains 52.8% CaO and 2.2% MgO plus large amounts of other elements such as Fe, P, Si, and Mn (Ali and Shahram, 2007).

Experiments had shown that moderate rates of slag, as soil amendment have substantially increased iron content in soil. Steel slag appears to be a promising and inexpensive source of Fe to alleviate Fe chlorosis in Fe-deficient calcareous soils (Wang and Cai, 2006). Simultaneously it also increases the plant uptake of Iron (Fe) and Copper (Cu) micronutrients (Melali and Shariatmadari, 2008). Considering the above mentioned facts, the present study was undertaken.

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MATERIALS AND METHODS

Soil samples for analysis purpose were collected from agricultural fields adjoining Nippon Denro Ispat Industry, MIDC, Kalmeshwar, during the academic year 2008. Soil samples were collected from a distance of 25m, 50m and 75m from the point of solid waste discharge. These samples were collected at a depth of about 10-15 cm from five different points on the fields, respectively. Grab samples were later mixed to form composite samples, respectively.

The soil samples, collected in thick plastic bags were brought to the laboratory for further analysis. The sample was spread out on a tray for air drying. After drying, it was sieved over a 2 mm sieve and stored in air tight polythene bags.

Physical soil parameters analyzed were pH, bulk density, moisture, water holding capacity and electrical conductivity. Chemical analysis included analysis of silica by Kolthoff and Sandell method (1952), % organic carbon calcium, magnesium, iron and aluminum by Piper method (1966), potassium sodium, titanium, phosphate, zinc and nitrogen by Jackson method (1967), copper by Cheng and Bray method (1953), manganese by Willard and Great house method (1917).

RESULTS AND DISCUSSION

Since silica is the major impurity of iron ore and coke, limestone works as a flux and removes this silica. This lime combined with silica forms molten slag. For every tonne of steel production, about 200 kg of slag is generated.

Steel slag is generally found in the form of big pebbles. It is crystalline in microstructure and non-hydraulic in nature. Chemical analysis of steel slag indicates the presence of high percentage of CaO and Fe_2O_3. Apart from these, the slag also contains considerable amount of SiO_2 and MgO. Chemical analysis of steel slag sample are given in table 1.

The soil falling under the study sites was Kali Soil or Black Cotton Soil, one of the six soil types found in Nagpur region. The various physical and chemical properties of this soil type are listed in table 2.

Steel slag or silicate liming materials are produced from blast furnace, converter or ladle slags. Careful selection and processing of appropriate slag qualities ensure an effective activity in the soil. Application of silicate liming materials neutralises soil acidity and supplies the soil with plant nutrients. Use of steel slag as silicate liming materials, supplies the soil with soluble silica and prevents irreversible soil degradation caused by clay mineral decomposition and silica dissolution.

Increasing the Ca and Si contents in the soil solution by the use of silicate limes leads to higher soil aggregate stability, improves soil structure and reduces soil degradation by erosion. Consequently higher uptake of silicon by plants increases their resistance against different plant diseases and minimizes the use of pesticides (Rex, 2006).

Silicate liming materials contain elements with useful properties for plant nutrition and soil quality. Laboratory and field experiments were conducted to study the effect of steel slag on crop productivity. The crop chosen was rice. Soil was mixed with farmyard manure (10% w/w) and amended with steel slag at 5%, 10%, 20% and 40% w/w, in the laboratory and added to selected site. Silicon content in soil showed an increase from initial silicon content 63.1 to observed 65.5%. Maximum root growth was also produced in depth, resulting in higher shoot dry matter and thus resulting in higher crop yields. pH of the test site, on addition of steel slag showed an increase from initial pH 7.6 to observed pH 7.8. Similar observations were made by Hua (2005), Ali and Shahram, (2007) and Gu *et al.* (2011). They reported that the soil pH value and the content of available silicon in soil were increased evidently after it was receiving blast furnace slag, and their increasing trends were more and more obvious with increasing dosage of the blast furnace slag. Addition of calcium and magnesium compounds in the slags improves soil pH. Both elements also serve as plant nutrients and stabilisers for soil aggregates.

Results of similar nature were observed by Carvalho *et al.* (2003). They observed that slag improved chemical attributes of the soil, increased root growth and root surface and reduced diameter. Magnesium in slags especially in blast furnace slag

has a better solubility than that of magnesium carbonate in limestone and dolomite. The observed magnesium content of soil showed an increase from an initial value of 1.55 to 1.6%. Silicate has beneficial effects on plant health, phosphate availability and soil structure. The bulk density value of soil, initial being 1.56 g/cm^3 decreased to 1.52 g/cm^3 on addition of slag. This indicated that the soil doesn't offer any kind of resistance to root penetration and has increased porosity and high permeability during post-monsoon season. The observed moisture content values indicated higher infiltration rate of the soil. The value showed a decrease from 45 to 44%. The observed conductivity value, which changed from 0.28 to 0.3 dS/m on addition of steel slag, indicated that there was optimum concentration of soluble salts and the soil lacks salinity problem at the site under study. Calcium and manganese content changed from initial 2.39 and 2.05% to experimentally observed 2.44% and 2.07%, respectively on addition of steel slag.

Nitrate and organic carbon content was relatively lower. A drop in nitrate value from 0.05 to 0.035% and sodium value from 0.38 to 0.36%, by the addition of steel slag, suggested that the soil was not intensely leached. Addition of steel slag negligibly lowered the organic carbon content from 0.62 to 0.6%, as this solid waste have almost negligible amount of organic carbon. Higher aluminum value and iron values were observed on the agricultural land amended with steel slag. The values showed an increase from 24.07 to 24.1% and 3.5 to 4.5% respectively. Observed potassium and phosphate values were found to be 1.75% and 0.09% respectively, almost similar to the optimum values of 1.6% and 0.08% respectively. Increase in amount of titanium from 0.04 to 0.09% was observed on addition of steel slag. Traces of arsenic, copper, zinc and manganese were also found at the agricultural setups. Experimentally the dose effect of 20% w/w was found to be the best suitable option during this study.

The amelioration of metal contaminated acidic soil and the alleviation of metal build up in rice by steel slag were also examined in this study. The results showed that the application of steel slag increased soil pH. It was also observed that there is a decrease in the phyto-availability of heavy metals by at least 55-60% and additionally suppression of metal uptake by rice. It was found that metal translocation from stem to leaf was noticeably controlled by adding amendments. This might be due to the increase of silicon concentration and co-precipitation with heavy metals in stem.The results obtained through this research indicated that the soil samples have an alkaline pH and high calcium and manganese content with relatively lesser amount of sodium.

As seen in table 3, all the observed values showed an increase within the threshold value of 15%. It can thus be inferred that all the observed values were within the permissible limit of nutrients in the soil. All the soil samples have optimum concentration of soluble salts and the soils lack salinity problem. The soils also showed increase in level of fertility and suitability for most crops. It was also observed that too much leaching of the important soil nutrients had not taken place.

The study thus showed that the soil can be effectively amended using steel slag. A Physico–chemical analysis of this solid waste has revealed the presence of both macro and micro nutrients, which can sustain plant growth. Its application in the agricultural land acts as a liming material and improves crop growth by neutralizing the soil acidity, increasing the water availability for the plants and supplement of nutrients. The presence of heavy metal contents in the soil also did not exceed the permissible limit. However, remedial measures might be required if the observed values cross the optimum level in the future, due to excessive metal leaching. It can thus be inferred that, use of proper amount of industrial solid waste not only helps in soil amendment, but its other uses also help to solve the problem of solid waste disposal to a great extent.

Table 1. Analysis of Steel Slag

Physical Properties	
pH	9.9
Electrical conductivity (dS/m)	0.16
Specific gravity >	34
Approximate dry rodded unit weight (kg/m^3)	1780
Water adsorption (%)	Up to 3
Chemical Properties	
CaO (%)	45
SiO_2 (%)	15
Fe_2O_3 (%)	25
MnO (%)	6.5
MgO (%)	7.8
Al_2O_3 (%)	1.9
P_2O_5 (%)	0.8
K_2O (%)	0.48
Na_2O (%)	0.33
As_2O_3 (%)	0.01
TiO_2 (%)	3.98

Table 2. Analysis of Black Cotton Soil

Physical Properties	
pH	7.6
Electrical conductivity (dS/m)	0.28
Sand (%)	24
Silt (%)	3.5
Clay (%)	72.8
Natural moisture content (%)	45
Bulk density (g/cm^3)	1.56
Water holding capacity (%)	63.8
Chemical Properties	
% Organic carbon	0.62
SiO_2 (%)	63.1
Al_2O_3 (%)	24.07
Fe_2O_3 (%)	3.5
CaO (%)	2.39
MgO (%)	1.55
MnO_4 (%)	2.05
TiO_2 (%)	0.04
P_2O_5 (%)	0.08
K_2O (%)	1.6
NO_3N (%)	0.05
Na_2O (%)	0.38
ESP	5

Table3. Changes in properties of soil on addition of steel slag

	Initial Value	Changed Value
pH	7.6	7.8
Electrical conductivity (dS/m)	0.28	0.3
Natural moisture content (%)	45	44
Bulk density (g/cm^3)	1.56	1.52
Water holding capacity (%)	63.5	64
% Organic carbon	0.62	0.6
SiO_2 (%)	63.1	65.5
Al_2O_3(%)	24.07	24.1
Fe_2O_3(%)	3.5	4.5
CaO (%)	2.39	2.44
MgO (%)	1.55	1.6
MnO_4(%)	2.05	2.07
TiO_2(%)	0.04	0.09
P_2O_5(%)	0.08	0.09
K_2O (%)	1.6	1.75
NO_3 N (%)	0.05	0.035
Na_2O (%)	0.38	0.36
As_2O_3(%)	0.002	0.003
ESP	5	4.45

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EFFECTS OF NUTRIENT AND PEST MANAGEMENT MODULES ON FIBRE QUALITIES OF BT AND NON BT COTTON (*Gossypium hirsutum* L.) HYBRIDS

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ABSTRACT

Field experiment was conducted during *kharif* seasons of 2004-05 and 2005-06 at Parbhani (Maharashtra) to study the effect of nutrient and pest management modules on fibre qualities of Bt and non-Bt cotton hybrids. The results revealed that Bt cotton hybrid MECH 184 significantly recorded higher staple length and bundle strength as compared to PHH 316 non Bt cotton hybrid. Whereas the fibre quality parameters viz., staple length, bundle strength, fibre fineness and uniformity ratio were not influenced significantly due to pest management as well as nutrient management treatments.

(Key words: Bt cotton, nutrient management, pest management, fibre qualities)

INTRODUCTION

Cotton (*Gossypium* spp.) is one of the most important commercial crop playing a key role in economical, political and social status of the world. Popularly known as ′White Gold′ is a premier cash crop of the most of SAARC countries with an enormous potential of sustainable employment generation both in rural and urban sector. Cotton cultivation in India, of late is proving to be less remunerative enterprise primarily because of high cost of production due to indiscriminate use of pesticides and chemical fertilizers. The excessive and indiscriminate use of pesticides also develops insecticide resistanceI major pests like bollworms and emergence of secondary pest in epidemic form making the cotton production risk prone compared to other crops (Kranthi *et al*., 2002). Thus, cotton production in India is, however, once again at cross roads facing tremendous new challenges of poor soil health, nutrient deficiencies, outbreak of pests and diseases, poor fibre quality and increased cost of production. Under such distress situation, introduction of transgenic "Bt cotton" appears to be viable option which will enhance quality fibre production, bring down pesticide use, cost of cultivation and ecological hazards. Based on the yield performance and economic benefits realized from Bt cotton, the first approval of Bt cotton cultivation in India was granted in the year 2002 by Government of India and the area under Bt cotton is being increasing in geometrical proportions leading to a total coverage of all *Hirsutum* cotton area of the country with the Bt cotton hybrids. Keeping in view, an attempt was made to find out the effect of nutrient and pest management modules on fibre qualities of Bt and non-Bt cotton hybrids under rainfed condition of Maharashtra.

MATERIALS AND METHODS

A field investigation entitled "Response of Bt and non-Bt cotton hybrids to nutrient and pest management" was conducted during *kharif* seasons of 2004-05 and 2005-06 at department of Agronomy, Marathwada Agricultural University, Parbhani (409 m mean sea level; 19° 16′ N and 76° 47′ E) with subtropical climate. Total rainfall received during cropping period (June to Feb) was 439.9 and 1275.9 mm distributed over 31 and 43 rainy days for the year 2004-05 and 2005-06 as against the normal precipitation of 885 mm in 57 rainy days (1974 to 2004), respectively. The maximum and minimum temperatures were 27.6 and 48.5°C and 27.2 to 38.1°C in the same order. The soils of the experimental plot were vertisols, low in available nitrogen (147.4, 156.00 kg ha^{-1}) and available phosphorus (18.24, 15.10 kg ha^{-1}), fairly rich in potassium (430.10, 442.25 kg ha^{-1}) and slightly alkaline in reaction (8.3, 8.2) during the year 2004-05 and 2005-06 respectively.

The experiment was laid out in split plot design replicated thrice. Eighteen treatment

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combinations comprising three cotton hybrids viz., insecticidal pest management and biopesticidal pest management modules (Table 1) and three nutrient managements viz., FYM 10 t ha^{-1}, 80:40:40 kg NPK ha^{-1}, 100:50:50 kg NPK ha^{-1}. Wherein treatment combinations, hybrid (H) and pest management (P) were allotted to main plots whereas, nutrient management (N) was accommodated in subplots. The gross plot size was 7.2 m x 5.4 m and the corresponding net plot size was 5.4 m x 3.6 m. The cotton was sown by hand dibbling at 90 cm x 60 cm spacing with one seed $hill^{-1}$. The seedlings emerged out completely within a week after a sowing and gap filling was done at 10 days after sowing. The experimental field was kept free from weeds during critical crop weed competition period. Fertilizers were applied as per treatments i.e. FYM 10 t ha^{-1}, 80:40:40 and 100:50:50 NPK kg ha^{-1}. FYM @ 10 t ha^{-1} was applied one week before sowing to treatment plots only and thoroughly mixed with soil with the help of hand hoe. Half dose of nitrogen, full dose of P_2O_5 and K_2O were applied as basal dose, while remaining half dose of nitrogen was applied one month after sowing. Fertilizers were applied by ring method. Plant protection measures were undertaken as and when the population incidence of particular pest reached to ETL in a particular treatment except release of *Trichograma chilonis* egg parasitoid which was undertaken at specific time and interval. The other cultural operations were done in the entire plot uniformly. For the fibre quality parameter study seed cotton samples were taken from first picking and ginned separately as per the treatments. Lint samples of 500 g each were taken to Ginning and Training Centre of Central Institute for Research on Cotton Technology, Nagpur. Observations on fibre qualities such as staple length (mm), bundle strength (g t^{-1}), uniformity ratio (per cent), and fibre fineness (µg $inch^{-1}$) were taken. The data were subjected to statistical analysis by following the standard statistical method (Panse and Sukhatme, 1985).

RESULTS AND DISCUSSION

The effects of cotton hybrids on fibre qualities were quite apparent wherein staple length (mm) was significantly higher in MECH 184 Bt and MECH 184 non-Bt than PHH 316 (Table 2). Whereas, bundle strength (g t^{-1}) did not differ significantly between MECH 184 Bt and MECH 184 non-Bt, however, it was significantly higher than PHH 316 during both the years. As far as fibre fineness was concerned, it was significantly more in PHH 316 compared to both MECH 184 Bt and MECH 184 non-Bt cotton hybrid during both the years. The uniformity ratio (per cent) did not show any notable change in MECH 184 Bt and its counterpart non-Bt MECH 184 and both were significantly inferior over PHH 316. The differences in fibre properties due to hybrids are obvious because fibre properties are primarily governed by the genetic makeup of hybrids coupled with strong genotype and environment (soil and climate) interaction, which modify the ultimate expression of fibre properties. The current level of information and understanding reveals that about 80 per cent of the variation in fibre length is governed by genetic factors. On the other hand 60 per cent of the variability in micronaire and 80 per cent of the variability in colour are controlled by environmental factors. Variation in fibre properties due to cotton hybrids were also reported by Srinivasan and Iyer (2002), wherein 2.5 % span length, uniformity ratio and tenacity amongst Bt and non Bt cotton was not varied significantly. However, significant differences in micronaire value between MECH 12 Bt, MECH 162 Bt and their respective non Bt cotton hybrids were observed. Similarly, Singh *et al*. (2003), observed that fibre qualities viz., 2.5 % span length (mm), uniformity ratio (%), micronaire value and tenacity (g t^{-1}) differed significantly among the Bt cotton and local check. The cotton hybrid MECH 12 non-Bt recorded significantly high span length (29.6 mm) followed by MECH 184 non/Bt (28.8 mm) than other hybrids. In case of uniformity ratio and tenacity (g t^{-1}), Bt cotton and non-Bt counterparts did not show significant differences. The commonly grown NHH 44 cotton hybrid recorded the maximum micronaire value followed by MECH 12 Bt and MECH 12 non-Bt. In another trial Halemani *et al*. (2004) tested response of Bt cotton hybrids to fertilizer doses (levels) under protective irrigation on medium deep soil at Dharwad. The result on quality parameter of Bt and non Bt cotton revealed that the hybrid differed significantly in 2.5 span length. Amongst the cotton hybrid RCH 2 Bt and its non Bt recorded significantly longer staple length. RCH 2 Bt and DHH 11 (check) were significantly superior in fibre fineness as compared to other hybrids. Fibre strength of RCH 2 Bt and RCH 20 Bt and their non bt cotton hybrid were

Table 1. Details of plant protection measures under taken on various cotton genotypes in various modules

Sr. No.	Particulars	2004 05				2005 06			
		MECH 184 Bt under Module I	MECH 184 Bt under Module II	MECH 184 non Bt PHH 316 under Module I	MECH 184 non Bt PHH 316 under Module II	MECH 184 Bt under Module I	MECH 184 Bt under Module II	MECH 184 non Bt PHH 316 under Module I	MECH 184 non Bt PHH 316 under Module II
1.	Methyl demeton @ 300 ml ha^{-1}	2 sprays	--	2 sprays	--	2 sprays	--	2 sprays	--
2	Release of T. *chilonis* @ 1.5 lakh ha^{-1}	--	2 times	--	2 times	--	2 times	--	2 times
3	Endosulfan 850 ml ha^{-1}	--	--	1 spray	--	--	--	2 sprays	--
4	Quinalphos 1 l ha^{-1}	--	--	1 spray	--	--	--	1 spray	--
5	Fenvalerate 350 ml ha^{-1}	--	--	1 spray	--	--	--	1 spray	--
6	Neemark 1 lit ha^{-1}	--	2 sprays	--	2 sprays	--	2 sprays	--	2 sprays
7	HaNPV @ 250 LE ha^{-1}	--	--	--	3 sprays	--	--	--	3 sprays

Module-I : Insecticidal pest management
Module-II : Biopesticidal pest manaement
Note: Seed of all cotton genotypes was treated with imidacloprid 70 WS @ 10 g kg^{-1} seed.

Table 2. Fiber quality parameters 2.5% SL (mm), bundle strength (gt^{-1}), fibre fineness (µg $inch^{-1}$) and uniformity ratio (%) as influenced by different treatments during 2004-05 and 2005-06

Treatments	2.5% SL		Fibre fineness (µg $inch^{-1}$)		Uniformity ratio (%)		Bundle strength ($g\ t^{-1}$)	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
Hybrids								
H_1 MECH 184 Bt	26.35	28.98	3.55	3.66	48.27	47.55	21.87	22.70
H_2 MECH 184 NBt	26.16	29.37	3.42	3.13	49.50	49.11	21.42	23.70
H_3 PHH 316	24.53	26.05	3.28	3.04	51.44	50.50	20.93	21.48
SEm +	0.36	0.19	0.06	0.09	0.69	0.35	0.20	0.37
CD (P=0.05)	1.16	0.60	0.20	0.28	2.17	1.12	0.65	1.19
Pest management								
P_1 Insecticidal	25.63	28.28	3.34	3.18	50.14	49.07	21.58	23.08
P_2 Biopesticidal	25.73	27.99	3.49	3.37	49.33	49.03	21.24	22.17
SEm +	0.30	0.15	0.05	0.07	0.56	0.29	0.16	0.31
CD (P=0.05)	-	-	-	-	-	-	-	-
Nutrient management								
F_1 FYM 10 t ha^{-1}	25.65	27.93	3.44	3.35	49.55	48.83	21.27	22.61
F_2 80:40:40 kg NPK ha^{-1}	25.71	28.46	3.40	3.25	50.00	48.66	21.53	22.55
F_3 100:50:50 kg NPK ha^{-1}	25.69	28.02	3.41	3.23	49.66	49.66	21.41	22.71
SEm ±	0.20	0.22	0.05	0.05	0.69	0.35	0.28	0.38
CD (P=0.05)	-	-	-	-	-	-	-	-

significantly superior over other hybrids. Uniformity ratio and maturity percentage did not vary among Bt hybrids. Hallikeri *et al*. (2004) while working on response of Bt cotton hybrid to fertilizer application under protective irrigation on medium deep soil at Dharwad during 2001-02 found that cotton hybrids differed significantly in fibre length. MECH 184 Bt has produced significantly superior fibre (29.1 mm) over other hybrids and local checks. Least fibre length was with MECH 162 non Bt hybrid. Micronaire value and maturity percentage were unaffected with different hybrids. Amongst the Bt hybrids, fibre strength was more with MECH 184 Bt (24.2 g tex^{-1}) and MECH 12 Bt (23.9 g tex^{-1}).

The fibre qualities such as 2.5 per cent span length (mm), bundle strength (g t^{-1}), fibre fineness (µg $inch^{-1}$) and uniformity ratio (per cent) did not influence significantly due to pest management and nutrient management levels during both the years (Table 3). This might be due to fact that fibre quality parameter are primarily governed by genetic make up of hybrids. Similarly, Narayana *et al*. (2011) also did not found any significant improvement in 2.5 % span length(mm), bundle strength (g t^{-1}), fibre fineness (µg $inch^{-1}$) and uniformity ratio (per cent) of Bt cotton due to nutrient management.

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CONSTRAINTS FACED AND SUGGESTIONS MADE BY THE SOIL TESTING LABORATORY STAFF FOR EFFECTIVE SOIL TESTING AND FERTILIZERS RECOMMENDATIONS TO CROP

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ABSTRACT

A survey study was undertaken for effective working of soil testing laboratories (STL) of Nagpur and Wardha districts during 2006-07 to 2008-09. The results revealed that out of 51 respondents (STL staffs), 26 had complete knowledge, 24 had partial knowledge, and 1 had no knowledge about 18 important activities carried out in STL. However, about adopting the knowledge of soil testing by the STL staff, 17 respondents had adopted completely, 24 had adopted partially and 6 had no knowledge about 18 important activities carried out in STL. Thus, STL did not have 100% trained staff. This may affect the precision in results of soil analyses for various soil testing aspects. The 96.1 % respondents expressed the need of recruitment of agriculture graduates and if possible post graduates in Soil Science and Agriculture Chemistry for smooth running of STL. The 88.2 % respondents opined that the soil sampling should be done very carefully as per prescribed procedure, if possible through expert. Soil testing recommendations should reach to farmers by conducting their training programmes at village level. The 70.6 % respondents said that for immediate identification and correction of nutrients deficiency there should be mobile soil testing laboratory, 62.7 % respondents said medium of instruction should be in local/ regional language, 52.5 % respondents raised the need of farmers' visits to model farms. The 52.9 % respondents opined that timely training of soil testing, knowledge of fertilizer recommendation and new agricultural technology is a need of STL staff. The 92.2 % respondents expressed the need of arrangement of regular power supply to STL, because it is a major external constraint due to power cut or failure.

(Key words: Soil testing laboratory, constraints, suggestions, training needs, staff)

INTRODUCTION

Soil testing is a dynamic process to identify nutritional status, problems, which evolve soil specific, crop specific solutions based on its analysis. The farmers are advised for soil fertility management through rational use of manure, fertilizers and amendments to make agriculture more productive and sustainable. Looking into the importance of sustainable agriculture and to maintain food grain production, the Government of Maharashtra had started soil testing laboratories (STLs) in each district through department of agriculture. The agricultural Universities, fertilizer and tractor companies, APMC, Krishi Uttpana Bazar Samities and other private institutions had provided soil testing services to farmers. The soil testing services is not popular amongst the farmers, because the farmers are not having the knowledge of the importance of soil testing laboratories. This might be due to gap in understanding between staff of STL and farmers. Some soil testing laboratory staffs have problems in their laboratories due to lack of sufficient knowledge of soil testing practices. Considering the above constraints, the present study was undertaken at College of Agriculture, Nagpur to study the constraints faced and suggestions made by STL staff from Nagpur and Wardha districts to improve the working of soil testing laboratories in state and to provide backup support for successful operations within the respective areas.

MATERIALS AND METHODS

The total nine Soil Testing Laboratories from Nagpur and Wardha districts were selected for the study. These were laboratories of Department of Soil Science and Agriculture Chemistry and Agronomy Section, College of Agriculture, Nagpur, State Department of Agriculure, Soil Testing Laboratory Nagpur and Wardha, NBSS & LUP, Nagpur, RCF, Bajaj Nagar, Nagpur, APMC, Nagpur, Govind Agrochemicals, Kelwad, District Nagpur and Satnam Krishi Chikitsalay, Bharsingi, Nagpur. The total 51 staff directly involved in analytical process of soil testing were selected for the study, which includes, 10 Agricultural University Staff (P), 9 Laboratory Incharge (LI), 8 Agricultural Officers (AO), 9 Agricultural Supervisors (S) and 15 Agricultural Assistants (AA). The information on 18 important soil testing and fertilizer recommendation practices were gathered to acquire data on knowledge and adoption, constraints faced and suggestions made by the STL staff for effective working of STL (Table 1 and 2). The data collected

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were tabulated and analyzed by using statistical tools like percentage, arithmetic mean, standard deviation, coefficient of correlation and regression etc.

RESULTS AND DISCUSSION

Staff involved in soil testing according to their knowledge :

The knowledge on eighteen important soil testing practices and fertilizer recommendations of individual respondents was noted. The results (Table 1) revealed that the 26 respondents (51.0 %) have complete knowledge and 24 respondents (47.0 %) have partial knowledge of soil testing practices. As per practice-wise knowledge, the respondents who had complete knowledge of time of soil sampling were 80.4 %, preparation of soil sample for analysis were 74.5 %, soil sampling technique used were 64.7 %, label of complete information were 64.7 % and recommendation given as per crop to be grown and instrument standardization for pH and EC were 60.8 %. However, the respondents who had partial knowledge, had taken soil samples were 78.4 %, Soil Health Card (SHC) suggestions followed by farmers were 64.7 %, recommendation for nutrient management and training given to farmers were 56.9 %, organic-C test were 54.9% and methods of nitrogen, phosphorus and potassium estimation were 52.9 %. However, 7 respondents (17.7 %) had no knowledge about distribution of SHC, visit to farmers field taken and nutrients deficiency observed (13.7 %), 6 respondents (11.8 %) had no knowledge of soil sample preparation for organic-C and other analyses (Table 1). Education, size of land holding, experience of farming, socio-economic status, use of farm literature for information and knowledge had non significant contribution in variation of training need (Shelar *et al*., 2007). Similar results were also noted by Kamble *et al*. (2011) and Sarode (2011). Thus, STL did not have 100% trained staff and this may affect the precision in results of soil analyses for various soil testing aspects.

Staff involved in soil testing according to their adoption :

Even though, 51 % respondents had complete knowledge of soil testing and fertilizer recommendation practices, but its complete adoptation was carried out by 33.3 % respondents and partial adoption by 54.9 % respondents. The soil testing practices which were adopted completely by more than 50 % respondents, which were SHC suggestions followed by farmers (80.4 %) and soil sampling technique used (66.3 %). However, amongst the respondents, 28 had adopted the knowledge of soil testing practices partially, 88.2 % respondents followed report distribution time and recommendation given as per crop to be grown, 76.5 % respondents carried out preparation of soil samples for organic-C and other analyses, 74.5 % respondents followed the time of soil sampling, 70.6 % respondents reported recommendation for nutrient management, 62.7 % for importance of soil testing, 56.9 % for training to farmers and materials required for soil testing. On an average 6 respondents (11.8 %) did not possess the knowledge of soil testing and fertilizer recommendations practices. It indicates they don't have any knowledge of soil testing. However, 31.4 % respondents had not participated in training given to farmers, 29.4 % respondents did not visit to farmers field and nutrients deficiency observed, 27.5 % respondents did not collect soil samples, 23.5 % failed in labeling of information, 15.7 % did not adopt methods of nitrogen, phosphorus and potassium estimation, and 15.7 % did not adopt organic-C test and awareness about suggestions followed by farmers. Majority of the onion growers had a medium level of adoption of the recommended onion production technology (Waman *et al*., 1998). This might be due to small confusion in understanding the procedure, hence they require training (Table 2).

Constraints faced by STL staff :

The employees working in soil testing laboratory faced approximately nine constraints (Table 3), out of which eight were personnel about lack of knowledge in soil testing practices i.e. less information about recommended varieties in particular soil type (72.5 % respondents), insufficient information about new agricultural technology specially in soil testing and fertilizer recommendation (52.9 % respondents), less information in soil testing (56.7 % respondents), soil sampling and preparation for laboratory analysis (52.9 % respondents) etc. The major external constraint was power cuts/ failures (92.2 % respondents) and lack of proper guidance about new

Table 1. Distribution of staff involved in soil testing according to their practice wise knowledge

Sr. No.	Soil testing practices	Knowledge (N= 51)					
		Complete		Partial		No	
		No.	%	No	%	No	%
1	Importance of soil testing	29	56.9	22	43.1	0	0
2	Materials required for soil testing	26	51.0	25	49.0	0	0
3	Soil sampling technique used	33	64.7	18	35.3	0	0
4	Soil samples taken by expert, farmers	11	21.6	40	78.4	0	0
5	Lable of complete information	33	64.7	18	35.3	0	0
6	Time of soil sampling	41	80.4	10	19.6	0	0
7	Preparation of soil sample for analysis	38	74.5	13	25.5	0	0
8	Soil sample passed through sieve for organic -C and other analyses	20	39.2	25	49.0	6	11.8
9	Weight of sample taken for organic-C test	23	45.1	25	49.0	3	5.9
10	Pot dichromate added by measuring cylinder, pipette, burette for organic-C test	23	45.1	28	54.9	0	0.0
11	Nitrogen, phosphorus and potassium estimated by method	24	47.1	27	52.9	0	0.0
12	Instrument standardization for pH/EC	31	60.8	18	35.3	2	3.9
13	Report distribution time	25	49.0	26	51.0	0	0.0
14	Recommendation given L/H or as per crop to be grown	31	60.8	20	39.2	0	0.0
15	Recommendation for chemical fertilizer/organic fertilizer/bio-fertilizer/integrated nutrient management	22	43.1	29	56.9	0	0.0
16	Training given to farmer	22	43.1	29	56.9	0	0.0
17	After distribution of SHC visit to farmer field taken and nutrients deficiency observed	18	35.3	26	51.0	7	13.7
18	SHC suggestions followed by farmer	18	35.3	33	64.7	0	0
	Mean	26	51.0	24	47.1	1	2.0

analytical procedures (62.7 % respondents) from department and insufficient training regarding soil testing.

Suggestions made by STL staff :

While collections of data from respondents, some suggestion were also sought with a view to improve the soil testing and fertilizer recommendation for crops in soil testing laboratory. 96.1 % respondents opined that at least agriculture graduate and if possible post graduate in Soil Science and Agriculture Chemistry may be recruited in soil testing laboratory, 90.2 % respondents expressed the need of constant necessary guidance from service providers, 88.2 % respondents expressed that soil sampling should be done very carefully as per prescribed procedure, if possible through expert, for effective adoption of soil testing recommendations, 70.6 % respondents felt the need of arranging village level meeting, training programmes and arranging for mobile soil testing laboratory for immediate identification of deficiency of nutrients and its correction, 62.7 % respondents expressed that information in local/ regional language be provided and 52.5 % suggested to organize farmers′ visits to model farms (Table 4). The training needs for certification of organic farming in the context of globalization, 92 per cent respondents suggested to provide information in local language, 80 per cent suggested to arrange village level training programme and almost 70 per cent of respondents suggested the necessity of constant guidance of service providers (Gorade *et al*., 2008).

Table 2. Distribution of staff involved in soil testing according to their practice wise adoption

Sr. No	Soil testing practices	Adoption (N= 51)					
		Complete				No	
		No.	%	No.	%	No.	%
1	Importance of soil testing	15	29.4	32	62.7	4	7.8
2	Materials required for soil testing used	17	33.3	29	56.9	5	9.8
3	Soil sampling technique followed	34	66.7	11	21.6	6	11.8
4	Soil samples actually taken by expert,	20	39.2	17	33.3	14	27.5
5	Lable of complete information noted	20	39.2	19	37.3	12	23.5
6	Time of soil sampling	7	13.7	38	74.5	6	11.8
7	Preparation of soil sample for analysis	12	23.5	39	76.5	0	0.0
8	Soil sample passed through sieve for organic-C and other analyses	12	23.5	39	76.5	0	0.0
9	Weight of sample taken for organic carbon test	17	33.3	26	51.0	8	15.7
10	Pot permanganate added by measuring cylinder, pipette, burette	19	37.3	26	51.0	6	11.8
11	Nitrogen, phosphorus and potassium estimated by method	17	33.3	26	51.0	8	15.7
12	Instrument standardization for pH/EC	25	49.0	26	51.0	0	0.0
13	Report distribution time	6	11.8	45	88.2	0	0.0
14	Recommendation given L/H or as per crop to be grown	6	11.8	45	88.2	0	0.0
15	Recommendation for chemical fertilizer/organic fertilizer/bio -fertilizer /integrated fert. given	15	29.4	36	70.6	0	0.0
16	Training given to farmer	6	11.8	29	56.9	16	31.4
17	After distribution of SHC visit to farmer field taken and nutrients deficiency observed	17	33.3	19	37.3	15	29.4
18	SHC suggestions followed by farmer	41	80.4	2	3.9	8	15.7
	Mean	17	33.3	28	54.9	6	11.8

Table 3. Constraints faced by staff working in soil testing laboratory

Constraints	Respondents	Per cent
1. How to take soil sample and preparation for analysis	27	52.9
2. Lack of knowledge and information about soil testing	29	56.7
3. Very little or not having knowledge about micronutrients	18	35.3
4. Lack of knowledge about recommended fertilizer dose	24	47.1
5. Lack of knowledge about suitability of soil for crop grown	26	51.0
6. Lack of knowledge about recommended varieties in particular soil type	37	72.5
7. Power cuts/ failures	47	92.2
8. Insufficient information about new agricultural technology specially soil testing and fertilizer recommendation	27	52.9
9. Lack of proper guidance about new analytical process	32	62.7

Table 4. Suggestions made by staff working in soil testing laboratory

	Suggestions	Respondents	Per cent
1.	Soil sampling should be done very carefully as per prescribe procedure if possible through expert	45	88.2
2.	Arrange village level meeting, training programmes for adoption of soil testing recommendations	36	70.6
3.	To organize farmers visits to model farms	27	52.9
4.	To provide information in local/ regional language	32	62.7
5.	At least agriculture graduate and if possible post graduate in Soil Science and Agriculture Chemistry may recruited in soil testing laboratory	49	96.1
6.	Mobile soil testing laboratory for immediate identification of deficiency of nutrients and its correction	36	70.6
7.	It is necessary to make available constant guidance of service providers	46	90 .2

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COMBINING ABILITY ANALYSIS OF YIELD AND YIELD CONTRIBUTING TRAITS IN LINSEED (*Linum usitatissimum* L.)

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ABSTRACT

The selected lines of linseed (*Linum usitatissimum* L.) were used to estimate the combining ability of important yield contributing characters and to select potential parents and crosses for linseed breeding programme at College of Agriculture, Nagpur during *rabi* 2009-10. The parents LCK-88062, PKDL-18, EC-1424, Nagarkot and NL-97 were good general combiners and may be utilized in improvement of yield and yield contributing traits. To broaden the genetic base, the three way and double crosses (NL-97 x PKDL-18) x Nagarkot, (NL-97 x PKDL-18) x (NL-260 x EC-1424) and (NL-260 xPKDL-18) x (NL97 x LCK-88062) may be utilized for deriving superior transgrates for seed yield plant^{-1}, number of capsules plant^{-1}, 1000 seed weight and budfly resistance.

(Keywords: Combining ability, yield contributing traits, linseed)

INTRODUCTION

The success in the development of superior varieties depends on the choice of parents for hybridization and amount and type of genetic variability present in the base population to be improved. Verma and Kumar (1974) and Joshi (1979) emphasized that greater attention should be paid on the choice of parents for hybridization. This should be based not only on *per se* performance but also on adaptability, genetic diversity and combining ability. Therefore, the present investigation was undertaken to estimate the combining ability of important yield contributing characters and selection of potential parents and crosses for linseed breeding programme.

MATERIALS AND METHODS

The experimental material comprised of 2 females, 19 males and 38 crosses among them. This complete set of material was grown in a Randomized Complete Block Design with two replications at the farm of College of Agriculture, Nagpur, during *rabi* 2009-10. The plants were spaced 45 cm between rows and plants. The cultivar NL-97 as border row was grown on all sides of the block to avoid border effect. Recommended package of practices were followed to raise a good crop. Data were recorded on five randomly selected plants of each family for nine characters *viz*., days to 50% flowering, plant height (cm), number of capsules plant^{-1}, number of branches plant^{-1}, days to maturity, 1000 seed weight (g), seed yield plant^{-1} (g), budfly percentage and Alternaria blight percentage.

The statistical and biometrical analysis was performed as per the methodology 1) Analysis of variance suggested by Panse and Sukatme (1954), and 2) Analysis of variance for combining ability (Line x Tester Analysis) gca, sca effects suggested by Kempthorne (1957).

RESULTS AND DISCUSSION

The analysis of variance for combining ability (Table 1) for different characters showed that the mean squares due to crosses were significant for all the characters indicating substantial genetic varability among crosses for combining ability. The mean squares due to males and females were significant for all the characters except alternnaria blight among females indicating importance of gca for characters under study. The males x female′s interactions were significant for all the characters except plant height indicating genetic variability for specific combining ability. The significant general combining ability and specific combining ability variation was also reported by Ratnaparkhi *et al.* (1998), Kusalkar (1999), Reddy (2008) and Mane (2009). The predictability ratio (gca *vs* sca) for days to 50% flowering (0.93), plant height (0.97), days to maturity (0.80) and 1000 seed weight (0.91) were near to unity. The closer this ratio to unity, greater is

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Table 1. Analysis of variance for combining ability

Source of variation	Degrees of freedom	Mean squares								
		Days to 50 % flowering	Plant height (cm)	Number of capsules plant $^{-1}$	Number of branches plant $^{-1}$	Days to maturity	1000 seed weight (g)	Seed yield plant $^{-1}$ (g)	Budfly (%)	Alternaria blight (%)
Replication	1	17.05	4.82	53.87	7.16	4.75	0.0005	4.13	9.44	1.70
Crosses	37	16.57**	96.11**	6755.62**	3.22**	14.51**	2.05*	11.16**	18.94**	15.36**
Males (m)	18	28.11**	126.05**	7548.34**	3.86**	17.48**	3.09**	12.81**	16.08**	18.75**
Females (f)	1	11.84**	791.54**	2900.65**	2.41*	12.64*	3.28**	5.19*	18.18**	0.09
Males X Females (m x f)	18	5.31**	27.53	6177.06**	2.63**	11.64**	0.94*	9.85**	21.85**	12.81**
Error	37	3.21	15.99	332.50	0.99	3.02	0.21	0.88	0.88	1.14
GCA vs SCA (Baker, 1978)		0.93	0.97	0.74	0.79	0.80	0.91	0.76	0.70	0.75

*, ** = significant at 5% and 1% level respectively

Table 2. General combining effects of the parents for different characters

Sr. No.	Genotypes	Days to 50 % flowering	Plant height (cm)	Number of capsules plant^{-1}	Number of branches plant^{-1}	Days to maturity	1000 seed wt. (g)	Seed yield plant^{-1} (g)	Budfly (%)	Alternaria blight (%)
	Females									
1	NL-97	0.40	3.23**	6.18**	0.18	0.41	0.21**	-0.26	-0.49**	0.04
2	PKV-NL-260	-0.40	-3.23**	-6.18**	-0.18	-0.41	0.21**	0.26	0.49**	-0.04
	SE(gi)±	**0.29**	**0.65**	**2.96**	**0.16**	**0.28**	**0.08**	**0.15**	**0.15**	**0.17**
	Males									
1	A-95B	-0.68	1.81	4.09	-0.89	3.14**	0.28	-1.67	0.70	-1.50**
2	EC-1392	-1.43	5.10**	-25.16**	-0.78	1.64	1.90**	0.82	1.36**	-3.78**
3	EC- 1424	-5.90**	10.00**	76.99**	0.22	0.39	1.06**	1.34**	0.17	-0.22
4	GS-234	-4.18**	11.46**	23.79**	-0.89	3.14**	0.66**	1.85**	-0.70	-0.81
5	PKDL-18	-0.43	2.55	46.94**	1.12**	-0.11	0.51*	2.38**	-2.60**	-2.37**
6	Ayogi	6.07**	6.98**	-70.16**	-0.41	-2.86**	1.38**	3.23**	2.42**	1.93**
7	ES-44	-0.68	1.29	9.56	-0.72	-0.11	0.05	-0.21	1.14*	-1.09*
8	R-552	2.07**	-4.65*	-79.96**	-0.68	-2.36**	1.29**	3.38**	2.35**	5.63**
9	EC-9826	2.07**	0.98	10.72	1.70**	0.39	-0.45*	-0.76	0.03	1.30*
10	EitA	0.07	2.61	-6.65	0.006	-1.61	-0.30	0.40	-1.47**	-2.51**
11	Kiran	1.07	-0.05	-27.86**	-0.73	1.89	0.48*	0.70	1.67**	-0.68
12	Shika	1.32	0.85	-42.21**	-0.28	3.39**	0.52*	-0.47	3.52**	0.26
13	LCK-88062	1.57	6.66**	67.23**	2.74**	-0.86	-1.24**	1.86**	0.23	0.77
14	JRF-5	2.32**	0.25	-21.10*	0.02	0.39	-0.86**	-0.46	-0.49	1.06*
15	Nagarkot	0.32	4.85*	47.69**	0.47	0.64	0.54*	2.12**	-5.10**	0.06
16	Sheela	-0.68	0.85	-2.08	0.72	-3.36**	-0.56*	1.71**	-2.19**	0.87
17	NL-142	0.32	4.71*	21.11*	-0.41	-2.36**	-0.68**	0.35	-0.20	-0.93
18	TL-28	-3.68**	-2.21	17.16*	-0.38	0.89	0.82**	2.77**	-1.23**	-1.34**
19	TL-56	0.57	-11.13**	-50.13**	-0.81	-2.36**	0.02	-1.04*	0.37	3.34**
	SE(gj)±	**0.90**	**2.00**	**9.12**	**0.50**	**1.23**	**0.23**	**0.47**	**0.47**	**0.53**

Table 3. The mean performance, gca effects of parents and sca effect of superior crosses

Crosses	Mean performance	GCA effects		SCA effects
		P_1	P_2	
Seed yield plant $^{-1}$(g)				
NL-97 x PKDL -18	7.89	-0.26 ^{NS}	2.38**	0.53 ^{NS}
PKV-NL-260 x PKDL -18	7.35	0.26 ^{NS}	2.38**	0.53 ^{NS}
NL-97 x LCK -88062	8.86	-0.26 ^{NS}	1.86**	-1.50**
Number of capsules plant $^{-1}$				
PKV-NL-260 x EC -1424	193.30	-6.18**	76.99**	-28.47**
NL-97 x LCK -88062	169.38	-6.18**	67.23**	-54.99**
PKV-NL-260 x PKDL -18	164.20	-6.18**	46.94**	-27.52**

the predictability based on general combining ability alone. It is concluded that high general combining ability of parent is the most important criteria for the selecting genetically superior lines that would give promising cross combinations for isolating agronomically desirable segregates from the segregating generations (Badwal *et al*., 1974).

The choice of parents for hybridization programme influences the success in crop improvement programme. The selection of parents based on *per se* performance is not always good indicator of superior combining parents (Allard, 1960). It is common experience that certain crosses produce many superior transgrates and some crosses between promising parents produce inferior progenies. Hence, we can identify the parents and crosses on the basis of combining ability, which is likely to give higher proportion of superior segregates rather than selecting on basis of *per se* performance. Hence, the combining ability analysis serves as an important tool for selection of parents with the highest breeding value. The parents with the high general combining ability effects may be used for improvement of individual trait *per se*.

In the present study gca effects were estimated for selection of parents (Table 2) indicated that the female parent NL-97 was good general combiner and may be selected for improvement of plant height, number of capsules plant^{-1}. Among males LCK-88062 was good general combiner and may be selected for improvement of plant height, number of capsules plant^{-1}, number of branches plant^{-1} and seed yield plant^{-1}. PKDL-18 was good general combiner and may be selected for improvement of branches plant^{-1}, seed yield plant^{-1} and budfly resistance. Parent EC-1424 was good general combiner for early flowering. It should be utilized in improvement for number of capsules plant^{-1} and 1000 seed weight also.

The crosses showing high mean performance, high gca effects of the parents involved in the cross and sca effects may serve as better source population for deriving superior segregates (Table 3). The same was also reported by Khorgade *et al.* (1990) and Ratnaparkhi *et al.* (1998). In the present study, the cross combination, NL-97 x LCK-88062 showed high gca, high mean performance with significant negative sca effect for seed yield plant^{-1} and number of capsules plant^{-1}, whereas, NL-97 x PKDL-18 and PKV-NL-260 x PKDL-18 showed high gca, high mean performance with low and non significant sca effects for seed yield plant^{-1}. For

number of capsule plant^{-1}, the cross combinations, PKV-NL-260 x EC-1424 and PKV-NL-260 x PKDL-18 showed high gca, high mean performance with significant negative sca effect. The parents involved in these crosses were found to be good general combiners for important economic traits.

To broaden the genetic base, it is necessary to produce three way or double crosses *viz*., (NL-97 x PKDL-18) x Nagarkot, (NL-97 x PKDL-18) x (PKV-NL-260 x EC-1424) and (PKV-NL-260 x PKDL-18) x (NL-97 x LCK-88062) may be utilized for deriving superior transgrets for seed yield plant^{-1}, number of capsules plant^{-1}, 1000 seed weight and budfly resistance through single seed descent (SSD) method. Also, selective intermating in F_2 should be adopted to break undesirable association so as to increase the frequency of desirable recombinant lines in segregating generations.

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EFFECT OF SOME NEW POST EMERGENCE HERBICIDES ON WEED AND PLANT GROWTH PARAMETERS OF SOYBEAN (*Glycine max* L.)

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ABSTRACT

A field experiment was conducted at the research farm of the College of Agriculture, Nagpur during *kharif* season 2010 to study the effect of some new post- emergence herbicides on weed and plant growth parameters of soybean (*Glycine max* L.) grown on clayey soil. The treatment of two hoeings and two handweedings at 20 DAS and 35 DAS being at par with the application of imazethapyr @ 75 g a.i. ha^{-1} at 15 DAS + 1 hoeing and 1 hand weeding at 35 DAS and chlorimuron ethyl @ 10 g a.i. ha^{-1} at 15 DAS + 1 hoeing and 1 hand weeding at 35 DAS. These treatments were found more effective in controlling weeds throughout crop growth period and improving growth characters viz., plant height, number of leaves plant^{-1}, leaf area index, number of branches plant^{-1} and plant dry matter (g) significantly over rest of the treatments under study. Highest grain yield and straw yield were obtained under two hoeings and two hand weedings at 20 DAS and 35 DAS which were at par with the application of imazethapyr @ 75g a.i. ha^{-1} at 15 DAS + 1 hoeing and 1 hand weeding at 35 DAS and chlorimuron ethyl @ 10 g a.i. ha^{-1} at 15 DAS + 1 hoeing and 1 hand weeding at 35 DAS.

(Key words: Soybean, herbicides, growth parameters, yield)

INTRODUCTION

Soybean (*Glycine max* L.) has emerged as a potential crop and has brought about perceptible change in the economy of the farmers of Vidharbha. Being a rainy season crop it suffers severly with the weed infestation resulting in growth and yield losses upto 77 % depending on the weed species and their density and period of weed –crop competition (Tiwari and Kurchania,1990).

Presently a number of herbicides like alachlor, fluchlorin, pendemethalin, metribuzin etc. are commercially available for weed control in soybean, but they are applied either before sowing the crop or emergence of soybean seedlings. The sowing time of most of crops including soybean is short in rainy season and farmer gives priority to sowing of the crop rather than to herbicides application for control of weeds. Hoeing and hand weeding is traditional and effective method of weed control, but sometimes due to continous rain as well as unavailability of labour at peak time are main limitations of manual weedings and hoeing. The only alternative that needs to be explored is the use of post-emergence herbicides. Considering the above facts present investigation was under during *kharif* 2010.

MATERIALS AND METHODS

The study was conducted on clayey soil during 2010, having pH 7.7, EC 0.21 dsm^{-1} and organic carbon 0.56% and analyzing low in available N(291.10 kg ha^{-1}), low in available P(24.18 kg ha^{-1}) and high in available K(464.30 kg ha^{-1}).

The experiment was laid out in RBD with ten treatments and four replications. Soybean crop (JS-335) was sown on 24 th june 2010 at 45cm x 5 cm spacing and raised with recommended package of practices (except weed management). The treatment comprised of unweeded control (T_1), 2 hoeings + 2 hand weedings at 20 DAS and 35 DAS(T_2), fenoxaprop-P-ethyl @ 100 a.i.ha^{-1} at 15 DAS (T_3), chlorimuron ethyl @ 10 g a.i. ha^{-1} at 15 DAS (T_4), imazethapyr @ 75 g a.i. ha^{-1} 15 DAS (T_5),fenoxaprop-P-ethyl @ 100 a.i.ha^{-1} + chlorimuron ethyl @ 10 g a.i. ha^{-1} at 15 DAS(T_6), imazethapyr @ 75 g a.i. ha^{-1} + fenoxaprop-P-ethyl @ 100 a.i.ha^{-1} at 15 DAS(T_7), fenoxaprop-P-ethyl @ 100 a.i.ha^{-1} at 15 DAS + 1 hoeing and 1 hand weeding at 35 DAS(T_8), chlorimuron ethyl @ 10 g a.i. ha^{-1} at 15 DAS + 1 hoeing and 1 hand weeding at 35 DAS(T_9), and imazethapyr @ 75 g a.i. ha^{-1} at 15 DAS + 1 hoeing and 1 hand weeding at 35 DAS(T_{10}).

Herbicides were sprayed with knap-sack spray with flat- fan nozzle using 500 litres of water ha^{-1}. The species- wise total weed population was recorded by the least count quadrat(1m^2) method at 80 DAS and at harvest , whereas weed dry matter were recorded at 80 DAS and at harvest and weed

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control efficiency was also calculated accordingly. The plant growth parameters viz., plant height , number of leaves plant^{-1}, leaf area index, number of branches plant^{-1} and plant dry matter (g) were recorded treatment wise periodically at 80 DAS and at harvest. Grain yield and straw yield were recorded after harvest of crop.

RESULTS AND DISCUSSION

Effect on weed studies

The experimental field was infested with various weed species, consisting of both dicot and monocot weeds and sedges. The most common species are *Parthenium hysterophorus*, *Euphorbia hitra*, *Digera arvensis*, *lagasca mollis* among dicot weeds, *Cynodon dactylon, Echinochloa crusgalli, Ergots major, Poa annua, Sorghum halepense* among the grasses and *Cyperus rotundus* among sedges. Other weeds were present in less number. All weed control treatments reduced the total weed population m^2 and weed dry matter (g) significantly as compared to unweeded control(Table1).

Two hoeings and two hand weedings at 20 and 35 DAS (T_2) recorded the lower total weed population, weed dry matter and weed control efficiency which were found to be significantly superior over all other treatments except imazethapyr @ 75 g a.i. ha^{-1} at 15 DAS + 1 hoeing and 1 hand weeding at 35 DAS (T_{10}) and chlorimuron ethyl @ 10 g a.i. ha^{-1} at 15 DAS + 1 hoeing and 1 hand weeding at 35 DAS(T_9). However, these treatments were at par with 2 hoeings and 2 hand weedings at 20 and 35 DAS(T_2). This could be due to better control of weeds by hoeing + weedings, application of chemical herbicides and also suppression of weeds by crop due to its large canopy. Similar results were also reported by Kushwah and Vyas (2005) and Dhane *et al.* (2010). They stated that application of post emergence herbicides in combination with cultural weed control methods were more effective in reducing weed biomass and getting higher weed control efficiency in soybean.

Effect on crop growth and yield parameters

All the growth and yield parameters were significantly affected the various weed control treatments (Table2). The growth characters viz., plant height, number of leaves plant^{-1}, leaf area index, number of branches plant^{-1}, and dry matter plant^{-1} as well as yield contributing characters viz., number of pods plant^{-1}, grain weight plant^{-1}, were significantly higher in 2 hoeings + 2 hand weedings at 20 and at 35 DAS(T_2) followed by imazethapyr @ 75 g a.i. ha^{-1} at 15 DAS + 1 hoeing +1 hand weeding at 35 DAS (T_{10}) and chlorimuron ethyl @ 10g a.i. ha^{-1} at 15 DAS +1 hoeing + 1 hand weeding at 35 DAS (T_9) were at par with treatment 2 hoeings + 2 hand weedings at 20 and at 35 DAS (T_2). Similarly, 2 hoeings + 2 hand weedings at 20 and 35 DAS (T_2) produced significantly more grain yield and straw yield of 1456 kg ha^{-1} and 2737 kg ha^{-1} followed by imazethapyr @ 75g a.i. ha^{-1} at 15 DAS + 1 hoeing +1 hand weeding at 35 DAS (T_{10}) and chlorimuron ethyl @ 10g a.i. ha^{-1} at 15 DAS +1 hoeing + 1 hand weeding at 35 DAS (T_9) respectively. These treatments were at par with 2 hoeings + 2 hand weedings at 20 and 35 DAS (T_2). All the growth and yield contributing characters as well as grain and straw yield were recorded highest in these treatments might be due to least weed population, which reduce crop weed competition for soil moisture, plant nutrients, solar radiation and space during active growth period resulting nutrient availability helps in rapid cell development to facilitating luxurious crop growth in these treatments. However, beneficial effect of post emergence application of imazethapyr and chlorimuron ethyl in combination and mechanical method in increasing soybean yield might be due to suppression of monocot and dicot weeds that helped in reducing soil moisture and nutrient losses made available to the soybean crop. Dhane *et al.*(2009) reported that, integrated weed control method of application of persuit @ 100g a.i. + one hoeing at 30 DAS was found superior than other integrated weed control methods. Kamdi (2010) also reported that, weed management through 2 hoeings +2 hand weedings at 20 and 35 DAS was found most effective control method in soybean by improving growth and more seed yield respectively.

Table 1. Effect of weed control treatments on total weed population, weed dry matter and weed control efficiency in soybean

Treatments	Total weed population		Weed dry matter g / m^{-2}		Weed control efficiency (%)
	Days after sowing				
	80	At harvest	80	At harvest	At harvest
T_1 – Control (unweeded)	8.35 (69.25)	8.07 (64.75)	227	215	-
T_2 – 2 hoeings + 2 hand weedings at 20 and 35 DAS	3.74 (13.50)	3.57 (12.25)	14. 50	15.20	92.79
T_3 – Fenoxaprop- p -ethyl @ 100 g a.i. ha^{-1} at 15 DAS	4.94 (24.00)	4.82 (22.25)	65.12	74.33	65.42
T_4 – Chlorimuron ethyl @ 10 g a.i. ha^{-1} at 15 DAS	4.94 (24.00)	4.82 (22.85)	63.00	71.74	66.63
T_5 – Imazethapyr @ 75 g a.i.g ha^{-1} at 15 DAS	4. 71 (21.75)	4.71 (21.75)	62.12	70.13	67.38
T_6 – Fenoxaprop- p - ethyl @ 100 g a.i. ha^{-1} + Chlorimuron ethyl @ 10 g a.i. ha^{-1} at 15 DAS	4.58 (20.50)	4.47 (19.50)	58.13	63.00	70.69
T_7 – Imazethapyr @ 75 g a.i.g ha^{-1} + Fenoxaprop - p - ethyl @ 100 g a.i. ha^{-1} at 15 DAS	4.92 (23.75)	4.79 (22.50)	60.75	68.64	68.07
T_8 – Fenoxaprop- p -ethyl @ 100 g a.i. ha^{-1} at 15 DAS + 1 hoeing and weeding at 35 DAS	4.10 (16.25)	3.87 (14.50)	16.65	20.12	90.64
T_9 – Chlorimuron ethyl @ 10 g a.i. ha^{-1} at 15 DAS + 1 hoeing + 1 h and weeding at 35 DAS	3.90 (14.75)	3.64 (12.75)	15.64	18.50	91.39
T_{10} – Imazethapyr @ 7.5 g and ha^{-1} at 15 DAS + 1 hoeing + 1 hand weeding at 35 DAS	3.84 (14.25)	3.59 (12.44)	14.50	18.00	91.62
S E (m) ±	0.17	0.18	0.96	1.23	–
C D at 5%	0.50	0.52	2.89	3.60	–

Figures in parentheses are original values and outside are transformed x +0.5 values

Table 2. Effect of weed control treatments on growth parameters and yield of soybean

Treatments	Plant height (cm)	Number of leaves plant^{-1}	Leaf area index	Number of branches plant^{-1}	Dry matter plant^{-1} (g)	Seed yield kg ha^{-1}	Straw yield kg ha^{-1}
T_1 – Control (unweeded)	35.90	17.50	7.61	3.90	16.66	833	1541
T_2 - 2 hoeings + 2 hand weedings at 20 and 35 DAS	47.75	29.75	12.60	5.75	23.02	1456	2737
T_3 – Fenoxaprop-p- ethyl @ 100 g a.i. ha^{-1} at 15 DAS	37.20	21.25	9.75	4.12	17.52	974	1650
T_4 – Chlorimuron ethyl @ 10 g a.i. ha^{-1} at 15 DAS	37.44	23.00	9.11	4.25	17.97	1010	1878
T_5 – Imazethapyr @ 75 g a.i. ha^{-1} at 15 DAS	38.45	24.65	9.20	4.30	18.16	1018	1894
T_6 - Fenoxaprop-p- ethyl @ 100 g a.i. ha^{-1} + Chlorimuron ethyl @ 10 g a.i. ha^{-1} at 15 DAS	39.75	25.10	9.95	4.40	18.28	1124	2100
T_7 - Imazethapyr @ 75 a.i.g ha^{-1}+ Fenoxaprop-p- ethyl @ 100 g a.i. ha^{-1} at 15 DAS	39.00	24.00	9.48	4.30	18.20	1037	1940
T_8 - Fenoxaprop-p- ethyl @ 100 g a.i. ha^{-1} at 15 DAS + 1 hoeing + 1 hand weeding at 35 DAS	42.70	25.90	10.68	5.30	20.50	1258	2365
T_9 - Chlorimuron ethyl @ 10 g a.i. ha^{-1} at 15 DAS + 1 hoeing + 1 hand weeding at 35 DAS	45.65	27.56	11.98	5.44	21.90	1295	2435
T_{10} - Imazethapyr @ 75 g a.i.ha^{-1} at 15 DAS + 1 hoeing + 1 hand weeding at 35 DAS	46.25	28.50	12.25	5.55	22.08	1365	2580
SE (m) ±	0.80	0.55	0.39	0.11	0.44	66	67
CD at 5%	2.10	1.60	1.18	0.32	1.31	195	198

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EFFECT OF SILAGE FEEDING ON QUALITY AND QUANTITY OF MILK OF CROSSBRED COWS

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ABSTRACT

Experiment was conducted on six crossbred cows (Jersey x Sahiwal) maintained at Animal Husbandry and Dairying Section, College of Agriculture, Nagpur during the year 2009. These cows were assigned three different dietary levels of sorghum silage namely 0 kg, 7.5 kg (75 %) and 10 kg 100^{-1} kg body weight (100 %) along with recommended concentrate mixture and dry roughages adlibitum, to determine the dry matter intake (DM), production and composition of milk. The cows which received 100 % sorghum silage showed significantly ($P < 0.05$) higher (2.789 kg) DM intake 100^{-1} kg body weight as compared to cows fed with 75 (2.769 kg) and 0 % (2.710) silage level. Overall, an increased trend in DM intake was observed with increased level of sorghum silage in the ration of experimental cows. Daily milk yield increased (5.462 l day^{-1}) significantly ($P < 0.05$) in cows which received 100 % sorghum silage as compared to cows which received 75 (4.867 l day^{-1}) and 0 (4.472 l day^{-1}) per cent sorghum silage. Whereas, fat and TS content of milk decreased with the increased level of sorghum silage. Feeding of sorghum silage does not show any significant effect on the SNF content of milk.

(Key words: Sorghum silage, DMI, production and milk composition)

INTRODUCTION

During monsoon plenty of greens are available which can be conserved in the form of silage. Silage plays a large role in the ration of dairy cattles to improve its nutritive value and digestibility and has been tested and implemented for many decades (Shaban *et al*., 2010). Sorghum is important fodder crop for feeding ruminants in lean period in Vidharbha region of Maharashtra. It is nutritious as well as palatable to cattle and can be fed as green, dry or in silage form. Silage provides forage during fodder scarcity especially in summer when there is shortage of green. Feeding of silage to milch animals improves the milk production, but sufficient quantity of silage is not available for large herd of milch animals. Present paper is focused on the effect of different levels of feeding sorghum silage on the milk yield and its composition to meet the minimum requirement of milch animals in available silage

MATERIALS AND METHODS

Six lactating crossbred cows (Jersey x Sahiwal) in their mid lactation, maintained at Animal Husbandry and Dairying Section, College of Agriculture, Nagpur were selected for the present study, and randomly divided into three equal groups of 2 cows and fed three dietary treatments by switch over method, thus, having six replications. These dietary supplements are, T_1 : recommended concentrate mixture + no sorghum silage (0 %), T_2 : recommended concentrate mixture + 7.5 kg sorghum silage 100^{-1} body weight (75 %) and T_3 : recommended concentrate mixture + 10 kg sorghum silage (100 %) and dry roughages adlibitum for a period of 63 days with a gap of 7 days for nullifying the effect of previous feed once at the beginning of the experiment, and at 21 and 42 days thereafter, to enable the switch over in feeding. . The animals were fed individually as per the requirement (Ranjhan, 1998). The concentrate mixture available in the market and sorghum silage prepared in this section were used. The observations were recorded, for dry matter intake and daily milk yield after completion of a gap of 7 days from the day of changing food as per treatments. The per cent SNF and total solid were determined according to ′Gravimetric method′ described in SP: 18, Part – XI of BIS (Anonymous, 1981) and per cent milk fat was determined according to ′Gerber′s method′ described in BIS: 1224 (Anonymous, 1958). The observations were recorded daily and continued for 14 days after a gap of 7 days given for changing the diet. The average data were subjected to statistical analysis as per the procedure given by Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

Dry matter intake

The biology of the feed intake and utilization in ruminant revolves round the study of dry matter intake (DM) and its utilization. In the present study, the DM intake and its utilization by the experimental cows was evaluated.

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Table 1. Average DMI, daily milk yield and composition of milk influenced by sorghum silage on daily observations basis for 14 days on the diet as per treatments

Treatments	DM intake (kg 100^{-1} Kg BW)	Daily milk yield (l day^{-1})	Fat (%)	SNF (%)	TS (%)
T_1 (0 % sorghum silage)	2.710	4.472	3.932	8.518	12.45
T_2 (75 % sorghum silage)	2.769	4.867	3.87 2	8.518	12.39
T_3 (100 % sorghum silage)	2.789	5.462	3.827	8.520	12.35
SE (m) ±	0.12	0.21	0.16	0.002	0.22
CD at 5%	0.32	0.31	0.41	-	0.46

The average DM intake of crossbred cows 100^{-1} kg body weight were 2.710, 2.769 and 2.789 kg for the treatment 0, 75 and 100 per cent respectively. The analysis of variance for DM intake indicated significant differences in the cows under various treatments. However, the numerical value of average DM intake by the cows under 100 per cent silage feeding was higher as compared to DM intake of the cows under 75 and 0 per cent silage feeding. From the above results, it was revealed that with the increased level of sorghum silage feeding, the dry matter intake increased significantly.

Singh *et al.* (2009) noticed that when crossbred heifers fed with green maize at different levels increased the dry matter intake.

Daily milk yield

The average milk yield day^{-1} of crossbred cows were 4.472, 4.867 and 5.462 l for the treatment 0, 75 and 100 per cent respectively. Milk yield day^{-1} were increased by 22.14 and 8.83 per cent, respectively in cows which received 100 and 75 per cent sorghum silage as compared to cows which did not received sorghum silage (0 %). Per day milk yield of crossbred cows proportionately increased with the increase in level of feeding sorghum silage.

4 % fat corrected milk yield was greater for cows fed with pearl millet silage than those fed corn silage (Amer and Mustafa, 2010), whereas non significant effect of corn silage feeding on milk production was reported by Brandt *et al*. (1970).

Milk Composition

Fat content in milk of cows which received 0, 75 and 100 per cent sorghum silage were 3.932, 3.872 and 3.827 per cent respectively. The fat content of milk decreased proportionately with the increased level of feeding sorghum silage. Amer and Mustafa (2010), recorded 4.17 and 3.78 % fat content in cow milk, fed pearl millet and corn silage respectively.

SNF content of milk of crossbred cows which received 0 and 75 per cent sorghum silage were same i.e. 8.518 per cent while cows received 100 per cent sorghum silage showed 8.520 per cent SNF but feeding of sorghum silage did not show any significant effect on the SNF content of milk.

Total solids content of milk of crossbred cows were 12.45, 12.39 and 12.35 per cent respectively for the treatment 0, 75 and 100 per cent. It was further observed that the total solids content of milk of crossbred cows decreased proportionately with the increased level of feeding sorghum silage. The results of present investigation confirmed the findings of Brandt *et al*. (1970), they observed the milk constituents produced in the first lactation were inconsistent during silage feeding.

Hence, it is opined that feeding of 100 and 75 per cent sorghum silage along with dry fodder adlibitum and recommended concentrate mixture to the crossbred cows will help to increase dry matter intake and milk production.

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EFFECTIVITY OF FOLIAR SPRAYS OF VERMICOMPOST WASH ON CHEMICAL, BIOCHEMICAL, YIELD AND YIELD CONTRIBUTING PARAMETERS OF GROUNDNUT (*Arachis hypogeae* L.)

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ABSTRACT

A field experiment was carried out during *kharif* season of 2009-10 at experimental farm of Botany section, College of Agriculture, Nagpur on chemical, biochemical and yield and yield contributing parameters of groundnut (*Arachis hypogeae* L.). Ten treatments viz., control, 100, 150, 200, 250, 300, 350, 400, 450 and 500 ppm were tried during experimentation. Data revealed that foliar sprays of vermicompost wash (VCW) exhibited their superiority over control. Two foliar sprays of 400 ppm followed 350 ppm through vermicompost wash showed their superiority over control and all other remaining treatments under study and significantly increased leaf chlorophyll content, leaf NPK content and seed oil content. Yield and yield contributing characters like shelling (%), HPS bold recovery percentage, and yield ha^{-1} also increased significantly by the same treatments when compared with control and rest of the treatments under study.

(Keywords: Groundnut, yield, vermicompost wash, biochemical parameters)

INTRODUCTION

Oil seed crops have been the backbone of agricultural economy of India from the time immemoral. It is a second major agricultural crop next to the food grains in acreage, tonnage and value.

Groundnut (*Arachis hypogeae* L.) is one of the important oil seed crop. Being a legume with root nodules, it can synthesize atmospheric nitrogen and therefore, improves soil fertility. The oil content of the seed varies from 44 to 50 per cent depending on the varieties and agronomic conditions. Groundnut oil is edible oil, it finds extensive use as a cooking medium both as refined oil and vanaspati Ghee. Kernels are also eaten raw, roasted or sweetened. They are rich in protein and vitamins A, B and some members of B_2 group. Their calorific value is 349 100^{-1} grams. The residual oilcake contains 7 to 8 per cent N, 1.5 per cent P_2O_5 and 12 per cent K_2O and is used as a fertilizer. Therefore, it is necessary to enhance productivity of groundnut by supplying required nutrients from fertilizer and biofertilizer.

Area under crop in the world was 26.42 million ha with the production of 433.5 mt. and productivity was 15.5 mt. In India it is grown on area of 6.6 million ha with the production of 5.9 million tonnes and productivity was 0.97 mt. (Anonymous, 2009).

Vermicompost wash is useful as foliar spray. It contains N 0.29 %, P 0.042 %, K 0.143 %, Ca 0.186 %, Mg 0.11 %, S 0.058 %, Fe 0.466 ppm, Mn 0.406 ppm, Zn 0.11 ppm, Cu 0.18 ppm, (Anonymous, 2007). It is transparent pale yellow to brown biofertilizer. It is a mixture of excretory product and mucous secretion of earth worm (*Lampito mautriti* and *Esenia foetida*) and organic micronutrients of soil, which may be promoted as potent biofertilizer for better growth and yield (Shweta *et al.,* 2005). Vermicompost wash is having approximately 1300 ppm humic acid, 116 ppm dissolved oxygen, 50 ppm inorganic phosphate, 168 ppm potassium and 121 ppm sodium (Haripriya and Pookodi, 2005). Considering the above facts the present investigation was undertaken to enhanced chemical and biochemical parameters and yield and yeld contributing parameters of groundnut.

MATERIALS AND METHODS

Present study entitled " Effectivity of foliar sprays of vermicompost wash on chemical, biochemical and yield and yield contributing parameters of groundnut (*Arachis hypogeae* L.)", was undertaken in experimental farm of Botany Section, College of Agriculture, Nagpur during 2009-10. Experiment was laid out in randomized block design. There were ten treatments replicated thrice.

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These treatments included different concentrations of vermicompost wash like T_1 (control), T_2 (100 ppm), T_3 (150 ppm), T_4 (200 ppm), T_5 (250 ppm), T_6 (300 ppm), T_7 (350 ppm), T_8 (400 ppm), T_9 (450 ppm), T_{10} (500 ppm). Foliar sprays of humic acid through vermicompost wash was given at 20 and 35 DAS respectively. Chemical and biochemical parameters like leaf chlorophyll content (mg g^{-1}), leaf N (%), P (%), K (%) content were recorded at 35, 50, and 65 DAS. Oil content in seed (%) was also estimated. Leaf chlorophyll content was estimated as per method suggested by Bruinsma (1982). Leaf N content was estimated by microkjeldhal′s method as suggested by Somichi (1972). Leaf P and leaf K was estimated by flame photometer as per method suggested by Jackson (1967). Oil content in seed was estimated by Soxlet apparatus as suggested by Sankaram (1965). Yield and yield contributing parameters like shelling (%), HPS bold kernel recovery and yield ha^{-1} were recorded after harvesting.

RESULTS AND DISSCUTION

Chemical and biochemical observations :

The chemical and biochemical studies with respect to chlorophyll and N, P, K content in leaves as well as oil contents in seeds estimated at various stages of observations have been presented here under.

Total chlorophyll content :

Leaves constitute most important aerial organ of the plants, playing a major role in the anabolic activities by means of the so called "Green Pigments" or "Chlorophyll" which they losses in abundance. This pigment is the sole medium of the photosynthetic process which in turn is the major synthetic pathway operative in plants. The data related to chlorophyll content in leaves of groundnut were recorded at 35, 50 and 65 DAS and are presented in table 1.

It is obvious from the data that chlorophyll content in leaves was maximum at 35 DAS but thereafter gradually decreased at 50 and 65 DAS. Nitrogen is a constituent element in chlorophyll which rapidly increases at vegetative stage as the nitrogen reserves are in ample quantity at this stage. However, rate of nitrogen mobilization is more to the reproductive part during pod formation and pod development than the rate of N uptake. Hence, increase in chlorophyll during 35 DAS might be due to increased uptake of N, P, K and other nutrients in early stage of plant growth.

The foliar application of 400 ppm VCW gave significantly more chlorophyll content at 35 DAS when compared with control and rest of the treatments. Remaining treatments viz., 350, 450, 500, 300, 250, 200, 150 and 100 ppm VCW in a descending manner were also found significantly superior over control at this stage of observation. At 50 DAS leaf chlorophyll content was significantly increased in treatment 400 ppm VCW followed by 350, 450, 500, 300, 250 and 200 ppm VCW in a descending manner when compared with control. Similarly, treatments 150 ppm and 100 ppm VCW also exhibited their significance over control at this stage. Leaf chlorophyll content at 65 DAS was significantly maximum in treatment 400 ppm VCW followed by 350 VCW when compared with control and other remaining treatments. Treatments 450 VCW also gave significantly more leaf chlorophyll content over control and rest of the treatments under study. Treatments 500, 300, 250, 200 ppm VCW were found at par with each other and also significantly enhanced leaf chlorophyll content in leaves over control and rest of the treatments under study. Treatments 150 ppm and 100 ppm VCW were also found significantly superior over control. The range of leaf chlorophyll content was 2.13, 2.15, 2.02 mg g^{-1} in control to 2.91,3.01,2.77 mg g^{-1} in treatment receiving 400 ppm VCW at 35, 50 and 65 DAS respectively.

Hu and Wang (2001) also reported that Komix humic acid containing organic fertilizer significantly increased chlorophyll content of spring soybean.

Nitrogen content in leaves :

Nitrogen is an important constituent of protein and protoplasm and essential for the growth of plant. An abundant supply of essential nitrogenous compound is required in each plant cell for normal cell division, growth and respiration. A high concentration of nitrogen is found in young tender plant tissue like buds tips of shoots and new leaves.

Data regarding nitrogen in leaves of groundnut was recorded at 35, 50 and 65 DAS and are presented in table 1.

Significant variation in leaf nitrogen content was observed at all the stages of observations. At 35 DAS leaf nitrogen was significantly increased by the foliar application of 400 ppm VCW followed by 350, 450, 500 and 300 ppm VCW in a descending manner when compared with control and rest of the treatments. Treatments 250, 200 and 150 ppm VCW also showed their significance over control, treatment 100 ppm was found at par with control in respect of nitrogen content in leaves at 50 DAS.

The trend of nitrogen content at 65 DAS was somewhat different. At this stage significantly maximum leaf nitrogen content was noticed in 400 ppm VCW concentration followed by 350, 450 and 500 ppm VCW. Remaining treatments i.e. 300, 250 , 200, 150 and 100 ppm in a descending manner also significantly increased leaf nitrogen content when compared with control.

The range of leaf nitrogen content was 3.66, 5.08 and 2.96 per cent in control and 4.22, 5.95 and 5.20 per cent in foliar application of 400 ppm VCW at 35, 50 and 65 DAS.

Data also revealed that leaf N content was increased from 35-50 DAS. Thereafter, it decreased at 65 DAS. At the vegetative period physiological and metabolic activity are at higher stage and this might be due to the fact that developing organs such as seeds do act as strong sink demand and may draw heavily the nitrogen from the leaves (Gardner *et al*., 1988).

Result recorded by Poonkodi (2003) also stated that decrease in nitrogen content might be due to translocation and utilization of nutrients for flower and pod formation.

The above finding supports the observation of Tan and Nopamornbodi (1978). They reported that application of humic acid resulted in a significantly increase in nitrogen content of corn shoots.

Nandkumar *et al*. (2004) also reported that foliar application of humic acid in combination with N, P, K increased soil nutrients (N, P, K, Fe, Mn, Zn, Cu) availability at all growth stages (tillering, flowering, harvesting) stages of Rice. Venkatramana *et al*. (2010) tried different concentrations (100,150,200 ppm) of vermiwash and cowdungwash at 25 and 35 days after pruning of mulberry and found increase in leaf nitrogen content in mulberry leaves. 200 ppm concentration was found most effective.

Leaf phosphorus :

Data pertaining phosphorus content in leaves estimated at 35, 50 and 65 DAS are presented in table 1.

Phosphorus is an important constituent of protoplasm and nucleic acid and nucleoproteins, also it is essential for the formation of grain development. Phosphorus content in leaves was increased gradually as growth enhanced up to 35-50 DAS and it decreased at 65 DAS. Data showed significance at all the stages of observations. All treatments were found significantly superior over control at 35 and 65 DAS but at 50 DAS treatments 100 ppm and 150 ppm VCW were found at par with control. The maximum P content was recorded in treatment 400 ppm VCW. Next to this treatment, the treatments were 350, 400, 450, 500, 250, 200, 150 and 100 and control in a descending manner at 35, 50 and 65 DAS.

These results are in agreements with Maheswari *et al*. (2003). They reported that foliar application of vermicompost wash at 1:5 dilution with complete dose of RDF resulted in higher P uptake in onion crop.

Asik *et al*. (2009) also observed that foliar application of 0.1 and 0.2% liquid HA increased the uptake of phosphorus in wheat crop.

Leaf potassium content in leaves :

It is apparent from the data presented in table 1 and that the K content in leaves was increased gradually from 35-50 DAS. Thereafter, slight decrease in K content was noticed at 65 DAS.

Data on potassium content in leaves of groundnut found statistically significant at 35, 50 and 65 DAS.

Treatment 400 ppm showed their significance and stood first in rank when compared with other treatments and control at 35 DAS. Next to this treatment the treatments were 350, 450,500, 300, 250, 100 ppm in a descending manner and these treatments were also found significantly superior over control. At 50 DAS 400 ppm VCW as a foliar spray was found significantly superior over control

and remaining treatments under study. Treatments 350, 450, 500, 300, 250, 200, 100 ppm VCW were also found significantly superior over control and other remaining treatments in a descending manner. Treatments 150 and 100 ppm could not able to produce more leaf potassium content and were found at par with control. At 65 DAS significantly maximum K content in leaves was exhibited by 400 ppm concentration followed by 350, 450 and 500 ppm respectively when compared with control and other treatments. Treatments 300, 250 and 200 ppm also showed their significance over control and remaining treatments with respect to leaf potassium content, but treatments 150 and 100 ppm VCW were found at par with control.

From the given data, it is observed that K content was increased up to 50 DAS and thereafter, get decreased at 65 DAS in younger stage. Plant may be able to uptake nutrients more readily than older one. Potassium in leaf tissue was found higher at 35 and 50 DAS mainly due to application of nutrients through VCW and it might also be because of relatively higher physiological activity, as the plant tissue were younger during this stage. At 65 DAS K content in leaves decreased which might be because of translocation of leaf K and it's utilization for development of food storage organ.

Similar finding with respect to this parameter was also reported by Asik *et al*. (2009). They stated that foliar application of 0.1 to 0.2 per cent liquid humic acids increased the uptake of K in wheat crop.

Oil content in seed :

Groundnut is mainly known as oilseed crop. Oil per cent in seed is one of the important aspects in quality of seed. The data regarding oil content in seed are given in table 1.

The data related to oil content were recorded after harvesting of the groundnut crop. The oil was found maximum in treatment receiving 400 ppm VCW. The range of oil content was 45.05 in control to 48.80 per cent in 400 ppm VCW. Next to this treatment the treatments were 350, 450, 500, 300, 250, 200, 150 and 100 ppm VCW in a descending manner in oil content. All these treatments in a descending manner were found significantly superior over each other except 450 and 500 ppm and 300 and 250 ppm VCW.

From above data, it is observed that oil per cent was significantly increased in all treatments receiving foliar sprays of VCW. It is because VCW is having sulphur and the sulphur (S) requirement of oil seed crop is quite high as compared to other crop (Das and Das, 1994).

Oil seed crops response to liberal application of sulphur. Sulphur is involved in the synthesis of fatty acid and also increased protein quality. Sulphur also increases oil and protein content of grains (Tandon, 1990).

Yield contributing parameters :

Shelling % (percentage) :

Shelling percentage was significantly highest in treatment receiving 400 ppm VCW (75.33) and lowest in control followed by 100 ppm. Rest of the treatments i.e. 350, 450, 500, 300, 200 and 150 in a descending manner also showed their significance in shelling percentage over control and 100 ppm VCW treatment.

Yield contributing parameters mainly include number of pods plant^{-1} weight of 100 kernels in groundnut. From the data it is evident that all these two yield contributing parameters significantly increased in the treatments receiving two foliar sprays of VCW at 20 and 35 DAS over control. The uptake of N, P, K during reproductive stages greatly influenced the pod formation and quality aspects of seed. Photosynthetic rate at grain filling are also increased. Cheng *et al*. (1995) reported that spraying of humic acid increased thousand grain weight and retarded senescence in wheat.

Boote *et al*. (1978) also stated that foliar application of N, P, K maintain leaf nutrition in photosynthesis, enhances N, P, K content and carbon balance and delays abscission, ultimately reacted in increasing yield and yield contributing attributes.

HPS bold kernel recovery % :

HPS bold kernel recovery percentage was ranged from 85.33% in control to 95.33% in 400 ppm VCW treatment. HPS recovery percentage was significantly maximum in treatment receiving 400 ppm VCW. Similarly 300, 450, 500, 200, 250, 150 and 100 ppm VCW in a descending manner also increased HPS bold recovery percentage significantly when compared with control.

Table 1. Effect of vermicompost wash on chemical and biochemical parameters of groundnut

Treatments	Leaf nitrogen content (%)			Leaf phoshorus content (%)			Leaf potassium content (%)			Leaf chlorophyll content (mg g^{-1})			Seed oil content (%)
	35	**50**	**65**	**35**	**50**	**65**	**35**	**50**	**65**	**35**	**50**	**65**	
T_1 (Control)	3.66	5.08	2.96	0.217	0.235	0.227	1.22	1.40	1.24	2.13	2.15	2.02	45.05
T_2 (100 ppm)	3.75	5.20	3.29	0.222	0.236	0.230	1.34	1.44	1.27	2.49	2.51	2.05	45.15
T_3 (150 ppm)	3.90	5.30	3.73	0.228	0.239	0.235	1.37	1.49	1.29	2.54	2.55	2.07	45.40
T_4 (200 ppm)	4.06	5.49	4.15	0.230	0.245	0.243	1.41	1.53	1.30	2.55	2.58	2.13	45.70
T_5 (250 ppm)	4.20	5.60	4.13	0.233	0.250	0.247	1.46	1.55	1.34	2.59	2.62	2.22	45.90
T_6 (300 ppm)	4.35	5.71	4.66	0.246	0.255	0.250	1.49	1.57	1.39	2.60	2.65	2.26	46.10
T_7 (350 ppm)	4.00	5.80	4.30	0.264	0.287	0.271	1.58	1.67	1.45	2.67	2.73	2.38	46.20
T_8 (400 ppm)	4.22	5.95	5.20	0.278	0.298	0.285	1.65	1.74	1.49	2.91	3.01	2.77	46.80
T_9 (450 ppm)	4.54	5.37	4.50	0.257	0.275	0.263	1.55	1.62	1.44	2.77	2.84	2.67	46.65
T_{10}(500 ppm)	4.68	5.28	4.10	0.252	0.261	0.250	1.53	1.59	1.42	2.68	2.77	2.55	46.35
SE (m) ±	0.139	0.094	0.159	0.0009	0.0007	0.0005	0.008	0.008	0.008	0.0007	0.0007	0.0006	0.033
CD at 5%	0.407	0.275	0.465	0.0028	0.0022	0.0015	0.026	0.025	0.024	0.0020	0.0021.	0.0017	0.096

Table 2 . Effect of vermicompost wash on HPS bold kernel recovery (%), Shelling (%), pod yield ha^{-1} (q)

Treatments	HPS bold kernel recovery %	Shelling (%)	ha^{-1} (q)
T_1 (Control)	85.33	70.62	22.59
T_2 (100 ppm)	90.00	70.70	22.34
T_3 (150 ppm)	96.66	71.86	24.74
T_4 (200 ppm)	91.33	71.98	25.83
T_5 (250 ppm)	92.00	72.17	25.94
T_6 (300 ppm)	92.66	72.27	25.12
T_7 (350 ppm)	95.00	74.29	26.54
T_8 (400 ppm)	95.33	75.33	27.81
T_9 (450 ppm)	94.00	72.78	26.70
T_{10} (500 ppm)	93.33	72.79	26.27
SE (m) ±	0.8946	0.615	0.016669
CD at 5%	2.606	1.793	0.04856

Pod yield ha^{-1} :

Pod yield is combination of yield attributing parameters and physiological efficiency of plant during present investigation.

Sources sink relation is key of the seed yield. The phloem loading at source (leaf) and unloading at sink (seed and fruit) by which the economic part will be getting the assimilates synthesized by photosynthesis. Partitioning of the assimilates in the plant during reproductive development is important for flower, fruit and seed crops. Thus, crop yield can be increased either by increasing the total dry matter production or by increasing the proportion of economic yield (HI) or both (Gardner *et al*., 1988).

The data regarding pod yield ha^{-1} presented in table 2. All the treatments receiving VCW significantly increased pod yield ha^{-1} when compared with control. Every treatment was found significantly superior over each other and over control also. Next to 400 ppm VCW treatment, treatments were 350, 450, 500, 300, 250, 200, 150 and 100 ppm VCW in a descending manner. These treatments significantly increased leaf nitrogen, phosphorus and potassium content and ultimately resulted in increase in seed yield. These might be the reasons for spectacular increase in overall pod yield of groundnut in the present investigation.

From the overall results it can be stated that foliar nutrition through humic source such as VCW with different concentrations improved chemical and biochemical and yield and yield contributing characters significantly.

The highest per cent increase in yield over control was observed in treatment sprayed with 400 ppm VCW i.e. 23.10 per cent. Next to this treatment foliar spray of 350 ppm also enhanced yield by 18.19% over control.

The above findings can be supported by research work of different scientists. Kaya *et al*. (2005) reported that foliar application of zinc and humic acid alone or in combination increased the grain yield of bread wheat. Hu and Wang (2001) reported that komix humic acid containing organic fertilizer significantly increased seed yield plant^{-1} of spring soybean. Ali and Elbordiny (2009) investigated the effect of potassium humate on yield of wheat (*Triticum aestivum*). They reported that foliar application of 50 and 100 ppm potassium humate significantly increased grain and straw yield of wheat when compared to control.

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EFFICACY OF OXADIARGYL ON WEED CONTROL AND YIELD OF AROMATIC RICE

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ABSTRACT

A field experiment was laid out in Randomized Block Design at the Agronomy farm, College of Agriculture, Nagpur during *kharif* season of 2009-2010 with three replications and nine treatments including unweeded check, weed free check, cultural as well as their combinations.

Integrated method of weed control such as oxadiargyl herbicide in combination with hoeing and weeding controlled most of perennial weeds and recorded the highest weed control efficiency and the lowest weed index value than its alone application. Among herbicidal treatment lowest dry matter of weeds was recorded under application of oxadiargyl @ 75 g ha^{-1} at 3-4 days after transplanting + one hoeing and one weeding.

Weed free check was significantly superior over all treatments. Application of oxadiargyl @ 75 g ha^{-1} at 3-4 days after transplanting showed positive effect on plant height and dry matter of plants. The values for various characters such as plant height, number of tillers, dry matter of plants, the number of effective tillers plant^{-1} and grain yield were recorded maximum in application of oxadiargyl @ 75 g ha^{-1} at 3-4 days after transplanting + one hoeing and one weeding at 40 DAT followed by the treatment two hoeings and two weedings. Highest B:C ratio (2.89) was also recorded by the same treatment. The highest net return was recorded in weed free check followed by oxadiargyl @ 75 g ha^{-1} at 3-4 days after transplanting + one hoeing and one weeding at 40 DAT and two hoeings and two weedings at 20 and 40 DAT.

(Key words : Aromatic rice, oxadiargyl, weed control)

INTRODUCTION

Among the cereals, rice (*Oryza sativa* Linn.) is the major source of calories for 40% of the world population. Aromatic rice constitutes a small but an important sub group of rice. These rated the best in quality and highly priced for their aroma, cooking and palatability.

Weed infestation is one of the limiting factors in rice production. Uncertain rainfall, no protective irrigation, attack of pests and diseases reduce the rice yield. Weed control has always been one of the major input of rice production. The farmers have to be more careful in weed control to exploit high yield potential of any variety. Now a days the chemical control method becoming popular among the farmers. Adeoson *et al.* (2009) reported that herbicide gave satisfactory performance in terms of weed control, crop response and yield of paddy than the farmers practice and was better than manual weeding. Manual weeding becomes difficult because of possible damage to rice plants, problem in differentiating grassy weeds, labour scarcity, time consumed and relatively less effectiveness.

The use of herbicide is potentially one of the most labour saving innovation and sustainable in terms of enhanced productivity in modern rice cultivation. But use of same group of herbicides over a period of time on a same piece of land leads to imbalance in terms of weeds shift and environmental pollution. The use of newer herbicide is essential in controlling weed population. The new and promising herbicide like oxadiargyl for early pre-emergence application has been developed which keep the land free during critical period of crop growth.

Therefore, the present investigation was undertaken to evaluate the use of herbicide cum cultural method with objectives to assess the efficacy of oxadiargyl on weed control and its effect on growth and yield of aromatic rice and to study economical method of weed control in aromatic rice.

MATERIALS AND METHODS

The experiment was laid out in Randomized Block Design at the Agronomy farm, College of Agriculture, Nagpur during *kharif* season of 2009-2010 with three replications and nine treatments including unweeded check, weed free check, cultural as well as their combinaions as given below.

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T_1 Check (unweeded)
T_2 Weed free check (as per need)
T_3 Two hoeings and two weedings at 20 and 40 DAT
T_4 Oxadiargyl @60 g ha^{-1} at 3-4 DAT
T_5 Oxadiargyl @ 75 g ha^{-1} at 3-4 DAT
T6 Oxadiargyl @ 90 g ha^{-1} at 3-4 DAT
T7 Oxadiargyl @ 60 g ha^{-1} + 1H+1W at 40 DAT
T8 Oxadiargyl @ 75 g ha^{-1} + 1H+1W at 40 DAT
T9 Oxadiargyl @ 90 g ha^{-1} + 1H+1W at 40 DAT

(H-Hoeing, W-weeding, DAT- Days after transplanting)

The scented variety PKV-Khamang recommended in Vidarbha was raised on nursery seedbed on 24th June 2009 and transplanting was done on 24th July 2009 with spacing of 20 cm x 15 cm. The recommended dose of fertilizer applied was 100:50:50 kg NPK ha^{-1}. The crop was harvested on 20th November 2009.

The experimental site was fairly uniform and levelled. The soil was clayey in texture with slightly alkaline in nature (pH 7.8). It was moderately low in available nitrogen (230.71 kg N ha^{-1}), moderate in available phosphorus (280.53 kg P_2O_5 ha^{-1}) content and high in available potassium (280.53 kg K_2O ha^{-1}). Rains are mostly received from south west monsoon during June to October with mean annual precipitation of 962 mm, which was generally received in 51 rainy days. Winter rains are uncertain. The total rainfall received during crop season i.e. June to November was 996.4 mm. The annual mean minimum temperature varied from 12.2^0 to 29.2^0C while the mean maximum temperature ranged from 27.3^0 to 44.6^0C.

The observations on various weed parameters like weed count m^{-2} (monocot, dicot and total) at harvest, dry matter of weed (kg ha^{-1}), weed biomass (kg ha^{-1}), weed index (%), weed control efficiency at harvest and NPK uptake by weed at harvest were recorded. The weed count, weed biomass and weed dry matter were recorded on one square meter area. The grain and straw samples were analyzed for nitrogen, phosphorus and potassium from five plants which were used for biometeric observations. Total nitrogen content in plant and seed samples were estimated by Kjeldhals′ method as described by Piper (1966). Total phosphorus was estimated in the diacid extract by vandomolybdate phosphoric acid method as described by Jackson (1967). Total potassium was determined by flame photometer method (Jackson,1967). The content of N,P,K and grain and straw yield were used to estimate the uptake of rice crop. Same procedure was adopted for uptake estimation from the weed where the content in weed and their respective dry matter estimated on hectare basis was used.

The observations on growth parameters of crop viz., height at harvest, number of total and effective tillers at harvest, dry matter accumulation at harvest, yield contributing characters viz., number of panicles $hill^{-1}$, number of grains $panicles^{-1}$, test weight and grain yield $plant^{-1}$ and yield, along with economics of the treatments were recorded. The height was recorded on five plants and for dry matter two plants were uprooted, dried in air and latter in oven, while all the growth contributing attributes were recorded at harvest on five observational plants.

RESULTS AND DISCUSSION

Effect on weed grwoth :

Data pertaining to weed study at harvest as influenced by different treatments are presented in table 1.

Effect on weed population m^{-2} :

All the herbicidal treatments recorded less weed population at harvest but could not exceed over weed free check. Two hoeings and two weedings at 20 and 40 DAT recorded the least weed population of monocot, dicot and total population among the weeding treatments and was at par with treatment oxadiargyl @ 60 g ha^{-1} + one hoeing and one weeding at 40 DAT, oxadiargyl @ 75 g ha^{-1} + one hoeing and one weeding at 40 DAT and oxadiargyl @ 90 g ha^{-1} at 3-4 DAT + one hoeing and one weeding at 40 DAT and found significantly superior over treatments Oxadiargyl @ 60 g ha^{-1} at 3-4 DAT, oxadiargyl @ 75 g ha^{-1} at 3-4 DAT and Oxadiargyl @ 90 g ha^{-1} at 3-4 DAT. These results are in agreement with those reported by Subramanyam *et al*. (2007) who also reported significantly lower weed density due to preemergence application of oxadiargyl at 75 g ha^{-1} + H.W. at 40 DAT.

The weed population in the experimental site was significantly reduced due to combination of cultural and herbicidal treatment. Weed free check recorded lower weed density while pre emergence application of oxadiargyl at 75 g ha^{-1} + one hoeing and one weeding at 40 DAT and was significantly superior among rest of treatments but at par with two hoeings and two weedings. Ramana *et al.* (2007) also reported that, the integrated use of oxadiargyl @ 80 g ha^{-1} as per-emergence spray followed by star weeding at 40 DAS or oxadiargly alone were effective in checking weed population and their growth.

Effect on weed biomass and weed dry matter :

Unweeded check recorded the highest weed biomass and weed dry matter and was inferior to all the treatments. Treatment weed free check recorded the lowest weed dry matter. Application of oxadiargyl @ 75 g ha^{-1} + one hoeing and one weeding at 40 DAT was found significantly superior over rest of treatments and was at par with treatments two hoeings and two weedings at 20 and 40 DAT and oxadiargly @ 90 g ha^{-1} + one hoeing and one weeding at 40 DAT in case of weed dry matter.

It is evident from the analysis of data that all the weed control measures brought significant reduction in weed biomass and weed dry matter as compared to unweeded check. Reduction was due to reduced weed population. The highest reduction in weed biomass and weed dry matter was found in weed free check followed by application of oxadiargyl at 75 g ha^{-1} + one hoeing and one weeding at 40 DAT and with two hoeings and weedings at 20 and 40 DAT. These results are in conformity with those of Subramanyam *et al.* (2007) who also found significantly lower weed dry weight in paddy with pre-emergence application of oxadiargyl at 75 g ha^{-1} + H.W. at 40 DAT.

Effect on weed control efficiency and weed index:

The data on weed control efficiency revealed that all the treatments gave positive values. The highest weed control efficiency and the lowest weed index were recorded with weed free check. WCE was higher and weed index was lower by application of oxadiargyl @ 75 g ha^{-1} + one hoeings and one weedings at 40 DAT followed by two hoeing and two weeding at 20 and 40 DAT.

Effect on nutrient uptake by weeds :

Unweeded check registered the highest uptake of nitrogen, phosphorous and potassium as maximum number of weeds were recorded in it. Weed free check was superior over all the treatments in minimizing NPK uptake. Application of oxadiargyl @ 75 g ha^{-1} + one hoeing and one weeding at 40 DAT was significantly superior over rest of treatments as there was less uptake of nutrients by the weed and cultural method two hoeing and two weeding at 20 and 40 DAT were at par in respect of N and K uptake.

Effect on aromatic rice crop :

The data pertaining to growth and yield of rice along with economy are presented in the table 2 and uptake study in table 1.

Effect on height of plant :

Treatment unweeded check recorded less plant height and hence found inferior. Treatment weed free check was significantly superior over all the treatments. Application of oxadiargyl @ 75 g ha^{-1} + one hoeing and one weeding at 40 DAT was found significantly superior over rest of the treatments and was at par with treatments two hoeings and two weedings at 20 and 40 DAT.

The increase in plant height under weed free check, application of oxadiargyl @ 75 g ha^{-1} + hoeing and weeding at 40 DAT, two hoeings and two weedings at 20 and 40 DAT might be due to good aeration of soil and least weed population observed in these treatments, which reduced crop weed competition for soil moisture, plant nutrients, solar radiation and space during active growth period.

Effect on total and effective number of tillers $hill^{-1}$:

At harvest the treatment weed free check was significantly superior over all the treatments. Application of oxadiargyl @ 75 g ha^{-1} + one hoeing and one weeding at 40 DAT was significantly superior over rest of treatments and was statistically similar with two hoeings and two weedings at 20 and 40 DAT and oxadiargyl @ 90 g ha^{-1} + one hoeing and one weeding at 40 DAT. Treatment unweeded check recorded minimum number of tillers.

Number of tillers significantly increased by all the given treatments except unweeded check which might be due to more weed population leading to adverse effect on production of tillers. Weed free check produced comparatively more number of tillers over treatment application having oxadiargyl @ 75 g ha^{-1} + hoeing and weeding at 40 DAT and that of two hoeings and two weedings at 20 and 40 DAT. These results are in agreement with those reported by Subramanyam *et al*. (2007) and Ramana *et al*. (2007) who also recorded significantly more number of tillers with weed free check compared to weedy check in rice.

Effect on mean total dry matter accumulation $hill^{-1}$:

Unweeded check recorded less dry matter accumulation and was found significantly more superior over all the treatments. Oxadiargyl @ 75 g ha^{-1} + one hoeing and one weeding at 40 DAT was significantly superior over rest of the treatments and was at par with the treatment two hoeings and two weedings at 20 and 40 DAT and oxadiargyl @ 90 g ha^{-1} + one hoeing and one weeding at 40 DAT.

The increase in dry matter accumulation might be due to less weed competition and good aeration of soil, thereby facilitating luxurious crop growth resulting into more dry matter accumulation $hill^{-1}$ as compared to control treatment. These results are supported by Subramanyam *et al.* (2007) and Ramana *et al*. (2007) who also recorded the lowest dry weight of weeds with weed free check and the highest weed dry weight with weedy check in rice.

Effect on number of panicles $hill^{-1}$:

Weed free check recorded significantly maximum number of panicles $hill^{-1}$ and was superior over all the treatments. Among cultural and herbicidal treatment oxadiargyl @ 75 g ha^{-1} + one hoeing and one weeding at 40 DAT was significantly superior over rest of the treatments but proved to be at par with treatment two hoeings and two weedings at 20 and 40 DAT.

Effect on number of grains $panicle^{-1}$:

Treatment unweeded check recorded less number of grains $panicle^{-1}$ and was less significantly inferior among all the treatments. Treatment weed free check recorded maximum number of grains $panicle^{-1}$ and was significantly superior over all the treatments. Application of oxadiargyl @ 75 g ha^{-1} + one hoeing and one weeding at 40 DAT was significantly superior over rest of the cultural and herbicidal treatments and was at par with two hoeings and two weeding at 20 and 40 DAT.

Effect on test weight :

Data revealed that the various treatments did not influence the 1000 grain weight significantly.

Effect on grain yield (q ha^{-1}) :

Data revealed that weed free check recorded the highest grain yield (44.97 q ha^{-1}) and was superior over all the treatments. Treatment oxadiargyly @ 75 g ha^{-1} + one hoeing and one weeding at 40 DAT was significantly superior over rest of the treatments and was found at par with the treatment two hoeings and two weedings at 20 and 40 DAT and oxadiargyl @ 90 g ha^{-1} + one hoeing and one weeding at 40 DAT. Treatment unweeded check recorded the lowest grain yield (22.23 q ha^{-1}). Puniya *et al.* (2007) also reported significantly maximum rice grain yield by weed free check followed by two hand weedings over non weeded check i.e. control.

Effect on straw yield (q ha^{-1}) :

The treatment weed free check was significantly superior over rest of the treatments and was at par with treatment having oxadiargyl @75 ha^{-1} + one hoeing and one weeding at 40 DAT and two hoeings and two weedings at 20 and 40 DAT. Unweeded check recorded the lowest straw yield (37.67 q ha^{-1}). Increase in straw yield of paddy might be due to luxurious growth and less crop weed competition in the above treatments.

Effect on harvest index :

Effect on harvest index was found to be non-significant. However, weed free check recorded maximum harvest index (43.15%). The weed free check resulted in producing significantly higher grain yield than rest of the treatments but herbicidal application of oxadiargyl @ 75 g ha^{-1} + hoeing and weeding 40 DAT and two hoeings and two weedings at 20 to 40 DAT were effective in reducing weed population which reduces competition for nutrients, space and water among the crop which resulted in increase in plant height, dry matter accumulation and ultimately grain yield of paddy.

Table 1. Weed and uptake study as influenced by different treatments

	Treatments	*Monocot weed population at harvest m^{-2}	*Dicot weed population at harvest m^{-2}	*Total weed population m^{-2} at harvest	Mean weed dry matter (kg ha^{-1})	Mean weed biomass (kg ha^{-1})	Weed control efficiency %	Weed Index %	Uptake by weeds (kg ha-1)			Uptake by rice crop (kg ha-1)		
T_1	Check (unweeded)	5.76 (32.67)	5.75 (32.53)	8.11 (65.20)	260.87	496.5	-	49.90	8.63	0.63	5.73	49.67	6.80	49.47
T_2	Weed free check	0.71 (0)	1.22 (1.00)	1.22 (1.00)	0.14	0.23	99.68	-	1.50	0.11	1.10	88.87	13.40	81.70
T_3	2H+2W at 20 and 40 DAT	3.43 (11.65)	2.85 (7.68)	4.49 (19.63)	78.93	150.67	69.74	6.49	2.73	0.28	2.37	83.00	12.20	75.73
T_4	Oxadiargyl @ 60 g ha^{-1} at 3-4 DAT	5.15 (26.33)	4.55 (20.25)	6.86 (46.57)	168.47	326.33	35.41	32.51	6.82	0.53	5.23	53.50	7.57	50.03
T_5	Oxadiargyl @ 75 g ha^{-1} at 3-4 DAT	4.83 (22.94)	3.94 (15.05)	6.20 (37.96)	108.33	205.73	58.47	16.52	5.73	0.39	3.70	64.73	8.35	58.20
T_6	Oxadiargyl @ 90 g ha^{-1} at 3-4 DAT	4.92 (23.77)	4.19 (17.06)	6.43 (40.83)	146.00	279.5	44.03	24.72	6.27	0.50	4.57	53.93	7.73	53.33
T_7	T4+1H+1W at 40 DAT	4.36 (18.67)	3.84 (14.24)	5.77 (32.91)	101.67	199.07	61.10	23.77	6.13	0.46	4.67	57.70	8.30	54.07
T_8	T5+1H+1W at 40 DAT	3.49 (11.75)	2.96 (8.31)	4.53 (20.07)	78.67	150.20	69.84	6.22	2.42	0.21	2.26	83.50	12.73	79.33
T_9	T6+1H+1W at 40 DAT	3.82 (14.33)	3.41 (11.15)	5.10 (25.48)	92.10	195.27	64.73	9.03	3.25	0.33	3.13	74.00	11.27	68.00
	SE(m)±	0.32	0.33	0.45	4.27	6.26	-	-	0.22	0.018	0.21	2.37	0.42	1.93
	CD at 5%	0.96	0.99	1.35	12.81	18.77	-	-	0.68	0.054	0.64	7.10	1.26	5.79
	GM	3.04	3.63	5.41	115.02	222.61	55.88	18.79	4.83	0.38	3.62	67.65	9.82	63.32

*Transformed values $\sqrt{x \times 0.5}$. Figures in parentheses are the original values. H-Hoeing, W-Weeding, DAT-Days after transplanting.

Table 1. Growth, yield, yield attributes of harvest and economics of paddy as influenced by different treatments

	Treatments	Mean height of plant (cm)	Mean number of total tillers hill^{-1}	Mean number effective tillers hill^{-1}	Mean dry matter accum-ulation hill^{-1}	No. of pan-icles hill^{-1}	No. of grains pan-icle^{-1}	Test weight (g)	Grain yield (q ha^{-1})	straw yield (q ha^{-1})	Harvest iindex (%)	Gross mone-tary return (Rs. ha^{-1})	Cost of culti-vation (Rs. ha^{-1})	Net mone-tary return (Rs. ha^{-1})	B:C Ratio
T_1	Check (unweeded)	45.67	6.96	4.84.	21.81	4.63	109.36	16.83	22.53	37.67	37.42	31161	18111	13050	1.72
T_2	Weed free check	66.23	18.20	13.7	37.77	13.94	133.20	17.77	44.97	59.23	43.15	61423	22421	38992	2.73
T_3	2h+2W at 20 and 40 DAT	63.97	16.35	11.73	35.16	12.33	131.33	17.53	42.05	57.05	42.44	57517	20847	36670	2.76
T_4	Oxdiargyl @ 60 g ha^{-1} at 3-4 DAT	57.90	9.51	7.80	32.10	7.00	121.83	16.93	30.35	43.15	41.29	41613	18957	26656	2.19
T_5	Oxdiargyl @ 75 g ha^{-1} at 3-4 DAT	59.62	13.23	9.90	31.55	8.83	124.64	17.47	37.54	52.06	41.88	51406	19062	32449	2.69
T_6	Oxdiargyl @ 90 g ha^{-1} at 3-4 DAT	58.90	10.66	8.30	31.76	7.19	122.60	16.95	33.85	48.00	41.35	46605	19167	27248	2.42
T_7	T4+1H+1W at 40 DAT	60.71	11.21	8.83	30.74	8.01	123.02	17.19	34.28	48.25	41.54	46978	20325	26651	2.31
T_8	T5+1H+1W at 40 DAT	64.37	16.54	12.33	35.85	12.37	131.57	16.69	42.17	57.50	42.52	57696	20430	37371	2.82
T_9	T6+1H+1W at 40 DAT	62.57	15.94	11.20	34.55	10.21	128.97	17.34	40.91	56.00	42.21	55983	20535	35448	2.72
	SE (m)±	0.56	0.51	0.38	0.44	0.36	0.47	0.36	0.90	0.83	2.08	--	587.77	587.77	--
	CD at 5%	1.70	1.54	1.15	1.31	1.08	1.41	N.S.	2.71	2.50	N.S.	--	1761.16	1761.16	--
	GM	59.99	13.18	9.85	32.26	9.39	125.16	17.18	36.51	51.10	41.53	30536	19984	30492	--

Effect on uptake of nutrient by crop :

All the weed control measures were significantly superior in respect of higher uptake of nitrogen over unweeded check. Weed free check recorded significantly higher nitrogen uptake over rest of the weed control measures. Treatments oxadiargyl @ 75 g ha^{-1} + one hoeing and one weeding at 40 DAT and two hoeings and two weedings at 20 and 40 DAT behaved similar with each other. All weed control measures registered significantly higher uptake of phosphorus and potassium over unweeded check. Weed free check noted significantly higher phosphorus and potassium uptake over rest of the treatments. The treatment oxadiargyl @ 75 g ha^{-1} + one hoeing and one weeding at 40 DAT found significantly superior over rest of the treatments. Unweeded check registered lower uptake of phosphorus and potassium and was inferior among all the treatments. Singh and Sharma (1995) also obtained similar results with weed free check where they reported higher phosphorus and potassium uptake over rest of the treatments.

Economics of treatments :

The gross monetary return was the highest due to weed free check follwed by treatment oxadiargyl @ 75 g ha^{-1} + one hoeing and one weeding at 40 DAT.

The least net return was recorded in unweeded check. The highest net return (Rs 38992 ha^{-1}) was recorded in weed free check. The treatment oxadiargyl @ 75 g ha^{-1}+ one hoeing and one weeding at 40 DAT also found superior in net return (Rs 37266 ha^{-1}) followed by two hoeings and two weedings (Rs 36670 ha^{-1}). The highest B:C ratio (2.83) was obtained in oxadiargyl @ 75 g ha^{-1} + one hoeing and one weeding at 40 DAT due to low cost of cultivation. Weedy check recorded lowest B:C ratio (1.72 and that of weed free check recorded B:C ratio of 2.73 followed by oxadiargyl @ 90 g ha^{-1} + one hoeing and one weeding at 40 DAT (2.72) and two hoeing and two weeding at 20 and 40 DAT (2.71). These results are in line with those reported by Ramana *et al.* (2007) who also found the maximum net return with oxadiargyl @ 80 g ha^{-1} + working with star weeder at 40 DAS, whereas the B:C ratio (1.37) was marginally higher with oxadiargyl @ 80 g ha^{-1} alone over oxadiargyl @ 80 g ha^{-1} + working with star weeder at 40 DAS in paddy. Subramanyam *et al.* (2007) also reported significantly highest net return and cost : benefit ratio in rice with oxadiargyl 75 g ha-1 + HW (40 DAT), followed by hand weeding twice (20 and 40 DAT).

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STUDY OF EFFICACY OF QUIZALOFOP ETHYL ON YIELD AND YIELD ATTRIBUTES AND ECONOMICS OF SOYBEAN

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ABSTRACT

A field experiment was carried out during the rainy season of 2008-09 at Agronomy farm, College of Agriculture, Nagpur, to study the effect of chemical and mechanical weed management in soybean crop. The treatment of two hoeings and two weedings at 20 and 40 DAS recorded significantly more yield than rest of the weed control treatments. Application of Quizalofop ethyl @ 62.5 g ha^{-1} at 20 DAS + 1 hoeing at 20 days after spraying recorded higher yield of soybean among chemical weed control treatments and was closely followed by one hoeing 15 DAS + Quizalofop ethyl @ 62.5 g ha^{-1} at 30 DAS. These treatments provided more effective control of the weeds throughout crop growth period of soybean improving yield attributes and consequently produced higher seed yield. GMR and NMR and B: C ratio was maximum under two hoeings and two weedings at 20 and 40 DAS (2.52). Next in order was the treatment of Quizalofop ethyl @ 50.0 g ha^{-1} at 10 DAS + 1 hoeing at 20 days after spraying(2.39).

(Key words: Quizalofop ethyl, grain yield economics)

INTRODUCTION

Soybean crop has a very high yield potential of 2500 - 2800 kg ha^{-1}, however, the average yield of soybean in India is 777 kg ha^{-1} which is considered to be very low as compared to world average yield of 1832 kg ha^{-1} (Sharma, 2007).Soybean being a rainy season crop, suffers severely due to infestation of several weeds resulting in yield losses up to 77% depending on the weed species, their density and period of weed crop competition (Tiwari and Kurchania, 1990). The use of herbicides or chemicals has assumed a great significance, particularly in intensive agriculture due to their ability of providing quick and effective eradication of weeds and economical weed management in terms of time, money and labour. Quizalofop ethyl is available in market and farmers utilizes in large scale in soybean crop in this region. In this view, it is essential to generate information on the effect of quizalpof ethyl with combination of existing mechanical and cultural weed control method in terms of yield and monetary benefit.

MATERIALS AND METHODS

A field experiment was conducted to study the efficacy of Quizalofop ethyl on yield and yield attributes of soybean and its economics during the *kharif* season of 2008-09 at Agronomy farm, College of Agriculture Nagpur. The experiment was laid out in randomized block design with twelve treatment combinations comprising four herbicidal concentrations, six combinations of chemical and mechanical weed management practices, one mechanical weed control and one unweeded control replicated thrice. The treatments were T_1 – Control , T_2 - 2 hoeings + 2 hand weedings at 20 and 40 DAS, T_3 -Quizalofop ethyl @ 50 g ha^{-1} at 10 DAS, T_4 - Quizalofop ethyl @ 50 g ha^{-1} at 20 DAS, T_5 - Quizalofop ethyl @ 50 g ha^{-1} at 10 DAS + 1 hoeing at 20 days after spraying, T_6 - Quizalofop ethyl @ 50 g ha^{-1} at 20 DAS + 1 hoeing at 20 days after spraying, T_7 - Hoeing 15 DAS + Quizalofop ethyl @ 50 g ha^{-1} at 30 DAS, T_8 - Quizalofop ethyl @ 62.5 g ha^{-1} at 10 DAS, T_9 - Quizalofop ethyl @ 62.5 g ha^{-1} at 20 DAS, T_{10} - Quizalofop ethyl @ 62.5 g ha^{-1} at 10 DAS + 1 hoeing at 20 days after spraying, T_{11} - Quizalofop ethyl @ 62.5 g ha^{-1} at 20 DAS + 1 hoeing at 20 days after spraying, T_{12} - Hoeing 15 DAS + Quizalofop ethyl @ 62.5 g ha^{-1} at 30 DAS. Soybean cultivar JS-335 was sown on 24th June 2008 by drilling method, using fertilizer dose of 30 and 75 kg nitrogen and phosphorus ha^{-1}, respectively at the time of sowing. The soil was characterized as clayey in texture, slightly alkaline in reaction (pH-7.3). The soil was low in nitrogen(229.3 kg ha^{-1}), medium in phosphorus(189.12 kg ha^{-1}) and fairly rich in potash(324.8 kg ha^{-1}). Five plants were selected randomly to record observations on yield contributing characters.

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In the experimental field, predominant weeds species were *Lagasca mollis, Euphorbia geniculata, Parthenium hysterophorus, Digera arvensis* among dicot weeds, *Echinochloa crusgalli, Cynodon dactylon, Eragrostis major, Poa annua, Sorghum halpense* among the grasses and sedge *Cyperus rotundus*. Other weeds were present in less number.

Quizalofop ethyl is a selective post emergence herbicide highly effective against grass weeds occurring in soybean. Quizalofop ethyl is less toxic and safe to mammals, birds etc. also observed safty normal while handling. It is compatible with many herbicides and fungicides. Recently introduce quizalofop ethyl is available in market with trade name as Targa super 5 EC.

RESULTS AND DISCUSSION

The data presented in table1 revealed that the treatment of 2 H + 2 HW at 20 and 40 DAS produced significantly higher number of pods and weight of grain plant^{-1} over the unweeded control and alone application of Quizalofop ethyl @ 50 g ha^{-1} at 10 and 20 DAS and 62.5 g ha^{-1} at 10 and 20 DAS. However, the application of Quizalofop ethyl @ 62.5 g ha^{-1} at 10 and 20 DAS in combination with 1 hoeing at 20 days after spraying and hoeing 15 DAS + quizalofop ethyl @ 62.5 g ha^{-1} at 30 DAS and Quizalofop ethyl @ 50 g ha^{-1} at 10 and 20 DAS in combination with 1 hoeing at 20 days after spraying and hoeing 15 DAS + quizalofop ethyl @ 50 g ha^{-1} at 30 DAS were at par with 2 H + 2 HW at 20 and 40 DAS . Unweeded control treatment recorded significantly less number of pods and weight of seeds plant^{-1} as compared to all other treatments.

The treatment comprising of 2 H + 2 HW at 20 and 40 DAS produced significantly maximum soybean grain yield (1160 kg ha^{-1}) as compared to unweeded control and alone application of herbicide. The herbicidal treatments in combination with 1 Hoeing at 20 days after spraying recorded significantly higher seed yield than the unweeded control treatment and were at par with 2 H + 2 HW at 20 and 40 DAS. Application of quizalofop ethyl @ 62.5 g ha^{-1} at 20 DAS + 1 hoeing at 20 days after spraying (1072 kg ha^{-1}) , hoeing 15 DAS + quizalofop ethyl @ 62.5 g ha^{-1} at 30 DAS(1063 kg ha^{-1}), quizalofop ethyl @ 62.5 g ha^{-1} at 10 DAS + 1 hoeing at 20 days after spraying(1049 kg ha^{-1}), quizalofop ethyl @ 50 g ha^{-1} at 10 DAS + 1 hoeing at 20 days after spraying, (1034 kg ha^{-1}) and quizalofop ethyl @ 50 g ha^{-1} at 20 DAS + 1 hoeing at 20 days after spraying (1001 kg ha^{-1}) were effective in reducing weed population and weed dry matter production and increased seed yield of soybean. Beneficial effect of post emergence application of quizalofop ethyl in increasing soybean yield may be attributed due to suppression of monocot and dicot weeds that helped in reducing soil moisture and nutrient losses thus making them available to the soybean crop.

Higher straw yield was recorded in treatment of two hoeings and two hand weedings at 20 and 40 DAS (1973 kg ha^{-1}) followed by treatment quizalofop ethyl @ 62.5 g ha^{-1} at 20 DAS + 1 hoeing 20 days after spraying(1822 kg ha^{-1}) and hoeing 15 DAS + quizalofop ethyl @ 62.5 g ha^{-1} at 30 DAS (1806 kg ha^{-1}). Least soybean straw yield was recorded in unweeded control treatment. Increase in straw yield of soybean might be due to luxurious crop growth and less crop weed competition in the cultural and herbicidal treatments. Similar results were also reported by Mandhre (2005) and Thakur (2008) in soybean. They reported that, number of pods plant^{-1}, seed yield plant^{-1}, harvest index and seed to straw ratio were more due to cultural weed control treatments (2H+2HW) and same treatment at 20 and 35 DAS was found to be more effective method of weed control in soybean crop

Economic studies

Weed management with two hoeings and two hand weedings at 20 and 40 DAS recorded significantly higher (GMR) Rs 26680 ha^{-1} and (NMR) Rs 16153 ha^{-1} over unweeded control and alone application of herbicide. Application of Quizalofop ethyl @ 50 g ha^{-1} at 10 and 20 DAS and Quizalofop ethyl @ 62.5 g ha^{-1} at 10 and 20 DAS in combination with 1 hoeing at 20 days after spraying were at par with treatment of 2H+2 HW at 20 and 40 DAS. Higher seed yield of soybean was attributed due to effective weed management that resulted in higher monetary returns. Mohod *et al*. (2002) reported highest profit with alone application of one weeding +2 followed by herbicide combination with one hoeing at 30 DAS. In respect of Benefit : Cost

Table 1. Yield and yield attributes of soybean as influenced by different weed control treatments

Treatment Details	No. of pods plant^{-1}	Weight of seeds plant^{-1} (g)	100 seed weight (g)	Seed yield (kg)ha^{-1}	Straw yield (kg) ha^{-1}
T_1 – Control	20.07	4.9	9.32	575	976
T_2 - 2 hoeings + 2 hand weedings at 20 and 40 DAS	35.01	7.31	10.37	1160	1973
T_3 - Quizalofop ethyl @ 50 g ha^{-1} at 10 DAS	29.17	6.15	10.02	854	1451
T_4 - Quizalofop ethyl @ 50 g ha^{-1} at 20 DAS	22.99	5.16	9.82	817	1389
T_5 - Quizalofop ethyl @ 50 g ha^{-1} at 10 DAS + 1 hoeing at 20 days after spraying	31.5	6.47	10.1	1034	1757
T_6 - Quizalofop ethyl @ 50 g ha^{-1} at 20 DAS + 1 hoeing at 20 days after spraying	31.04	6.39	10.08	1031	1752
T_7 - Hoeing 15 DAS + Quizalofop ethyl @ 50 g ha^{-1} at 30 DAS	30.6	6.33	10.02	1005	1705
T_8 - Quizalofop ethyl @ 62.5 g ha^{-1} at 10 DAS	29.02	6.03	9.96	841	1429
T_9 - Quizalofop ethyl @ 62.5 g ha^{-1} at 20 DAS	29.34	6.17	9.98	921	1566
T_{10} - Quizalofop ethyl @ 62.5 g ha^{-1} at 10 DAS + 1 hoeing at 20 days after spraying	32.03	6.54	10.11	1049	1782
T_{11} - Quizalofop ethyl @ 62.5 g ha^{-1} at 20 DAS + 1 hoeing at 20 days after spraying	33.01	6.7	10.14	1072	1822
T_{12} - Hoeing 15 DAS + Quizalofop ethyl @ 62.5 g ha^{-1} at 30 DAS	32.5	6.63	10.12	1063	1806
S E (m) ±	1.67	0.36	0.60	55.28	94.09
C D at 5%	4.95	1.06	–	163	278

Table 2. Economics of weed control treatments in soybean

Treatments	Gross monetary return (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net monetary return (Rs ha^{-1})	B:C Ratio
T_1 – Control	13225	8139	5086	1.62
T_2 - 2 hoeings + 2 hand weedings at 20 and 40 DAS	26680	10527	16153	2.52
T_3 - Quizalofop ethyl @ 50 g ha^{-1} at 10 DAS	19642	9677	9965	2.02
T_4 - Quizalofop ethyl @ 50 g ha^{-1} at 20 DAS	18791	9677	9114	1.94
T_5 - Quizalofop ethyl @ 50 g ha^{-1} at 10 DAS +1 hoeing at 20 days after Spraying	23782	9971	13811	2.39
T_6 - Quizalofop ethyl @ 50 g ha^{-1} at 20 DAS +1 hoeing at 20 days after Spraying	23713	9971	13742	2.38
T_7 - Hoeing 15 DAS + Quizalofop ethyl @ 50 g ha^{-1} at 30 DAS	23115	9971	13144	2.32
T_8 -Quizalofop ethyl @ 62.5 g ha^{-1} at 10 DAS	19343	10177	9166	1.90
T_9 - Quizalofop ethyl @ 62.5 g ha^{-1} at 20 DAS	21183	10177	11006	2.08
T_{10}- Quizalofop ethyl @ 62.5 g ha^{-1} at 10 DAS + 1 hoeing at 20 days after spraying	24127	10471	13656	2.30
T_{11} - Quizalofop ethyl @ 62.5 g ha^{-1} at 20 DAS + 1 hoeing at 20 days after spraying	24656	10471	14185	2.35
T_{12} - Hoeing 15 DAS + Quizalofop ethy @ 62.5 g ha^{-1} at 30 DAS	24449	10471	13978	2.33
S E (m) ±	1272	–	1272	–
C D at 5%	3758	–	3758	–

ratio, higher B:C ratio was obtained with the treatment consisting of 2H + 2HW at 20 and 40 DAS (2.52) followed by quizalofop ethyl @ 50 g ha^{-1} at 10 DAS +1 hoeing at 20 days after spraying (2.39). However, the unweeded control treatment recorded lowest B: C ratio (1.62) as a result of higher crop weed competition which reduced the soybean yield significantly. Similar result was also reported by Yadav *et al.* (2009). They reported that, the highest B:C ratio of 2.11 was recorded under weed free check followed by 2.10 with 2 hand weedings (15 and 30 DAS)

Thus, application of quizalofop ethyl @ 50 - 62.5 g ha^{-1} at 10 and 20 DAS along with 1 hoeing at 20 days after spraying produced significantly higher seed yield and monetary returns in soybean and was comparable with 2 hoeings and 2 hand weedings at 20 and 40 days after sowing.

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PATH ANALYSIS OF MORPHOPHYSIOLOGICAL, BIOCHEMICAL AND YIELD CONTRIBUTING TRAITS IN MUSTARD (*Brassica juncea*)

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ABSTRACT

The experiment to study the correlation and path analysis of morphophysiological, biochemical and yield contributing character using 17 mustard genotypes viz., Shatabdi, Pusa bold, Bio-902, Urvashi, JD-6, GM-2, Sej-2, Laxmi, Seeta, Ashirvad, Kranti, Vardhan, Varuna, PCR-7, Pusa bahar, RH-819 and Geeta was conducted during *rabi* 2010-2011. Observations on plant height, number of primary branches, leaf area, total dry matter production, relative growth rate (RGR), net Assimilation rate (NET), chlorophyll and N, P, K, content in leaves, number of siliqua plant^{-1}, 1000-seed weight, number of seeds 20 siliqua^{-1}, seed yield plant^{-1}, plot^{-1} and ha^{-1} were recorded. The seventeen genotypes of mustard showed significant variation among them for all the characters studied. The correlation studies indicated positive significant correlation of all the characters except plant height with yield. The path analysis revealed the importance of number of siliqua plant^{-1}, number of primary branches, 1000 seed weight, leaf area at 45 DAS and dry weight at 65 DAS for improving seed yield in mustard. Considering these characters the genotypes Laxmi and Seeta were identified as superior genotypes which are recommended for cultivation in the place of Pusa bold as a substitute.

(Key words: Mustard, path analysis, morphophysiological and biochemical parameters)

INTRODUCTION

Indian mustard *Brassica juncea* is the most important member of *rabi* oilseed crop group accounting for more than 75% area under Rapeseed-mustard. In recent years there has been increase in the production of rapeseed mustard. The average productivity in India is low in comparison to that of the developed countries. In India however, production of edible oil is grossly short of the requirement, consequently, large quantity have to be imported for making of the shortfall, which in turn is a heavy drain on foreign exchange resources. Vigorous efforts therefore, are needed to increase the yield level and to achieve self sufficiency. Efforts are being made to cut short the imports and to increase the area and production potential of various oilseeds. There is direct need to develop high yielding varieties of *Brassica* to further enhance its productivity in country (Khan *et al*., 2005).

Yield is a polygenically controlled complex character and is determined by a number of component characters. The growth analysis technique helps in understanding the growth pattern and also contribution of various plant parts to economic yield. It also helps in finding out the yield and yield contributing characters. Thus, growth analysis forms the basis for manipulation of productivity of crop. Seed yield is a complex character and is influenced by several other characters known as yield contributing characters which may have positive or negative effect on this trait. It is important to examine the contribution of each of the trait in order to give more attention to those having greatest influence on seed yield. Therefore, information on the association of characters with seed yield is of great importance to define selection criteria for mustard in terms of yield. Correlation between the different morpho-physiological parameters, chemical and biochemical parameters, and yield components with yield gives an idea of growth and yield attributes, promotion of which helps in realization of higher productivity. Usefulness of information obtained from correlation can be enhanced by partitioning them into direct and indirect effect by path coefficient analysis.

Therefore, the present study with 17 genotypes of *Brassica juncea* was planned and executed to study the association of morpho-physiological, chemical, biochemical and yield contributing parameters with yield and to partition the correlation into direct and indirect effect and to identify promising genotypes for cultivation.

MATERIALS AND METHODS

This experiment was conducted to study the correlation and path analysis of morphophysiological, biochemical and yield contributing characters with yield in mustard during

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rabi 2010-2011 at the farm of Agricultural Botany Section, College of Agriculture, Nagpur. The experimental material consisted of 17 mustard genotypes (Shatabdi, Pusa bold, Bio-902, Urvashi, JD-6, GM-2, Sej-2, Laxmi, Seeta, Ashirvad, Kranti, Vardhan, Varuna, PCR-7, Pusa bahar, RH-819 and Geeta). Seeds were sown at the rate of 5 to 6 kg ha^{-1} by dibbling method at a spacing 45 cm x 15 cm on 24th Nov. 2010 after receiving the sufficient rainfall. Thinning was carried out after full emergence so as to maintain required number of plants $plot^{-1}$. Intercultural operations were also undertaken as and when required.

The observations on dry matter production and leaf area were recorded on 25 day's old plant and thereafter, three observations at an interval of 20 days were also recorded. Plant height and number of primary branches were recorded on five randomly selected plants in each genotype at maturity. Relative growth rate and net assimilation rate were also calculated at an interval of 20 days based on total dry matter accumulation and period of accumulation. The leaf samples were analyzed for their chlorophyll, nitrogen, phosphorus and potassium content at 25, 45 and 65 DAS. Observations on the yield and yield contributing characters like number of siliqua $plant^{-1}$, number of seeds 20 $siliqua^{-1}$, 1000-seed weight and seed yield $plant^{-1}$, $plot^{-1}$ and ha^{-1} were also recorded. The data collected were subjected to statistical analysis suggested by Panse and Sukatme (1954). Simple correlations of different traits with yield were calculated by using the formulas given by Singh and Choudhary (1994), and Path coefficient analysis was carried out by the method suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The correlation coefficient (r) calculated in this study revealed significant positive correlation of all morpho-physiological, chemical and biochemical parameters and yield components with seed yield except plant height. In order to obtain the developmental relations, the correlation coefficient and the causes and effect of relationship between yield, morpho-physiological, chemical, biochemical and yield components were studied in mustard through path coefficient analysis. The direct and indirect effect estimated for morpho-physiological, chemical, biochemical and yield components at different stages indicated positive and negative values for both direct and indirect effect. The characters which contributed maximum indirect effects were alone considered for discussion (Table1).

Path analysis among the characters studied at genotypic level indicated that number of siliqua $plant^{-1}$ (48.18%) exerted maximum direct effect followed by leaf area at 45 DAS (45.93%), chlorophyll content at 25 DAS (39.35%), dry weight at 65 DAS (32.68%), number of primary branches (29.41%), phosphorus content at 65 DAS (28.54%), 1000-seed weight (28.21%) which were also supported by very high positive correlation with seed yield. Similar to these results high positive direct effect of siliqua $plant^{-1}$, leaf area at 45 DAS, number of branches and 1000 seed weight were also reported by Pagar (2005), Khan *et al.* (2005) and Gangapur *et al.* (2009).

The indirect effect of phosphorus content at 45 DAS on yield through different yield components was found to be maximum i. e. 260.66% followed by leaf area at 65 DAS (193.3%), chlorophyll content at 45 DAS (154.26%), nitrogen content at 45 DAS (121.36%), potassium content at 45 DAS (118.97%), leaf area at 25 DAS (117.65%), dry weight at 45 DAS (127.78%) and nitrogen content at 65 DAS (104.69%). The major contributors to the total indirect effect were primary branches $plant^{-1}$, 1000-seed weight, leaf area at 45 DAS, dry weight at 65 DAS and chlorophyll at 25 DAS.

The study on path analysis indicated that morpho-physiological characters like number of primary branches, leaf area at 45 DAS, dry weight at 45 and 65 DAS and yield components like 1000 seed weight and number of siliqua $plant^{-1}$ were found to exert high positive direct effect with seed yield. The chemical and biochemical characters except chlorophyll content at 25 DAS and phosphorus content at 65 DAS showed either positive low direct effect or negative direct effect. This reveals that the morpho-physiological and yield components should be given more weightage as compared to chemical and biochemical characters for the selection of promising genotypes.

Table 1. Direct and total indirect effect of different parameters on seed yield plants^{-1} in mustard

Sr. No.	Characters	Correlation co efficent	Direct effect	% Direct effect	Total Indirect effect	% Indirect effect	% Major contributing characters
1)	No. of pr imary branches	0.748	0.220	29.41	0.527	70.56	Dry weight at 65 DAS (32.05) , Leaf area at 45 DAS (30.71) 1000 seed weight (27.24) , Chlorophyll at 25 DAS (25.26)
2)	No. of siliqua	0.958	0.461	48.18	0.496	51.81	Leaf area at 45 DAS (31.79) , Dry weight at 65 DA S (31.19) Chlorophyll at 25DAS (27.42) , Primary branches (24.72) 1000 seed weight (24.32)
3)	1000 -seed weight	0.899	0.253	28.21	0.645	71.78	Leaf area at 45 DAS (44.62) , Dry weight at 65 DAS (29.95) Dry weight at 25 DAS (26.15) , Chlorophyll at 25DAS (25.04) Primary branches (19.64)
4)	Leaf area at 25 DAS	0.762	-0.134	-17.659	0.896	117.65	Leaf area at 45 DAS (40.06) , Dry weight at 65 DAS (29.58) Chlorophyll at 25DAS (28.02) , 1000 seed weight (19.80) Primary branches (18.32)
5)	Leaf area at 45 DAS	0.957	0.4 40	45.93	0.517	54.01	Dry weight at 65 DAS (31.64) , Chlorophyll at 25DAS (28.12) 1000 seed weight (24.07) , Nitrogen at 25 DAS (16.17)
6)	Leaf area at 65 DAS	0.922	-0.861	-93.36	1.783	193.3	Leaf area at 45 DAS (48.63) , Dry weight at 65 DAS (28.23) Chlorophy ll at 25DAS (26.13) , 1000 seed weight (23.64) Primary branches (17.33)
7)	Dry weight at 25 DAS	0.894	0.158	17.671	0.736	82.32	Leaf area at 45 DAS (43.46) , Dry weight at 65 DAS (27.79) 1000 seed weight (26.05) , Chlorophyll at 25DAS (19.39) Primary branches (18.64)
8)	Dry weight at 45 DAS	0.810	0.038	-4.79	0.84	104.78	Leaf area at 45 DAS (47.76) , Dry weight at 65 DAS (31.07) Chlorophyll at 25DAS (26.63) ,1000 seed weight (20.74)
9)	Dry weight at 65 DAS	0.968	0.316	32.68	0.651	67.31	Leaf area at 45 DAS (43.5 7), Chlorophyll at 25DAS (25.56) 1000 seed weight (22.26) , Primary branches (17.25) Dry weight at 25 DAS (12.83)
10)	Chlorophyll content at 25 DAS	0.823	0.324	39.36	0.499	60.62	1000 seed weight (221.22) , Leaf area at 45 DAS (44.17) Dry weight at 65 DAS (2 9.15), Primary branches (15.60) Plant height (14.65)
	Chlorophyll content at 45 DAS	0.765	-0.414	-54.06	1.180	154.26	Leaf area at 45 DAS (46.48) , Chlorophyll at 25DAS (29.20) Dry weight at 45 DAS (29.20) , 1000 seed weight (25.34) Primary branches (20 .86)

Contd....

12)	Chlorophyll content at 65 DAS	0.820	0.142	17.34	0.677	82.56	Leaf area at 45 DAS (45.65) , Dry weight at 65 DAS (31.78) Chlorophyll at 25DAS (29.50) , 1000 seed weight (21.40) Primary branches (20.72)
13)	Nitrogen content at 25 DAS	0.984	0.140	14.2 2	0.843	85.72	Leaf area at 45 DAS (49.34) , Dry weight at 65 DAS (31.81) Chlorophyll at 25DAS (28.25) , 1000 seed weight (25.65) Primary branches (20.87)
14)	Nitrogen content at 45 DAS	0.923	-0.197	-21.35	1.12	121.36	Leaf area at 45 DAS (51.74) , Dry weight at 65 DAS (32.94) Chlorophyll at 25DAS (29.60) , 1000 seed weight (25.44) Primary branches (21.19)
15)	Nitrogen content at 65 DAS	0.886	-0.041	-4.68	0.928	104.69	Leaf area at 45 DAS (53.38) , Dry weight at 65 DAS (34.69) Chlorophyll at 25DAS 16)(30.54) , 100 0 seed weight (25.31) Plant height (21.20)
16)	Phosphorus content at 25 DAS	0.928	0.026	2.8	0.902	97.19	Leaf area at 45 DAS (50.15) , Dry weight at 65 DAS (29.79) Chlorophyll at 25DAS (26.53) , 1000 seed weight (25.37) Primary branches (23.39)
17)	Phosphor us content at 45 DAS	0.999	-1.605	-160.6	2.604	260.66	Leaf area at 45 DAS (47.14) , Dry weight at 65 DAS (26.86) Chlorophyll at 25DAS (26.05) , 1000 seed weight (23.43) Primary branches (21.11)
18)	Phosphorus content at 65 DAS	0.946	0.271	28.54	0.676	71.74	Leaf area at 45 DAS (49.02) ,Dry weight at 65 DAS (28.94) Chlorophyll at 25DAS (28.69) , 1000 seed weight (24.58) Primary branches (23.27)
19)	Potassium content at 25 DAS	0.790	0.147	18.651	0.642	81.33	Leaf area at 45 DAS (47.72) , Dry weight at 65 DAS (28.6 9) Chlorophyll at 25DAS (28.69) , 1000 seed weight (29.64)
20)	Potassium content at 45 DAS	0.987	-0.187	-18.976	1.174	118.97	Leaf area at 45 DAS (50.91) , Chlorophyll at 25DAS (26.27) Dry weight at 65 DAS (31.18) , 1000 seed weight (23.27) Primary branches (20.63)
21)	Potassium content at 65 DAS	0.937	0.085	9.162	0.851	90.83	Leaf area at 45 DAS (48.10) , Dry weight at 65 DAS (27.07) 1000 seed weight (22.50) , Chlorophyll at 25DAS (20.15) Primary branches (18.92)

Table 2. Mean performance of promising genotypes for selected traits

		Mean performance							
Sr. No.	Name of genotypes	Number of branches^{-1}	Number of siliqua plant^{-1}	1000 seed weight	Leaf area at 45 DAS	Dry weight at 65 DAS	Seed yield plant^{-1} (g)	Seed yield plot^{-1} (kg)	Seed yield hectare^{-1} (q)
1	Laxmi	5.27	178.03	6.78	4.11	57.70	9.14	0.91	13.51
2	Seeta	5.19	173.81	6.16	3.80	51.62	8.80	0.88	13.05
3	Pusa bold	4.92	167.47	6.55	3.76	39.70	7.32	0.72	10.80
	SE(m) ±	0.182	5.743	0.132	0.116	2.26	0.360	0.035	0.534

The studies on correlation and path coefficient analysis indicated the need for giving weightage for number of siliqua plant^{-1}, number of primary branches, 1000-seed weight, leaf area at 45 DAS and dry weight at 65 DAS for improving seed yield in mustard. These results were in accordance with Khan *et al.* (2005) and Gangapur *et al.* (2009) who also reported significant importance of number of siliqua plant^{-1}, number of primary branches, 1000 seed weight for improving seed yield in mustard.

From this study, it was observed that the characters like number of siliqua plant^{-1}, number of primary branches, 1000-seed weight, leaf area at 45 DAS and dry weight at 65 DAS, should be given due weightage for identification of promising genotypes. The mean performance of seventeen genotypes when compared for above characters along with seed yield, it was found that Laxmi ranked first followed by Seeta and Pusa bold (Table 2). In most of the areas Pusa bold is grown due to its superiority and high yielding capacity. As Laxmi and Seeta had either surpassed or at par with Pusa bold for different characters these two genotypes were identified as the promising genotypes and are recommended for cultivation as a substitute for Pusa bold.

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EFFECT OF ADDITION OF FULLY AND PARTIALLY DECOMPOSED FYM ON FERTILITY STATUS OF VERTISOL AND FODDER YIELD OF SORGHUM

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ABSTRACT

A field experiment was conducted during 2009-10 at AHDS farm, College of Agriculture, Nagpur on, "Effect of FYM on mineralization of N and yield of fodder sorghum". The experimental site was slightly alkaline (pH-7.96, EC- 0.37 dSm^{-1}), medium in organic-C (0.70%), low for available N and P (213.24 and 11.15 kg ha^{-1} respectively) and high in available K (336.5 kg ha^{-1}) having very high cation exchange capacity (52.34 cmol(p+) kg^{-1}). The results revealed that in slightly alkaline soil, the pH and EC of soil were slightly decreased with the increase in application of partially or fully decomposed FYM 5 to 10 t ha^{-1}. The CO_2 evolution increased at initial period and hence, content of ammonical-N increased at initial and at later period, content of nitrate-N increased due to addition of 5 to 10 t ha^{-1} fully decomposed FYM along with recommended dose of inorganic fertilizers throughout the growth period of sorghum which reflected into higher grain and fodder yield of sorghum than the combinations of partially decomposed FYM and inorganic fertilizers, only RDF and over absolute control. The nutrient availability was higher where only fully decomposed FYM was added. The higher available nutrients after harvest of sorghum due to addition of partially decomposed FYM either lost by volatilization of nitrogen, also not built up soil organic status because of loss of carbon due to higher temperature and fixation of other nutrients. Therefore, it is concluded to use only fully decomposed FYM in rainfed for higher yield and soil sustainability.

(Keywords: Partially and fully decomposed FYM, nitrogen mineralization, carbon loss)

INTRODUCTION

Mineralization of nitrogen is the process by which nitrogen in organic compounds becomes converted to the inorganic ammonium (NH_4^+) and nitrate (NO_3^-) ions carried out by different soil microorganisms in the region having a mean temperature of 30^0C, 1^0C increase in temperature would lead to 3 per cent loss of soil organic carbon. The rate of CO_2 evolution is generally higher in summer than in winter, while in rainy season it was intermediate (Bijracharya *et al.,* 2000). The rate of CO_2 evolution, release of NH_4-N had a linear relationship with organic carbon content in the soils. The rate of NO_3-N loss continued to increase to 40^0C, but raising the temperature to 60^0C brought a decrease. The soil moisture content invariably declined with increase in incubation temperature; however, ammonium and nitrate-N concentration increased with increase in soil temperature upto 30^0C, after which it declined sharply in the soils (Gupta and Tripathi 1986). Integration of inorganic fertilizers with organic manures will not only sustain the crop production but also be effective in improving soil health and enhance nutrient use efficiency (Verma *et al*., 2005). Sorghum is a heavy nutrient feeder and nutrient sensitive crop. It was therefore, an experiment was planed to understand studies of organic residues addition for management of soil fertility, CO_2 evolution, nitrogen mineralization and productivity of sorghum.

MATERIALS AND METHODS

The field experiment was conducted during 2009-10 at AHDS Section, College of Agriculture, Nagpur with ten treatments replicated thrice in RBD. The treatments were T_1- Control, T_2 – RDF (80:40:40 NPK kg ha^{-1}), T_3 – FYM 5 t ha^{-1}PD, T_4 – FYM 10 t ha^{-1}PD, T_5 – FYM 5 t ha^{-1}PD + RDF, T_6 –FYM 10t ha^{-1}PD + RDF, T_7 – FYM 5 t ha^{-1}FD, T_8 – FYM 10 t ha^{-1}FD, T_9 – FYM 5 t ha^{-1}FD + RDF and T_{10} – FYM 10 t ha^{-1}FD +RDF. The partially decomposed FYM (PD) means, FYM having C : N ratio above 20 :1 (27.55/0.47 = 58.62) and fully decomposed FYM (FD) means having C :N ratio between 14 :1 to 18 :1 (13.3/0.81=16.42). The forage sorghum cultivar CSV-15 was sown on 17- 08 - 2009, before that FYM and fertilizers were applied as per treatment on 15-08-2009 and 17-08- 2009 respectively. The sorghum was harvested for fodder on 18- 11- 2010. The initial and at harvest of sorghum soil and plant samples were collected, processes and analyzed as per standard routine procedures. The CO_2 evolution (mg $day^{-1}ha^{-1}$) was measured by alkali trap method (Pramer and Schmidt, 1964), organic C

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(g kg $^{-1}$) by wet oxidation method (Walkley and Black, 1934), available N (kg ha^{-1}) by alkaline permanganate method (Subbiah and Asija, 1956), available P (kg ha^{-1}) by Olsen′s method (Jackson,1967), available K (kg ha^{-1}) by neutral normal ammonium acetate extractant using flame photometer (Jackson,1967), NH_4-N and NO_3-N (mg kg^{-1}) by distillation method (Chopra and Kanwar, 1991), the total nitrogen from plant sample (%) by Kjeldahl′s method (Piper,1966), phosphorus (%) by Vanadomolybdate yellow colour using di-acid extract method (Jackson,1967) and potassium (%) by flame photometer from di-acid extract (Jackson,1967). The initial fertility status of soil was CEC 52.34 cmol (p+) kg^{-1}, pH- 7.96, E.C. 0.37 dSm^{-1}, organic C 0.69 %, available N 225.3 kg ha^{-1}, P 11.92 kg ha^{-1}, K 320.5 kg ha^{-1}.

The initial fertility status of soil before application of nutrients and as properties of partially and fully decomposed FYM are given in table 1.

RESULTS AND DISCUSSION

Influence on NH_4-N and NO_3-N

The content of NH_4- N was maximum at initial period i.e at 30 days after incubation and thereafter, it started declining with incubation period up to November in all treatments. Whereas, slight more NH_4–N was recorded in December and thereafter, it showed significantly decreasing trend. N mineralization rates were significantly higher during the initial period and decreased with time in all soils, at initial period NH_4–N more than $N0_3$–N but at latter stage the trend was reversed (Table 2). This might be due to subsequent microbial oxidation of NH_4–N to $N0_3$+ NO_2 (Gupta *et al.,* 2005).

The increase in addition of fully decomposed FYM @ 5-10 t ha^{-1} with RDF recorded maximum $N0_3$-N from 30 days to 120 days of incubation period (138.3 to 125.2 and 128.3 to 126.1 mg kg^{-1}) respectively than addition of partially decomposed FYM with and without chemical fertilizers, RDF and control. It indicates the availability of $N0_3$-N was maximum from establishment of sorghum to its complete maturity. The increased NO_3-N content possibly due to conversion of mineral-N via nitrification process (Santhy *et al*., 2001). However, where partially decomposed FYM was added with or without recommended dose of fertilizer, there maximum content of $N0_3$-N was recorded at latter stage i.e at 150 days of addition of FYM in field (109.3, 116.4, 116.2 and 122.3 mg kg^{-1} respectively). This indicates the partially decomposed FYM immobilized the nutrient content in it and also nutrient added through fertilizer at initial stage and during crop growth period (Table 3).

Influence on CO_2 evolution

The result revealed that the CO_2 evolution at initial period was maximum in all the treatments. However it was maximum in fully decomposed FYM than partially decomposed. Whereas the CO_2 evolution was maximum in latter period in partially decomposed FYM (Table No. 4, 5 and 6). There was the highest CO_2 evolution at 30 days of incubation, the CO_2 evolution declined up to 80 days and again increased in all treatments except control (Sarode *et al.*, 2009).

Influence on organic-C content

The organic-C content was maximum where fully decomposed FYM was added with or without chemical fertilizers (7.6 to 7.2 g kg^{-1}) than addition of partially decomposed FYM (7.4 to 6.9 g kg^{-1}), recommended dose of fertilizer (6.8 to 6.6 g kg^{-1}) and absolute control treatment (6.9 to 6.4 g kg^{-1}) from September to November. Thereafter, slight increase in its level was observed from December to January and again reduction in its level was recorded from February to March in all the treatments. This might be due to addition of plant residues and its mineralization. The addition of fully decomposed FYM with or without RDF improved the organic carbon status of soil (7.5 to 7.2 g kg^{-1}) than partially decomposed FYM (7.3 to 7.1 g kg^{-1}), recommended fertilizer dose and absolute control (7.1 g kg^{-1}) during March. Similarly the build up in organic-C status was recorded, where partially and fully decomposed FYM was added with or without chemical fertilizer (7.1 to 7.0 g kg^{-1}) over addition of RDF (6.8 g kg^{-1}) and absolute control (6.7 g kg^{-1}) over initial status (6.9 g kg^{-1}) in last year experiment with same randomization and treatment at same site on 15th July, 2009 observation (Table 7).

Table 1. Initial fertility status of soil as well as properties of partially and fully decomposed FYM

Sr. No.	Properties	Fully decomposed	Partially decomposed	Soil
1	Sand (%)			15.23
2	Silt (%)			20.46
3	Clay (%)			64.31
4	Bulk density Mgm-3			1.42
5	CEC cmol (p+) kg^{-1}			52.34
6	Organic C (%)			0.69
7	Available N (kg ha^{-1})			225.30
8	Available P (kg ha^{-1})			11.92
9	Available K (kg ha^{-1})			320.50
10	pH	7.02	8.26	7.96
11	E.C. (dSm^{-1})	1.16	2.00	0.37
12	Decomposition period (days)	140	30	
13	Colour	Dark brown	Brown	
14	Odour	Earthy smell	foul smell	
15	Moisture (%)	35.5	58%	
16	Temperature (^0C)	39.5	59.45	
17	TOC (%)	13.3	27.55	
18	N (%)	0.81	0.47	
19	C:N <18 – 10	16.42	58.62	
20	P (%)	0.81	0.56	
21	NH_4-N (%)	0.19	0.14	
22	NO_3-N (%)	0.29	0.18	
23	K (%)	1.12	0.72	

Table 2. Effect of partially and fully decomposed FYM on content of NH_4 - N at 30 days interval (mg kg^{-1})

Treatment	**15.09.09**	**15.10.09**	**14.11.09**	**14.12.09**	**13.01.10**	**12.02.10**
T_1- Control	19.7	16.4	14.0	14.3	14.2	15.2
T_2 – RDF	36.3	21.2	15.6	18.6	16.2	16.4
T_3 – FYM 5 t ha^{-1}PD	22.4	16.6	14.2	15.3	14.4	15.4
T_4 – FYM 10 t ha^{-1}PD	27.9	18.3	14.2	16.2	14.6	15.6
T_5 – FYM 5 t ha^{-1}PD + RDF	21.6	26.8	**16.2**	20.6	16.6	15.6
T_6 –FYM 10 t ha^{-1} PD + RDF	**34.6**	27.6	**16.4**	**22.4**	**18.4**	**18.8**
T_7 – FYM 5 t ha^{-1}FD	33.2	20.3	14.3	18.7	18.9	18.8
T_8 – FYM 10 t ha^{-1}FD	35.8	26.6	15.2	20.8	18.2	17.2
T_9 – FYM 5 t ha^{-1}FD + RDF	36.6	30.4	16.0	22.8	18.4	17.6
T_{10} – FYM 10 t ha^{-1}FD +RDF	**38.8**	**30.8**	**16.3**	**23.4**	**18.6**	**17.9**
S E (m) ±	0.66	0.70	0.44	0.46	0.48	0.47
C D at 5%	1.92	2.04	1.27	1.34	1.39	1.37
C V	3.71	5.16	4.95	4.13	4.92	4.84

Table 3. Effect of partially and fully decomposed FYM on content of $N0_3$ - N at 30 days interval (mg kg^{-1})

Treatments	15.09.09	15.10.09	14.11.09	14.12.09	13.01.10	12.02.10
T_1- Control	98.2	95.1	88.4	77.2	87.1	92.8
T_2 – RDF	107.6	104.2	100.1	92.4	98.2	92.3
T_3 – FYM 5 t ha^{-1}PD	98.7	91.9	95.5	106.3	**109.3**	102.2
T_4 – FYM 10 t ha^{-1}PD	103.6	96.3	95.1	109.5	**116.4**	111.3
T_5 – FYM 5 t ha^{-1}PD + RDF	107.2	99.5	103.5	113.4	**116.2**	117.3
T_6 –FYM 10 t ha^{-1}PD + RDF	108.4	100.3	111.3	114.5	**122.3**	**121.1**
T_7 – FYM 5 t ha^{-1}FD	113.9	110.7	107.5	112.2	99.6	97.6
T_8 – FYM 10 t ha^{-1}FD	110.7	111.2	105.6	116.7	**109.3**	98.2
T_9 – FYM 5 t ha^{-1}FD + RDF	128.3	124.3	112.2	126.1	101.2	102.6
T_{10} – FYM 10 t ha^{-1}FD +RDF	**130.4**	**138.3**	**129.5**	**125.2**	109.5	118.3
S E (m) ±	0.52	1.4	0.9	0.8	0.75	0.8
C D at 5%	1.50	4.1	2.7	2.6	2.2	2.5
C V	8.08	2.29	1.52	1.42	1.22	1.42

Table 4. Effect of partially and fully decomposed FYM on CO_2 evolution at one day interval (kg ha^{-1})

Treatments	16.08.09	17.08.09	18.08.09	19.08.09	20.08.09	21.08.09	22.08.09
T_1- Control	32.64	32.00	32.27	29.00	29.64	26.55	23.27
T_2 – RDF	45.39	48.45	53.25	47.57	43.10	26.19	18.10
T_3 – FYM 5 t ha^{-1}PD	41.14	52.56	55.4	50.11	43.56	32.44	26.22
T_4 – FYM 10 t ha^{-1}PD	**59.58**	**63.76**	**69.06**	**73.28**	63.77	49.25	34.63
T_5– FYM 5 t ha^{-1}PD + RDF	43.61	53.26	63.26	59.79	53.07	37.12	28.56
T_6–FYM 10 t ha^{-1}PD + RDF	**66.19**	**71.25**	**72.31**	**75.69**	64.31	49.89	34.94
T_7 – FYM 5 t ha^{-1}FD	49.63	54.04	55.18	50.71	48.18	38.51	24.25
T_8 – FYM 10 t ha^{-1}FD	60.39	63.41	65.13	61.65	57.92	44.85	26.42
T_9 – FYM 5 t ha^{-1}FD + RDF	64.80	64.30	64.8	62.67	61.28	47.74	25.87
T_{10} –FYM 10 t ha^{-1}FD +RDF	**66.00**	**73.33**	**73.19**	68.33	65.97	49.25	29.62

Table 5. Effect of partially and fully decomposed FYM on CO_2 evolution at 7 days interval (kg ha^{-1})

Treatments	29.08.09	05.09.09	12.09.09	19.09.09	26.09.09	3.10.09	10.10.09
T_1- Control	28.88	29.00	29.64	22.64	24.00	18	15.27
T_2 – RDF	38.26	38.45	33.10	25.39	25.27	24.86	23.10
T_3 – FYM 5 t ha^{-1}PD	49.29	52.56	43.56	31.14	26.89	27.3	23.22
T_4 – FYM 10 t ha^{-1}PD	**70.63**	**68.44**	**63.77**	**59.58**	**47.05**	**37.66**	**24.63**
T_5– FYM 5 t ha^{-1}	47.58	53.26	43.07	43.61	35.92	36.9	18.56
T_6–FYM 10 t ha^{-1}	**65.14**	**71.25**	**64.31**	**56.19**	**43.11**	**37.08**	24.94
T_7 – FYM 5 t ha^{-1}FD	39.60	34.04	38.18	39.63	29.30	20.81	19.25
T_8 – FYM 10 t ha^{-1}FD	48.54	33.41	37.92	40.39	27.65	25.07	22.42
T_9 – FYM 5 t ha^{-1}	41.47	34.30	41.28	34.80	29.53	27.49	23.87
T_{10}– FYM 10 t ha^{-1}	48.92	35.14	35.97	37.92	31.11	30.14	24.62

Table 6. Effect of partially and fully decomposed FYM on CO_2 evolution at 15 and 30 days interval (kg ha^{-1})

Treatment	25.10.09	9.11.09	24.11.09	15.12.09	30.12.09	30.01.10	29.02.10
T_1- Control	19.00	13.27	10.27	9.04	8.39	38.88	43.93
T_2 – RDF	17.57	13.10	10.90	9.60	10.48	38.26	34.66
T_3 – FYM 5 t ha^{-1}PD	20.11	16.22	16.29	13.78	12.33	49.29	45.11
T_4 – FYM 10 t ha^{-1}PD	**23.28**	**24.63**	**27.97**	**21.19**	**20.63**	**50.63**	**63.75**
T_5– FYM 5 t ha^{-1}PD + RDF	19.79	18.56	19.27	16.21	16.21	47.58	45.16
T_6–FYM 10 t ha^{-1}PD + RDF	**25.69**	**24.94**	**25.44**	**21.89**	**22.11**	**65.14**	**60.08**
T_7 – FYM 5 t ha^{-1} FD	20.71	19.25	19.86	16.97	16.69	49.60	44.07
T_8 – FYM 10 t ha^{-1}FD	21.65	22.42	24.15	20.27	19.98	58.54	53.06
T_9 – FYM 5 t ha$^{-}{}_1$FD + RDF	22.67	23.87	25.70	21.40	21.05	51.47	48.41
T_{10} – FYM 10 t ha^{-1}FD +RDF	23.33	24.62	23.08	22.53	20.50	58.92	56.50

Table 7. Effect of partially and fully decomposed FYM on content of organic C at 30 days interval (g kg^{-1})

Treatments	15.07.09	15.09.09	15.10.09	14.11.09	14.12.09	13.01.10	12.02.10	15.03.10
T_1 Control	**6.7**	6.9	6.8	6.4	6.9	7.0	7.2	7.1
T^2 RDF	**6.8**	6.8	6.6	6.6	7.2	7.2	7.4	7.3
T_3 FYM 5 t ha^{-1}PD	6.9	7.2	7.0	6.9	6.5	7.4	7.4	7.3
T_4 FYM 10 t ha^{-1}PD	7.0	7.3	7.1	6.9	6.6	7.5	7.2	7.1
T_5 FYM 5 t ha^{-1}PD + RDF	7.0	7.2	7.1	6.9	7.2	7.5	7.2	7.1
T_6 FYM 10 t ha^{-1}PD + RDF	7.0	7.4	7.3	7.1	7.0	7.5	7.4	7.2
T_7 FYM 5 t ha^{-1}FD	7.0	7.3	7.2	7.2	7.0	7.6	7.4	7.2
T_8 FYM 10 t ha^{-1}FD	**7.1**	**7.5**	**7.4**	**7.2**	**7.3**	**7.7**	**7.4**	**7.3**
T_9 FYM 5 t ha^{-1}FD + RDF	**7.0**	**7.3**	**7.3**	**7.3**	**7.2**	**7.8**	**7.6**	**7.4**
T_{10} FYM 10 t ha^{-1}FD +RDF	**7.1**	**7.6**	**7.5**	**7.4**	**7.4**	**7.9**	**7.7**	**7.5**
S E (m) ±	0.07	0.08	0.06	0.08	0.08	0.07	0.07	0.05
C D at 5%	0.19	0.24	0.19	0.24	0.23	0.22	0.22	0.15
C V	1.70	1.97	1.56	2.01	1.91	1.76	1.75	1.23
Initial	**6.9**							

Table 8. Effect of partially and fully decomposed FYM on nutrient content in sorghum

Treatments	Content of Nutrients (%)		
	N	P	K
T_1- Control	0.34	0.18	0.95
T_2 – RDF	0.39	0.30	1.15
T_3 - 5 t ha^{-1}, PD-FYM	0.36	0.20	1.05
T_4 – 10 t ha^{-1}, PD-FYM	0.37	0.22	1.10
T_5 - 5 t ha^{-1}, PD-FYM + RDF	0.37	0.22	1.20
T_6 – 10 t ha^{-1}, PD-FYM	0.38	0.20	1.25
T_7 - 5 t ha^{-1}, FD-FYM	0.37	0.28	1.27
T_8 – 10 t ha^{-1}, FD-FYM	**0.40**	0.28	1.25
T_9 - 5 t ha^{-1}, FD-FYM + RDF	**0.40**	**0.30**	1.30
T_{10}– 10 t ha^{-1}, FD-FYM + RDF	**0.41**	**0.30**	**1.35**
S E (m) ±	0.012	0.015	0.007
C D at 5%	0.033	0.045	0.019
C V	5.26	1.56	3.75

Table 9. Effect of partially and fully decomposed FYM on yield and uptake of nutrients by Sorghum

Treatment	Fodder yield ((q ha^{-1})	Total uptake (kg ha^{-1}) N	P	K
T_1- Control	58.79	19.98	10.57	55.84
T_2 – RDF	71.63	27.93	21.48	82.37
T_3 – FYM 5 t ha^{-1} PD	59.79	21.52	11.95	62.78
T_4 – FYM 10 t ha^{-1} PD	62.26	22.83	13.69	68.41
T_5 – FYM 5 t ha^{-1} PD + RDF	67.90	25.12	14.93	81.48
T_6 –FYM 10 t ha^{-1} PD + RDF	70.25	26.58	14.04	87.81
T_7 – FYM 5 t ha^{-1} FD	71.36	26.40	19.97	90.63
T_8 – FYM 10 t ha^{-1} FD	72.68	29.06	20.34	90.85
T_9 – FYM 5 t ha^{-1} FD + RDF	74.14	29.65	22.24	96.38
T_{10} – FYM 10 t ha^{-1} FD +RDF	**77.96**	**31.96**	**23.38**	105.24
S E (m) ±	0.55	0.343	0.155	0.63
C D at 5%	1.58	0.999	0.453	1.89
C V	13.7	2.28	1.56	2.32

Table 10. Effect of partially and fully decomposed FYM on soil reaction and fertility status of soil

Treatments	pH	EC (dSm^{-1})	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
T_1- Control	7.90	0.38	196.50	10.91	283.7
T_2 – RDF	7.92	**0.396**	217.47	12.44	309.8
T_3 – FYM 5 t ha^{-1} PD	7.79	0.377	200.70	14.36	294.9
T_4 – FYM 10 t ha^{-1} PD	7.81	0.373	204.88	15.90	313.6
T_5 – FYM 5 t ha^{-1} PD + RDF	7.80	0.374	206.97	15.86	**343.4**
T_6 –FYM 10 t ha^{-1} PD + RDF	7.77	0.375	210.70	16.95	**369.5**
T_7 – FYM 5 t ha^{-1} FD	**7.71**	0.375	**213.24**	**18.32**	**350.8**
T_8 – FYM 10 t ha^{-1} FD	**7.65**	**0.37**	**215.33**	**18.32**	**388.2**
T_9 – FYM 5 t ha^{-1} FD + RDF	7.78	0.375	**222.70**	**20.1**	**395.7**
T_{10}–FYM 10 t ha^{-1} FD +RDF	7.86	0.378	**225.83**	**20.51**	**414.4**
S E (m) ±	0.05	0.002	1.67	0.25	8.69
C D at 5%	0.16	0.006	4.87	0.75	25.33
C V	1.08	0.89	1.37	2.72	4.35
Initial	**7.96**	**0.370**	**213.24**	**11.15**	**336**

Table 11. Correlation coefficient of organic- C with each NH_4-N and yield of sorghum

Properties	30-OC	60-OC	90-OC	120-OC	150-OC	180-OC
30-$N0_3$	0.043					
60-NO_3		0.599**				
90-NO_3			0.450**			
120-NO_3				0.742**		
150-NO_3					0.681**	
180-NO_3						0.694**
30-NH_4	0.527**					
60-NH_4		0.571**				
90-NH_4			0.751**			
120-NH_4				0.965**		
150-NH_4					-0.125	
180-NH_4						0.073
Fodder Yield	0.601**	0.484**	0.517**	0.735**	0.650**	0.814**

r value - 5 % 0.316, 1 % 0.408

Table 12. Correlation coefficient of $N0_3$-N with NH_4-N and yield of sorghum

Properties	30 NO_3 – N	60 NO_3 – N	90 NO_3 – N	120 NO_3 – N	150 NO_3 – N	180 NO_3 – N	Fodder Yield
30-NH_4 – N	0.034	0.817**	0.614**	0.824**	0.779**	0.750**	**0.843****
60-NH_4 – N	-0.095	**0.752****	0.533**	0.749**	0.728**	0.737**	**0.812****
90-NH_4 – N	-0.091	0.849**	**0.730****	0.889**	0.829**	0.867**	**0.817****
120-NH_4 – N	0.127	0.766**	0.563**	**0.785****	0.709**	0.620**	**0.743****
150-NH_4 – N	0.033	0.379*	0.440**	0.408**	0.201	0.184	0.211
180-NH_4 – N	-0.316*	0.539**	0.596**	0.534**	0.269	0.231	0.190
Fodder Yield	0.302	**0.742****	**0.632****	**0.807****	**0.782-****	**0.695****	-

r value - 5 % 0.316 1 % 0.408

Partially and fully decomposed FYM

Influence on content of nutrients NPK

The content of nutrients NPK were significantly higher in treatment received 10 t ha^{-1} fully decomposed FYM with recommended dose of fertilizer over all other treatments (Table 8). The higher uptake of nutrients in this treatment might be due to higher content and maximum fodder yield by this treatment.

Influence on yield and uptake of nutrients

Application of 10 t ha^{-1} fully decomposed FYM with recommended dose of fertilizer recorded significantly higher fodder yield (77.96 q ha^{-1}) of sorghum over all other treatments followed by application of 5 t ha^{-1} fully decomposed FYM with recommended dose of fertilizer (74.14 q ha^{-1}), which was 8.84 per cent and 3.50 per cent higher over recommended dose of fertilizer (Table 9). Combined application of FYM and NPK has better result on soil fertility as well as higher productivity of crops (Ravankar *et al*., 2005). The higher uptake of nutrients NPK in this treatment might be due to higher content and maximum fodder yield by this treatment.

Influence on soil reaction and fertility status

The reduction in pH and electrical conductivity was recorded, where fully decomposed FYM was added without recommended fertilizes dose (T_6 7.65 and 0.37) which was lower than initial status respectively. The application of organic manure alone and in combination with inorganic fertilizers resulted in decrease in soil pH (Chalwade *et al*., 2006). The significantly higher available NPK were recorded in treatment received 10 t ha^{-1} fully decomposed FYM with recommended dose of fertilizer over all other treatments. The treatment where no any organic and inorganic fertilizers were added lowered the available nutrients status than initial (Table 10). The balance use of fertilizers is required continuously either alone or in combination with organic manure for sustaining soil fertility and productivity of crop (Thakur *et al*., 2011).

Influence on correlation of organic-C with each NH_4–N, NO_3–N and yield of sorghum

The nitrate nitrogen was significantly and positively correlated with organic C from 60 – 180 days from addition of FYM whereas, ammoniacal – N was significantly and positively correlated with organic C from 30 – 120 days from addition of FYM. It support the higher content of ammoniacal – N at initial period. The content of organic- C noted significant and positive correlation with fodder yield of sorghum through out the growth period (Table 11).

Influence on correlation coefficient of $N0_3$-N with NH_4-N and yield of sorghum

The content of NO_3 – N is dependent of NH_4– N and showed significant and positive correlation with NH_4– N from 60 – 120 days and with yield from 60 – 180 days. The sorghum yield was significantly and positively correlated with NH_4–N from 30 – 120 days (Table 12).

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EFFECT OF HEAT TREATMENT ON CHEMICAL COMPOSTION, *IN-VITRO* DRY MATTER DIGESTIBILITY AND PROTEIN PROTECTION OF SOYBEAN MEAL

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ABSTRACT

A lab experiment was conducted in Animal Husbandry and Dairying Section, College of Agriculture, Nagpur during the year 2009 to determine the effect of heat treatment on chemical composition, *in-vitro* dry matter digestibility, *in-vitro* protein degradability and protein protection in soybean meal. Ground soybean meal was subjected to heat treatment at constant temperature of 125^{0}C with different time levels i.e. 2 (T_2), $2^{1/2}$ (T_3), 3 (T_4) and $3^{1/2}$ hours (T_5) and one without heat treatment i.e. control (T_1). The chemical composition (dry matter, crude protein, crude fibre, ether extract and total ash) of soybean meal treated with heat at different durations was more or less similar to that untreated soybean meal. The differences in content of DM, CP, CF, EE and TA were non-significant in all the treatments. The average *in-vitro* dry matter digestibility under control, 2, $2^{1/2}$, 3, and $3^{1/2}$ hours of heating were 65.15, 52.21, 44.78, 38.15 and 34.75 per cent respectively. The *in-vitro* dry matter digestibility lowered significantly (34.77 %) when soybean meal was heated at 125^{0}C for $3^{1/2}$ hours. The protein degradability of soybean meal were 63.28, 32.47, 23.26, 19.26 and 13.29 per cent for control, 2, $2^{1/2}$, 3, and $3^{1/2}$ hours of heating respectively. It was the highest (63.28 %) in control treatment, whereas the lowest (13.29 %) in the heat treatment for $3^{1/2}$ hours. Thus, the per cent protein protection in soybean meal was significantly increased with the increase in heating duration. It was maximum (79 %) in $3^{1/2}$ hours of heating and minimum (48.69 %) protein protection was found when soybean meal was heated for 2 hours.

(Key words: Soybean meal, heat treatment, *in-vitro* dry matter digestibility, *in-vitro* protein degradability and protein protection)

INTRODUCTION

Inadequate feed supply is the major constraint in the rearing of dairy animals. India is facing an acute shortage of feeds and fodders. The available feed resources need to be utilized judiciously and with value addition, as the feeds available are of inferior quality consisting of straws of cereals, pulses and other crop residues having lower palatability, lower digestibility, high fibre content and low level of energy, proteins, minerals and vitamins.

Soybean meal is one of the richest feed ingredient which contains proteins, vitamins and essential amino acids. However, raw soybean meal contains some antinutritional factors which cause gastrointestinal disturbances, impair growth, increase in disease susceptibility and depressed performance (Liener, 1994). Earlier, the difficulties were encountered for the use of soybean products in animal feed. This was mostly related to lack of sufficient scientific information on nutrient quality for processed soybeans. However, it was found suitable for animals and its health (Hill, 2000). To maximize the supply of nutrients for farm animals for their growth, production and reproduction continuous efforts are made by exploiting the various methods of rumen bypass, of which heat treatment is the most prominent method. After extrusion or heat treatment, the nutritional potential of this valuable raw material can be retained and used in various animal feed formulations (Purushotam *et al*., 2006).

Determination of feed protein degradation is one of the important basic studies that is receiving attention while formulating rations for animals. Protein forms one of the most significant constituents of ruminants ration. It is, therefore, of paramount importance to ensure that this constituent is utilized with efficiency. Study made by Walli *et al.* (2000) proved that heat treatment is effective in protecting excessive protein degradation from soybean meal. Application of this technology has the potential to improve the economic returns for village dairy farmers in India.

Hence, study was undertaken to understand the optimal extrusion condition to make the extruded soybean meal useful nutritional ingredient for animals.

MATERIALS AND METHODS

The study material was consist of soybean

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meal purchased from the market was oven dried, ground in feed mill to pass through 1 mm sieve and stored in airtight containers. The ground soybean feed was given heat treatment by using hot air oven at constant temperature of 125^{0}C for different time intervals viz., T_1 (control or untreated), T_2 (2 hours), T_3 ($2^{1/2}$ hours), T_4 (3 hours) and T_5 ($3^{1/2}$ hours). The heated samples were ground finally after heat treatment. The treated and untreated dried ground samples of soybean meal were analyzed on dry matter basis for the chemical composition viz., dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE) and total ash (TA) as per AOAC (Anonymous, 2002).

Rumen liquor used for *in-vitro* digestibility was collected from a crossbred cow fed on roughage diet. The well mixed sample of rumen liquor was drawn from different parts of rumen of cow by suction, using five inch long twenty gauge hypodermic needle. Rumen liquor was collected in one litre bottle covered with dark cloth and immediately taken to the laboratory, strained through four layer muslin cloth and stored at 38 – 39^{0}C. *In-vitro* dry matter digestibility of soybean meal was performed as per the procedure of Barnes *et al*. (1971) and *in-vitro* protein degradability of heat treated soybean meal was carried out by following the method of Lohan and Gupta (1990). The data were analyzed by using Completely Randomized Design (Amble, 1975).

RESULTS AND DISCUSSION

Chemical composition :

Chemical composition of untreated (control) and treated (2, $2^{1/2}$, 3, $3^{1/2}$ hours) soybean meal samples with constant temperature of 125^{0}C at different time intervals revealed (Table 2), that the dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE) and total ash (TA) contents in untreated and heat treated soybean meal was more or less similar. The results showed that heat treatment did not have any significant effect on the chemical composition of soybean meal. The results are in agreement with the results of Purushotam *et al*. (2006) who observed extrusion did not hamper the important chemical nutrient. Eweedah *et al*. (1997) also observed non–significant relation in chemical composition and heat treatment in soybean meal.

***In-vitro* dry matter digestibility :**

In-vitro dry matter digestibility of soybean meal in untreated (control) and heat treated for 2, $2^{1/2}$, 3 and $3^{1/2}$ hours were 65.15, 52.21, 44.78, 38.15 and 34.77 per cent respectively. Significantly highest *in-vitro* dry matter digestibility was observed in control treatment and it decreased significantly ($P < 0.05$) with increase in duration of heating. Hence, it was inferred that *in–vitro* dry matter digestibility decreased significantly with the increase in duration of heat treatment in soybean meal. The findings are in agreement with the findings of Sampath and Sivraman (1987) who observed that the heating at 150^{0}C for 2 hours reduced the dry matter content (digestibility) of groundnut cake, gingely cake and rubber seed cake by 26, 25 and 5 per cent respectively during 24 hours incubation in the rumen by using nylon bag technique.

***In-vitro* protein degradability** :

The protein degradability of heat treated soybean meal heated for 2, $2^{1/2}$, 3 and $3^{1/2}$ hours were 63.28, 32.47, 23.26, 19.26 and 13.29 per cent respectively. It was observed that the protein degradation was significantly reduced in soybean meal which was heated for 2, $2^{1/2}$, 3 and $3^{1/2}$ hours compared to control treatment. The results revealed that the protein degradation decreased with the increase in heating period of soybean meal. Similar results were reported by Yugandhar Kumar *et al.* (1994) who observed that the protein disappearance of heat treated soybean meal was 37.41 per cent. Also the results reported by Walli *et al*. (2000) showed that, the effective protein degradability in rumen was reduced from 60 to 37.8 per cent in heat treated soybean meal.

Protein protection :

The per cent protein protection of soybean meal heated for 2, $2^{1/2}$, 3 and $3^{1/2}$ hours were 48.69, 63.25, 69.57 and 79 per cent respectively as that of untreated soybean meal. The results showed a significant ($P < 0.05$) variation among the treatments. Further, it was observed that the per cent protein protection increased with the increase in the duration of heating. Hence, , it was concluded that the increased duration of heat treatment was more effective in reducing the excessive protein degradation from soybean meal.

Table 2. Effect of heat treatment on chemical composition, *in-vitro* dry matter digestibility, protein degradation, % reduction in protein degradabilityof heat treatment of soybean meal

Heat treatment (125^0C)	Chemical composition of soybean meal					IVDMD	IVPD	% reduction in PD in comparison to control	% Protein protection in comparison to control
	DM	CP	CF	EE	TA				
T_1 (Control)	92.30	46.20	5.25	1.04	5.78	65.15	63.28	-	-
T_2 (2 hr)	92.35	46.48	5.19	1.05	5.55	52.21	32.47	30.81	48.69
T_3 ($2^{1/2}$ hr)	92.05	46.07	5.02	1.07	5.71	44.78	23.26	40.02	63.25
T_4 (3 hr)	92.19	46.19	5.18	1.08	5.72	38.15	19.26	44.02	69.57
T_5 ($3^{1/2}$ hr)	92.20	46.15	5.15	1.06	5.68	34.77	13.29	49.99	79.00
SE	0.19	0.18	0.82	0.02	0.07	0.067	0.067	--	0.249
CD at 5 %	--	--	--	--	--	0.20	0.20	--	0.751

DM – Dry matter, CP – Crude Protein, CF – Crude fibre, EE – Ether extract, TA – Total ash, IVDMD – *In-vitro* dry matter digestibility, IVPD – *In-vitro* Protein degradability, PD – Protein degradability

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GROWTH, FLOWERING AND YIELD OF GOLDEN ROD AS INFLUENCED BY NITROGEN AND POTASSIUM

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ABSTRACT

An experiment entitled, "Growth, flowering and yield of golden rod as influenced by nitrogen and potassium" was carried out at Horticulture Section, College of Agriculture, Nagpur, during Nov., 2009 to April, 2010 with sixteen treatment combinations in factorial randomized block design. The treatments comprised of four levels each of nitrogen and potassium *viz*., 0, 50, 100 and 150 kg ha^{-1}. The results of present investigation revealed that, application of 150 kg ha^{-1} each of nitrogen and potassium produced significantly maximum plant height, number of leaves $plant^{-1}$ and maximum longevity of inflorescence *in situ*, whereas, earliness for the emergence of flower stalk and opening of flower stalk was recorded with the application of 0 kg nitrogen and potassium ha^{-1}. However, significantly the maximum number of suckers $plant^{-1}$and yield of flower stalks in respect of number of flower stalks $plant^{-1}$ and $hectare^{-1}$ were recorded under the treatment of 150 kg N ha^{-1} and 100 kg K_2O ha^{-1}.

(Key words: Golden rod, nitrogen, potassium, growth, flowering)

INTRODUCTION

Now-a-days, there is a great demand for cut flowers in local and export market. The cut flowers are mainly used for bouquet preparation as well as for flower arrangement. Rose, gladiolus, gerbera, orchid, golden rod etc. are some of the important cut flowers having a great demand in the cut flower market.

Golden rod is grown for its attractive, long and straight flower stalk. It is a member of compositeae family, botanically known as *Solidago canadensis* (Linn). It is locally called as *SONTURA*. It produces large panicles of yellow flowers for several months in a year which are very attractive as cut flowers and are used in bouquet preparation and also for table decoration. This hardy perennial herb can be grown under almost all climatic and soil conditions. It usually prefers sunny location.

Amongst the various agro-techniques, proper boosting is a key element in cultivation of golden rod. The major nutrients like nitrogen and potassium play a vital role in producing better yield of quality flowers of golden rod. Proper cultural practices for this flower crop are still not available. Hence, to find out the suitable dose of major nutrients like nitrogen and potassium for the production of better yield and quality flower stalks of golden rod under Nagpur conditions, the present investigation was under taken.

MATERIALS AND METHODS

The present investigation was carried out at Horticulture Section, College of Agriculture, Nagpur during Nov. 2009 to April 2010 to study the effect of nitrogen and potassium on growth and flowering of golden rod. Sixteen treatment combinations with four levels of nitrogen (0, 50, 100 and 150 Kg ha^{-1}) and four levels of potassium (0, 50, 100 and 150 Kg ha^{-1}) were tried in factorial randomized block design with three replications. Golden rod suckers of uniform size were transplanted at the spacing of 30 cm x 30 cm in the month of November, 2009. Half dose of nitrogen and full dose of potassium were supplied as per the treatment before transplanting and remaining half dose of nitrogen was applied after 45 days of transplanting. However, phosphorus was applied as basal dose before transplanting. Ten plants were selected randomly from each plot for recording various growth, flowering and yield observations *viz*., plant height, leaves $plant^{-1}$and suckers produced $plant^{-1}$ recorded at 90 days after transplanting, days required for emergence of flower stalk and opening of first floret on flower stalk, longevity of inflorescence *in situ*, flower stalks produced $plant^{-1}$, etc.

RESULTS AND DISCUSSION

The data presented in Table 1 revealed that, different levels of nitrogen and potassium had

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significant effect on all growth and flowering parameters of golden rod studied.

Growth parameters

Significantly the highest plant height (21.13 cm), leaves plant^{-1} (85.25) and suckers plant^{-1}(4.2) were recorded at higher level of nitrogen i.e. 150 kg N ha^{-1} which was followed by the treatment of 100 kg N ha^{-1}(19.64 cm, 75.50 and 3.47, respectively), whereas, application of 0 kg N ha^{-1} had produced significantly minimum plant height (17.31 cm), leaves plant^{-1} (62.92) and suckers plant^{-1} (2.19). This might be due to general improvement in growth and development of plant by nitrogenous fertilizers as the nitrogen is involved in various metabolic processes of plant. Similar increase in height of plant and leaves plant^{-1} due to higher dose of nitrogen was recorded by Baboo *et al.* (2005) and Sharma *et al.* (2006) in African marigold.

The treatment of 150 kg K_2O ha^{-1} had produced significantly the maximum height of plant (19.22 cm) and leaves plant^{-1}(75.50) and it was found to be at par with the treatment of 100 kg K_2O ha^{-1} (18.95 cm and 74.46, respectively), whereas, significantly the maximum suckers plant^{-1} (3.13) were produced due to the application of 100 kg K_2O ha^{-1}and it was found to be at par with the treatment of 150 kg K_2O ha^{-1} (3.01). However, significantly minimum plant height (18.66 cm), leaves plant^{-1} (71.00) and suckers plant^{-1}(2.94) were produced due to non-application of nitrogen and it was found to be at par with the treatment of 50 kg K_2O ha^{-1}(18.79 cm, 71.91 and 2.95, respectively).The beneficial effect of potassium in promoting the growth of golden rod plants may be explained from the fact that, potassium involved in synthesis of peptide bond and protein and carbohydrate metabolism and also participates in rapid cell division and differentiation. Similar increase in growth of African marigold due to application of higher dose of potassium was reported by Pal and Ghosh (2010).

The interaction effect due to nitrogen and potassium on growth parameters such as height of plant, number of leaves plant^{-1} and number of suckers plant^{-1} was found to be non significant.

Flowering and yield parameters

The results indicated that, significantly minimum days were required for emergence of flower stalk (93.98 days) and opening of first floret on flower stalk of golden rod (98.31 days) due to non application of nitrogen and it was found to be at par with the treatment of 50 kg N ha^{-1} (94.49 and 98.43 days, respectively), however, due to the application of higher dose of nitrogen the emergence of flower stalk and opening of first floret on flower stalk was delayed. This might be due to more vegetative growth of plant with the application of higher level of nitrogen which decreased C: N ratio and there by delayed flower stalk emergence. However, significantly the maximum longevity of inflorescence *in situ* was recorded due to the treatment of 150 kg N ha^{-1} (12.58 days) followed by 100 kg N ha^{-1} (11.09 days). This might be due to more vegetative growth and high protoplasmic and moisture content of flower stalk due to an increased level of nitrogen. The results are in agreement with Lale (2002) who reported that, the earliest emergence of flower stalk and opening of first floret on flower stalk in golden rod was recorded with the application of the lowest dose of nitrogen (0 kg ha^{-1}), however, it was delayed with the increase in the dose.

Among the different levels of potassium applied significantly minimum days were required for emergence of flower stalk (94.26 days) and opening of first floret on the flower stalk (98.47 days) with the treatment of 0 kg K_2O ha^{-1} which was found to be at par with 50 kg K_2O ha^{-1}(94.39 and 98.55 days. respectively), however, significantly maximum days were required for emergence of flower stalk (98.39 days) and opening of first floret on the flower stalk (101.99 days) due to the treatment of 100 and 150 kg K_2O ha^{-1}, respectively. The results are in conformity with Pal and Ghosh (2010) in African marigold who revealed that, flower bud emergence was delayed gradually with the increase in the level of potassium from 0 to 200 kg ha^{-1}. Similarly, longevity of inflorescence *in situ* was found significantly maximum with the treatment of 150 kg K_2O ha^{-1} (10.70 days) and it was found to be at par with 100 and 50 kg K_2O ha^{-1}(10.67 and 10.65 days, respectively). This is in conformity with the findings of Sharma and Singh (2007) who reported that, durability of gladiolus spikes was increased with increasing levels of potassium.

Table 1. Effect of nitrogen and potassium on growth and flowering attributes in golden rod

Treatments	Plant height (cm)	Leaves plant^{-1}	Suckers plant^{-1}	Days required for emergence of flower stalk	Days required for opening of first floret on flower stalk	Longevity of inflorescence *in situ* (days)	Flower stalks plant^{-1}	Flower stalks ha^{-1} (lakh)
Nitrogen								
N_0 – 0 kg N ha^{-1}	17.31	62.92	2.19	93.98	98.31	8.58	2.36	2.26
N_1 – 50 kg N ha^{-1}	17.56	69.17	2.28	94.49	98.43	9.57	2.82	2.74
N_2 – 100 kg N ha^{-1}	19.64	75.50	3.47	98.18	100.26	11.09	3.34	2.90
N_3- 150 kg N ha^{-1}	21.13	85.25	4.20	98.57	103.29	12.58	3.67	3.69
SE (m) ±	0.14	0.36	0.05	1.31	0.69	0.16	0.11	0.09
CD (P= 0.05)	0.42	1.04	0.15	3.80	1.98	0.47	0.27	0.25
Potassium								
K_0 - 0 kg K_2O ha^{-1}	18.66	71.00	2.94	94.26	98.47	9.8	3.00	2.84
K_1 - 50 kg K_2O ha^{-1}	18.79	71.91	2.95	94.39	98.55	10.65	3. 08	2.92
K_2 - 100 kg K_2O ha^{-1}	18.95	74.46	3.13	9839	101.26	10.67	3.29	3.10
K_3- 150 kg K_2O ha^{-1}	19.22	75.50	3.01	98.16	101.99	10.70	2.76	2.72
SE (m) ±	0.14	0.36	0.05	1.31	0.69	0.16	0.11	0.09
CD (P= 0.05)	0.42	1.04	0.15	3.80	1.98	0.47	0.27	0.25
Interaction effect								
N x K								
SE (m) ±	0.29	0.72	0.10	2.63	1.37	0.33	0.22	0.17
CD (P= 0.05)	-	-	-	-	-	-	-	-

The interaction effect due to nitrogen and potassium on flowering characters such as days required for emergence of flower stalk, opening of first floret on flower stalk and longevity of inflorescence *in situ* was found to be non-significant.

The flower yield of golden rod in respect of flower stalks produced plant^{-1} and ha^{-1} were recorded significantly the maximum under the treatment of 150 kg N ha^{-1}(3.67 and 3.69 lakh, respectively) followed by the treatment of 100 kg N ha^{-1} (3.34 and 2.90 lakh, respectively), whereas, significantly minimum flower stalks plant^{-1} and ha^{-1} were produced under the treatment of 0 kg N ha^{-1} (2.36 and 2.26 lakh, respectively). Similar increase in flower yield with increase in the level of nitrogen was also reported by Gaikwad *et al*. (2004) in China aster and Baboo *et al*. (2005) in African marigold. This might be due to better vegetative growth of plant in terms of plant height and leaves produced plant^{-1} with the application of higher dose of nitrogen.

The application of 100 kg K_2O ha^{-1} had recorded significantly the maximum flower stalks plant^{-1} (3.29) and ha^{-1}(3.10 lakh) and it was followed by the treatment of 50 kg K_2O ha^{-1}(3.08 and 2.92 lakh, respectively). However, application of 150 kg K_2O ha^{-1} had produced significantly minimum flower stalks plant^{-1} and ha^{-1} (2.76 and 2.72 lakh, respectively) which was found at par with the treatment of 0 kg K_2O ha^{-1} (3.00 and 2.84 lakh, respectively). It is clear from the data that, the number of flower stalks plant^{-1} and ha^{-1} increased upto the certain level but above that, it gets decreased. This might be due to the role of adequate amount of potassium in promotion of plant growth as well as flower yield. The results were correlated with Pal and Ghosh (2010) who registered that, application of 100 kg ha^{-1} potassium was more beneficial than the higher levels in respect of flower yield in African marigold.

The data pertaining to the flower stalks produced plant^{-1} and ha^{-1} in golden rod were not influenced statistically due to an interaction of nitrogen and potassium levels.

From the study it can be inferred that, application of nitrogen and potassium improved the flower yield. The data also indicates that, the application of 150 kg nitrogen and 100 kg potassium ha^{-1} can be more remunerative in respect of flower yield of golden rod.

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QUALITY ASSESSMENT OF GOAT MILK AFFECTED BY SUBCLINICAL MASTITIS

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ABSTRACT

Sound health of the udder is the most important in production of safe and suitable milk for human consumption. Goat mastitis should be considered as the serious condition because of reduction in quality and quantity of milk which can lead to potential zoonotic problem to the consumer. There are many managerial factors affecting milk production as well as milk composition, of which mastitis is one of the important threatening and costliest factor.

The present experiment entitled "Effect of subclinical mastitis on quality of goat milk" was conducted during the year 2009 – 2010 in Animal Husbandry and Dairying Section, College of Agriculture, Nagpur, with an objective to assess the quality (fat, SNF, TS and pH) of goat milk as affected by subclinical mastitis. The experimental material consisted of 20 normal and 20 subclinical mastitic milk samples from 20 goats having one normal and other half affected by subclinical mastitis. Results obtained after testing the significance between subclinical mastitic milk and normal milk revealed that, the average fat, solid not fat and total solid content of the affected samples decreased significantly (P < 0.01) by 0.35, 0.47 and 0.77 units as compared to normal milk samples. The average pH increased significantly (P <0.01) by 0.8 units in subclinical mastitic samples. Experimental results showed that, subclinical mastitis hampered the milk quality of goat milk.

(Key words: Subclinical mastitis, goat and milk quality)

INTRODUCTION

Goat is a multi functional animal and plays a significant role in the economy and nutrition of landless, small and marginal farmers in the country. Goats are small sized animals, highly adaptable to broadest range of climatic and geographic conditions and their appealing nature choose them as a popular livestock species than the other mammalian breeds. It is believed that the goat was earliest ruminant to be domesticated (Zeuner, 1963).

Today goats are known all over the world as the next major important milk producers followed by the cows and buffaloes. Goat milk is nutritionally similar with cow milk, having high properties of fat globules which facilitate early digestion. Goat milk also possesses some of anti-allergic properties. The goat milk contains 4.97 % fat, 4.3 % protein, 4.1 % lactose, 0.89 % ash and 14.2 % total solids. Goat milk has much lower contents of vitamins B_6 and B_{12} (Devendra and Burns, 1970).

Mastitis is the inflammation of mammary gland usually as a result of microbial infection. It is occurring in subclinical, clinical and acute form. Subclinical mastitis has a little difficulty as compared to clinical one because alternations in milk contains are unnoticed and hidden to naked eyes in inspection and as a result of which subclinical mastitis seems to responsible for greater losses in milk of goat.

In rural area, the awareness about the subclinical mastitis is very less to the goat owner as compared to clinical mastitis. Majorities of mastitis in goats are not easily diagnosed and required various laboratory tests. Subclinical mastitis is characterized by biochemical changes in composition of milk, these compositional changes reflecting the degree of physical damage are well marked and can be used as a basic indicator for diagnosis of subclinical mastitis. Hence, taking into consideration the above mentioned threats, the present experiment was conducted to assess the quality of goat milk affected by subclinical mastitis.

MATERIALS AND METHODS

The present experiment was based on the survey made during the year 2009 – 2010 in Hingna tahsil of Nagpur district.

Total 80 goats were screened against subclinical mastitis from four different villages viz., Mohagaon Zilpi, Meta Umari, Ambazari and Devali of Hingna tahsil. Out of 80 goats and 160 halves tested, 57 (71.25 %) goats and 89 (55.62 %) halves were found positive for presence of subclinical

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Table 1 : Effect of subclinical mastitis on quality of goat milk

Samples	Normal milk				Subclinical mastitic milk			
	Fat	Solid not fat	Total solid	pH	Fat	Solid not fat	Total solid	pH
1	4.10	8.00	12.10	6.30	3.90	7.80	11.70	7.14
2	3.80	8.35	12.15	6.25	3.50	8.05	11.55	7.09
3	4.15	8.15	12.30	6.38	3.90	7.90	11.80	7.20
4	4.19	8.01	12.20	6.40	4.00	7.60	11.60	6.99
5	4.00	8.30	12.10	6.79	3.80	7.50	11.50	7.24
6	4.30	8.50	12.80	6.30	3.80	8.00	11.80	7.38
7	4.09	8.00	12.09	6.40	3.90	7.70	11.79	7.12
8	4.30	8.50	12.80	6.70	4.00	8.10	12.10	7.14
9	4.30	8.80	13.10	6.40	3.80	7.70	11.50	7.30
10	4.30	8.50	12.80	6.50	3.80	7.80	11.60	7.12
11	4.10	8.40	12.50	6.20	3.80	8.00	11.80	7.21
12	4.30	8.80	13.10	6.30	3.90	8.40	12.30	7.30
13	4.30	8.79	13.09	6.25	4.00	8.19	12.19	7.11
14	4.20	8.86	13.06	6.30	3.90	8.30	12.26	7.32
15	4.25	8.75	13.00	6.38	3.09	8.40	12.30	7.18
16	4.30	8.45	12.75	6.40	3.80	8.10	11.90	6.98
17	3.95	8.85	12.80	6.25	4.00	8.30	12.30	7.08
18	4.30	8.80	13.10	6.30	3.90	8.30	12.20	7.29
19	4.15	8.03	12.18	6.35	3.80	7.50	11.30	7.10
20	4.30	8.80	13.10	6.40	3.70	8.60	12.30	7.16
Average ± SE (m)	4.17 ± 0.036	8.48 ± 0.070	12.65 ± 0.090	6.37 ± 0.032	3.82 ± 0.047	8.01 ± 0.071	11.88 ± 0.073	7.17 ± 0.024
		't' tab = 2.878			't' cal = 5.86**	't' cal = 4.671**	't' cal = 6.56**	't' cal = 19.62**

** Significant at 1% level (P < 0.01)

mastitis by Modified California Mastitis Test (Pandit and Mehta, 1969). The milk samples (20 normal and 20 positive) were collected from 20 positive goats, having one normal half and another with subclinical mastitis, in sterilized glass bottles. The collected milk samples were subjected to chemical analysis viz., fat by Gerber′s method as described in BIS: 1224 (Anonymous, 1958). Solid not fat was determined according standard procedure as described in SP: 18, Part – XI of BIS (Anonymous, 1981). Total solid determined according to Gravimetric method described in SP: 18 Part – XI of BIS (Anonymous, 1981) and pH was determined by using indicator strip described in SP: 18 Part – XI of BIS (Anonymous, 1981) and digital pH meter. Analysis of the milk samples were done at Animal Husbandry and Dairying Section, College of Agriculture, Nagpur.

A Student ′t′ test was used to test the significance between normal and subclinical mastitic milk of goats described by Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

The average fat percentage in normal and subclinical mastitic milk was observed as 4.17 ± 0.036 and 3.82 ± 0.047 per cent respectively (Table 1). The average percentage of fat significantly ($P < 0.01$) decreased in subclinical mastitic milk samples. Decrease in fat content in milk due to subclinical mastitis was observed by Bhoyar (2006). Leitner *et al.* (2004) also reported that the composition of milk was significantly altered in infected halves of mastitis udder in goat, with average values of fat 61.7 ± 0.21 g l^{-1} for abnormal halves and 64.9 ± 0.26 g l^{-1} for normal halves. Our results are in agreement with their results.

The average solid not fat content in normal milk was 8.48 ± 0.070 per cent and that of subclinical mastitic milk was 8.01 ± 0.071 per cent. Thus, it decreased significantly in all subclinical mastitic milk samples. Bhad (2008) and Bhoyar (2006) noticed decreased solid not fat content of cow milk affected by subclinical mastitis.

The average percentage of total solids of normal and subclinical mastitic milk was observed as 12.65 ± 0.090 and 11.88 ± 0.073 per cent respectively. The average total solid per cent of subclinical mastitic milk decreased significantly ($P < 0.01$). Sung (2001) observed that, the total solids content of milk was positively correlated with milk somatic cell count (SCC).

The average pH of normal and subclinical mastitic milk was 6.37 ± 0.032 and 7.17 ± 0.024 per cent respectively. Thus, pH increased significantly ($P < 0.01$) by 0.8 units in subclinical mastitic milk as compared to normal milk. Bhad (2008) reported, the pH of cow milk affected by subclinical mastitis was 7.00 ± 0.11 per cent and that of normal milk was 6.78 ± 0.082 per cent, also Boechat and Favarin (1992) observed increase in pH of goat milk affected with subclinical mastitis. Increased in pH of Subclinical mastitis milk in the study could be due to increased permeability of the gland tissue to blood components which results in higher values in milk. This might be partially due to increased movement of bicarbonate ions into milk, since the lactose production decreased and the alkaline salts from the blood entered the milk which becomes more alkaline showing pH above 7.0 as indicated by Rao (1990).

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EFFECT OF NITRATE CONTAMINATION IN SOILS OF JALGAON DISTRICT

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ABSTRACT

In order to evaluate nitrate contamination in soils of heavily fertilized area in Jalgaon district of Maharashtra, talukawise 47 soil sampling sites were selected .These samples were collected from 0-20 cm , 20-40 cm and 40-60 cm depths in low(<100 kg ha^{-1}), medium(100-200 kg ha^{-1}) and high(>200 kg ha^{-1}) fertilizer consuming areas. The field work was carried out in Jalgaon district during post-monsoon 2006 and pre-monsoon 2007. The soils from the study area were calcareous, moderately well drained of alluvial origin. Seasonwise overall nitrate accumulation in 141 soil samples ranged from 0.00 to 11.67, 0.00 to 8.70 and 0.00 to 8.21 ppm at depth 0-20, 20-40 and 40-60 cm respectively in the pre-monsoon 2007 and 0.00 to 2.71, 0.00 to 2.63 and 0.00 to 2.06 ppm at depth 0-20, 20-40 and 40-60 cm respectively in the post-monsoon 2006 season. Nitrate was relatively higher in the soil surface layers as compared to subsurface layers.

(Key words : Nitrate , heavily fertilized soils, Jalgaon district)

INTRODUCTION

Soil may be defined as the weathered superficial layer of the earth′s crust that typically is made up of decomposed and partly decomposed parent rock material with associated organic matter in various stages of decomposition. Soils in the field are not a monolithic mass of unchanging composition. They are characterized by large spatial variability in both the horizontal and vertical dimensions (Mussa *et al*., 2009). Currently global application of N fertilizer is about equally distributed between developed and developing countries.

Galloway *et al.* (1995) estimated that global N fertilizer production will increase 60-90% by the year 2025 and two thirds of the total will be applied in the developing world. Understanding N leaching from fertilized agriculture is important for several reasons. Nitrogen is a very important nutrient element in agriculture. In soils it occurs in organic and inorganic forms. Inorganic N occurs primarily as nitrate in arable soils. Nitrate is subject to various processes such as plant uptake, leaching from soils among others. Nitrate leaching is a global problem. Recently, there have been many studies made in India which point to the danger of nitrate leaching and subsequent pollution of ground waters. Due to increased agricultural activity which is necessary for enhanced food production and also due to industrial activity, there is an increasing evidence of nitrate pollution of ground waters.

Concentration of nitrate in food may cause methemoglobinemia in babies (Rao and Puttanna, 2000). It has been cited as a risk factor in developing gastric and intestinal cancer (Stanley *et al.,*1975). Specific vulnerability to agricultural system is a function of contaminant factors. The most important factors influencing the amount of nitrate movement are the amount of nitrate dissolved in the soil solution, the nitrate use efficiency of plants, the rate of immobilization by soil micro–organisms or newly synthesized soil organic matter, the amount of water available for runoff and leaching through the soil. The investigation was carried out with the objective to study the nitrate accumulation in soil profile due to heavy fertilization to various crops in the Jalgaon district.

MATERIALS AND METHODS

Soil sampling was carried out during post-monsoon 2006 and pre-monsoon 2007.Blockwise soil sampling sites were located in Jalgaon district. Jalgaon district was divided into 15 talukas (Table 1) on the basis of fertilizer ($N + P_2O_5 + K_2O$) consumption rate in kg ha^{-1} in a ratio of 1:3:6 respectively for low (<100 kg ha^{-1}), medium (100 – 200 kg ha^{-1}) and high (>200 kg ha^{-1}). Soil sampling site from each village was located during field survey and 141 soil sampled up to 60 cm depth in 20 cm increments was done by digging pits in post-monsoon 2006 and pre-monsoon 2007 seasons. Soil sampling up to 60 cm depth has been recommended for soil nitrate measurements (Miller and Donahue, 1990). The sample sites were kept the same to

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observe variations. 2 M KCl was employed to extract soil nitrate with soil: extractant ratio of 1:5 and determined colorimetrically with Flow Injection Analyzer (Model:Foss FlA star 5000) at Indian Institute of Soil Science, Bhopal. The method involves the reduction of NO_3^- to NO_2^- with a large–sized copperized cadmium column and detection of NO_2^- formed by the Griess–Ilosvay procedure. This technique is relatively simple and not subject to interferences by common constituents in soil extracts. Considering the sample load, sensitivity of method and the level of interferences, automated Cd reduction based colorimetric method was the best option for NO_3^- analysis in the range of 0.5 to 10 ppm NO_3^--N. Modified Griess–I losvay procedure uses sulfanilamide for diazotization and N– (1–naphthyl) - ethylenediamine for coupling reaction. The rate of the colour development, its stability and the sensitivity has been found to be increased (Ferore and O′Brien, 1962).

RESULTS AND DISCUSSION

Season wise overall means for all 141 soil samples in post - monsoon 2006 and pre - monsoon 2007 were 0.51 and 2.27 ppm respectively showing an increase of 1.76 ppm in pre - monsoon 2007 over post - monsoon 2006 (Table 2). Garwood and Tyson (2009) revealed that losses of nitrate-N were particularly severe during winter following a dry autum. Russell (1973) reported that arable soils, particularly in temperate regions, have a fairly constant but low content of ammonical nitrogen but a very variable and high nitrate N content, ranging from 2 to 20 mg N as nitrate kg^{-1} of soil for normal soils rising up to 60 mg for rich garden soils. Cropped soils do not accumulate nitrates because they are taken up by the growing crops and some proportion either is leached down into the deep sub-soil or lost through denitrification or utilized by the microorganisms in the vicinity of roots. The gentrification occurs when the supply of oxygen required by soil microorganisms is restricted, generally by excessive moisture. In this respect the critical moisture level has been found to be about 60 per cent of the water holding capacity (Bear, 1964).

The data pertaining to nitrate content in soil (Table 3) revealed that, the nitrate content was found substantially higher in pre-monsoon than post-monsoon. During the rainy season, decrease in ammonium and nitrate – N may be due to the greater demand for nutrients by higher plants which grow vigorously during this period (Arunachalam *et al*.,1996). The surface layers showed more nitrates than subsurface layers in the pre-monsoon season. The nitrogen salts move up and down in the soil solution, depending on direction of water movement of the two general types of nitrogen salts, nitrates moves more readily,for it does not attach itself to soil particles. On the other hand, ammonical nitrogen is adsorbed by the soil colloids. As it is converted to nitrate, it becomes mobile (Mussa *et al*.,2009). An oxidized top soil layer of thickness of about few mm to 1 cm below the soil surface and a reduced layer in the rest of the root zone in which the dominant processes are mineralization, denitrification, immobilization, leaching and plant uptake (Chowdary *et al*.,2002). It may be due to lesser mobility of nitrates from surface to subsurface layers in the profile for want of sufficient moisture.

Data presented in table 4 showed a proportion of high nitrate levels in the soils in the areas of fertilizer consumption. In low fertilizer use areas, out of total fifteen soil samples, 03 (20 per cent) showed nitrate-N content of higher than 5 ppm. The similar values were 13.3 per cent (06 out of 45 samples) and 12.3 per cent (10 out of 81 samples) in the areas of medium and high fertilizer consumption areas, respectively. Thus, high and moderate fertilizer consumption areas showed less percentage of samples having nitrates higher than 5 ppm. It might be due to abundant growth of crops with adequate fertilizers leading to higher N uptake and immobilization of mineral N with enhanced microbial growth. Thus, it could be inferred that, the heavy fertilization in banana, cotton, sorghum growing areas do not induce nitrate accumulation in the soil profile.

Table 1. Selection of soil and water sampling site

Fertilizer use (kg ha^{-1})	Name of taluka	No.of villages taluka^{-1}	No.of soil sampling sites taluka^{-1}	No.of water samples taluka^{-1}	Name of villages in the respective talukas					
Low < 100	Amalner	1	1	8	Mehergaon					
	Chalisgaon	1	1	9	Bhoras					
	Jamner	1	1	10	Hiwarkhed					
	Pachora	1	1	10	Nagar Dewla					
	Parola	1	1	9	Bhilali					
	Total	**5**	**5**	**46**						
Medium 100 200	Bhusawal	3	3	29	Takali	Peprisekam	Bohardi			
	Bodwad	3	3	20	Nandgaon	Sonoti	Borgaonwaki			
	Chopda	3	3	18	Lasur	Adgaon	Chahardi			
	Dharangaon	3	3	30	Pimpri	Kandari	Pastane			
	Erandol	3	3	29	Palaskheda	Jalu	Varkhedi			
	Total	**15**	**15**	**126**						
High >200	Bhadgaon	6	6	52	Pendgaon	Kajgaon	Bhadgaon	Tondgaon	Wadgaon	Umare
	Jalgaon	6	6	51	Nimkhedi	Savkhed	Dhanwad	Umale	Deohari	Kandhari
	Muktainagar	6	6	51	Melsangave	Panchane	Mondalde	Shambalde	Uchande	Khamkheda
	Raver	6	4	53	Golwada	Nimbhora	Singnur	Khirdi	Puri	Bambalwadi
	Yawal	6	5	47	Giradgaon	Waghoda	Kaswe	Duskheda	Wadoda	Viroda
	Total	**30**	**27**	**254**						
Grand Total		**50**	**47**	**426**						

Table 2. Seasonal variation of nitrate-N (ppm) in soil profile

Depth (cm)	Post - monsoon 2006			Pre-monsoon 2007			
	Range	Mean	SD	Range	Mean	SD	't' value
0 – 20	0 – 2.71	0.59	0.58	0 – 11.67	2.70	2.77	5.09**
20 – 40	0 –2.63	0.51	0.47	0 – 8.70	2.11	2.14	4.88**
40 – 60	0 – 2.06	0.44	0.65	0 – 8.21	2.00	2.20	4.89**

Table 3. Mean nitrate-N content (ppm) under different fertilizer consumption areas

Fertilizer used (kg ha^{-1})	Post-monsoon 2006	Pre-monsoon 2007
Low : <100		
0-20 cm	0.54	3.19
20-40 cm	0.56	1.78
40-60 cm	0.36	2.99
Medium : 100-200		
0-20 cm	0.81	2.86
20-40 cm	0.60	2.32
40-60 cm	0.55	1.82
High : >200		
0-20 cm	0.48	2.52
20-40 cm	0.45	2.06
40-60 cm	0.40	1.92

Table 4. Soil samples showing >5 ppm nitrates under different fertilizer consumption areas in Jalgaon district under pre-monsoon condition

Fertilizer used (kg ha^{-1})	Taluka	Village	Depth (cm)	Pre-monsoon 2007 (ppm)
Low : <100	Jammer	Hiwarkhed	40-60	6.64
	Parola	Bhilali	0-20	11.67
			40-60	6.53
Medium:100-200	Bhusawal	Takali	0-20	8.09
			20-40	7.14
	Bodwad	Nandgaon	0-20	6.33
			20-40	6.54
		Sonoti	40-60	5.68
	Chopda	Lasur	0-20	6.82
High : >200	Bhadgaon	Pendgaon	40-60	8.21
	Jalgaon	Nimkhedi	0-20	5.40
		Savkhed	0-20	9.46
			20-40	8.70
			40-60	8.05
		Kandhari	0-20	5.15
	Muktainagar	Panchane	0-20	7.93
		Mondalde	20-40	5.80
		Khamkheda	0-20	5.13
	Yawal	Waghoda	0-20	5.06

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INTEGRATED WEED MANAGEMENT IN GARLIC

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ABSTRACT

The present investigation entitled "Integrated weed management in garlic" was carried out during *rabi* season of the year 2008-09 at Horticulture Section, College of Agriculture, Nagpur with eleven treatments and three replications in Randomised Block Design. The treatments comprised of three concentrations each of two herbicides *viz*., pendimethalin (1.0, 0.75 and 0.5 kg ha^{-1}) as pre-emergence, oxyfluorfen (0.2, 0.15 and 0.1 kg ha^{-1}) as pre-emergence and oxyfluorfen (0.1, 0.075 and 0.05 kg ha^{-1}) as post-emergence. The herbicide at higher concentration was tested alone, whereas, herbicide with medium concentration was supplemented with one hand weeding at 40 DAP (days after planting) and herbicide with lower concentration was supplemented with two hand weedings at 30 and 60 DAP, one cultural treatment of three hand weedings at 20, 40 and 60 DAP and a control treatment (no weeding). The results of the present investigation revealed that, the treatment of pendimethalin (pre-em) @ 0.5 kg ha^{-1} + 2HW (hand weedings) was found significantly superior in reducing population of monocot as well as dicot weeds, days required for maturity. This treatment was also found beneficial for increasing growth characters *viz.,* height of plant, leaves plant^{-1}, post harvest characters *viz.,* diameter of bulb, length of bulb, weight of bulb and cloves bulb^{-1} and yield parameters *viz.,* bulb yield of garlic ha^{-1} and cost benefit ratio (2.98). However, application of oxyfluorfen (pre-em) @ 0.1 kg ha^{-1} was found to be the next best treatment.

(Key words: Garlic, weed control, hand weeding, pendimethalin, oxyfluorfen)

INTRODUCTION

Vegetables play an important role in human diet by providing nutritious components which are essential constituents of balanced diet. Vegetables are naturally available and cheapest source of nutrients. India is the second leading vegetable producer of the world. Garlic is the second most important bulb crop after onion. The most troublesome problem faced by garlic growers is the control of weed particularly during the early stages of crop growth. Because of higher plant density and slow initial growth of the plants having erect tubular leaves, the intercultural operations become difficult and the crop suffers heavily due to the weeds.

Weed reduces the bulb yield to the extent of 40-80% (Verma and Singh, 1996). Therefore, it is essential to keep the field weed free during critical period of plant growth. Hence, the present investigation was carried out to find out suitable and effective herbicides for better plant growth, and getting maximum yield of better quality garlic bulbs.

MATERIALS AND METHODS

The present investigation was carried out at Horticulture Section, College of Agriculture, Nagpur during 2008-09. The experiment was laid out in Randomised Block Design with eleven treatments and three replications. The treatments comprised of two herbicides *viz.*, pendimethalin as pre-emergence, oxyfluorfen as pre-emergence and post-emergence with three concentrations each as below-

- Pendimethalin pre-em. @ 1.0, 0.75 and 0.5 kg ha^{-1}
- Oxyfluorfen pre-em. @ 0.2, 0.15 and 0.1 kg ha^{-1}
- Oxyfluorfen post-em. @ 0.1, 0.075 and 0.05 kg ha^{-1}

The herbicide at higher concentration was tested alone, whereas, herbicide with medium concentration was supplemented with one hand weeding at 40 DAP and herbicide with lower concentration was supplemented with two hand weedings at 30 and 60 DAP, one cultural treatment of three hand weedings at 20, 40 and 60 DAP and a control treatment (no weeding).

Uniform size cloves were planted on flat beds. The recommended dose of fertilizer for garlic i.e. 100 kg N ha^{-1} and 50 kg P_2O_5 ha^{-1} was applied. Pendimethalin and oxyfluorfen being pre-emergence herbicide were applied after planting and before emergence of cloves. However, oxyfluorfen being post emergence also was applied 5 days after emergence of plant. Ten plants were selected randomly from each plot for growth and post harvest observations *viz.,* number of monocot and dicot

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weeds m^2, height of plant and leaves $plant^{-1}$ at 120 days after planting, days required for maturity of bulbs, diameter, length and weight of bulb, cloves $bulb^{-1}$ and bulb yield of garlic ha^{-1}. Economics (B:C ratio) of different treatments was also calculated.

RESULTS AND DISCUSSION

The data presented in the table 1 revealed that, significantly minimum monocot weeds (25.33) per m^2 were observed in the cultural treatment of three hand weedings at 20, 40 and 60 days after planting and it was found to be at par with the treatment of pendimethalin (pre-em) @ 0.5 kg ha^{-1} + 2HW (29.33), however, the maximum monocot weeds (144.00) per m^2 were recorded in the control treatment. This might be due to the cultural treatment of three hand weedings which caused the reduction of maximum monocot weed population which was followed by the treatment of pendimethalin (pre-em) @ 0.5 kg ha^{-1} with two hand weedings at 30 and 60 days after planting. Similar reduction in the monocot weed population due to application of herbicide alongwith hand weeding was also reported by Ushakumari *et al.* (2001) and Kumar and Mourya (2006) in onion.

Similarly, significantly minimum dicot weeds (12.00) per m^2 were recorded in the treatment of pendimethalin (pre-em) @ 0.5 kg ha^{-1} + 2HW which was found to be at par with the application of oxyfluorfen (pre-em) @ 0.1 kg ha^{-1} + 2 HW (16.00). However, the maximum dicot weeds (98.73) per m^2 were noticed in the control treatment (T_{11}). This might be due to the better efficacy of pendimethalin in controlling the dicot weeds followed by two hand weedings at 30 and 60 days after planting of garlic. Similar results due to the application of pendimethalin along with one or two hand weedings are reported by Kumar and Mourya (2006) and Warade *et al.* (2008) in onion.

As regards the growth characters, significantly maximum plant height (68.79 cm) and leaves $plant^{-1}$ (9.20) were noted due to an application of pendimethalin (pre-em) @ 0.5 kg ha^{-1}+ 2HW which was found to be at par with the treatment of oxyfluorfen (pre-em) @ 0.1 kg ha^{-1} + 2 HW (68.12 cm), pendimethalin (pre-em) @ 0.75 kg ha^{-1}+ 2HW (67.35 cm) and oxyfluorfen (post-em) @ 0.05 kg ha^{-1} + 2 HW (66.96 cm) in respect of plant height and the treatments *viz.,* oxyfluorfen (pre-em) @ 0.1 kg ha^{-1} + 2 HW (9.03cm), oxyfluorfen (pre-em) @ 0.15 kg ha^{-1} + 2 HW (8.93), oxyfluorfen (post-em) @ 0.05 kg ha^{-1} + 2 HW (8.83) and pendimethalin (pre-em) @ 0.75 kg ha^{-1} + 2HW (8.73) in respect of leaves $plant^{-1}$. However, minimum plant height (60.15 cm) and leaves $plant^{-1}$ (7.13) were recorded in the control treatment. This might be due to minimum weed competition with the main crop due to application of pre emergence spray of pendimethalin @ 0.5 kg ha^{-1} with two hand weedings at 30 and 60 days after planting of garlic cloves which might have favoured maximum utilization of light and more metabolic activities resulted into maximum plant heights and leaves $plant^{-1}$. The results are in agreement with Singh and Nandal (2002) in garlic and Warade *et al.* (2008) in onion who reported that, pendimethalin application when supplemented with one or two hand weedings resulted in significant increase in growth of plants.

Minimum days were required for maturity of garlic bulbs (155.00 days) due to the application of pendimethalin (pre-em) @ 0.5 kg ha^{-1}+ 2HW, whereas, the maximum days were required for maturity of garlic bulb (159.00 days) in the control treatment. This might be due to more accumulation of metabolites synthesized by greater height of plant and maximum number of leaves produced under the treatment pendimethalin (pre-em) @ 0.5kg ha^{-1} supplimented with two hand weedings which might have resulted into early development of garlic bulbs.

In respect of the post harvest parameters of garlic, significantly the maximum diameter of bulb (3.89 cm), length of bulb (3.32 cm), weight of bulb (15.69 g) and cloves $bulb^{-1}$ (18.43) were recorded due to application of pendimethalin (pre-em) @ 0.5 kg ha^{-1} + 2HW. However, the minimum diameter of bulb (3.29 cm), length of bulb (2.65 cm), weight of a bulb (9.65 g), and cloves $bulb^{-1}$ (14.00) were recorded in treatment of no weeding. This might be due to the lowest weed competition throughout the critical crop growth period and loosening of the soil due to hand weedings at 30 and 60 days after planting which might have promoted the better development of bulbs, thus resulted into maximum size and weight of

Table 1. Growth and yield of garlic as affected by integrated weed management

Treatments	Number of monocot weeds (m^2)	Number of dicot weeds (m^2)	Height of plant (cm)	Leaves $plant^{-1}$	Days required for maturity of bulbs	Dia meter of bulb (cm)	Length of bulb (cm)	Number of cloves $bulb^{-1}$	Weight of bulb (g)	Bulb yield of garlic ha^{-1} (q)	B:C ratio
T_1 - (Pendi-Pre-em @1.0 kg ha^{-1})	100.00	50.67	66.02	7.93	157.00	3.81	2.72	17.26	13.43	94.66	2.68
T_2 - (Pendi-Pre-em @ 0.75 kg ha^{-1}+1 HW)	53.34	38.60	67.35	8.83	156.33	3.78	2.87	17.80	14.17	102.66	2.79
T_3 - (Pendi-Pre-em @ 0.5 kg ha^{-1}+ 2 HW)	29.33	12.00	68.79	9.20	155.00	3.89	3.32	18.43	15.69	113.66	2.98
T_4 - (Oxy-Pre-em @ 0.2 kg ha^{-1})	98.52	64.00	64.45	7.90	157.33	3.53	2.72	15.73	13.08	91.00	2.58
T_5 - (Oxy-Pre-em @ 0.15 kg ha^{-1}+1 HW)	81.34	37.35	65.73	8.93	157.66	3.60	2.84	15.95	13.52	95.33	2.57
T_6 - (Oxy-Pre-em @ 0.1 kg ha^{-1}+2 HW)	57.36	16.00	68.12	9.03	156.66	3.84	3.11	18.12	15.26	109.00	2.84
T_7 - (Oxy-Post-em @ 0.1 kg ha^{-1})	99.27	65.02	65.16	7.80	158.66	3.44	2.66	15.43	12.26	86.00	2.48
T_8 - (Oxy-Post-em @ 0.075 kg ha^{-1} + 1 HW)	83.22	43.20	65.71	8.00	158.00	3.48	2.70	16.74	12.35	86.33	2.28
T_9 - (Oxy-Post-em @ 0.05 kg ha^{-1}+2 HW)	61.42	17.45	66.96	8.38	157.33	3.78	3.04	17.91	12.39	104.00	2.65
T_{10} - (Three-Hand weeding s at 20, 40 and 60 DAP)	25.33	31.00	65.55	8.46	155.66	3.75	3.02	16.86	13.82	97.66	2.46
T_{11} - (Control -No weeding)	144.00	98.73	65.15	7.13	159.00	3.29	2.65	14.00	09.65	62.00	1.81
SE (m)	2.24	1.39	0.86	0.23	1.16	0.13	0.03	0.79	0.34	1.28	-
CD at 5%	6.62	4.10	2.53	0.67	3.44	0.38	0.10	2.34	1.00	3.78	-

garlic bulbs. Due to application of herbicide along with hand weeding operation, Mahmmod *et al.* (2002) and Mohammad and Imran (2003) had also reported an improvement in the quality of garlic bulbs.

Similarly, due to the application of pendimethalin (pre-em) @ 0.5 kg ha^{-1}+ 2HW significantly the maximum yield of garlic bulbs ha^{-1} (113.66 q) was produced which was followed by the treatment of oxyfluorfen (pre-em) @ 0.1 kg ha^{-1} + 2 HW (109.00 q) and oxyfluorfen (post-em) @ 0.05 kg ha^{-1} + 2 HW (104.00 q), however, minimum yield of garlic bulbs $hectare^{-1}$ (62.00 q) was recorded in the control treatment. The maximum bulb yield ha^{-1} produced by the treatment T_3 (pendimethalin (pre-em) @ 0.5 kg ha^{-1}+ 2HW) might be due to the better weed control, higher plant population and maximum diameter and weight of bulbs which in turn resulted into the highest $hectare^{-1}$ yield of garlic bulbs. Superiority of pendimethalin alongwith one or two hand weedings for increasing the yield of garlic bulbs was reported by Rameshwar *et al.* (2002) and Warade *et al.* (2008) in onion and Singh *and* Nandal (2002) and Mohammad and Imran (2003) in garlic.

Economics of weed control:

It is evident from the table 1 that, the treatment T_3 (pendimethalin (pre-em) @ 0.5 kg ha^{-1}+ 2HW) proved to be the most profitable over all other treatments in terms of benefit cost ratio (2.98). The other treatments *viz*., oxyfluorfen (pre-em) @ 0.1 kg ha^{-1} + 2 HW and pendimethalin (pre-em) @ 0.75 kg ha^{-1}+ 2HW were found to be the next best treatments in terms of benefit cost ratio (2.84 and 2.79, respectively).

Therefore, It can be inferred that, the treatment of pre-emergence application of pendimethalin @ 0.5 kg ha^{-1} along with two hand weedings at 30 and 60 DAP was found superior in respect of growth parameters and obtaining maximum yield of better quality garlic bulbs.

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EFFECT OF ORANGE PULP EXTRACT ON SENSORY QUALITY, CHEMICAL PROPERTIES AND COST STRUCTURE OF CHAKKA WHEY BEVERAGE

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ABSTRACT

The research work on effect of different combinations of orange pulp extract on sensory quality, chemical properties and cost structure of chakka of whey beverage was conducted during 2009-10 in the department of Animal Husbandry and dairying at College of Agriculture, Nagpur. The different concentrations of orange pulp extract were T_1 (0%), T_2 (5%), T_3 (10%) T_4 (15%) and T_5 (20%). 10 per cent constant rate of sugar was mixed in chakka whey for preparation of beverage. The different levels of orange pulp extract had a definite effect on improving the sensory quality like colour, flavour, consistency and overall acceptability of chakka whey beverage. The score regarding the quality of chakka whey beverage showed that beverage prepared by utilizing chakka whey with 10 per cent orange pulp extract had secured the highest score (8.862) and ranked as most acceptable product. Similarly chemical properties viz., protein, titratable acidity and total solids significantly increased by treatment T_5 (80% chakka whey + 20% orange pulp extract) when compared with control and other remaining treatments but fat content was significantly decreased by the addition of increasing concentration (0-20%) of orange pulp extract. Ash content was increased in treatment T_4 (85% chakka whey + 15% orange pulp extract). Thus, it is inferred that a good quality chakka whey beverage can be prepared by utilizing 90 per cent chakka whey + 10 per cent orange pulp extract and 10 per cent sugar (costing Rs. 15.43 l^{-1}).

(Key words : Chakka whey, orange pulp extract, sensory evaluation, chemical properties, cost structure)

INTRODUCTION

Milk is considered as the most satisfactory an ideal and complete diet in short it is called as "Bank of nutrients". India is the largest milk producing country in the world, during the year 2009-10 it was recorded as 108 million tonnes (Anonymous, 2009).

Whey is obtained as a by product during the preparation of paneer, channa, shrikhand and cheese. It contains 10 per cent of the milk proteins and most of water soluble vitamins, lactose, minerals (Sahu *et al.*, 2005). Chakka whey from cow milk contained minerals like Ca, Mg, P, citrates, Na, K, Cl, Cu, Fe and Zn at 113.80, 10.76, 73.62, 00.00, 38.36, 130.20, 115.27, 0.019, 0.057 and 0.373 mg 100 g^{-1}, respectively (Boghra *et al.*, 1998).

Orange is one of the most common fruit available in India. It contains 1 g protein, 13 g carbohydrate, 6 g fibre, 8-12% TSS, 0.5-1.5% titratable acidity and 50 K cal energy (Bose *et al.*, 2002). Keeping in view the nutritive value of both, the above said research had done to study the effect of different concentrations of orange pulp extract on sensory quality, chemical properties and cost structure of chakka whey beverage.

MATERIALS AND METHODS

The material used and methods applied during the investigation on "effect of orange pulp extract on sensory quality, chemical properties and cost structure of chakka whey beverage" are as follows.

The experiment was conducted in CRD (completely randomized design) with five treatments and four replications during the year 2009-10 at Animal Husbandry and Dairying Section, College of Agriculture, Nagpur.

Analytical grade chemicals were used for chemical analysis of chakka whey beverage. Milk for experiment was collected from dairy farm, College of Agriculture, Nagpur, culture (*Steptococcus cremories* @ 1 per cent) was brought from NDRI Karnal (India) for preparation of dahi, oranges were brought from market, rinds were removed seeds and fibres were also removed and then thoroughly mixed it in juicer to get orange pulp extract for blending it with chakka whey, score card on the basis of 9 point hedonic scale was used for sensory evaluation.

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The milk collected was first standardized @ 4% level of fat then heated at 80ºC for 15 min to avoid contamination, after cooling it was inoculated with 1 per cent *Steptococcus cremories* at 37± 1ºC for preparation of dahi, after preparation of dahi separation of whey was started upto 5-6 hours by tying curd in the muslin cloth. After getting whey 10% sugar was added treatment wise considering its quality. Treatments included different combinations like T_1 (control i.e. 100% chakka whey + no orange pulp extract), T_2 (95% chakka whey + 5% orange pulp extract), T_3 (90% chakka whey + 10% orange pulp extract), T_4 (85% chakka whey + 15% orange pulp extract), T_5 (80% chakka whey + 20% orange pulp extract). The observations were recorded for colour, flavour, consistency and overall acceptability by using score card on the basis of 9 point hedonic scale (Anonymous, 1971). Fat content was determined and recorded (Anonymous, 1977). Total solid was also determined (Anonymous, 1961). Ash content also estimated (Anonymous, 1995). Protein content was estimated by micro-kjeldahl′s method (Anonymous, 1961). Titratable acidity was worked out (Anonymous, 1961). Statistical analysis was done as per method suggested by Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

Colour :

The data from table 1 showed that the mean score for colour of the product during various treatments like T_1 (100% chakka whey + 0% orange pulp extract), T_2 (95% chakka whey + 5% orange pulp extract), T_3 (90% chakka whey + 10% orange pulp extract), T_4 (85% chakka whey + 15% orange pulp extract) were 8.745, 8.642, 8.832, 8.570 and 8.562 respectively. It is observed that highest score of 8.832 was recorded in treatment T_3 (90% chakka whey + 10% orange pulp extract) for colour which was found at par with the score obtained 8.745 in treatment with 100% chakka whey + 0% orange pulp extract. The lowest score of 8.562 was obtained in treatment with 80% chakka whey + 20% orange pulp extract. Similar results were obtained by Babar *et al.* (2008). They observed that the highest score of 8.82 was obtained for colour of chakka whey beverage blended with 90 per cent chakka whey + 15 per cent pomegranate juice and 10 per cent sugar.

Flavour :

The data from table 1 showed that the score obtained for flavour were 8.700, 8.845, 8.905, 8.567 and 8.552 for treatments T_1 (100% chakka whey + 0% orange pulp extract), T_2 (95% chakka whey + 5% orange pulp extract), T_3 (90% chakka whey + 10% orange pulp extract), T_4 (85% chakka whey + 15% orange pulp extract) and T_5 (80% chakka whey + 20% orange pulp extract) respectively. The highest score of 8.905 for flavour was obtained by treatment with 90% chakka whey + 10% orange pulp extract which was at par with the treatment 95% chakka whey + 5% orange pulp extract (8.845). The lowest score of 8.552 was obtained by treatment with 80% chakka whey + 20% orange pulp extract. Similar results were obtained by Sanap (2004). He reported that 6 per cent mango concentrate level in chakka whey scored the highest points 8.50 while 0 per cent mango concentrate level was scored lowest point 6.25 for flavour of beverage.

Consistency :

Consistency is one of the parameter which matters during the preparation of chakka whey beverage. The data from table 1 revealed that the mean score obtained for consistency was 8.630, 8.720, 8.867, 8.477, 8.397 for treatments T_1 (100% chakka whey + 0% orange pulp extract), T_2 (95% chakka whey + 5% orange pulp extract), T_3 (90% chakka whey + 10% orange pulp extract), T_4 (85% chakka whey + 15% orange pulp extract) and T_5 (80% chakka whey + 20% orange pulp extract) respectively. The highest score of 8.867 was obtained for the treatment with 90% chakka whey + 10% orange pulp extract which was at par with the score 8.720 of treatment 95% whey + 5% orange pulp extract. The lowest score of 8.397 was obtained in treatment with 80% whey + 20% orange pulp extract. Similar results were obtained by Babar *et al.* (2008). They noted highest score of 8.82 for consistency in treatment with 15 per cent pomegranate juice in chakka whey beverage with 10 per cent constant rate of sugar.

Overall Acceptability :

The data from table 1 showed that the mean

score obtained for overall acceptability were 8.690, 8.732, 8.862, 8.537, 8.500 for treatments T_1 (100% chakka whey + 0% orange pulp extract), T_2 (95% chakka whey + 5% orange pulp extract), T_3 (90% Chakka whey + 10% orange pulp extract), T_4 (85% chakka whey + 15% orange pulp extract) and T_5 (80% chakka whey + 20% orange pulp extract) respectively. The highest score of 8.862 was obtained in treatment with 90% chakka whey + 10% orange pulp extract which was at par with the score 8.732 obtained during the treatment with 95% chakka whey + 10% orange pulp extract. The lowest score of 8.500 was obtained in the treatment with 80% chakka whey + 20% orange pulp extract. Similar results were obtained by Sanap (2004). He noted that 6 per cent mango concentrate blended with chakka whey with 10 per cent sugar level scored highest point 8.75 in comparison with other treatments while chakka whey beverage without mango concentrate had scored lowest point 7.25 for overall acceptability.

Fat :

The data pertaining to fat content of chakka whey beverage of different levels of orange pulp extract are presented in table 1. The average fat content in chakka whey beverage was significantly affected due to addition of orange pulp extract. The mean fat percentage were 0.262, 0.170, 0.127, 0.117 and 0.062 with treatment T_1 (100% chakka whey + 0% orange pulp extract), T_2 (95% chakka whey + 5% orange pulp extract), T_3 (90% chakka whey + 10% orange pulp extract), T_4 (85% chakka whey + 15% orange pulp extract) and T_5 (80% chakka whey + 20% orange pulp extract) respectively. It indicates that fat content in chakka whey beverage was significantly highest in treatment T_1 (control i.e. 100% chakka whey + 0% orange pulp extract) and lowest in T_5 (80% chakka whey + 20% orange pulp extract). Fat content in chakka whey beverage was decreased as the concentration of orange pulp extract in the beverage increased. Similar observation was recorded by Babar *et al.* (2008). They observed that 0% pomegranate juice contained higher fat (0.256) when compared with rest of the treatments i.e. addition of 10, 15, 20% pomegranate juice respectively under study.

Total solid :

The data pertaining the total solid content of chakka whey beverage by the different levels of orange pulp extract are presented in table 1. The data indicates that average total solid content in the chakka whey beverage was significantly affected due to addition of orange pulp extract. The mean total solid percentage were 11.925, 13.537, 15.224, 16.851, and 18.099 in treatments T_1 (100% chakka whey + 0% orange pulp extract), T_2 (95% chakka whey + 5% orange pulp extract), T_3 (90% chakka whey + 10% orange pulp extract), T_4 (85% chakka whey + 15% orange pulp extract) and T_5 (80% chakka whey + 20% orange pulp extract) respectively. It indicates that total solid content in chakka whey beverage increased with the increase in levels of orange pulp extract. It was observed higher in treatment T_5 (80% chakka whey + 20% orange pulp extract) and lower in treatment T_1 (100% chakka whey + 20% orange pulp extract). Similarly total solid was also decreased in treatments T_4 (85% chakka whey + 15% orange pulp extract), T_3 (90% chakka whey + 10% orange pulp extract) and T_2 (95% chakka whey + 5% orange pulp extract) in a descending manner. The data given in present study is in close agreement with the report published by Sanap (2004). He found highest total solid (20.161) in chakka whey beverage with 6 per cent mango concentrate and 10 per cent sugar. However, minimum total solids (11.922) was found in beverage without mango concentrate.

Ash :

The data pertaining to the ash content of chakka whey beverage by the different levels of orange pulp extract are presented in table 1. It indicated that the ash content in treatment T_1 (100% chakka whey + 0% orange pulp extract), T_2 (95% chakka whey + 5% orange pulp extract), T_3 (90% chakka whey + 10% orange pulp extract), T_4 (85% chakka whey + 15% orange pulp extract) and T_5 (80% chakka whey + 20% orange pulp extract) were 0.430, 0.462, 0.472, 0.477 and 0.510 per cent respectively. The ash content was significantly highest in treatment T_5 (80% chakka whey + 20% orange pulp extract) i.e. 0.510 per cent and the lowest in treatment T_1 (control) i.e. 0.430 per cent. The treatments T_4 (85% chakka whey + 15% orange pulp extract), T_3 (90% chakka whey + 10% orange pulp extract) and T_2 (95% chakka whey + 5% orange pulp extract) also

showed their significance in ash content and significantly increased ash content over control (100% chakka whey + 0% orange pulp extract). Similar observations were recorded by Babar *et al.* (2008). They tested pomegranate juice @ 0, 10, 15 and 20% with 10% sugar mixed in chakka whey for manufacture of beverage and found that ash content of the product increased with the increase in the level of pomegranate juice.

Protein :

The data pertaining to the protein content of chakka whey beverage by the different levels of orange pulp extract are presented in table 1. It is observed from table 1 that protein content in chakka whey beverage ranged from 0.402 to 0.545 per cent. The average protein content were 0.402, 0.470, 0.490, 0.505 and 0.545 per cent in treatments T_1 (100% chakka whey + 0% orange pulp extract), T_2 (95% chakka whey + 5% orange pulp extract), T_3 (90% chakka whey + 10% orange pulp extract), T_4 (85% chakka whey + 15% orange pulp extract) and T_5 (80% chakka whey + 20% orange pulp extract) respectively. The chakka whey beverage with 20 per cent orange pulp extract and 80 per cent chakka whey had highest protein content (0.545%), while chakka whey beverage prepared with 0 per cent orange pulp extract and 100% chakka whey had lowest (0.402%) protein content. Similarly treatments T_4 (85% chakka whey + 15% orange pulp extract), T_3 (90% chakka whey + 10% orange pulp extract), T_2 (95% chakka whey + 5% orange pulp extract) also significantly increased protein content in a descending manner over control (100% chakka whey + 0% orange pulp extract). Similar observations were also reported by Ranade (2003). He tested three levels (0,15 and 20%) of pineapple juice and three sugar levels (10, 15, 20%) in chakka whey beverage blended. The highest per cent of protein was found in treatment containing 20% pineapple juice with 20% sugar.

Titratable acidity :

The data pertaining to the acidity of chakka whey beverage by different levels of orange pulp extract are presented in table 1. It indicates that under different treatments T_1 (100% chakka whey + 0% orange pulp extract), T_2 (95% chakka whey + 5% orange pulp extract), T_3 (90% chakka whey + 10% orange pulp extract), T_4 (85% chakka whey + 15% orange pulp extract) and T_5 (80% chakka whey + 20% orange pulp extract) average acidity content in chakka whey beverage were 0.257, 0.280, 0.320, 0.327 and 0.380 per cent and respectively. It is observed from the data that increasing concentration of orange pulp extract i.e. 0,5,10,15 and 20% also significantly increased titratable acidity of chakka whey beverage and the values were 0.257, 0.280, 0.230, 0.327 and 0.380 respectively. Sanap (2004) studied the chakka whey beverage blended with mango juice with the 0, 2, 4, 6, 8, and 10 per cent and sugar level @ 10 per cent and concluded that chakka whey beverage with mango concentrate had best suited with treatment 6 per cent mango concentrate and 10 per cent sugar. Acidity level of chakka whey beverage of these treatment was 0.720%.

Cost structure of chakka whey beverage (Rs. l^{-1}) :

The data on addition of orange pulp extract in the cost structure of chakka whey beverage prepared under various treatments are presented in table 2. The cost of production of one litre chakka whey beverage was calculated by taking into consideration the prevailing retail market prices for the various items viz., chakka whey, sugar, orange pulp extract, while the other charges such as fuel and labour etc. were worked out on the basis of actual hours of the work performed for the preparation of one litre chakka whey beverage. The data showed that cost of production of one litre chakka whey beverage under various treatments ranged from 7.51 (T_1 100% chakka whey + 0% orange pulp extract) to 23.39 (T_5 80% chakka whey + 20% orange pulp extract). The cost of production of plain chakka whey beverage was considerably less than chakka whey beverage blended with orange pulp extract. Increased level of added orange pulp extract showed the increasing trend in cost of production of chakka whey beverage. These differences were mainly because of variable levels of orange pulp extract. The lowest cost of production of Rs. 7.51 l^{-1} was calculated in case of plain chakka whey beverage treatment T_1 (100% chakka whey + 0% orange pulp extract). However, a best treatment selected by judges was T_3 (90% chakka whey + 10% orange pulp extract) with cost Rs. 15.43 l^{-1}. The cost of production of chakka whey beverage in the best treatment was higher than the plain chakka whey beverage. It was observed that chakka whey beverage with 10 per cent orange pulp extract and 90 per cent chakka whey was superior

Table 1. Effect of different levels of orange pulp extract on colour, flavour, consistency, overall acceptability, fat, total solid, ash, protein and titratable acidity of chakka whey beverage

Treatments	Colour	Flavour	Consistency	Overall acceptability	Fat (%)	Total solid (%)	Ash (%)	Protein (%)	Titratable acidity (%)
T_1 (100% whey + 0% orange pulp extract)	8.745	8.700	8.630	8.690	0.262	11.925	0.480	0.402	0.257
T_2 (95% whey + 5% orange pulp extract)	8.642	8.845	8.720	8.732	0.170	13.537	0.462	0.470	0.280
T_3 (90% whey + 10% orange pulp extract)	8.832	8.905	8.867	8.862	0.127	15.224	0.472	0.490	0.320
T_4 (85% whey + 15% orange pulp extract)	8.570	8.567	8.477	8.537	0.117	16.851	0.477	0.505	0.327
T_5 (80% whey + 20% orange pulp extract)	8.562	8.552	8.397	8.500	0.062	18.099	0.510	0.545	0.380
SE (m)	0.034	0.029	0.037	0.023	0.010	0.021	0.005	0.005	0.008
CD at 5%	0.105	0.090	0.112	0.071	0.033	0.064	0.017	0.016	0.026

Table 2. Estimated cost structure of chakka whey beverage prepared with different levels of orange pulp extract (Rs l^{-1})

Item	T_1 (100% whey + 0% orange pulp extract)		T_2 (95% whey + 5% orange pulp extract)		T_3 (90% whey + 10% orange pulp extract)		T_4 (85% whey + 15% orange pulp extract)		T_5 (80% whey + 20% orange pulp extract)	
	Qty	Value Rs.	Qty	Value Rs	Qty	Value Rs	Qty	Value Rs.	Qty	Value Rs.
Chakka Whey(ml)	1000	0.50	950	0.45	900	0.42	850	0.40	800	0.38
Sugar (g) @ Rs.32 kg^{-1}	100	3.20	100	3.20	100	3.20	100	3.20	100	3.20
Orange pulp (ml) extract (@ Rs 80 l^{-1})	-	-	50	4.00	100	8.00	150	12.00	200	16.00
Fuel charges LPG (g) Rs. 350 (14.2 kg^{-1})	27.66	0.66	27.66	0.66	27.66	0.66	27.66	0.66	27.66	0.66
Labour hour (@ Rs.100 day^{-1}) (Rs.0.21 min^{-1})	15	3.15	15	3.15	15	3.15	15	3.15	15	3.15
Total cost	7.51		11.46		15.43		19.41		23.39	

among all treatments regarding sensory and chemical properties. Similar results were obtained by Sanap (2004). He found that treatment with 6 per cent mango concentrate and 10 per cent sugar blended with chakka whey as a optimum treatment (costing Rs. 9.68 l^{-1}) when compared with other treatment levels with mango concentrates i.e. 0, 2, 4, 8, 10 per cent and sugar @ 10 per cent constant rate. The cost of production of the same treatments were Rs. 4.02, 6.18, 7.84, 11.43 and 13.05 l^{-1} respectively.

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DEVELOPMENT OF GROWTH MODEL FOR PREDICTION OF PRECIPITATION

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ABSTRACT

The study of prediction of precipitation by development of growth model was undertaken at Zonal Agril. Research Station, Sindewahi Distt. Chandrapur (M.S.) for the period (2002-2006) for which daily point rainfall data for a period of 31 years (1970 to 2001) were collected from IMD, Pune and used for probability analysis following Weibulls method. The Logistic model was developed and weekly cumulative precipitation values were predicted and the same were tested with observed precipitation for the period from 2002-2006 at probability level of 25%, 50%, and 75%. The Logestic model gave reliable prediction at 75% probability levels when compared with actual data. It can be used for rainfall prediction while irrigation and crop planning. The cumulative predicted value at 75% probability levels was 1265.81mm and the average observed value for subsequent five years (2002-2006) was 1160.00 mm.

(Key words : Precipitation, Weibull method, logistic model, prediction)

INTRODUCTION

Rainfall varies not only with the time but also with geographical areas. It plays important roles in agricultural and non agricultural operations. Presence and absence of certain amount of rainfall at crucial time can determine the success and failure of venture. Hence, irrigation planning is essential for successful agricultural system. For planning an irrigation water supply system is essential to estimate the irrigation water requirement during different weeks of crop growing period. It will naturally depend upon rainfall in the concerned week and evopo transpiration in the same week. Thus, the information on rainfall which is likely to occur in different weeks is necessary to estimate the irrigation water requirement in concerned weeks. Different growth models are developed by the authors for prediction of precipitation (Prasad,*et al.* 2007 and Gadgil and Shrinivasan,2011). These models are location specific, meaning thereby the constants in these models vary from region to region depending on the rainfall pattern. One such good model is Logistic model. In the present study effort were made to develop Logistic model for Sindewahi Reaserch Station following the standard procedure and test its suitability in this area by comparing it with actual data.

MATERIALS AND METHODS

This study was conducted in the year 2002-2006 at Zonal Agricultural Research Station, Sindewahi, District. Chandrapur (M.S.) for which daily point rainfall data for a period of 31 years (1970 to 2001) were collected from IMD, Pune and transformed into corresponding data of 52 standard meteorological weeks. To develop the constants of logistic model, weekly values of precipitation were arranged in descending order of magnitude. The most commonly used Weibull (1939) formula was applied for probability analysis for each standard meteorological week. The rainfall values were plotted against corresponding computed probability on normal probability paper and for all these weeks the precipitation probability curves were drawn, 1.

The expected precipitation magnitude at 25%, 50% and 75% probability levels were estimated. Afterward the cumulative precipitation at different probability levels were analysed using Logistic model for prediction (Prasad, *et al.*, 2007).

The Logistic model can be expressed as follows.
Where,
Y= Predicted cumulative rainfall
X= Standard week from 1 to 52
a,b,c= Constants

The cumulative rainfall values were chronologically divided into three equal segments. The subtotal of reciprocals of individual observation in each of these segments was obtained. The subtotals were represented in chronological order by S_1,S_2 and S_3. The difference between the subtotals i.e. S_1–S_2 and S_3-S_2 were represented by D_1 and D_2 respectively. Number of observations in each segment is denoted by n.

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The values of constants a,b and c of this model were computed by the relationship given by Mills (1995) as given below.

$$a = \frac{1}{n} S_1 - \left(\frac{d_1}{C^n - 1} \right)$$

$$b = \frac{d_1 (C-1)}{(C^n - 1)^2}$$

$$C = \left(\frac{d_2}{d_1} \right)^{1/n}$$

The mathematical expression for prediction of cumulative rainfall was developed using the values of constants. The suitability of model was studied by computing coefficient of determination and per cent average absolute deviation between the actual cumulative rainfall and its predicted values at different probability levels (Sulochana and Rajeevan, 2005).

RESULTS AND DISCUSSSION

Average weekly precipitation corresponding to each standerd week at probability levels at 25%,50% and 75% worked out using Weibull′s method are given in table l. From the table, it is clear that the precipitation values are sufficiently good for paddy crop from24thMet.Week to 42ndMet.week. (June to Oct.)

These average weekly precipitation values given in table 1 are then converted into weekly cumulative precipitation value and are given in table 2 at different probability levels. From the table, it is very clear that as the average precipitation of Sindewahi station is 1200 mm and the weekly cumulative precipitation at 75% probability is showing closer fit with the average annual precipitation the logistic model for prediction at 75% probability appears reliable. The cumulative precipitation at 25% and 50% probability level is showing prediction at much higher level than the average precipitation of the centre and hence, prediction at 25% and 50% probability levels do not provide reliable prediction.

The values of constants for Logistic model were developed using the method suggested by Mills (1955) from the previous 31 years precipitation data. which was collected from IMD, Pune for Sindhewahi station at different probability levels and are given in the table 3.

Using the Logestic model developed for Sindewahi station the cumulative rainfall values were predicted for all the weeks and at different probability levels of 25%, 50% and 75% and are presented in table 4. From the table 4, it is very clear that when prediction at 25%, 50% and 75% are estimated and observed critically, the prediction at 25% and 50% are at much higher side than the average precipitation of Sindewahi station and the precipitation at 75% probability was showing closer fit with the observed values of precipitation of the same station. Similar model was used by Prasad *et al.* (2007) for monthly prediction.

The suitability of the logistic model developed for Sindewahi station was tested statistically by computing two statistical parameters namely coefficient of determination and per cent average absolute deviation between the observed values and their predicted values.

From the table 5, it is observed that the Logistic model gave the reliable prediction at probability level and hence it can be suitably used for prediction of precipitation in these areas while planning irrigation water management by developing the logistic model with prediction at 75% probability.

The comparison of predicted values of precipitation at 75% probability level was made with average actual precipitation from 2002 to 2006 at Sindewahi station and thereafter average observed values of Sindewahi station of weekly precipitation from 2002 to 2006 were compared with weekly precipitation values at 75% probability level and and presented graphically in figure No. 2.which show good fitting between predicted and actual average values. Similar prediction was made by Sulochana and Shrinivasan (2011).

The predicted values were compared with actual observed values at 75% probability levels for more accurate comparison (Fig. 2). The careful observation of the Fig.2 showed there is closed fitting between predicted values and average observed values.

Table 1. Average weekly precipitation at different probability levels for Sindewahi Station

Met. Week	Dates	Weekly average precipitation at different probabilities in mm		
		25%	*50%*	75%
22	28-03, June	23.33	15.64	9.19
23	04-10, June	67.46	45.86	27.74
24	12-18, June	238.67	179.83	106.89
25	19-24, June	215.08	165.84	114.85
26	25-01, July	443.52	^ 336.06	202.90
27	02-07,July	191.52	136.93	93.59
28	09-15.July	150.12	93.48	36.83
29	16-22, July	234.09	176.37	122.52
30	23-29, July	164.67	129.29	81.50
31	30-05, August	194.18	148.13	108.36
32	06-12, August	192.12	154.84	100.99
33	13-19, August	166.22	103.69	41.16
34	20-26, August	157.52	90.23	22.94
35	27-02, September	112.08	69.05	26.09
36	03-09, September	128.15	97.50	67.70
37	10-16, September	110.04	80.02	44.77
38	17-23, September	125.81	90.55	53.96
39	24-30, September	111.05	84.88	57.23
40	01-07, October	86.67	63.54	40.44
41	08-14, October	116.61	80.61	43.45
42	15-21, October	78.61	49.92	25.26
43	22-28, October	25.52	12.26	0.29
44	29-04, November	5.89	2.55	0.23
45	05-11, November	4.98	3.08	1.55
46	12-18, November	5.15	1.79	0.82
47	19-25, November	4.55	3.93	0.29
48	26-02, December	1.64	0.58	0.089
49	03-09, December	0.95	0.38	0.68
50	10-16, December	20.12	9.06	0.27
51	17-23, December	1.63	0.58	0.63
52	24 31, December	7.57	3.11	0.43

Table 2. Weekly cumulative precipitation at different probability levels for Sindewahi Station

Met. Week	Dates	Weekly cumulative precipitation at different probabilities in mm		
		25%	**50%**	**75%**
22	28-03, June	23.33	15.64	9.19
23	04-10, June	90.79	61.50	36.93
24	12-18, June	329.46	241.33	143.82
25	19-24. June	544.54	407.17	298.67
26	25-01, July	988.04	743.23	461.57
27	02-07, July	1179.58	880.15	555.16
28	09-15, July	1329.70	973.63	591.99
29	16-22. July	1563.79	1150.00	677.68
30	23-29,July	1728.46	1279.29	749.18
31	30-05, August	1922.64	1427.42	867.54
32	06-12, August	2114.76	1582.26	968.53
33	13-19, August	2280.98	1685.95	1009.69
34	20-26, August	2438.50	1776.18	1032.53
35	27-02, September	2550.51	1845.23	1058.72
36	03-09, September	2678.66	1942.73	1126.42
37	10-16, September	2788.70	2022.75	1172.19
38	17-23, September	2914.51	2113.30	1225.15
39	24-30, September	3025.56	2198.18	1282.82
40	01-07, October	3112.23	2261.69	1322.82
41	08-14, October	3228.84	2342.30	1366.27
42	15-21, October	3307.45	2392.22	1391.53
43	22-28, October	3332.57	2404.48	1391.82
44	29-04, November	3338.46	2407.03	1392.05
45	05-11, November	3343.44	2410.11	1393.60
46	12-18, November	3348.59	2411.90	1394.58
47	19-25, November	3353.14	2415.83	1395.40
48	26-02, December	3354.78	2416.41	1395.69
49	03-09, December	3355.72	2416.79	1395.78
50	10-16, December	3375.84	2425.85	1396.40
51	17-23, December	3377.48	2426.43	1396.72
52	24-31, December	3385.04	2429.53	1397.35

Table 3. Values of constants for logistic model at different probability levels for Sindewahi station

Model	Constants	Values of constants at different probability levels		
		25%	**50%**	**75%**
Logistic model	a	0.0003	0.00046	0.00079
	b	0.02143	0.03499	0.0597
	c	0.6481	0.6055	0.5989

Table 4. Predicted Weekly Cumulative Precipitation using Logistic Model for Sindewahi Station at different probability levels compared with mean observed values

Met. Week	Dates	Predicted Weekly cumulative precipitation at different probabilities in mm			Mean observed values
		25%	50%	75%	
23	04-10, June	107.511	75.253	45.038	2.80
24	12-18, June	162.888	121.542	73.451	16.75
25	19-24, June	245.046	193.675	118.056	48.65
26	25-01, July	363.587	302.312	185.533	156.96
27	02-07, July	529.636	457.799	282.098	289.70
28	09-15, July	752.310	664.848	409.854	322.70
29	16-22, July	1034.073	915.580	562.392	399.30
30	23-29, July	1365.532	1186.522	723.702	504.20
31	30-05, August	1723.593	1445.536	873.805	585.99
32	06-12, August	2076.469	1665.707	997.743	679.04
33	13-19, August	2394.140	1834.932	1090.366	737.34
34	20-26, August	2657.648	1955.206	1154.555	803.10
35	27-02, September	2861.785	2036.013	1196.749	861.70
36	03-09, September	3011.712	2088.271	1223.529	893.35
37	10-16, September	3117.565	2121.238	1240.149	960.40
38	17-23, September	3190.234	2141.711	1250.321	1020.90
39	24-30, September	3239.168	2154.300	1256.493	1071.75
40	01-07, October	3271.692	2161.995	1260.218	1100.90
41	08-14, October	3293.122	2166.681	1262.460	1071.25
42	15-21. October	3307.161	2169.528	1263.807	1123.70
43	22-28, October	3316.324	2171.256	1264.615	1146.55
44	29-04, November	3322.290	2172.303	1265.099	1152.30
45	05-11, November	3326.168	2172.938	1265.389	1155.60
46	12-18, November	3328.686	2173.323	1265.563	1156.15
47	19-25, November	3330.320	2173.556	1265.667	1157.30
48	26-02, December	3331.380	2173.697	1265.823	1157.85
49	03-09, December	3332.067	2173.782	1265.767	1158.85
50	10-16, December	3332.512	2173.834	1262.789	1159.50
51	17-23, December	3332.801	2173.865	1265.803	1160.00
52	24-31, December	3332.953	2173.884	1265.811	1160.00

Table 5. Values of Coefficient of determination and per cent average absolute deviation between predicted cumulative precipitation and their observed values using Logistic Model for Sindewahi Station

Model	Coefficient of determination and per cent average absolute deviation at different probability level					
	25%		50 %		75%	
	Coefficient of determination	Per cent average absolute deviation	Coefficient of determination	Per cent average absolute deviation	Coefficient of determination	Per cent average absolute deviation
Logistic Model	0.9640	21.18	0.9521	21.28	0.9465	21.24

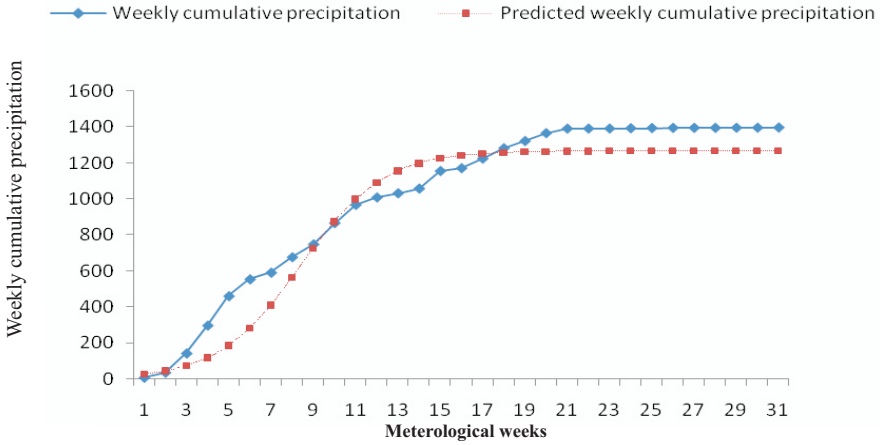

Fig 1. A graph between weekly cumulative precipitation & predicted weekly cumulative precipitation at 75% probability level

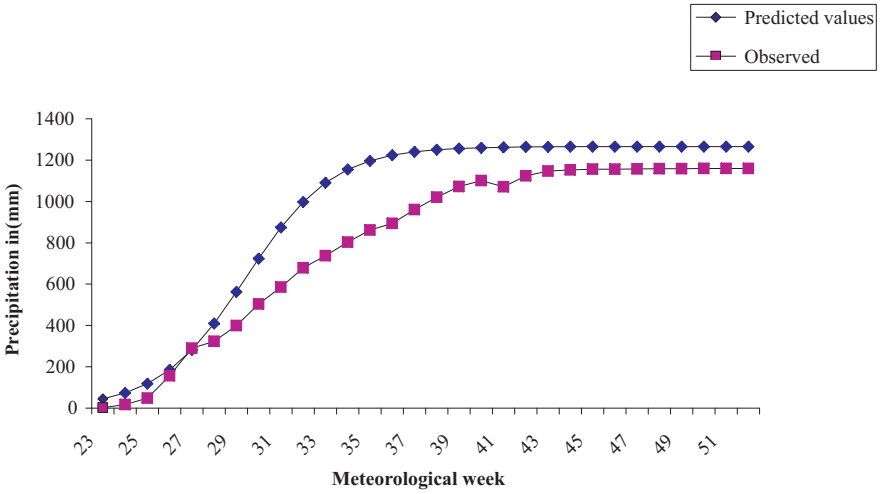

Fig 2. Comparision of predicted and observed values at 75 % probability level by logistic model for Sindewahi station

Table 6. Comparison of predicted and observed of subsequent five years (2002-2006) at 75 % probability level for Sindewahi station

Met. Week	Dates	Predicted values	Observed values
23	04-10, June	45.03841	2.80
24	12-18, June	73.45161	16.75
25	19-24, June	118.0563	48.65
26	25-01, July	185.5331	156.96
27	02-07, July	282.092	289.70
28	09-15, July	409.8548	322.70
29	16-22, July	562.3924	399.30
30	23-29, July	723.7022	504.20
31	30-05, August	873.8055	585.99
32	06-12, August	997.7433	679.04
33	13-19, August	1090.366	737.34
34	20-26, August	1154.555	803.10
35	27-02, September	1196.749	861.70
36	03-09, September	1223.529	893.35
37	10-16, September	1240.149	960.40
38	17-23, September	1250.310	1020.90
39	24-30, September	1256.493	1071.75
40	01-07, October	1260.218	1100.90
41	08-14, October	1262.460	1071.25
42	15-21. October	1263.807	1123.70
43	22-28, October	1264.615	1146.55
44	29-04, November	1265.099	1152.30
45	05-11, November	1265.389	1155.60
46	12-18, November	1265.563	1156.15
47	19-25, November	1265.667	1157.30
48	26-02, December	1265.823	1157.85
49	03-09, December	1265.767	1158.85
50	10-16, December	1265.789	1159.50
51	17-23, December	1265.803	1160.00
52	24-31, December	1265.811	1160.00

Therefore ,logistic model gives reliable prediction of precipitation at 75% probability levels and hence, it can be suitably used for prediction of precipitation in these areas while planning irrigation water management, crop planning, and designing the soil and water conservation structures.

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EFFECT OF FOLIAR SPRAYS OF COW URINE AND NAA ON MORPHO-PHYSIOLOGICAL, CHEMICAL, BIOCHEMICAL PARAMETERS AND YIELD OF SOYBEAN (*Glycine max* L.)

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ABSTRACT

The experiement was conducted to study the effect of two foliar sprays of different concentrations of NAA (50ppm) and cow urine (2%,4%,6%) at 25 and 40 days after sowing on soybean cultivar JS-335. The experiment was laid out in FRBD with three replications with spacing of 30 cm x 10 cm in *kharif* (2005 to 2007). Observations on morpho-physiological (leaf area, dry matter, plant height), chemical (N, P, K) and biochemical (chlorophyll, protein, oil) parameters were recorded at 50 and 70 days after sowing. Observations on number of pods plant^{-1}, 100 seed weight, seed yield plot^{-1} and seed yield hectare^{-1} were also recorded after harvesting. Pooled analysis was done after completion of three years experiment. Considering the cow urine concentrations 6% cow urine spray and 50 ppm NAA alone and in combination were found more effective in enhancing the morpho-physiological, chemical biochemical and yield and yield contributing parameters when compared with control.

(Key words: Soybean, cow urine, NAA, foliar spray, morpho-physiological, chemical, biochemical parameters)

INTRODUCTION

Soybean (*Glycine max* L. Merril) descirbed as the wonder legume and oil seed crop of India. Soybean belonging to the family 'leguminoceae', sub family "Papilionoidae" and genus glycine having chromosome number 2n=40.

Soybean is a treasure of nutrients and manifold uses in agriculture, medicine and industrial sectors. Soybean contains about 40% good quality protein and 20% cholesterol free oil, 21% carbohydrates, 0.69% phosphorous, 0.024% calcium, 0.0115% iron and all other amino acids. It has highest content of lycine (5%) in which most of the cereals are deficient. It is the rich source of minerals and vitamins and has high caloric value. It is an exception among pulses because of its use in milk production. The biological value of soybean protein is a good as that of meat and fish protein and thus, serves as a good source of supplementing the traditional protein and calories. The oil extracted from the seed is being used for culinary purpose. Soybean is used as a fodder, forage as it serves as an excellent nutritive foods for livestock and poultry and it helps in maintaining the soil fertility by fixing the atmospheric nitrogen (65 to 100 kg ha^{-1}) in the soil through root nodules.

Considering the importance of soybean from nutritional and production point of view, it becomes necessary to cultivate soybean crop with expectation of higher yield. The crop productivity can be increased through physiological approaches by co-ordinating plant process to synthesize dry matter and partitioning its major quantum of effective yield contributing factors. The yield of soybean may be enhanced through physiological manipulations such as foliar application of cow urine and NAA.

The experiment consists of the use of organic manure in the form of cow urine and synthetic auxin i.e. NAA. In India the cattle population is enough and large quantity of cow urine is produced. Use of only inorganic fertilizers in the filed is not enough to produce higher yield. Use of organic manures is also required for sustainable agriculture. NAA is also readily available so there is no problem of getting it. The organics can improve soil condition and its foliar spray is beneficial for improving growth of the plant. These sources are readily available. Large amount of cow urine get washed so it can be profitably used in the field.

In India area under soybean crop was 93.63 lakh hectares with the production of 101.28 lakh metric tons and productivity was 1089 kg ha^{-1}. In Vidarbha area under soybean crop was 15.51 lakh hectares with the production of 16.38 lakh metric tons and productivity was 1054 kg ha^{-1} (Anonymus, 2010).

Considering the above facts present investigation was under to investigate the effect of cow urine and NAA on morpho-physiological, chemical, biochemical parameters and yield of soybean.

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MATERIALS AND METHODS

Experiment was laid out in FRBD with three replications consisting of two levels of NAA (0 and 50 ppm) and four levels of cow urine (0, 2%, 4%, 6%). Seeds were sown by dibbling at spacing of 30 x 10 cm. The experiment was conducted in *kharif* from year 2005 to 2007. Soybean cultivar JS-335 was tested. Spraying of NAA and cow urine alone and in combination was done at 25 and 40 days after sowing. Observations on morpho-physiological parameters viz., plant height at maturity, leaf area, dry matter, leaf chlorophyll, NPK content in leaves were recorded at 50 and 70 days after sowing. Protein and oil content in seed were also estimated after harvesting. Observations on 100 seed weight, number of pods plant^{-1} , seed yield plot^{-1} and hectare^{-1} were also recorded. Chlorophyll was estimated by colorimeter as per method suggested by Bruinsma (1982). Nitrogen content in leaves and protein content in seed was determined by micro-kjeldahl's methods given by Somichi *et al.* (1972). Phosphorus content in leaves as determined by vando molobdate yellow colour method given by Jackson (1967). Potassium content in leaves was determined by flame photometer by diacid extract method given by Jackson (1967). Oil content in seed was estimated by ether extraction method (soxhlet extractor method) as outlined by Sankaram (1965).

RESULTS AND DISCUSSION

Plant height :

Data regarding plant height was found statistically significant. Significantly more plant height was noticed in 6% cow urine spray. Next to this treatment were 4% cow urine and 2% cow urine when compared with control. Similarly foliar application of 50 ppm NAA also increased plant height significantly over control. Interaction between NAA and cow urine were found non-significant.

Leaf area :

Leaf area play a key role in absorption of radiation in the deposition of photosynthesis during the diurnal and seasonal cycles and in the pathways and rates of bio-gieochemical cycling within the canopy soil systems. Leaf area depends on the number and size of leaves and hence, the total leaf area is an important parameter for assessing the ability of plant to synthesis its dry matter. The photosynthetic capacity of plant is a function of leaf area development.

Leaf area recorded at 50 and 70 days after sowing gave a significant results. At 50 days after sowing significantly maximum leaf area was found in 6% cow urine spray when compared with control and other remaining treatments. Similarly 4% and 2% cow urine spray also increased leaf area over control at this stage. Foliar application of 50 ppm NAA also increased leaf area significantly over control at 50 days after sowing. Similar results were also obtained by Ingale (2007). He tried foliar sprays of 2,4 and 6% cow urine and 50 ppm NAA alone and in combination on black gram and found increase in leaf area. At this stage interactions were found non-significant. Data regarding leaf area at 70 days after sowing also showed significant variation. Near about similar trend was noticed as recorded at 50 days after sowing. But interactions between NAA and cow urine was found significant.

Dry matter :

Dry matter plant^{-1} was recorded at 50 and 70 days after sowing. Dry matter was significantly increased at these stages, all the treatment were found significantly superior over each other and over control also at both the stages of observations. At 50 to 70 days after sowing foliar application of 6% cow urine produced significantly more dry matter over control and rest of the treatments under observation. Similarly foliar application of 50 ppm NAA resulted in more dry matter over control. Deogirkar (2010) also reported that foliar spray of cow urine and NAA alone and in combination significantly increased dry matter production of chick pea. Interaction between NAA and cow urine was found significant at both the stages of observations. The treatment receiving foliar spray of cow urine and NAA increased growth (plant height and leaf area) and it might have contributed for increasing photosynthesis potential of the plant and ultimately resulted in increased dry matter production in the present investigation.

Chlorophyll content :

Chlorophyll in the green pigment present in

leaf and playing main role in photosynthetic activity and there by increasing the weight of the plant. It is revealed from the data that foliar application of NAA and cow urine significantly increased chlorophyll content in leaf in treatment 6% cow urine spray at both the stages of observations. Next to this treatment were 4% and 2% cow urine spray, in these treatments chlorophyll content was also significantly more when compared with control. Similarly 50 ppm NAA spray also enhanced chlorophyll over control of 50 and 70 days after sowing. Interaction between NAA and cow urine was also found significant at both the stages of observations.

In young stages plant may be able to uptake more nutrients from soil than the older one. The increase in chlorophyll might be due to increased uptake of N and other nutrients in early stage of plant growth. The proper function of N in plant nutrition requires that the other essential elements particlarly P, K, Ca and Mg be present in adequate supply. The foliar application of cow urine gave these additional nutrients to crop and this might have accelerated chlorophyll synthesis. Application of growth hormones like IAA and NAA also accelerated the uptake of nutrients in groundnut (Sagare and Naphade, 1987). Kumavat and Mahajan (2009) concluded that the foliar application of panchagavya + neem leaf extract increased chlorophyll nutrient content and nitrate reductase activity in groundnut.

N content in leaves :

Nitrogen is a important constituent of protein and protoplasm and essential for plant growth. Nitrogen deficiency causes chlorosis and malfunctioning of the photosynthesis process. Plant cells require adequate supply of N for normal cell division and growth of the plant. Tender shoots, tip of shoots, bud, leaves contains high nitrogen content. The data obtained about nitrogen content in leaves are given in table 1. It is observed from the data that there was significant increase in leaf nitrogen due to foliar sprays of cow urine at various concentrations (i.e. 6, 4 and 2% in a descending manner) and growth hormone NAA (50 ppm) at 50 and 70 days after sowing. Considering the concentration of cow urine, N content was maximum due to foliar sprays of 6% cow urine over rest of treatments and control. It was also significantly maximum in 4% cow urine when compared with control and 2% cow urine treatment at both the stages of observations. Similarly application of 50 ppm NAA significantly increased N content in leaves at 50 and 70 days after sowing.

From this data it is observed that leaf nitrogen content was maximum at 50 days after sowing and reduced thereafter at 70 days after sowing. The decrease in nitrogen content at later stage might be due to fact that younger leaves and developing organs such as seeds act as strong sink demand and may draw heavily nitrogen from older leaves (Gardner *et al.,* 1988). Thakare *et al.* (2006) reported that foliar application of 6% cow urine + 2% DAP or urea with 50 ppm NAA or IAA increased leaf nitrogen content in soybean.

P content in leaves :

The data with respect to phosphorous content in leaves are tabulated in table 1. Phosphorus content in leaves was significantly increased by 50 ppm NAA at 50 and 70 days after sowing. It was known that growth hormone increases the uptake of nutrients from soil and also increases metabolic activity in the plant cell (Sagare and Naphade, 1987).

Data regarding foliar application of cow urine at different concentrations was found non-significant. Interactions among NAA and cow urine were also found non significant.

K content in leaves :

Potassium content in leaves at 50 and 70 days after sowing was significantly increased by the application of 50 ppm NAA over control. Similarly different concentrations of cow urine had shown their significance over control in respect of K content in leaves. It was significantly maximum at 6% cow urine followed by 4 and 2% cow urine spray at both the stages of observations. Interactions were also found significant.

It was observed that potassium content was significantly maximum at 50 days after sowing but at 70 days after sowing it was decreased. The decrease in potassium content might be due to diversion of potassium towards developing pods of soybean. Thakare *et al.* (2006) observed that foliar application of 6% cow urine and 2% DAP or urea with 50 ppm NAA or IAA significantly increased leaf potassium content in soybean when compared with control.

Protein and oil content in seed :

Although quality of crop products such as protein, oil and sucrose content and appearance are genetically controlled. The nutrition of plants can have considerable impact on the expression of quality. It is therefore, essential to judiciously take care on the nutrient supply at grain formation stage. Protein and oil content of the seed are one of the considerable factors for seed quality determination

Table 1. Effect of foliar sprays and of cow urine and NAA on morpho-physiological parameters of soybean (Pooled mean of 3 year)

Treatments	Height (cm)	Leaf area (dm^2)		Dry matter (g)		Chlorophyll content (mg g^{-1})		N content in leaves (%)		P content in leaves (%)		K content in leaves (%)	
		50 DAS	70 DAS	50 DAS	70 DAS	50 DAS	70 DAS	50 DAS	70 DAS	50 DAS	70 DAS	50 DAS	70 DAS
NAA Levels													
0 ppm NAA (water spray)	30.02	6.22	9.37	5.10	13.74	1.42	1.17	3.00	2.05	0.42	0.64	1.57	1.19
50 ppm NAA	34.80	7.36	11.32	5.96	16.96	1.51	1.24	3.24	2.42	0.50	0.76	1.81	1.31
SE (m) ±	0.29	0.57	0.11	0.05	0.23	0.0018	0.0005	0.005	0.010	0.0027	0.006	0.017	0.003
CD at 5%	0.80	1.41	0.30	0.14	0.63	0.0051	0.0015	0.014	0.028	0.0076	0.017	0.047	0.008
Cow Urine Level													
Cow Urine 0% (water spray)	29.88	6.09	9.46	5.06	14.07	1.43	1.18	3.02	2.07	0.43	0.65	1.60	1.19
Cow Urine 2%	32.00	6.71	10.19	5.42	14.70	1.46	1.20	3.06	2.18	0.45	0.68	1.65	1.23
Cow Urine 4%	32.94	6.96	10.76	5.65	15.62	1.48	1.22	3.17	2.27	0.47	0.72	1.71	1.26
Cow Urine 6%	34.83	7.39	10.98	5.98	17.02	1.50	1.23	3.23	2.40	0.49	0.75	1.79	1.31
SE (m) ±	0.31	0.11	0.11	0.06	0.20	0.0018	0.0009	0.006	0.014	0.0038	0.007	0.012	0.005
CD at 5%	0.86	0.30	0.30	0.17	0.56	0.0051	0.0026	0.018	0.039	–	–	0.034	0.015
Interaction													
SE (m) ±	0.41	0.12	0.16	0.30	0.14	0.0018	0.001	0.016	0.017	0.005	0.010	0.010	0.007
CD at 5%	–	–	0.44	0.83	0.39	0.0052	0.003	0.044	–	–	–	0.027	0.020
CV %	3.58	5.04	4.47	15.20	2.60	0.37	0.28	1.47	2.19	3.19	4.07	1.68	1.65

Table 2. Effect of foliar spray and of cow urine and NAA on quality aspects, yield and yield contributing parameters of soybean (pooled mean of 3 years)

Treatments	Protein content in seeds (%)	Oil content in seeds (%)	100 seed weight (g)	No. of pods plant^{-1}	Seeds yield plot^{-1} (kg)	Seeds yield ha^{-1} (q)
NAA Levels						
0 ppm NAA (water spray)	32.72	16.62	8.69	33.47	1.466	15.28
50 ppm NAA	36.72	18.57	9.54	41.44	1.670	17.40
SE (m) ±	0.09	0.05	0.06	0.29	0.012	0.12
CD at 5%	0.26	0.15	0.16	–	0.035	0.36
Cow Urine Level						
Cow Urine 0% (water spray)	33.12	16.71	8.83	34.44	1.494	15.57
Cow Urine 2%	34.24	17.42	8.98	36.50	1.528	15.92
Cow Urine 4%	35.36	17.96	9.21	38.33	1.574	16.40
Cow Urine 6%	36.20	18.30	9.43	40.55	1.675	17.45
SE (m) ±	0.13	0.09	0.05	0.57	0.014	0.14
CD at 5%	–	0.26	0.15	1.58	0.039	0.41
Interaction						
SE (m) ±	0.18	0.14	0.08	0.60	0.016	0.17
CD at 5%	–	0.39	–	–	0.045	0.47
CV %	1.47	2.26	2.50	4.50	2.97	2.97

also. The data regarding protein and oil content in seed are given in table 2.

Protein and oil content in seed significantly enhanced by the foliar sprays of 50 ppm NAA over control. Foliar application of cow urine with increasing concentrations significantly enhanced oil content in seed when compared with control. Interactions among NAA and cow urine were found significant in oil content in seed only.

Yield and yield contributing parameters :

The significant variation in yield and yield contributing parameters were evident due to application of various levels of cow urine and 50 ppm NAA. Significantly maximum 100 seed weight, number of pods plant^{-1} and plot^{-1} were recorded by the application of 6% cow urine followed by 4% cow urine when compared with control. Similarly application of 50 ppm NAA also increased 100 seed weight and seed yield plant^{-1} and hectare^{-1} significantly when compared with control. Interaction between cow urine spray with 50 ppm NAA was found significant and it was significantly more in treatment 6% cow urine + 50 ppm NAA spray.

Foliar application of cow urine at various concentrations provides sufficient supply of N,P,K which not only plays a key role in growth of the plant but also improves pod quality and yield of crop. The foliar application of N,P,K maintain leaf nutrition in photosynthesis, enhances N,P,K content and carbon balance and delays abscission ultimately resulting in increase in yield and yield attributes (Boote *et al.,* 1978).

Auxins like NAA are such a plant growth regulator which can manipulate a variety of growth and development phenomenon in various crops. A foliar application of IAA has been found to increase fruit size with consequent enhancement in seed yield in different crops like groundnut (Lee, 1990).

The above data gives clear view that 6% cow urine and 50 ppm NAA assures significantly better results. As these treatments were given through foliar sprays, the observed superiority might be due to foliar feeding of major nutrient like N,P,K to plant through cow urine and NAA. When nutrients required by the plant are applied through foliage, there is enhancement in uptake, translocation and synthesis of photosynthetic assimilates which results into increase in various plant growth characters such as plant height, leaf area, total dry matter, chlorophyll content, which ultimately results into increase in seed yield (number of pods plant^{-1} , 100 seed weight, seed yield plant^{-1} and plot^{-1} etc). These might be the reasons responsible for spectacular increase in overall seed yield of soybean in the present investigation.

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OBITURY

PROFESSOR U. M. SHITOLE (1938-2011)

Prof. Uttam Madhaorao Shitole, one of the most distinguished Professor of Agronomy and Founder member of Journal of Soil and Crops, expired on May 19, 2011 after a short illness at his residence in Nagpur.

Born on November 24, 1938 at Virwada Dist. Akola. Professor Shitole obtained his B.Sc. (Agri.) degree from Nagpur University, Nagpur in 1965 and M.Sc. (Agri) from Dr. Panjabrao Deshmukh Krishi Vidyapeth (Dr. P.D.K.V.), Akola in 1978. He served in various capacities since 1966 viz., Agril. officer, Senior Research Assistant, Asstt. Professor and Associate Professor of Agronomy in Agriculture Department and Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. He had about 25 years of teaching experience to Under Graduate and Post Graduate students at Agriculture College Nagpur and Akola. He guided about 15 M.Sc. (Agri) students and contributed 20 research papers.

Prof. Shitole would always be remembered for his kindness, courtesy and simplicity. He is survived by his wife, three daughters and one son.

We all pray to almighty that his soul may rest in eternal peace and give strength and solace to members of his family to bear this bereavement.

All Founder Members
Association of Soil and
Crops Research Scientists,
Nagpur (MS) India

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