Volume 34 Number 3 September, 2009 ISSN 0378-2395

Journal of Maharashtra Agricultural Universities

CONTENTS

PUBLICATION OF THE
MAHATMA PHULE KRISHI VIDYAPEETH, RAHURI,
DR. PANJABRAO DESHMUKH KRISHI VIDYAPEETH, AKOLA,
MARATHWADA AGRICULTURAL UNIVERSITY, PARBHANI AND
DR. BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH, DAPOLI, M.S. (INDIA)

RESEARCH NOTES

J. Maharashtra agric. Univ., 34 (3) : 245-248 (2009)

Influence of Integrated Nutrient Management on Growth and Yield of Potato Preceded by Cereals and Legumes*

M. S. Shirole[1], A. V. Solanke[2] and S. H. Kharbade[3]
Mahatma Phule Krishi Vidyapeeth, Rahuri - 413 722 (India)
(Received : 12-07-2008)

ABSTRACT

Among the preceding cereals and legumes in a potato based cropping sequence, the growth of potato was significantly higher in soybean as a preceding crop. It also recorded the highest tuber yield on pooled mean basis. An application of 75 per cent RDF + 25 per cent N through FYM recorded higher growth and tuber yield on pooled mean basis.

Key words : Potato, growth characters, yield.

Potato can be grown in wide range of climatic conditions and soil types. In potato based cropping systems several pulses and oilseed crops are likely to fit well. This leads to crop diversification and may also improve the overall productivity (Roy *et al*. 1999). Organic matter restoration in soil is important for enhancing crop production, sustaining biological health and maintaining carbon status. Organic manures alone cannot satisfy the crop nutrient requirements. Chemical fertilizers contain higher nutrients than organic manures and release nutrients almost immediately. For better utilization of resources and to produce high yields of crops, integrated nutrient management is the best approach. With this background in view, the present investigation was undertaken.

MATERIALS AND METHODS

The field experiment on potato preceded by pearlmillet, maize, soybean and groundnut was conducted during 2003-04 and 2004-05 at Mahatma Phule Krishi Vidyapeeth, Rahuri. The soil was sandy clay loam having pH 8.20, E.C. 0.13 dSm^{-1}, bulk density 1.34 gcc^{-1} and having available N, P, K, 220.45, 21.80 and 309.95 kg ha^{-1}, respectively. The first experiment on cereals and legumes conducted during *kharif* season was laid out in split plot design with four main plot treatments replicated thrice. The recommended dose of fertilizer for pearlmillet; maize, soybean and groundnut was 60:30:30, 120:60:60, 50:75:0 and 25:50:0 NPK kg ha^{-1} respectively. For pearlmillet and maize, half dose of N and full dose of P and K was applied as basal dose and the remaining half dose of N was applied as top dressing 30 DAS as per the treatments whereas, for soybean and groundnut the recommended dose of fertilizer was applied in full at the time of sowing. The gross plot and net plot sizes were 3.60 x 4.80 m^2 and 2.40 x 3.60 m^2 respectively. The varieties used for pearlmillet, maize, soybean and groundnut were Shraddha, African Tall, JS - 335 and TG - 26, respectively.

They were sown at spacing of 45 x 15, 60 x 20, 30 x 10 and 30 x 10 cm, respectively. The second experiment on potato was conducted during rabi season as sub plot. The treatments applied to potato were 50 per cent RDF + 50 per cent N through FYM, 75 per cent RDF + 25 per cent N through FYM, 75 per cent RDF and 100 per cent RDF. The recommended dose of fertilizer for potato was 120:60:120 NPK kg ha^{-1}. Half dose of N and full dose of P and K was applied as basal dose and the remaining half dose of N was applied as top dressing 30 DAS as per the treatments. Potato crop variety Kufri Jyoti was planted at spacing of 60 x 20 cm.

RESULTS AND DISCUSSION

Growth characters : It is evident from the data presented in Table 1 that, the plant height and number of branches of potato were not significantly influenced during both the years. Potato preceded by soybean recorded the highest number of leaves $plant^{-1}$ (49.54 and 50.12 during 2003-04 and 2004-05, respectively). It was at par with potato preceded by groundnut and significantly superior over rest of the crops during 2003-04, while during 2004-05, it was significantly superior over rest of the crops. Potato preceded by soybean recorded the highest leaf area (23.34 and 24.54 dm^2 during 2003-04 and 2004-05, respectively). It was at par with

* Part of Ph. D. thesis submitted by the senior author to M.P.K.V., Rahuri.

1. and 3. Ph. D. students 2. Associate Professor of Agronomy.

Table 1. Effect of preceding crops on growth of potato at harvest.

Treatment	Plant hieght (cm)		Branches plant^{-1}		Leaves plant^{-1}		Leaf area plant^{-1} (dm^2)		Plant spread plant^{-1} (cm)		Total dry matter plant^{-1} (g)	
	03-04	04-05	03-04	04-05	03-04	04-05	03-04	04-05	03-04	04-05	03-04	04-05
Preceding crops :												
Pearlmillet	40.32	42.24	12.07	12.35	46.22	46.07	19.73	20.73	56.63	55.61	50.39	62.10
Maize	40.10	41.70	11.65	12.18	45.49	44.73	18.36	20.00	55.81	54.53	45.96	57.51
Soybean	41.20	42.54	12.20	12.40	49.54	50.12	23.34	24.54	62.92	61.23	64.20	70.57
Groundnut	40.31	41.98	11.83	12.25	48.62	48.80	21.98	22.81	61.35	60.82	58.17	65.74
S. E.±	0.64	0.84	0.18	0.16	0.30	0.08	0.53	1.14	0.06	1.23	2.76	1.13
C. D. at 5%	N. S.	N. S.			1.04	0.29	1.83		0.21	4.25	9.54	3.89
Fertilizer levels (%) :												
50 RDF + 50 N (FYM)	40.48	41.86	11.87	12.20	47.04	46.52	19.72	20.98	59.07	57.87	54.38	67.21
50 RDF + 50 N (FYM)	40.76	42.48	12.07	12.47	48.96	48.92	22.74	23.87	61.87	60.65	57.07	69.82
75 RDF	40.01	41.74	11.78	12.17	46.02	46.28	19.43	20.55	56.79	56.62	46.87	57.06
100 RDF	40.68	42.37	12.0.3	12.35	47.85	48.00	21.52	22.68	58.99	57.05	60.39	61.83
S. E.±	0.71	0.71	0.18	0.20	0.37	0.92	0.46	0.23	0.68	1.51	2.51	1.69
C. D. at 5%	N. S.	N. S.	N. S.	N. S.	1.08	N. S.	1.83	0.66	1.98	N. S.	7.32	4.92
Interaction :												
S. E.±	1.42	1.43	0.36	0.39	0.74	1.48	0.91	0.45	1.35	3.01	5.01	3.37
C. D. at 5%	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	9.84
Mean	40.48	42.12	11.94	12.30	47.47	47.43	20.85	22.02	59.18	58.05	54.68	63.98

potato preceded by groundnut and significantly superior over rest of the crops during 2003-04 while, during 2004-05 it was at par with rest of the crops. Potato preceded by soybean recorded the highest plant spread (62.92 and 61.23 cm during 2003-04 and 2004-05, respectively). It was significantly superior over rest of the crops during 2003-04 while, during 2004-05 it was at par with potato preceded by groundnut and significantly superior over rest of the treatments. Potato preceded by soybean recorded the highest total dry matter (64.20 and 70.57 g during 2003-04 and 2004-05, respectively). It was at par with potato preceded by groundnut and significantly superior over rest of the treatments during 2003-04 while, during 2004-05 it significantly superior over rest of the treatments. This might be due to better availability of N under legume crop. Similar results were also obtained by Griffin and Hesterman (1991).

The plant height and number of branches were not significantly influenced during both the years. Application of 75 per cent RDF + 25 per cent RDF through FYM recorded the highest number of leaves plant^{-1} (48.96 and 48.92 during 2003-04 and 2004-05, respectively). It was significantly superior over rest of the treatments during 2003-04, while during 2004-05 it was at par with rest of the treatments. Application of 75 per cent RDF + 25 per cent RDF through FYM recorded the highest leaf area plant-1 (22.74 and 23.87 dm^2 during 2003-04 and 2004-05, respectively). It was at par with 100 per cent RDF and significantly superior over rest of the treatments during 2003-04 while, during 2004-05 it was significantly superior over rest of the treatments. Application of 75 per cent RDF + N through FYM recorded the highest plant spread (61.87 and 60.65 cm during 2003-04 and 2004-05, respectively). It was significantly superior over rest of the treatments during 2003-04 while, during 2004-05 it was at par with rest of the treatments. Application of 100 per cent RDF recorded the highest total dry matter (60.39 g) during 2003-04 and it was at par with 75 per cent RDF + 50 per cent N through FYM and 50 per cent RDF + 50 per cent N through FYM. During 2004-05, the highest total dry matter (69.82 g) was recorded with application of 75 per cent RDF + 25 per cent N through FYM it was at par with 50 per cent RDF + 50 per cent N through FYM and significantly superior over rest of the treatments. Similar results were

Table 2. Yield of preceding crops and its effect on yield of potato.

Treatment	Yield of preceding crops (q ha^{-1})		Straw yield of preceding crops (q ha^{-1})		Tuber yield of potato (q ha^{-1})			Haulm yield of potato (q ha^{-1})		
	03-04	04-05	03-04	04-05	03-04	04-05	Pooled mean	03-04	04-05	Pooled mean
Preceding crops :										
Pearlmillet	22.30	23.20	41.48	43.32	145.57	184.49	165.00	7.11	7.29	7.20
Maize	25.54	26.86	107.58	115.84	133.51	170.77	152.14	7.08	7.27	7.18
Soybean	23.99	26.15	24.68	28.76	187.28	208.64	197.96	8.43	7.53	7.98
Groundnut	21.08	22.46	32.68	34.81	156.14	197.09	176.61	8.40	8.23	8.32
S. E.±	-	-	-	-	9.91	3.60	6.19	0.08	0.13	0.10
C. D. at 5%	-	-	-	-	34.30	12.47	21.43	N. S.	0.48	0.32
Fertilizer levels (%) :										
50 RDF + 50 N (FYM)	-	-	-	-	158.29	200.27	179.28	7.65	7.51	7.58
75 RDF + 25 N (FYM)	-	-	-	-	163.80	206.88	185.34	7.90	7.67	7.79
75 RDF	-	-	-	-	134.59	168.19	151.39	7.71	7.25	7.48
100 RDF	-	-	-	-	165.77	185.65	175.71	7.75	7.89	7.82
S. E.±	-	-	-	-	8.18	6.20	5.25	0.11	0.10	0.10
C. D. at 5%	-	-	-	-	23.89	18.10	15.31	N. S.	N. S.	N. S.
Interaction :										
S. E.±	-	-	-	-	16.37	12.40	10.49	0.21	0.20	0.20
C. D. at 5%	-	-	-	-	N. S.	36.21	30.62	N. S.	N. S.	N. S.
Mean	-	-	-	-	155.61	190.25	172.93	7.75	7.58	7.67

obtained by Raj wade *et al.*, (2000) and Saxena *et al*., (2001).

Yield : It is evident from data presented in Table 2 that, potato preceded by soybean recorded the highest tuber yield (187.28, 208.64 and 197.96 q ha^{-1} during 2003-04, 2004-05 and on pooled mean basis, respectively), which was at par with potato preceded by groundnut during both the years and on pooled mean basis. Similar results were obtained by Grewal and Sharma (1981). During 2003-04, 100 per cent RDF recorded the highest tuber yield (165.77 q ha^{-1}). It was at par with 75 per cent RDF + 25 per cent N through FYM and 50 per cent RDF + 50 per cent N through FYM. During 2004-05, 75 per cent RDF + 25 per cent N through FYM recorded the highest tuber yield

Table 3. Economics of potato preceded by cereals and legumes (pooled mean).

Treatment	Gross monetary returns (Rs ha^{-1})	Net monetary returns (Rs ha^{-1})	Benefit: cost ratio
Preceding crops :			
Pearlmillet	80395	31684	1.62
Maize	80315	26746	1.50
Soybean	120251	58251	1.94
Groundnut	122087	58668	1.92
S. E.±	2478	2478	0.04
C. D. at 5%	8572	8572	0.15
Fertilizer levels (%) :			
50 RDF + 50 N (FYM)	103302	45666	1.78
75 RDF + 25 N (FYM)	105726	46001	1.74
75 RDF	92146	37586	1.68
100 RDF	101874	46118	1.81
S. E.±	2098	2098	0.04
C. D. at 5%	6124	6124	N. S.
Interaction :			
S. E.±	4197	4197	0.08
C. D. at 5%	12248	12248	N. S.
Mean	100762	43843	1.75

(206.88 q ha^{-1}) it was at par with 50 per cent RDF + 50 per cent N through FYM and significantly superior over rest of the treatments. On pooled mean basis 75 per cent RDF + 25 per cent N through FYM recorded the highest tuber yield (185.34 q ha^{-1}) it was at par with 50 per cent RDF + 50 per cent N through FYM and 100 per cent RDF.

This might be due to the fact that groundnut and soybean being leguminous crop, there was addition of nitrogen and organic matter enhancing the availability of nitrogen, phosphorus and potassium that ultimately increased the potato yield in a sequence (Mondal and Roy, 2001). Similar results were obtained by Roy *et al*. (1999) and Singh and Sharma (2002). Potato preceded by soybean recorded the highest haulm yield (8.43 q ha^{-1}) during 2003-04 and it was at par with rest of the treatments. While, during 2004-05 and on pooled mean basis potato preceded by groundnut recorded the highest haulm yield (8.23 and 8.32 q ha^{-1} respectively). It was significantly superior over rest of the treatments. Fertilizer levels did not significantly influence the haulm yield. Similar results were obtained by Griffin and Hesterman (1991).

The potato preceded by groundnut (Table 3) recorded the highest gross monetary returns (Rs. 1,22,087 ha^{-1}) on pooled mean basis which, was at par with potato preceded by soybean and significantly superior over rest of the treatments. An application of 75 per cent RDF + 25 per cent N through FYM recorded the highest gross monetary returns (Rs. 1,05,726 ha^{-1}) on pooled mean basis. It was at par with 50 per cent RDF + 50 per cent N through FYM and 100 per cent RDF. Potato preceded by groundnut recorded the highest net monetary returns (Rs. 58,668 ha^{-1}) on pooled mean basis which, was at par with potato preceded by sorghum and significantly superior over rest of the treatments. An application of 100 per cent RDF recorded the highest net monetary returns (Rs. 46,118 ha^{-1}) on pooled mean basis. It was at par with 75 per cent RDF + 25 per cent N through FYM and 50 per cent RDF + 50 per cent N through FYM.

Potato preceded by soybean recorded the highest B:C ratio (1.94) on pooled mean basis which, was at par with potato preceded by groundnut and significantly superior over rest of the treatments. An application of 100 per cent RDF recorded the highest B:C ratio (1.81) on pooled mean basis. However, it was at par with rest of the treatments. Similar results were reported by Jadhav (1986) and Patil *et al*. (1997).

LITERATURE CITED

Grewal, J. S. and R. C. Sharma. 1981. Fertilizer use in potato based cropping system in India. Pert. News. 33-43.

Griffin, T. S. and O. B. Hesterman. 1991. Potato response to legume and fertilizer nitrogen sources. Agron. J. 83 (6): 1004-1012.

Jadhav, A. S. 1986. Studies on the wheat based cropping systems with reference to fertilizer management. Ph. D. thesis submitted to Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.)

Mondal, S. S. and B. Roy. 2001. Effect of potassium applied with or without sulphur and farmyard manure on the yield and nutrient uptake by crops in potato (*Solanum tuberousum*), jute (*Corchorus* sp.) and rice (*Oryza sativd*) sequence. Indian J. agric Sci. 71(2) : 116-117.

Patil, M. P., N. C. Hulamani, S. I. Athani, and M. G. Patil. 1997. Response of potato (*Solarium tuberosum*) cv. Kufri Chandramukhi to integrated nutrient management. Adv. Agric. Res. In India. 8: 135-139.

Rajwade, V. B., R. N. S. Banafer and A. C. Pathak. 2000. Growth analysis of potato in relation to biodynamic package and organic manures with chemical fertilizers. J. Indian Potato Assoc. 27(1-2) : 55-58.

Roy S. K., R. C. Sharma and K. C. Sud. 1999. Production potential, profitability and soil fertility as affected by potato based crop sequences in N. W. Plains of Punjab. J. Indian Potato Assoc. 26(1 and 2): 33-38.

Saxena, S. C., H. S. Manral and A. S. Chandel. 2001. Effect of inorganic and organic sources of nutrients on soybean (*Glycine max*). Indian J. Agron. 46 (1) : 135-140.

Singh, S. K. and R. C. Sharma. 2002. Effect of inoculation, nitrogen and phosphorus on yield and nutrient uptake of potato and their residual effect on radish. J. Indian Potato Assoc. 29(1-2): 41-45.

J. Maharashtra agric. Univ., 34 (3) : 249-251 (2009)

Effect of Integrated Nitrogen Management on Growth and Yield of Baby Corn (*Zea mays* L.) cv. Mridula

Lalit Kumar Rao[1], Rajesh Singh[2], Ashok Kumar[3] and G. M. Lal[4]
Department of Agronomy, Allahabad Agricultural Institute - Deemed University, Allahabad - 211 007 (India)
(Received : 12-07-2008)

ABSTRACT

The application of 120 kg N as 90 kg N ha^{-1} through urea along with 30 kg N fixed in the rhizosphere of roots by the seed inoculated *Azospirillum* significantly increased the growth attributes including plant height, number of leaves $plant^{-1}$, dry matter, crop growth rate and relative growth rate. This also had significant increase in yield components (including the number of cobs $plant^{-1}$, length of cobs and cob weight) and produced the highest cob yield of 22.05 q ha^{-1} (without husk) and green fodder yield (264.60 q ha^{-1}).

Key words : Baby corn, poultry manure, *Azotobacter* and *Azospirillum*.

Application of chemical fertilizers alone for increasing crop production is not sustainable on long term basis since it may lead to nutrient imbalance. The efficiency of applied nitrogenous fertilizers has been reported to be only 30-50 per cent. Besides this, with the escalating costs of energy based fertilizer materials, integrated nutrient supply approach, combining organic and biological sources along with chemical fertilizer would be more remunerative for getting higher returns with considerable fertilizer economy. Madhavi *et al.* (1996) have reported that, better metabolism is found in maize plants which results in better grain yield in which poultry manure is used to substitute some of the NPK recommendations in addition to inorganic fertilizers. The work of Panwar *et al*. (2001) revealed that, seed inoculation of maize seeds with *Azotobacter* and *Azospirillum* increased the maize yield by 7 -12 per cent. Das (l998) and Tilak (1998) reported that, *Azotobacter* and *Azospirillum* flxes 30 kg ha^{-1} nitrogen in cereals. The present experiment was conducted with a view to reduce the cost incurred on nitrogenous fertilizers and to study the effect of supplementing nitrogen through poultry manure as an organic source and *Azotobacter* and *Azospirillum* seed inoculation as a biofertilizer source in combination with inorganic nitrogen supplied through urea on the growth and yield of baby corn.

MATERIALS AND METHODS

The field experiment was conducted at the Crop Research Farm, Department of Agronomy, Allahabad Agricultural Institute - Deemed University, Allahabad using baby corn hybrid Mridula, during rainy season of 2006. The experimental soil was sandy loam in texture having a pH of 7.7, EC of 0.22 dSm^{-1}, organic carbon content of 0.84 per cent and the available NPK were analyzed to be 182.5 kg ha^{-1}, 29 kg ha^{-1} and 160 kg ha^{-1} respectively. The experiment was laid out in a randomized block design having twelve treatments which were replicated thrice. The treatments comprised of two levels of nitrogen *viz.*, 90 and 120 kg ha^{-1} which was maintained by substituting 30 kg nitrogen through poultry manure or by seed inoculation with *Azotobacter* and *Azospirillum* in combination with inorganic nitrogenous fertilizer which was compared with same levels of N through inorganic fertilizers alone. In addition to the nitrogen management the recommended doses of phosphorus and potassium were maintained in all the treatments. The nitrogen content of poultry manure and urea were analyzed to be 3.4 and 46 per cent respectively. On the basis of nitrogen content, the manure and fertilizer requirement was worked out before application. Maize seeds were inoculated with *Azotobacter* and *Azospirillum* cultures as per the standard procedure and according to the treatment requirements.

RESULTS AND DISCUSSION

Growth components : The growth components *viz*. plant height, number of leaves $plant^{-1}$, dry matter production, crop growth rate and relative growth rate (Table 1) differed significantly amongst various treatments. Significantly higher values for plant height (110.22 cm), number of leaves $plant^{-1}$ (11.55), dry matter

1, 3. M. Sc. (Agronomy) student. 2. Assistant Professor, Dept. of Agronomy, 4. Assistant Professor, Department of Genetics and Plant Breeding,

Table 1. Effect of integrated nitrogen management (INM) on the growth and yield attributes of baby corn (*Zea mays* L.)

Treatments (kg N)	Plant height plant^{-1} (cm)	Leaves plant^{-1}	Dry matter production	Crop growth rate (g day^{-1} m^2)	Relative growth rate (g g^{-1} day^{-1})	Cobes plant^{-1}	Length of cob (cm)	Cob weight (without husk) (g)	Cob yield (without husk) (q ha^{-1})	Green fodder yield (q ha^{-1})
90 (U)	99.88	10.4	46.67	30.77	0.0307	1.89	7.31	5.23	14.64	175.68
120 (U)	103.55	10.55	48.67	31.06	0.0293	2.00	7.39	5.38	15.94	191.28
60 (U) + 30 (PM)	104.33	10.66	49.00	33.30	0.0321	2.00	7.44	5.46	16.18	194.16
90 (U) + 30 (PM)	102.66	10.55	48.67	33.49	0.0327	1.89	7.37	5.37	15.04	180.48
60 (U) + 30 (*Azoto*)	98.77	10.44	47.00	31.67	0.0317	1.89	7.29	5.15	14.42	173.04
90 (U) + 30 (*Azoto*)	106.11	11.00	54.00	38.73	0.0348	2.11	7.77	5.80	18.13	217.56
60 (U) + 30 (*Azospi*)	98.77	10.44	46.67	31.43	0.0317	1.77	7.24	5.07	13.29	159.48
90 (U) + 30 (*Azospi*)	110.22	11.55	60.00	46.04	0.0387	2.44	7.78	6.10	22.05	264.60
60 (U) + 30 (*Azoto*) + 30 (*Azospi*)	105.77	10.66	53.63	39.23	0.0359	2.00	7.68	5.77	17.10	205.20
60 (U) + 30 (PM) + 30 (*Azoto*)	104.55	10.66	50.00	33.76	0.0318	2.00	7.47	5.56	16.47	197.64
60 (U) + 30 (PM) + 30 (*Azospi*)	105.77	10.89	50.67	35.31	0.0334	2.00	7.63	5.74	17.01	204.12
30 (U) + 30 (PM) + 30 (*Azospi*) + 30 (*Azoto*)	94.55	10.33	45.00	29.29	0.0302	1.66	7.15	5.04	12.39	148.68
F- test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
C. D. (P = 0.05)	1.40	0.30	1.52	2.10	0.0016	0.22	0.21	0.23	0.31	2.78

U = Urea, PM = Poultry manure, Azoto = *Azotobacter*, Azospi = *Azospirillum*

production (60 g plant^{-1}), crop growth rate (46.04 g day^{-1} m^{-2}) and relative growth rate (0.0387 g g^{-1} day^{-1}) was observed under the treatment where 120 kg nitrogen was applied, of which 90 kg nitrogen was supplied through urea in addition to 30 kg nitrogen fixed in the rhizosphere by the seed inoculated *Azospirillum*. These results are in conformity with the findings of Rout *et al.* (2001) who reported that seed inoculation with *Azospirillum* in addition to inorganic nitrogen application produces higher plant height, maximum number of leaves plant^{-1} and plant dry weight in maize as compared to entire dose of nitrogen provided through urea alone.

The probable reasons for above findings might be due to sufficient availability of nitrogen for the maize plants initially due to inorganic nitrogen fertilization which was later supplemented by nitrogen fixation in the rhizosphere of maize plants by *Azospirillum* which was saved against leaching losses and was fully available to the maize plants. The above findings are in conformity with the findings of Madhavi *et al*. (l995) and Vadivel *et al*. (2001).

Yield components and yield : The number of cobs plant^{-1}, cob weight, cob yield and green fodder yield were found to be significantly influenced by application of 120 kg nitrogen of which 90 kg nitrogen supplied through urea in combination with 30 kg nitrogen provided by rhizosphere fixation by seed inoculated *Azospirillum* culture. The highest number of cobs plant^{-1} (2.44) was observed in the same treatment which was significantly higher than all the other treatments.

The maximum length of cobs (7.78 cm) and cob weight (without husk) of 6.10 g were again obtained in the treatment where 90 kg nitrogen was applied through urea in combination with seed inoculation by *Azospirillum*, however, the value was statistically at par with that obtained from the treatment where 90 kg nitrogen was applied through urea along with seed inoculation by *Azotobacter* and treatment where 60 kg nitrogen was applied through urea along with seed inoculation with *Azotobacter* and *Azospirillum* respectively.

The highest cob yield of 22.05 q ha^{-1} (without husk) and green fodder yield of 264.60 q ha^{-1} were obtained under the treatment where 90 kg nitrogen was applied through urea along with seed inoculation with *Azospirillum* which was significantly higher than rest of the treatments.

The probable reasons for higher yield components and yield obtained under the treatment where 90 kg nitrogen was applied through urea along with seed inoculation with *Azospirillum* might be due to better

initial growth of maize plants due to basal application of urea and better growth and yield at the later stages due to rhizosphere fixed nitrogen by *Azospirillum* culture which was fully available to maize plants as it checked the leaching losses as compared to application of entire doses of nitrogen by urea alone. Similar findings of higher dry matter accumulation and increased yield of maize under integrated nitrogen management by substituting chemical nitrogen by *Azospirillum* seed inoculation have also been reported by Mishra *et al*. (1998), Laxminarayana (2001) and Rout *et al*. (2001).

It can be concluded, that application of 90 kg nitrogen through urea and 30 kg nitrogen through seed inoculation with *Azospirillum* significantly increased the yield of baby corn over the rest of the treatments.

LITERATURE CITED

Das, P. C. 1998. Manures and fertilizers. Kalyani Publ, Ludhiana.

Laxminarayana, K. 2001. Effect of *Azotobacter* and *Azospirillum* on yield performance of maize in hilly regions of Mizoram. Indian J. of Hill Famg. 14(2): 134-137.

Madhavi, B. L., M. S. Reddy and P. C. Rao. l995. Integrated nutrient management using poultry manure and fertilizers for maize. J. of Res. APAU, 23(3/4): 1-4.

Madhavi, B. L., M. S. Reddy and B. G. Reddy. l996. Effect of poultry manure and fertilizers on yield and micronutrients uptake by maize. J. of Res. ANGRAU, 24(1/2): 154-156.

Mishra, M., A. K. Patjoshi and D. Jena. 1998. Effect of biofertilization on production of maize (*Zea mays* L.). Indian J. of Agron. 43(2): 307-310.

Panwar, J. D. S., S. P. Saikia and V. S. G. R. Naidu. 2001. Biofertilizers are enhancing crop productivity and environmental security. Indian Fmg. 50(1): 56-60.

Rout, D., M. R. Satapathy and B. K. Mohapatra. 2001. Effect of biofertilizers on nitrogen economy in maize. Madras Agric J. 88(7/9): 530-532.

Tilak, K. V. B. R. l998. Bacterial Fertilizers. ICAR, New Delhi.

Vadivel, N., P. Subbian and A. Velayutham. 2001. Effect of integrated nitrogen management practices on the growth and yield of rainfed winter maize (*Zea mays* L.) Indian J. of Agron. 46(2): 250-254.

J. Maharashtra agric. Univ., 34 (3) : 251-255 (2009)

Enrichment of Cattle Dung Compost by Using Bioinoculant and Mineral Amendments

G. M. Battikopad[1], M. B. Jadhav[2], D. D. Sawale[3], B. D. Tamboli[4] and S. R. Mane[5]
Division of Soil Science and Agricultural Chemistry, College of Agriculture, Pune - 411 005 (India)
(Received : 25-08-2008)

ABSTRACT

Studies on enrichment of cattle dung compost was done with mineral amendments like rock phosphate, micronutrients i.e. iron pyrite, manganese sulphate, zinc sulphate and copper sulphate and bioinoculants *viz*., *Bacillus* spp., *Azotobacter*, composting culture, effective microorganisms and earthworm. Among the various treatments, cattle dung enriched with rock phosphate + micronutrient + *Bacillus* spp. + *Azotobacter* + composting culture + effective microorganisms and earthworm resulted in significant decrease in organic carbon and C:N ratio at both 60 and 120 days of composting. The total nitrogen, water soluble and citrate soluble phosphorus, CEC, fulvic and humic acid, E_4/E_6 ratio increased significantly at both 60 and 120 days enrichment. The microbial population (bacteria and fungi) significantly increased up to 60 days and thereafter decreased significantly at 120 days. However, the actinomycetes increased significantly at 60 and 120 days of composting, but magnitude was less than bacteria and fungi.

Key words : Enrichment, cattle dung, mineral amendments, bioinoculants.

India produces about 1800 mt of animal dung per annum. Even if two third of the dung is used for biogas generation, it is expected to yield about 440 mt of manure per year that is equivalent to 2.90 mt N, 2.75 mt P_2O_5 and 1.89 mt K_2O (Anon., 2001).Over the years, the farmers in India have been using cattle dung and urine as manure directly in their field. However, due to unscientific method of collection and management of dung and urine, a lot of wastages of N, P and K occurres. Apart from this, considerable part of the dung collected is being dried and used as fuel cakes. Looking to nutritive value of milk and prices offered to milk, many more dairy industries have been established during last decade.

l. M. Sc.(Agri) student., 2. Asso. Prof., 3 and 4. Asstt. Prof. and 5. Agricultural Asstt.

Improper use of cattle dung, farmers are not getting proper output from it. It is therefore, necessary to preserve and increase the nutrient content of cattle dung compost by using mineral amendments and bioinoculants. Hence, the present investigation was carried out to study the effect of bioinoculants and mineral amendments on enrichment of cattle dung compost.

MATERIALS AND METHODS

The experiment was conducted at Agronomy farm, College of Agriculture, Pune in 2006-07 with enrichment process in earthen composting pits having volume of 0.125 m^3 (50 x 50 x 50 cm.) The experiment was conducted by using 50 kg raw cattle dung in each earthen pit. The experiment was laid out in FRBD with ten treatments replicated three times. The treatment consisted of cattle dung alone (C), C + rock phosphate (RP) 50 g kg^{-1} dung, C + RP + micronutriments (M) through iron pyrite 5g, $MnSO_4$ 0.5 g, $ZnSO_4$ 1 g and $CuSO_4$ 0.25 g kg^{-1} dung, C + RP + M + *Bacillus* (B) 0.5 ml kg^{-1} dung, C + RP + M + B + *Azotobacter* (A) 0.5 ml kg^{-1} dung, C + RP + M + B + A + composting culture (CC), C + RP + M + B + A + Effective micro organisms (EM) 0.5 ml per kg dung, C + RP + M + B + A + Earth worm (EW) one earthworm per kg dung, C + RP + M + B + A + EM + EW, C + RP + M + B + A + CC + EM + EW. As per the treatments the raw cattle dung was filled layer by layer in the pits and all sides were covered with polythene sheet to avoid the leaching of nutrients. The moisture was maintained at 55.0 ± 5 per cent throughout the composting period by loss in weight. The earthworm and bioinoculants were added 30 days after filling the pits in respective treatments. The turning was done at 60th day of the enrichment process. The enriched cattle dung samples were collected at 60 and 120 days of enrichment and analyzed for moisture by gravimetric method, (A.O.A.C., 1980), ash (%) and organic carbon (%) by ignition method (Gorsuch.1970), total nitrogen by micro-kjeldhal method and water soluble and citrate soluble phosphorus was estimated by stannous chloride method (Jackson, 1973), micronutrients were estimated using Atomic Absorption Spectrophotometer (Lindsay and Norvell, 1978), cation exchange capacity(CEC) by barium acetate method (Harada and Inoko,1980), E_4/E_6 ratio for humic fractions by 0.5 M $NaHCO_3$ extractant (Chen, *et al.* 1977) and total microbial count by standard dilution plate technique (Pikovskaya 1948).

RESULTS AND DISCUSSION

Moisture : No significant differences were obtained in moisture content at 60 and 120

Table 1. Enrichment of cattle dung as influenced by bioinoculants and mineral amendments at 60 days.

Treatments	Moist. (%)	Ash (%)	O.C. (%)	Total N (%)	WSP (mg 100 g^{-1})	CSP (mg 100 g^{-1})	CEC (cmol (p+) kg^{-1})	Humic acid	Fulvic acid	C:N ratio	E_4/E_6 ratio	Total microbial counts (g^{-1} fresh compost)		
												Bacteria (10^6 CFU)	Fungi (10^4 CFU)	Actino-mycetes 10^3) CFU)
T_1 : Cattle dung alone ©	60.7	30.7	40.1	1.6	18.0	24.0	85.3	8.7	2.9	26.2	4.6	10.3	7.1	6.2
T_2 : C + Rock Phosphate (RP)	59.8	46.3	31.1	1.6	20.6	51.3	86.2	8.3	4.1	23.4	7.0	10.5	8.3	6.3
T_3 : C + RP + Micronutrients (M)	57.6	47.4	30.4	1.7	21.3	60.0	86.4	8.5	4.3	22.8	8.5	10.6	9.2	6.4
T_4 : C + RP + M + *Bacillus* (B)	54.6	48.5	29.8	1.7	24.0	64.6	87.6	8.5	4.3	22.6	10.5	14.7	20.1	6.5
T_5 : C + RP + M + B + *Azotobacter* (A)	57.3	52.3	27.6	1.7	22.3	65.6	90.7	9.2	4.7	21.5	10.5	23.6	20.2	6.7
T_6 : T_5 + Composting culture (CC)	56.2	51.2	28.2	1.8	22.3	64.6	92.3	10.2	5.2	21.0	10.7	41.2	22.4	7.3
T_7 : T_5 + Effective micro organisms (EM)	57.2	51.9	27.8	1.8	22.0	65.3	93.5	10.2	5.4	20.7	11.2	42.8	23.3	8.4
T_8 : T_5 + Earth worm (EW)	56.7	52.2	27.6	1.8	24.0	66.6	128.4	10.3	5.4	20.6	12.1	44.6	25.5	10.5
T_9 : T_5 + EM + EW	53.2	53.4	27.0	1.9	30.0	84.0	131.2	10.5	5.7	20.1	12.4	45.3	26.3	11.3
T_{10} : T_5 + CC + EM + EW	55.9	55.5	25.7	2.1	33.6	85.0	135.3	10.8	7.8	12.2	12.8	48.2	30.1	11.6
S. Em.±	5.9	4.8	2.9	0.26	2.4	1.1	1.1	1.0	0.5	1.3	1.0	1.1	1.1	0.8
CD at 5%	NS	14.3	8.8	0.77	7.1	3.4	3.4	NS	1.5	4.0	3.0	3.4	3.4	2.5
Initial values	59.7	30.7	49.1	1.4	16.0	18.0	81.2	7.8	1.9	36.1	4.3	9.2	6.3	4.3

Table 2. Enrichment of cattle dung as influenced by bioinoculants and mineral amendments at 120 days.

Treatments	Moist. (%)	Ash (%)	O.C. (%)	Total N (%)	WSP (mg 100 g^{-1})	CSP (mg 100 g^{-1})	CEC (cmol (p+) kg^{-1})	Humic acid	Fulvic acid	C:N ratio	E_4/E_6 ratio	Total microbial counts (g^{-1} fresh compost)		
												Bacteria (10^6 CFU)	Fungi (10^4 CFU)	Actino-mycetes 10^3) CFU)
T_1 : Cattle dung alone ©	60.3	32.2	39.2	1.50	21.6	27.6	91.0	8.5	2.4	24.4	4.0	8.4	6.1	6.3
T_2 : C + Rock Phosphate (RP)	56.3	47.7	30.3	2.31	26.0	61.3	92.2	9.0	2.9	16.7	4.8	9.2	7.6	7.2
T_3 : C + RP + Micronutrients (M)	57.6	48.2	30.0	2.37	28.6	63.3	93.4	9.3	3.2	16.4	5.5	9.6	8.4	7.5
T_4 : C + RP + M + *Bacillus* (B)	54.3	50.2	28.8	2.42	35.0	66.3	93.5	9.5	3.4	15.4	5.3	13.2	13.3	7.4
T_5 : C + RP + M + B + *Azotobacter* (A)	54.3	54.4	26.4	2.61	35.0	65.0	96.4	9.5	3.4	14.6	5.3	15.3	14.1	7.2
T_6 : T_5 + Composting culture (CC)	55.6	54.7	26.2	2.56	36.0	74.3	96.3	10.5	3.5	14.5	5.4	35.3	14.2	7.6
T_7 : T_5 + Effective micro organisms (EM)	50.0	53.6	26.8	2.59	36.3	74.3	98.2	10.7	3.6	14.4	5.4	38.6	15.3	8.2
T_8 : T5 + Earth worm (EW)	53.3	55.7	25.6	2.61	36.3	87.3	132.4	10.6	3.7	14.3	5.0	40.3	16.4	10.3
T_9 : T5 + EM + EW	55.0	58.1	24.2	2.67	37.0	101.6	136.3	10.8	3.8	14.2	5.2	42.1	17.2	11.2
T_{10} : T5 + CC + EM + EW	53.0	58.8	23.8	2.78	38.6	112.0	138.2	11.4	4.9	10.0	5.8	45.3	20.3	11.8
S. Em.±	-	5.1	2.8	0.24	2.4	1.1	1.1	1.0	0.3	1.2	0.5	1.1	1.2	0.3
CD at 5%	NS	15.4	8.4	0.73	7.1	3.4	3.4	NS	1.0	3.7	NS	3.4	2.5	0.8
Initial values	59.7	30.7	49.1	1.4	16.0	18.0	81.2	7.8	1.9	36.1	4.3	9.2	6.3	4.3

days of composting due to different treatments. (Table 1 and 2). At 60 days moisture varied from 53.2 to 60.7 per cent while at 120 days it was from 50 to 60.3 per cent. However, the cattle dung enriched with rock phosphate + micro-nutrients + *Bacillus* spp. + *Azotobacter* + composting culture + effective microorganisms recorded lowest moisture (50%) at 120 days composting than rest of the treatments.

Ash : The per cent ash content was significantly increased due to different enrichment components over cattle dung alone at both 60 and 120 days of composting (Table land 2). The per cent ash increased with advance composting irrespective of the treatments. Among the various enrich treatments C + RP + M + B+ Azotobacter (A) + CC + EM + EW recorded significantly highest ash per cent (55.5 and 58.8) over cattle dung alone at 60 and 120 days of composting respectively. However, it was on par with T_2 and T_9. This might be due to loss in weight attributed to mineralization of organic fractions during composting (Chefetz, *et al.* 1996).

Organic carbon : The organic carbon content was decreased with increasing composting period from 60 to 120 days (Table 1 and 2). The per cent organic carbon content was significantly decreased due to different enrich components over cattle dung alone, however T10 recorded significantly lowest organic carbon (25.7 and 23.8%) at 60 and 120 days composting respectively. But it was on par with rest of treatments except T_1. The reduction in organic carbon content might be due to utilization of organic carbon as energy source to built up the protoplasm and release of CO_2 through breakdown of carbon by microorganisms during composting. These results are in conformity with findings of Mathur *et al.* (1980) and Mahesweri (2002).

Total nitrogen : The total nitrogen content was increased with advance composting. Total N content in enriched cattle dung differed significantly in all the treatment combinations at 60 and 120 days composting (Table 1 and 2). Among the different treatment combinations T_{10} (C + RP + M + B A + CC + EM + EW) recorded significantly higher total N content (2.1 and 2.78%) at 60 days and 120 days composting respectively. However, it was on par with rest of the enrich treatments at both the stages of composting. The enrichment with all components under study resulted in higher N content in cattle dung manures. This might be due to additive effect of mineral amendments and bioinoculants which increased the rate of mineralization and thereby

increased the N content and consequently decreased the C:N ratio. Similar results were reported by Asija *et al.* (1984), Babitha (1999) and Kadalli (1999).

Water soluble and citrate soluble phosphorus : The water soluble and citrate soluble phosphorus were increased with advance composting due to different enrichment treatment combinations (Table 1 and 2). The water soluble and citrate soluble P were increased significantly due to different treatment combinations over cattle dung alone at 60 and 120 days composting. Among the different treatment combinations T_{10} recorded significantly higher water soluble and citrate soluble P over cattle dung alone at 60 and 120 days of composting baring few exceptions. In general the citrate soluble P content of enriched cattle dung manure was higher than that of water soluble P. This might be due to enrichment with rock phosphate. Similar observations were also reported by Mathur *et al*. (1980) and Bhanawase *et al*. (1994).

Cation exchange capacity (CEC) : The CEC of enriched cattle dung increased significantly at 60 and 120 days composting over cattle dung alone. Among the enriched treatment combination T_{10} recorded significantly higest CEC (135.2 and 138.2 c.mole (p^+) kg) at 60 and 120 days composting respectively over cattle dung alone. However, it was on par with T_9 at 120 days composting. The increase in CEC might be due to degree of humification, some functional groups like -COOH, phenolic and alcoholic-OH are responsible to increase in CEC. Similar results were also noticed by Allison and Cover (1960).

Humic acid and fulvic acid : No sightficant differences were obtained in humic acid content due to different treatment combinations (Table 1 and 2). However, the humic acid content was increased with increase in composting period. The mineral amendments and bioinoculant treated compost registered higher values of humic acid ranging from 8.3 to 10.8 and 9.0 to 11.4 per cent at 60^{th} and 120^{th} day of composting respectively.

The fulvic acid content was increased significantly due to different treatment combinations over untreated cattle dung at 60 and 120 days composting. However, the fulvic acid content was decreased with advance composting. Among the various treatment combinations T_{10} recorded significantly higher values of 7.8 and 4.9 per cent of treatments at 60 and 120 days composting respectively. The decrease in fulvic acid with advance stage of composting (at 120 days) indicated that the fulvic acid was converted into humic acid and it was increased at maturity stage of compost. These results are in conformity with finding of Singh and Amberger (1990).

C:N ratio : The C:N ratio decreased significantly due to different mineral and bioinoculant treatments over cattle dung alone at 60 and 120 days of composting. The C:N ratio was decreased with advance composting. Among the enriched treatments T_{10} recorded significantly lower C:N ratio of 12.2 and 10.0 at 60 and 120 days composting over other treatments. This might be due to increase in biological activity due to enrichment with mineral and bioinoculant as reported by Tiwari *et al*. (1989).

E_4/E_6 ratio : The E_4/E_6 ratio decreased with advance composting. The E_4/E_6 ratio was increased significantly due to enriched minerals and bioinoculant treatments over cattle dung alone at 60 days composting. Among enriched treatments, T_{10} recorded significantly highest E_4/E_6 ratio (12.8) at 60 days composting, However, it was on par with T_4 to T_9.

Total microbial count : The total microbial count namely bacteria, fungi and actinomycetes were increased significantly due to enrichment with minerals and bioinoculants over cattle dung alone at 60 and 120 days of composting. The microbial count for bacteria, fungi and actinomycetes were decreased with advance composting barring few exceptions. Among different enrichment combinations, T_{10} recorded significantly highest microbial count of bacteria 48.2, 45.3, fungi 30.1, 20.3, and Actinomycetes 11.6, 11.8 at 60 and 120 days of composting respectively. However, it was on par with T_9 in case of bacteria and actinomycetes count at 60 and 120 days composting. Similar results were also reported by Bangar and Patil (1980).

From the forgoing discussion it is evident that the application of rock phosphate, micronutrients, *Bacillus* spp., *Azotobacter*, composting culture, effective microorganisms and earthworm was more effective and beneficial for enrichment of cattle dung.

LITERATURE CITED

Allison, F. E. and R. C. Cover. 1960. Rates of decomposition of short leaf pine saw dust in soil at various levels of N and lime. Soil. Sci., 89: 194-201.

Anonymous. 2001. The Department of Agriculture and Cooperation, Task Force on Organic Farming. In part x of its report, pp 16-27.

A.O.A.C. 1980. Official Methods of Analysis. 13th Edn. (Association of Official Agricultural Chemists : Washington, D.C., U.S.A.).

Asija, A. K., R. P. Pareek, R. A. Singhania and S. Singh. 1984. Effect of method of preparation of enrichment on the quality of manure, J. Indian Soc. Soil. Sci., 32: 323- 329.

Babitha, 1999. Quality and efficiency of enriched press mud compost. M. Sc. (Agri.) thesis, Univ. of Agric. Sci., Bangalore.

Bangar, S. G. and P. L. Patil. 1980. Effect of C: N ratio and phosphatic fertilizers on decomposition of wheat straw. J. Indian Soc. Soil Sci. 28 (4): 543-546.

Bhanawase, D. B., P. H. Rasal, B. R. Jadhav and P. L. Patil. 1994. Mineralization of nutrients during the production of phosphocompost. J. Indian. Soc. Soil Sci., 42: 142-147.

Chefetz, B., P. G. Hatcher, Y. Hadar and Y. Chen. 1996. Chemical and biological characterization of organic matter during composting of municipal solid waste. J. Environ. Qual., 25: 776-785.

Chen, Y., N. Senisi and M. Schnitzer. 1977. Information provided on humic substances by E_4/E_6 ratios. Soil Sci. Soc. Am., J., 41: 352-358.

Gorsuch, T. T. 1970. The Destruction of Organic Matter. Pergamon Press Ltd. New York,: 143-144.

Harada, Y. and A. Inoko. l980. The measurement of the cation exchange capacity for the estimation of the degree of maturity. Soil Sci. Plant Nutr., 26(1): 127-134.

Jackson, M. L. 1973. Soil Chemical Analysis : Prentice Hall, New Delhi, pp. 1-485.

Kadalli, G. G. 1999. Coir dust based enriched compost and characterization of humic fractions. Ph.D. thesis, Univ. of Agric. Sci. Bangalore.

Lindsay, W. L. and W. A. Norvell. 1978. Development of DTPA soil test for Zn, Fe, Mn and Cu. Soil Sci. Soc. AM. J., 42: 421-428.

Maheswari, M. 2002. Value added manure from coffee pulp waste. Eco-friendly management of solid and liquid wastes for agriculture, pp. 148-154.

Mathur, B. S., A. K. Sarkar and B. Mishra. 1980. Release of nitrogen and Phosphorus from compost charged with rock phosphate J. Indian Soc. Soil Sci. 28(2): 206-212.

Pikovskaya, R. I. 1948. Mobilization of phosphorus in soil in connection with vital activity of some microbial species. Microbiologiya. 17: 362-370.

Singh, C. P. and A. Amberger. 1990. Humic substances in straw compost with rock phosphate, Biol. Waste. 31(3): 165-174.

Tiwari, V. N., A. N. Pathak and L. K. Lehri. 1989. Effect of cattle dung and rockphosphate and compositing of wool waste. Biol. Wastes. 27: 237-241.

J. Maharashtra agric. Univ., 34 (3) : 256-259 (2009)

Yield and Nutrient Uptake by Grain Amaranth as Influenced by Moisture Stress and Nitrogen Management with Bio-fertilizers

P. P. Chaudhari[1], P. T. Patel[2] and L. J. Desai[3]
Regional Research Station, S. D. Agricultural University, Sardarkrushinagar - 385 506 (India)
(Received : 25-08-2008)

ABSTRACT

Among moisture stress treatments, without moisture stress ranked at top, producing 16.58 and 22.07 per cent higher grain yield over moisture stress imposed at active vegetative stage and at two growth stages, respectively in pooled data. Similarly stover yield increment of 21.45 and 28.28 per cent was noted with adequate moisture supply. The yield increment was attributed to significant improvement in stem thickness, length of main inflorescence, spikelets per plant and 1000 seeds weight under adequate moisture supply. However, the lowest water use efficiency (5.30 kg ha^{-1} mm^{-1}) was obtained with maximum water consumption under no moisture stress. Maximum uptake of nitrogen and phosphorus by the crop was observed with no moisture stress treatment followed by moisture stress at active vegetative stage. Among the nitrogen management treatments, 60 kg N ha^{-1} integrating seed inoculation with *Azotobacter* liquid culture brought remarkable improvement in stem thickness, length of main inflorescence, number of lateral spikelets and 1000 seed weight which ultimately reflected in increase in grain and stover yields during both the years. In pooled data, it produced 12.39, 45.88 and 223.27 per cent higher grain yield over 60, 40 and zero kg N ha^{-1}, respectively in pooled data. Treatment N_{60} + *Azotobacter* liquid showed its superiority in terms of consumption of water (218.6 mm) and water use efficiency (7.19 kg ha^{-1} mm^{-1}). Maximum uptake of N (76.6 kg ha^{-1}) and P (13.24 kg ha^{-1}) was realized with N_{60} + *Azotobacter* liquid culture as against the corresponding values of 70 kg N ha^{-1} and 11.9 kg P ha^{-1} with N_{60}. Combination of N_{60} + *Azotobacter* liquid culture and no moisture stress helped to achieve highest grain yield of 1780 kg ha^{-1}.

Key words : Grain amaranth, yield, uptake, water use efficiency.

Grain amaranth (*Amaranthus hypochondriacus* L.) is a potential upcoming subsidiary food crop, considered by many as crop of the future. Application of irrigation water at critical growth stages without significant reduction in yield is also one of the approaches for water scarce areas. Nitrogenous fertilizers form a basic input for getting higher yield. The liquid bio-fertilizer of good quality holds great promise over the carrier material transport (Hegde, 2002).

MATERIALS AND METHODS

An experiment was conducted at Sardarkrushinagar Dantiwada Agricultural University, Sardar-krushinagar during *rabi* season of two consecutive years, 2004-05 and 2005-06. Geographically, Sardar-krushinagar is situated at 24°-19' North latitude and 72°-19' East longitude with an elevation of 154.52 meters above the mean sea level. It is located in the North Gujarat Agro-climatic zone and characterized by sub-tropical monsoon type semi-arid climate with extreme cold winter, hot and dry windy summer. The soil was sandy loam, very low in organic carbon (0.15%) and available N (168.0 kg ha^{-1}), high in available P_2O_5 (32.4 kg ha^{-1}) and medium in K_2O (234.0 kg ha^{-1}). The experiment comprising three main plot treatments of moisture stress *viz*., no moisture stress (M_1) (irrigation schedules on early vegetative, active vegetative, flowering, grain formation and grain filling stages); stress at active vegetative stage (M_2) and stress at active vegetative and grain filling stage (M_3), and seven treatments of nitrogen management (0, 40, 60 kg ha^{-1}) with or without two types of biofertilizers (liquid and powder) in sub plots was laid out in a split plot design with four replications. Phosphorus @ 40 kg P_2O_5 ha^{-1} was applied through single super phosphate as a basal dose in ploughed furrows before sowing. Nitrogen from urea, was applied at two levels *viz*., 40 and 60 kg ha^{-1}, each in two equal splits as per treatments. Half of N was applied as basal at the time of sowing in furrows and the remaining half as top dressing at first irrigation in (early vegetative stage) the respective plots. Liquid agar slant and lignite carrier based culture of *Azotobacter* (*Azotobacter chroococcum*) strain ABA-1 were used. The seeds of amaranth cv. GA-2 were first inoculated with *Azotobacter* (ABA-1) culture one hour before sowing. Carrier based culture (powder) was suspended in 10 per cent jaggery solution and the seeds were thoroughly mixed in it to have uniform coating. Liquid agar slant *Azotobacter* culture @ 20 ml per one kg seed was sprinkled on seeds spread in thin layer and mixed. As a sticker, jaggery solution was used. The seeds were

1. Assistant Research Scientist, 2. Associate Director of Research and 3. Asstt. Professor.

thoroughly mixed and then allowed to dry in the shade for an hour before sowing. These treated seeds were utilized for sowing as per treatments. The seeds were sown keeping row to row distance of 45 cm using a seed rate 1.0 kg ha^{-1} One common irrigation of 50 mm depth was applied at the time of sowing and subsequent irrigations as per moisture stress treatments (five irrigations in no moisture stress, four irrigations in stress at active vegetative stage and three irrigations in stress at active vegetative and grain filling stages) were applied with the same depth. During the course of investigation, soil moisture studies were carried out, drawing soil samples before sowing, just before each irrigation and 24 hrs after each irrigation as well as at harvest. Sampling was performed with the help of screw auger from 0-30, 30-60, 60-90 and 90-120 cm soil depth. Soil moisture content was estimated by gravimetric method after oven drying the samples at 105°C to a constant weight.

Table 1. Yield and yield attributes of grain amaranth as influenced by moisture stress and nitrogen management with bio-fertilizer.

Treatment	Plant height (cm)	Stem thick-ness (cm)	Length of main inflore-scence (cm)	Number of lateral spike-lets	1000 seed weight (g)	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})
Moisture stress :							
No moisture stress	147.38	1.06	73.11	55.00	0.68	1322	4377
Stress at AVS	138.94	1.00	66.39	53.13	0.66	1134	3604
Stress at AVS & GFIS	135.00	0.96	63.32	50.39	0.63	1083	3412
S. Em±	1.61	0.01	0.87	0.70	0.01	17.4	52.6
CD (P=0.05)	4.67	0.04	2.68	2.14	0.03	53.6	162.1
N management (kg ha^{-1}) with bio-fertilizer (N) :							
No N	99.65	0.64	44.24	39.72	0.63	477	1802
40 N	140.77	1.02	65.00	52.88	0.65	1057	3665
40 N + *Azotobacter* liquid	144.10	1.04	67.01	53.67	0.65	1178	3907
40 N + *Azotobacter* powder	142.35	1.03	66.00	53.62	0.66	1144	3770
60 N	149.14	1.10	73.98	56.03	0.66	1372	4313
60 N + *Azotobacter* liquid	154.10	1.11	79.18	57.33	0.68	1542	4634
60 N + *Azotobacter* powder	152.97	1.11	77.83	56.63	0.68	1489	4592
S. Em±	1.75	0.02	1.05	0.90	0.01	21.3	56.5
CD (P=0.05)	4.90	0.05	2.95	2.51	0.03	59.7	158.5

AVS = Active vegetative stage, GFIS = Grain filling stage

RESULTS AND DISCUSSION

Effect of moisture stress : The outcome of the investigation revealed that grain and stover yield was decreased with increase in moisture stress (Table 1). No moisture stress showed its significant superiority. Significantly the lowest grain yield was recorded when stress imposed at AVS (Active vegetative stage) and GFIS (Grain filling stage). The magnitude of increase in grain yield with no moisture stress was to the tune of 15.40, 17.99 and 16.58 per cent over stress at AVS as well as 21.79, 22.35 and 22.07 per cent over stress at AVS and GFIS during 2004-05, 2005-06 and in pooled data respectively. The yield increment is attributed to improvement in length of main inflorescence, number of lateral spikelets and 1000 seeds weight. The reduction in grain yield under stress at AVS over no moisture stress is worked out to 13.35, 15.25 and 14.22 per cent during first and second year as well as on pooled basis, respectively. However, the differences in yield were observed marginal when stress imposed either at one or two growth stages. This indicated that the active vegetative stage is most critical for irrigation as compared to grain filling stage in grain amaranth crop. Like grain yield, no moisture Stress produced 21.45 and 28.28 per cent higher stover yield over stress at AVS and AVS as well as at GIFS, respectively. Higher stover yield is ascribed to increment in plant height and stem thickness recorded with no moisture stress. These results colloborate with the findings of Mishra *et al*. (1997). Moreover moisture stress at active vegetative stage adversely affected the development of floral primordia, and the effect extended to grain formation and ultimately poor grain yield (Gowda *et al.* 1999, Ayodele 2000 and Nehra 2000).

The consumptive use of water (CU) was successively decreased as moisture stress increased during 2004-05, 2005-06 and the mean values over seasons (Table 2). The maximum CU of water (246.2 mm) was recorded under no moisture stress followed by stress at active vegetative stage (200.2 mm). It accounted 22.98 and 53.20 per cent higher CU than that of stress at AVS (active vegetative stage) and stress at AVS and GFIS(grain filling

stage) on pooled data basis, respectively. Higher consumption of water with more number of irrigations is attributed to luxurious growth under adequate moisture supply, which in turn increased the evapotranspiration losses. On the other hand, limited water supply under stress at active vegetative (AVS) and grain filling stage (GFIS) (3 irrigations) reduced vegetative growth of the crop and hence less water used by the crop. Water use efficiency (WUE) was increased as moisture stress increased. Though, maximum stress, it could not realize proportionate yield increment and thereby lower WUE supply, the inter plant competition for moisture might have helped to enhance WUE. Similar findings have been reported by Patel *et al*. (2005).

Maximum uptake of N and P by the crop was noticed with no moisture stress followed by moisture stress at active vegetative stage. Moisture stress at active vegetative and grain filling stage led to minimum uptake. This indicated that supply of sufficient moisture to the crop led better utilization of N and P. This might be due to increase in mass flow transport of nutrients with sufficient soil moisture availability. These findings are in accordance with those reported by Patel (2003).

Effect of nitrogen management with bio-fertilizers : Integration of bio-fertilizers with nitrogen exerted affirmative effect on grain and stover yield over only N application during both the years and in pooled data (Table 1). Treatment N_{60} + liquid culture of *Azotobacter* produced maximum grain yield (1542 kg ha^{-1}) which accounted 3.56, 12.39 and 45.88 per cent higher over N_{60} + powder culture of *Azotobacter*, N_{60} and N_{40}, respectively. The same treatment (N_{60} + liquid culture of *Azotobacter*) expressed its superiority producing stover yield of 4634 kg ha^{-1}. In general, both the forms (powder and liquid) found equally effective with respective level of N. Higher grain yield associated with higher length of main inflorescence, more number of lateral spikelets and 1000 seed weight per plant. Similarly higher stover yield is ascribed to higher plant height and maximum stem thickness. Similar findings have been reported by Nehra *et al*. (2001), Deokar and Sawant (2002) and Rathore *et al.* (2004).

Maximum consumptive use of water was registered with N_{60} + *Azotobacter* liquid culture (Table 2). This might be due to luxurious vegetative growth of crop when nitrogen requirements are fulfilled. Appreciable increase in water use

Table 2. Consumptive use of water, water use efficiency and nutrient uptake of grain amaranth as influenced by moisture stress and nitrogen management with bio-fertilizers.

Treatment	Consumptive use of water (mm)	Water use efficiency (kg ha^{-1} mm^{-1})	Nutrient uptake (kg ha^{-1})	
			N	P
Moisture stress :				
No moisture stress	246.2	5.30	68.60	11.66
Stress at AVS	200.2	5.65	56.28	9.77
Stress at AVS & GFIS	160.7	6.68	53.02	9.32
N management (kg ha-1) with bio-fertilizer (N) :				
No N	181.4	2.69	23.35	4.29
40 N	189.7	5.71	51.83	9.24
40 N + *Azotobacter* liquid	201.2	6.03	58.54	10.27
40 N + *Azotobacter* powder	193.1	6.07	56.27	9.93
60 N	214.6	6.50	70.07	11.90
60 N + *Azotobacter* liquid	218.6	7.19	78.62	13.24
60 N + *Azotobacter* powder	217.8	6.94	76.41	12.88

AVS = Active vegetative stage, GFIS = Grain filling stage.

Table 3. Interaction effect of moisture stress and N management with bio fertilizers on grain yield (kg ha^{-1}) (Pooled data).

N management with bio-fertilizers (N)	Moisture stress		
	No stress	AVS	AVGF
N_0	517	467	447
N_{40}	1129	1034	1008
N_{40} + *Azotobacter* liquid	1293	1159	1083
N_{40} + *Azotobacter* powder	1255	1128	1048
N_{60}	1565	1300	1252
N_{60} + *Azotobacter* liquid	1784	1446	1406
N_{60} + *Azotobacter* powder	1714	1406	1347
SEm±	36.8		
CD (P=0.05)	103.3		

AVS = Stress at active vegrtative stage, AVGF = Stress at active vegetative and grain filling stage.

efficiency (WUE) was observed with *Azotobacter* treatments either liquid or powder form combined with N over N alone. Maximum WUE was achieved under treatment N_{60} + *Azotobacter* liquid culture. These findings followed the pattern with Arya and Singh (2001).

Nitrogen management treatments had spectacular impact on N and P uptake by the crop (Table 2). Among all the treatments, N_{60} + *Azotobacter* liquid culture ranked at top followed by N_{60} + *Azotobacter* powder culture. The increase in uptake of N is attributed to the favourable effect of *Azotobacter* inoculation on growth and yield attributes. Which resulted in higher yield with higher N uptake. This might be due to fixation of molecular nitrogen by *Azotobacter*. However, soils of experimental plot responded well to *Azotobacter* treatment due to poor nitrogen status. These results are in agreement with those reported by Panchal *et al*. (1991) in case of uptake of nutrients. Similar positive response of *Azotobacter* in uptake of nitrogen and phosphorus has also been observed by Singh and Totawat (2002).

Interaction effect : Interaction between moisture stress and nitrogen management was significant (Table 3). Treatment combination, no moisture stress with N_{60} + *Azotobacter* liquid culture remaining at par with no moisture stress with N_{60} + *Azotobacter* powder culture produced maximum grain yield. This might be due to adequate moisture and nutrient supply during entire life period of crop. Spectacular response of liquid form of *Azotobacter* was noted with N_{40} and N_{60} over N alone at all the stress levels. *Azotobacter* with 40 kg N helped to enhance grain yield over only 40 kg N up to stress at active vegetative whereas at higher level, *Azotobacter* tended to improve yield when stress imposed stress at stress at active vegetative and grain filling stage stress. Rapid growth of *Azotobacter* under adequate N supply with irrigations during initial crop growth might have helped in better performance of *Azotobacter* culture treatments.

Irrigating the crop at all physiological growth stages i.e. no moisture stress and supplying 60 kg N ha^{-1} along with seeds inoculating by *Azotobacter* liquid culture gave maximum yield of grain amaranth. Missing irrigation at active vegetative stage led to critical reduction in grain and stover yield even with supply of higher dose of nitrogen.

LITERATURE CITED

Arya, M. P. S. and R. V. Singh. 2001. Response of amaranth to levels and time of nitrogen application. Indian J. Agron., 46(1) : 186-189.

Ayodele, A. S. 2000. Influence of soil water stress on growth and yield of Amaranth spp. Bulletin Peneclitian Hortikultura, 20(4) : 36-44.

Deokar, C. D. and D. M. Sawant 2002. Effect of *Azotobacter* liquid bioinoculants on grain and fodder yield on hybrid sorghum. J. Maharashtra agric. Univ. 21(2) : 154-155.

Hegde, S. V. 2002. Liquid bio-fertilizers in Indian agriculture. Bio-fert. Newslett. 10: 17-25.

Gowda, A., M. Rangaswamy and V. C. Reddy. 1999. Performance of amaranthus (*Amaranthus cruentus* L.) under soil moisture stress at different growth stages. Curr. Res., 28: 171-172.

Mishra, P. N., S. K. Tewari and D. Singh. l997. Scheduling of irrigation in grain amaranth (*Amaranthus hypochondriacus* L.) grown on marginal soils. Ann. Agric. Res., 18(3): 304-308.

Nehra, A. S., I. S. Hooda and K. P. Singh. 2001. Effect of integrated nutrient management on growth and yield of wheat (*Triticum aestivam*). Indian J. Agron., 46(1): 112-117.

Nehra, O. P. 2000. Response of grain amaranth (*Amaranthus hypochondriacus* L.) to irrigation and nitrogen application. HaryanaJ. Agron., 16(1-2) : 174-175.

Panchal, D. B., R. B. Patel and K. C. Dalai, 1991. Effect of nitrogen and phosphorus on grain yield and nutrient uptake by amaranth. GAU. Res. J., 16 (2) : 71-72.

Patel, N. S. 2003. Response of irrigation and nitrogen on the quality and yield of grain amaranth (*Amaranthus hypochondriacus* L.) under North Gujarat conditions. M. Sc. (Agri.) thesis submitted to GAU, Sardarkrushinagar.

Patel, B. M., Y. Ravindrababu, P. G. Patel, M. M. Patel and D. K. Patel. 2005. Response of grain amaranth (*Amaranthus hypochodriacus* L.) to irrigation and nitrogen fertilizer. J. Soil and Crops- 15(2): 247-250

Rathore, M. S., I. Singh and M. S. Chandawat. 2004. Suitability of grain amaranth (*Amaranthus hypochodriacus* L.) cultivars for arid western plains zone of Rajasthan and their response to nitrogen application. Crop Res. 27(1): 54-57.

Singh, R. and K. L. Totawat. 2002. Effect of integrated use of nitrogen on the performance of maize (*Zea mays* L.) on halplustalfs of sub-humid southern plains of Rajasthan. Indian J. Agric. Res., 36 (2): 102-107.

J. Maharashtra agric. Univ., 34 (3) : 260-262 (2009)

Effect of Mulches, Levels of Fertilizer and Organic Manure on Yield of *Rabi* Sweet corn (*Zea mays saccharata*)

S. P. Gosavi[1], S. A. Chavan[2] and S. B. Bhagat[3]
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli - 415 712 (India)
(Received : 25-08-2008)

ABSTRACT

The black polythene mulch produced significantly more length of cob, weight of cob with husk, number of kernels per cob and green cob yield than rest of the treatments. RDF recorded significantly superior values of all the yield attributing characters and yield, than control and 20 t FYM ha^{-1} was significantly superior in respect of weight of the cob with and without husk, length of cob, number of kernels per cob and kernel weight per cob over rest of the treatments except length of cobs and number of kernels per cob, where 15 t FYM ha^{-1} treatment was at par with the former treatment. Further, 15 t FYM ha^{-1} was significantly superior over 10 t FYM ha^{-1} and all the yield characters increased with subsequent increase in the levels of FYM.

Key words : Mulches, fertilizer, FYM levels, yield, sweet corn.

Sweet corn (*Zea mays saccharata*) also known as sugar corn is a type of maize (*Zea mays*), specifically bred to increase the sugar content. Mulches help to increase the crop yield due to improved soil temperature and soil micro-flora, reduce fertilizer leaching, evaporation and supress weed problem. Integrated nutrient management approach, i.e. combining organic and chemical fertilizers would be more remunerative for getting higher returns. In this view the experiement was conducted to see the possibility of the organic and inorganic sources of nutrients in maintaining physico-chemical properties, fertility of soils and to increase the sweet corn yields in rabi season.

MATERIALS AND METHODS

The field experiment was conducted during *rabi* season of the year 2005-2006 on a medium black soil of the ASPEE, Agriculture Research and Development Foundation, Tansa Farm, Thane (M.S.) in spilt-spilt plot design. The main plot treatments comprised of four types of mulches (control, paddy straw, transparent and black polythene mulches). While in the sub plot treatments there were two levels of fertilizer (control and RDF) and the sub- sub plot treatment comprised three levels of FYM (10,15 and 20 t ha^{-1} of FYM). Thus, there were 24-treatment combinations, replicated thrice. The soil of experimental plot was clay loam in texture with high content of organic matter (1.98 %), moderately high in available nitrogen (445.53 kg ha^{-1}) and phosphorus (25.54 kg ha^{-1}), very high in available potassium (424.10 kg ha^{-1}) before sowing of the experiment. The crop was sown on 27th November during 2005. The sweet corn cultivar "Sugar-75" was used in the present investigation. Two seeds per hill were dibbled at each spot at about 5 cm depth. After sowing, the seeds were covered with soil. Gap filling was undertaken immediately at 8 days after sowing to maintain the uniform plant population wherever necessary. Similarly thinning was carried out at 20 days after sowing in order to maintain one plant per hill within the row.

Well decomposed farmyard manure was applied in each plot as per the treatment i.e. 10, 15 and 20 tons ha^{-1} and mixed throughly in the soil after layout. There were twelve combinations in a replication without fertilizer i.e. no nitrogen, phosphorus and potassium application. The fertilizers were applied in other twelve combinations i.e. recommended dose of 225:60:60 kg N, P_2O_5 and K_2O ha^{-1}. Before sowing a basal dose of 40 per cent N with full of P_2O_5 and K_2O were applied by placement method at the depth of 8 to 10 cm below in the soil surface at 60 cm rows in the form of urea, single super phosphate and muriate of potash respectively. The second 30 per cent dose of nitrogen was top dressed at knee high stage i.e. 30-35 DAS and the remaining 30 per cent N at pre tasselling stage i.e. 60-65 DAS. The plot area as per treatment was covered by transparent mulch, black polythene mulch and paddy straw mulch before sowing. Transparent polythene mulch used for mulching had 90 cm width, 15 micron thickness. The holes of 2.5 cm diameter were made in polythene mulch then it was spread over the plots. The black polythene mulch

1. Surveillance Inspector (NIWSP), 2. Asso. Director of Research 3. Asstt. Professor.

used for mulching had 120 cm width and 25 micron thickness. The paddy straw of 5 cm thickness was spread over each plot (M2).

RESULTS AND DISCUSSION

Effect of mulches : Data pertaining to the yield contributing characters of sweet corn revealed that black polythene mulch produced significantly higher length of cob, weight of cob with husk and number of kernels per cob, green cob yield and stover yield than rest of the treatments. It was followed by transparent polythene mulch which was at par with paddy straw mulch and both of these mulching treatments were significantly superior over control. However, other yield attributing and yield characters namely weight of cobs without husk, number of kernel and kernel rows per cob, number of cobs per plant and kernel weight per cob and total biomass yield were not influenced significantly due to the mulches. Mulch helps to increase the crop yield due to improved soil temperature and soil micro-flora, reduced fertilizer leaching, evaporation and supressing weeds problem. However, total biomass yield was not influenced significantly due to the mulches (Table 1). These results are comparable with those reported by Kulkarni *et al.* (1998) and Kwabiah (2004).

Effect of fertilizer levels : Data (Table 1) revealed that recommended dose of fertilizer recorded significantly superior values of all the yield attributing and yield characters than control.

Effect of FYM levels : Data indicated that 20 t FYM ha^{-1} was significantly superior in respect of weight of the cob with and without husk, length of cob, number of kernels per cob, kernel weight per cob, green cob yield and stover yield over rest of the treatments except length of cobs and number of kernels per cob where 15 t FYM ha^{-1} treatment was at par with the former treatment. Further, 15 t FYM ha^{-1} was significantly superior over 10 t FYM ha^{-1} in respect of all the above referred characters. However, number of kernel rows per cob and number of cobs per plant and total biomass yield were not influenced significantly due to the FYM levels. Integrated nutrient supply approach, combining organic and chemical fertilizers would be more remunerative for getting higher returns. Differential behaviour of the sweet corn crop due to variation in fertilizer application in respect of the growth and yield attributing characters reflected into differential green cob yield, green stover yield and total biomass yield. The green cobs yield, green stover yield and total biomass

Table 1. Yield and yield contributing characters of sweet corn as influenced by the different treatments.

Treatments	Weight of the cob (g)		Length of cob (cm)	Kernel rows cob^{-1}	Kernels cob^{-1}	Cobs plant-1	Kernel weight cob^{-1} (g)	Yield (q ha^{-1})	
	With husk	Without husk						Green cob yield	Stover yield
Main plot treatments (mulches) :									
M_0 - Control	249.67	179.50	14.76	13.53	347.72	1.13	118.00	194.38	235.11
M_1 - Black polythene	340.61	250.22	18.31	15.13	496.54	1.42	178.11	275.59	326.97
M_2 - Paddy straw	300.78	218.72	16.78	14.34	434.44	1.18	149.17	219.93	328.96
M_3 - Transparent polythene	305.13	221.36	17.05	14.67	456.04	1.51	164.72	246.69	303.61
S. E.±	6.79	6.08	0.19	0.24	6.68	0.05	5.61	7.41	4.89
C. D. at 5%	23.51	NS	0.67	NS	23.13	NS	NS	25.63	16.93
Sub-plot treatments (Fertilizer levels) :									
R_0 - Control	169.19	127.88	13.62	13.37	279.02	0.99	88.25	87.32	195.15
R_1 - RDF	428.9	307.01	19.82	15.46	588.35	1.22	216.74	263.91	400.78
S. E.±	6.26	5.23	0.24	0.23	10.91	0.02	5.76	7.11	6.02
C. D. at 5%	20.43	17.06	0.79	0.76	35.57	0.06	18.78	23.17	19.64
Sub-Sub plot treatments (level of farm yard manure) :									
F_1 - FYM @ 10 t ha^{-1}	272.17	199.20	16.25	14.37	418.62	1.22	140.80	218.35	288.60
F_2 - FYM @ 15 t ha^{-1}	294.48	217.07	16.76	14.43	437.10	1.31	154.53	236.22	298.91
F_3 - FYM @ 20 t ha^{-1}	330.50	236.08	17.17	14.45	445.34	1.41	162.17	247.87	308.48
S. E.±	3.15	2.84	0.15	0.23	5.31	0.32	1.85	2.80	1.72
C. D. at 5%	9.09	8.21	0.45	NS	15.33	NS	5.33	8.07	4.97

yield were significantly higher under application of RDF than control. Similar results were also obtained by Gawade (1998), Gzazia *et al.* (2003) and Kunjir (2004). However, the interaction effects of the factors under study were non significant in respect of yield attributes and yield of sweet corn.

LITERATURE CITED

Gawade, D. G. 1998. Response of sweet corn (*Zea mays saccharatd*) to nutrient management. Thesis submitted for M. Sc. (Agri.) degree to Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (M.S.).

Kulkarni, G. N., S. B. Kalaghatagi and S. M. Mutanal. 1998. Effect of various mulches and scheduling of irrigation on growth and yield of summer maize. Maharashtra agric. Univ., 23(2): 223-224.

Kwabiah, A. B. 2004. Growth and yield of sweet corn cultivars in response to planting date and plastic mulch in a short season environment. Scientia Hort. 102(2): 147-166.

Gzazia, J. D., P. A. Tittonell, D. Germinara and A. Chiesa. 2003. Phosphorus and nitrogen fertilization in sweet corn (*Zea mays saccharatd*). Spanish J. of Agril. Res. 1(2): 103-107.

Kunjir, S. S. 2004. Effect of planting geometry, nitrogen levels and micronutrients on the performance of sweet corn under lateritic soils. Thesis submitted for M. Sc. (Agri.) to Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (M.S.).

J. Maharashtra agric. Univ., 34 (3) : 262-265 (2009)

Nutrient Content and Uptake, Quality and Economics of Barley Fertilized with P and Zn under Light Textured Soils of Rajasthan

Taresh Kumar[1], R. Sammauria[2] and B. L. Pareek[3]
College of Agriculture, Bikaner - 334 006 (India)
(Received : 27-08-2008)

ABSTRACT

Results of field experiment indicated that N content in grain, total uptake of N and P, grain and straw yields, net monetary returns and B:C ratio increased significantly up to application of 19.35 kg P ha^{-1}. N and protein content in straw, P content in grain and total uptake of K increased significantly up to application of 12.9 kg P ha^{-1}. But P application had somewhat antagonistic effect on Zn content and total uptake of Zn. Zn content in grain and straw decreased significantly with the increasing level of P and the highest total uptake of Zn was recorded with 6.45 kg P ha^{-1} and further increase in P levels resulted in significant decrease in total Zn uptake. Application of 30 kg $ZnSO_4$ ha^{-1} significantly improved N and Zn content in grain and straw, total uptake of N and Zn, grain yield and net monetary returns, However, total uptake of P and K and straw yield increased only up to 20 kg $ZnSO_4$ ha^{-1}. P content in straw decreased significantly. Highest B:C ratio was obtained with the application of 10 kg $ZnSO_4$ ha^{-1}. On the basis of regression analysis, the optimum dose of P and Zn were worked out to be as 24.7 kg P ha^{-1} and 35.11 kg $ZnSO_4$ ha^{-1}, respectively.

Key words : P, Zn, barley, nutrient content, nutrient uptake, grain yield, net monetary returns, optimum dose.

Rajasthan has a prime position in barley production in India. Due to its multifold uses and greater adaptability to diverse and adverse farming situations, area under barley is continuously increasing in North West part of Rajasthan. The loamy sand soils of the region are poor in fertility status having unfavourable salt balance with limited water availability but barley is capable of giving successful production under such conditions. Apart from this, agronomic suitability of the crop in this region, low cost of production and fairly stable prices in recent years are the reasons for increasing area under this crop. P and Zn both have numerous vital roles in plants and their adequate supply is prerequisite for optimization of yield. In Rajasthan, 40 per cent of soils are deficient in Zn (Government of Rajasthan, 2001) but its deficiency is not necessarily accompanied with visual symptoms. Further, P and Zn interaction affects the availability and utilization of both the nutrients and imbalance of any in soil matrix affects the dynamics of nutrient affecting the availability of either adversely (Nayak and Gupta 1995). Though soil of experimental site was medium in available P but the information on conjunctive use of P and Zn in barley is severely

1. Ph. D. Scholar, Rajasthan College of Agriculture, MPUAT, Udaipur 2. Associate Professor (Agronomy) Dryland Farming Research Station, MPUAT, Arjia, Bhilwara. 3. Assistant Professor (Agronomy).

lacking in the region. Considering these views, present investigation was carried out.

MATERIALS AND METHODS

Experiment was conducted during the *rabi* season of 2005-06 at Instructional Farm, College of Agriculture, Rajasthan Agricultural University, Bikaner. The soil was loamy sand, low in organic carbon (0.08 %), available N (112.16 kg ha^{-1}), and DTPA extractable Zn (0.56 ppm) and medium in available P (12.5 kg P ha^{-1}) and high in K (199.59 kg K ha^{-1}). Treatments comprised of four levels of P (0, 6.45, 12.9 and 19.35 kg P ha^{-1}) and 4 levels of Zn (0, 10, 20 and 30 kg ZnSO4 ha^{-1}). The experiment was laid out in a factorial randomized block design with three replications. A uniform basal dose of N (45 kg ha^{-1}) and P and Zn to barley as per treatment were drilled through diammonium phosphate and zinc sulphate, respectively. Rest of N was applied through urea and 45 kg N was applied as top dressing in standing crop through urea at 30 DAS. A uniform dose of K (45 kg ha^{-1}) was applied through muriate of potash as basal. Barley crop (Var. RD-2503) was sown at 22.5 cm apart on 15 November, 2005 and harvested on 20 March, 2006. Other package of practices were as per recommendations. Nutrient contents in grain and straw were estimated by following standard procedures. Nutrient contents of grain and straw were multiplied with grain and straw yield respectively and total of both was recorded as total uptake of the particular nutrient. Cost of cultivation and gross monetary returns for each treatment were computed on the basis of prevailing market prices of inputs and produce. Net monetary returns and B:C ratio were worked. In order to work out optimum doses of P and Zn, a regression analysis was done for grain yield of barley as a quadratic function of nutrients ($Y= a + bx + cx^2$) by using following formula.

$$X_{opt} = \frac{Px / Py - b_1}{2b_2}$$

Where, P_x and P_y are the market prices for each kg of nutrient and grain yield, respectively and b_1 and b_2 are regression coefficients of linear and quadratic components of the production function.

RESULTS AND DISCUSSION

Effect of P : Increasing levels of P significantly increased the per cent N and protein content in grain and straw and it was found significant up to application of 19.35 kg P ha^{-1} in grain and up to 12.9 kg P ha^{-1} in straw (Table 1). Per cent P content in grain also increased significantly up to application of 6.45 kg P ha^{-1}. Per cent P content in straw also increased significantly over control but all levels were found at par in this respect. Increased per cent content of N and P may be attributed to the further increase in availability of P in medium status soil that probably developed efficient root system augmenting uptake of P as well as N. The highest total uptake of N and P was recorded with the application of 19.35 kg P ha^{-1} which was significantly higher to rest of other levels (Table 2). Per cent K content in grain and straw was not affected significantly with the application of any level of P in comparison to control (Table 1) but total uptake of K increased significantly that was the highest with the application of 19.35 kg P ha^{-1}, however, it was found at par to that of 12.9 kg P ha^{-1} (Table 2). Significant reduction in Zn content was noticed with the application of P indicating antagonistic relationship. Zinc content in grain reduced up to application of 19.35

Table 1. Effect of P and Zn application on nutrient and protein content of barley.

Treatment	N content (%)		P content (%)		K content (%)		Zn content (ppm)		Protein content (%)	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
P levels (kg ha^{-1}) :										
0.00	1.829	0.463	0.397	0.067	0.473	1.120	27.26	19.43	11.433	2.894
6.45	1.852	0.468	0.433	0.073	0.469	1.111	26.35	18.77	11.573	2.925
12.90	1.873	0.474	0.441	0.074	0.464	1.100	21.26	15.15	11.704	2.963
19.35	1.892	0.478	0.447	0.075	0.462	1.096	19.00	14.93	11.822	2.988
S. Em±	0.006	0.001	0.005	0.001	0.004	0.010	0.15	0.16	0.036	0.006
C. D. at 5%	0.017	0.004	0.013	0.002	NS	NS	0.43	0.46	0.103	0.025
$ZnSO_4$ levels (kg ha^{-1}) :										
00	1.830	0.463	0.434	0.074	0.468	1.109	21.37	15.73	11.436	2.894
10	1.859	0.470	0.431	0.073	0.468	1.110	22.49	16.19	11.620	2.938
20	1.872	0.473	0.428	0.072	0.466	1.105	24.16	17.21	11.703	2.956
30	1.884	0.476	0.424	0.071	0.465	1.103	26.75	19.15	11.774	2.975
S. Em±	0.006	0.001	0.005	0.001	0.004	0.010	0.149	0.160	0.036	0.006
C. D. at 5%	0.017	0.004	NS	0.002	NS	NS	0.43	0.46	0.103	0.025

kg P ha^{-1} and up to 12.9 kg P ha^{-1} in straw. Decrease in Zn content at higher P level might be due to decrease in the available Zn in soil probably due to formation of complexes with excess P or probable interference in translocation (Sharma and Bapat 2000 and Singh and Chauhan, 2005). A characteristic pattern was noticed with regard to total uptake of Zn that increased significantly over control with the application of 6.45 kg P ha^{-1} but it decreased significantly with further increase in P levels (Table 2). Lowest total uptake of Zn was observed with the application of 19.35 kg P ha^{-1} which was at par with 12.9 kg P ha^{-1} but both of these were found significantly lower than control in this respect. The increase in total uptake of Zn with initial levels of P may be attributed to the increase in dry matter despite of decrease in content in grain and straw, however, with further increase in P levels reduction in contents was so great that increasing dry matter could not compensate it and significant reduction in total uptake was evident.

Seed and straw yields enhanced significantly with the application of P and the highest yields (3790.07 and 5576.62 kg ha^{-1}) were obtained with the application of 19.35 kg P ha^{-1}. Increased yields with the increasing P levels may be ascribed to the better nutritional environment in the rhizosphere by increasing availability of P and also developing well developed root system enabling more uptakes of other nutrients also and this might have improved the growth of crop ultimately resulting in higher grain and straw yields. The highest net monetary returns (Rs 19377 ha^{-1}) and B: C ratio (3.17) were also observed with the application of 19.35 kg P ha^{-1}.

Table 2. Effect of P and Zn application on nutrient uptake, grain yield and economics of barley.

Treatment	Nutrient uptake (kg ha^{-1})				Yield (kg ha^{-1})		Economics	
	N	P	K	Zn	Grain	Straw	Net monetary returns (Rs. ha^{-1})	B:C ratio
P levels (kg ha^{-1}) :								
0.00	75.07	14.73	65.34	1.700	2941.23	4593.97	14152	2.76
6.45	85.65	18.16	71.56	1.842	3347.95	5031.33	16764	3.00
12.90	92.17	19.68	74.88	1.565	3576.21	5298.39	18111	3.09
19.35	98.47	21.13	78.65	1.600	3790.07	5576.62	19377	3.17
S. Em±	1.67	0.38	1.52	0.030	70.43	102.78	-	-
C. D. at 5%	4.81	1.09	4.39	0.085	203.40	296.85	-	-
$ZnSO_4$ levels (kg ha^{-1}) :								
00	74.99	16.17	64.62	1.340	2935.35	4587.85	14826	3.01
10	85.45	18.06	71.05	1.543	3325.63	5001.52	16830	3.07
20	92.68	19.33	75.77	1.767	3593.25	5342.64	18001	3.02
30	98.25	20.14	78.99	2.058	3801.23	5568.31	18749	2.93
S. Em±	1.67	0.38	1.52	0.030	70.43	102.78	-	-
C. D. at 5%	4.81	1.09	4.39	0.085	203.40	296.85	-	-

Effect of Zn : N content of grain and straw and protein content in grain increased significantly with the application of increasing levels of Zn and the highest contents were recorded with the application of 30 kg $ZnSO_4$ ha^{-1} which was at par with the application of 20 kg $ZnSO_4$ ha^{-1} (Table 1). Zinc content of grain and straw also increased significantly with the increasing levels of Zn application and the highest content was recorded with the application of 30 kg $ZnSO_4$ ha^{-1}. Increased availability of Zn in soil due to its application possibly improved the content of grain and straw and probably improved functioning of physiological processes that might have helped in increased absorption of other nutrients also. However, application of Zn brought significant reduction in the P content of straw of the barley and lowest content was recorded with the application of 30 kg $ZnSO_4$ ha^{-1} which was at par with other levels of Zn. Higher availability of Zn might have reduced the availability of P resulting in reduced content of P (Nayak and

Table 3. Regression analysis of barley yield as a function of P and Zn fertilization.

Parameters	Value
Optimum level of P (P.opt)	24.66 kg P ha^{-1}
Yield at P.opt	38.58 q ha^{-1}
a	29.49
b	42.21
c	-48.25
R^2 value	0.9966
Px / Py	3.55
Optimum level of Zn (Zn.opt)	35.51 kg $ZnSO_4$ ha^{-1}
Yield at Zn.opt	38.67 q ha^{-1}
a	29.38
b	42.31
c	-45.5
R^2 value	0.9995
Px / Py	10.00

Gupta, 1995, Jain, 2004 and Sammauria, 2007). P content in grain and K content in grain and straw did not affect significantly with the application of any level of Zn.

The highest total uptake of N and Zn was recorded with the application of 30 kg $ZnSO_4$ ha^{-1} which was significantly higher over rest of the levels (Table 1). Total uptake of P and K was also the highest with the application of 30 kg $ZnSO_4$ ha^{-1} but it was at par with 20 kg $ZnSO_4$ ha^{-1}. The highest grain yield was obtained with the application of 30 kg $ZnSO_4$ ha^{-1} that was significantly better over rest of the levels, however, straw yield obtained with this level was found at par with the application of 20 kg $ZnSO_4$ ha^{-1}. Zinc has been reported to have definite role in reproductive physiology especially in initiation of reproductive primordial and favourable partitioning of photosynthates towards sink (Jain and Dahama, 2006) that probably led to significant improvement in grain yield. The highest net monetary returns (Rs. 18749 ha^{-1}) were also recorded with the application of 30 kg $ZnSO_4$ ha^{-1} but the highest value of B:C ratio (3.07) was recorded with the application of 10 kg $ZnSO_4$ ha^{-1} and further increase beyond this level decreased the B:C ratio and it was even lower than control with the application of 30 kg $ZnSO_4$ ha^{-1}.

Response studies : Grain yield of barley was found highly positively correlated with the total uptake of P and Zn with the correlation coefficient (r) of 0.971 and 0.515, respectively. Simple regression equation (Y = a + bx) developed was also suggestive of increase in grain yield of barley due to total uptake of P and Zn. The relationship indicated that response of barley was linear to P and Zn application and the response equations are as below.

P : Y = 2.156 + 0.6028x

Zn : Y = 558.65 + 32.75x

On the basis of regression analysis, the optimum dose of P and Zn worked out to be 57.36 kg P and 35.11 kg $ZnSO_4$ ha^{-1}, respectively (Table 3). The corresponding expected grain yields for P and Zn were 38.58 and 38.67 q ha^{-1}, respectively. The higher values of coefficient of determination for both the nutrients indicated very high degree of closeness between the predicted and observed values.

LITERATURE CITED

Government of Rajasthan 2001. Agriculture in Rajasthan : Some facts, Directorate of Agriculture. Pant Krishi Bhawan, Jaipur.

Jain N. K. 2004. Studies on P and Zn fertilization in wheat [*Triticum aestivum*] and their residual effect on pearl millet [*Pennisetum glaucum*]. Ph. D. (Agro.) thesis. Rajasthan Agricultural University, Bikaner.

Jain N. K., and A. K. Dahama. 2006, Direct and residual effect of P and Zn fertilization on productivity of wheat pearl millet cropping system. Indian J. of Agron. 51(3): 165-169.

Nayak A. K. and M. L. Gupta. 1995. P. Zn and organic matter interaction in relation to uptake, tissue concentration and absorption rate of P in wheat. J. Indian Soc. Soil. Sc. 43(4): 633-36.

Sammauria, R. 2007. Response of fenugreek (*Trigonella foenum-graecum*) to phosphorus and zinc application and their residual effect on succeeding pearl millet (*Pennisetum glaucum*) under irrigated conditions of North West Rajasthan. Ph. D. (Agro.) Thesis. Rajasthan Agricultural University, Bikaner.

Sharma, B. L., and P. N. Bapat. 2000. Levels of micronutrient cations in various plant parts of wheat as influenced by zinc and phosphorus application. J. Indian Soc. Soil Sci. 48(1): 130-134.

Singh, Y. P. and C. P. S. Chauhan. 2005. Effect of sulphur, phosphorus and *Rhizobium* inoculation on yield, content of micronutrients and phosphorus utilization of lentil. Indian J. Pulse Res. 18(2): 21 1-213.

J. Maharashtra agric. Univ., 34 (3) : 266-268 (2009)

Soil Moisture, Nodulation, Yield Attributes and Quality of Soybean Under Integrated Nutrient Management

B. R. Gajbhiye[1] and C. V. Mali[2]
College of Agriculture, Latur - 413 512 (India)
(Received : 27-09-2008)

ABSTRACT

The significant increase in moisture content of soil profile at all the critical growth stages of crop was found with application of organics. The application of FYM @ 10 t ha^{-1} showed higher soil moisture and maximum nodulation as compared to other treatments. The number of pods $plant^{-1}$ were higher with RDF + Purna-11 @ 60 kg ha^{-1}. The highest grain yield was obtained with application of RDF along with organics. The application of RDF in combination with Purna-11 @ 60 kg ha^{-1} produced highest hundred seed weight (12.40 g), protein content (40.62 %), oil content (20%) and oil yield in soybean.

Key words : lntegrated nutrient management, soybean yield, protein and oil content.

In the last two to three decades, there is a considerable increase in irrigation facilities. Use of high yielding varieties coupled with intensive cropping have led to the depletion of organic matter and thereby decreased the productivity of soil. Organic amendments have favourable effects on productivity of soil, water holding capacity and soil microbial activity and play an important role in improving the quality of crop. Nitrogen fixing bacteria including *Azotobactor* are the constituents of organic amendments, which help in the synthesis of lndol Acetic Acid, Gibbrellic acid, cytokinins and vitamins that are essential growth substances. Hence, use of the organic amendment is one of the best remedies for obtaining sustainable high yields with improvement in quality of soil and crop. Therefore, efforts have been made to find out the effect of Purna-11 as an organic amendment on nodulation, yield and quality of soybean in Vertisols.

1. Asstt Prof, of SSAC and 2. Head, Department of Soil Science and Agril. Chemistry, MAU, Parbhani 431 402.

MATERIALS AND METHODS

A field experiment was conducted to study the effect of organic amendment Purna-11 on nodulation, yield and quality of soybean during *kharif* 2004-2005 on College farm, MAU, Parbhani. The treatments included (T_0) conlrol, (T_1) recommended dose of fertilizer, (T_2) RDF + Purna-11 @ 60 kg ha^{-1}, (T_3) ½ RDF + Purna-11 @ 150 kg ha^{-1}, (T4) ½ RDF + Purna-11 @ 300 kg ha^{-1}, (T5) Purna-11 @ @ 300 kg ha^{-1}, (T6) Purna-11 @ 500 kg ha^{-1}, (T7) FYM @ 10 ha^{-1} with four replications in RBD.

The experimental soil was clay in texture having pH 7.8, EC 0.35 dSm^{-1} $CaCO_3$ 5.4 per cent and organic carbon 0.5 per cent with low in available N, P and high in available K. Necessary cultural operations and plant protection schedule was followed for maintaining plant population and protection of crop. The organic amendment Purna-11 obtained from Purna sugar factory incorporated in experimental plot had organic carbon (32.40%), nitrogen (2.6%), phosphorus (1.4%), potassium (0.43%) and also Fe, Zn, Mn and Cu. The plant samples along with roots were uprooted carefully at flowering and pod formation stage. The roots were washed with fine jet of water and number of nodules were counted. The crop was harvested after 90 days of sowing and seed yield was recorded. Soil moisture content in soil profile (45 cm depth) was recorded at flowering and pod formation stages as per the method described by Singh *et al*. (1980), Seed samples collected were oven dried, ground in mixer and analyzed for crude protein by multiplying per cent nitrogen with the factor 6.25. Oil percentage was estimated with Soxhlet extraction method.

RESULTS AND DISCUSSION

Moisture content : The data (Table 1) indicated that application of FYM @ 10 t ha^{-1} (T_7) recorded significantly higher moisture content in soil at flowering and pod formation stages followed by considerable reduction due to RDF + Purna-11 @ 60 kg ha^{-1} (T_2). The moisture content in soil was further reduced due to application of 100 and 50 per cent RDF along with organic amendment @ 150 or 300 kg ha^{-1}. The addition of Purna-11 alone (T_5 and T_6) also showed further reduction in moisture

content. There was significant reduction in moisture content as the treatments were altered. Similar pattern in moisture content was recorded at harvest stage.

The data on nodule count plant^{-1} (Table 1) indicated that the application of FYM @ 10 t ha^{-1} recorded maximum number of nodules at flowering (43 plant^{-1}) and pod formation (53 plant^{-1}) in soybean over rest of the treatments. The addition of RDF alone (T_1) or along with Purna-11 (T_2) or 50 per cent RDF + Purna-11 (T_3 and T_4) produced more or less similar number of nodules. However, number of nodules was reduced significantly with the application of Purna-11 alone (T_5 and T_6). The number of nodules was decreased considerably as the treatments were altered. The improvement in soil moisture with an application of organic (FYM) recorded in this study may be attributed to the higher water retention characteristics of organic amendments as reported by Bhatia and Shukla (1982). Bellakki and Badanur (1997) also reported high content of water at field capacity with the combination of FYM and fertilizers. The maximum nodulation at flowering and pod formation stage with application of FYM @ 10 t ha^{-1} in soil confirmed the findings of Kundu *et al.* (1998) who reported an increase in N fixation through symbiotic process with the incorporation of organic manures in soil.

Table 1. Moisture content (%) of soil and nodulation in soybean as influenced by organic amendment.

Treatments	Flowering		Pod formation		Harvest
	Moisture content (%)	Nodule count plant^{-1}	Moisture content (%)	Nodule count plant^{-1}	Moisture content (%)
T_0	29.90	29	33.75	37	22.45
T_1	32.10	36	34.70	33	24.00
T_2	32.75	38	34.85	45	24.80
T_3	32.00	35	34.15	35	23.35
T_4	32.50	38	34.00	45	23.10
T_5	31.35	31	34.60	39	24.35
T_6	31.85	33	34.80	41	24.95
T_7	33.25	43	34.85	53	24.80
S. E.±	0.10	3.1	0.04	3.2	0.04
C. D. at 5%	0.31	9.3	0.13	9.4	0.12

Table 2. Yield attributes, grain yield and quality parameters of soybean as influenced by organic amendment.

Tretments	Pods plant^{-1}	Grains pod^{-1}	Grain yield (q ha^{-1})	Hundred seed wt. (g)	Protein content (%)	Oil content (%)	Oil yield (kg ha^{-1})
T_0	56	2	17.7	11.32	39.25	18.02	318.9
T_1	77	3	27.7	12.32	40.31	19.80	548.4
T_2	82	3	29.5	12.14	40.62	20.00	590.6
T_3	60	2	25.8	11.92	40.06	19.04	492.1
T_4	72	3	26.6	12.22	40.18	19.85	529.0
T_5	65	2	20.0	11.75	39.56	18.56	371.5
T_6	69	2	20.5	11.82	39.75	18.66	381.5
T_7	73	2	23.1	12.02	39.93	19.17	442.8
S. E.±	4.77	0.13	0.64	0.314	0.38	0.76	27
C. D. at 5%	14.00	0.38	1.92	0.923	1.10	NS	24.31

Yield attributes and grain yield : The data on yield attributes and grain yield of soybean (Table 2) revealed that the application of RDF + Purna-11 @ 60 kg ha^{-1} (T_2) produced maximum number of pods plant^{-1} followed by RDF (T_1). However, treatments T_4, T_5, T_6 and T_7 were at par with T_2. The application of 50 per cent RDF + 150 kg Purna-11 ha^{-1} showed significantly less number of pods (60) plant^{-1}. The number of grains pod^{-1} were higher with T_1, T_2 and T_4 than other treatments.

The highest grain yield (29.5 q ha^{-1}) was recorded with the application of 100 per cent RDF along with Purna-11 @ 60 kg ha^{-1} followed by slight reduction upto 27.7 q ha^{-1} with the addition of 100 per cent RDF (T_1). Further as the treatments were altered to T_3, or T_4 reduced the grain yield significantly and were at par with each other. The application of FYM and Purna-11 alone showed drastic reduction in yield of soybean.

The maximum number of pods plant^{-1} and grain yield recorded with RDF + Purna-11 @ 60 kg ha^{-1} (T_2) may be attributed to higher moisture retention enhancing nutrient availability and finally increased the yield attributes and yield of soybean

as reported by Chaubey *et al*. (2002).

Quality parameters : The data presented in Table 2 further indicated that application of RDF along with Purna-11 @ 60 kg ha^{-1} (T_2) showed highest test weight (12.40 g) followed by 12.32 g with the application of RDF (T_1). The test weight of soybean did not differ significantly with different treatments. Similarly application of RDF with Purna-11 @ 60 kg ha^{-1} (T_2) recorded highest protein content (40.62) followed by 40.31 per cent due to addition of RDF (T_1) in soybean. The oil yield recorded with treatment T_2 was significantly superior to other treatments. Thus the application of 100 per cent RDF along with 60 kg ha^{-1} of Purna-11 showed highest grain, oil content and protein content in soybean. Nagar *et al*. (1993) also observed that oil and protein content of the soybean grains increased significantly with increasing doses of fertilizers. These results also confirm the findings of Bachhav and Sable (1996) who reported that an application of half N through inorganics and half through FYM produced maximum protein and oil content in soybean.

LITERATURE CITED

Bachhav, P. R. and R. N. Sable. 1996. Effect of different sources of nitrogen on growth parameters, yield and quality of soybean. J. Maharashtra agric. Univ. 21 (2): 244-247.

Bellakki, M. A. and V. P. Badanur. 1997. Long term effect of integrated nutrient management on properties of Vertisol under dry land agriculture. J. Indian Soc. Soil Sci., 45(3): 438-442.

Bhatia, K. S. and K. K. Shukla. l982. Effect of continuous application of fertilizers and manures on some physical properties of eroded alluvial soil. J. Indian Soc. Soil Sci., 30(1) : 33-36.

Chaubey, N. K., G. K. Shrivastava, B. S. Joshi and R. S. Tripathi. 2002. Influence of FYM and inorganic nutrition on productivity of linseed (*Linum usitatissimum* L) under limited irrigation in Chhattisgarh plains. J. Oilseed Res, 19(2): 213-214.

Kundu, S., K. K. Barman, M. Singh, M. C. Manna and P. N. Takkar. 1998. Effect of FYM on N_2 fixation in soybean (*Glycine max*) and its contribution to soil nitrogen J. Indian Soc. Soil. Sci., 46(4): 692-694.

Nagar. R. P., G. C. Mali and P. Lal. 1993. Effect of phosphorus and sulphur on Yield and chemical composition of soybean in Verttisol. J. Indian Soc. Soil, Sci., 41(2): 385-386.

Singh, L., R. N. S. Verma and S. S. Lohia. 1980. Effect of continuous application of FYM and chemical fertilizers on some soil properties. J. Indian Soc. Soil Sci., 28(2): 170-172.

J. Maharashtra agric. Univ., 34 (3) : 269-271 (2009)

Effect of Plant Growth Regulators and Micronutrients on Physical and Chemical Characters of Banana (*Musa spp*) cv. Shrimanti

S. S. Yadlod[1], B. A. Kadam[2] and B. M. Rodge[3]
Department of Horticulture, Marathwada Agricultural University, Parbhani - 431 402 (India)
(Received : 27-09-2008)

ABSTRACT

The maximum weight of mature finger (185.60g) was found in two sprays of micronutrient mixture (1%) followed by one spray of 1 per cent micronutrient mixture (180.82g). Minimum reduction in per cent loss in weight (3.70%) during ripening was found with waxol (6%) followed by two sprays of 1% micronutrient mixture (4.32 %), IAA 80 ppm (4.36%) and maximum was found in control (6.75%). Maximum TSS (21.70%) and reducing sugar (12.90%), was recorded with IAA 80 ppm. Maximum non-reducing sugar (3.84%) was observed in two sprays of 1% micronutrient mixture and minimum in control (3.05 %). Maximum Vit. C (0.98) was observed in GA_3 80 ppm which was significantly superior over all the treatments and minimum in one spray of 1% micronutrient mixture (0.69). Highest pH was recorded with IAA 80 ppm (5.37) and lowest in control (5.26). It was found that application of IAA 80 ppm, GA_3 80 ppm and two sprays of 1% micronutrients mixture, waxol (6%) were effective for physical and chemical characters of banana cv. Shrimanti.

Key words : Micronutrients mixture, growth requlaters, physico-chemical properties, banana.

In India, people prefer fresh fruits instead of canned products. The economics of banana depends on the cost of transportation and storage. However, low shelf life and bad transportability are two major problems in case of banana. It is generally harvested when green between 70 to 100 per cent maturity and ripened before consumption (Paul Thomson *et al.* 1968). Pre harvest and post harvest handling of banana fruits is an important aspect of banana trade. Early and even maturity of bunches are the immediate needs of the banana growers of the region. An investigation was therefore conducted to find out the effect of plant growth substances and micronutrients on quality of banana cv. Shrimanti.

Part of M. Sc. (Agri), thesis submitted by first author to M.A.U. Parbhani

1. Asstt. Professor, 2. Professor and 3. Ph. D. Scholar.

MATERIALS AND METHODS

A field experiment was conducted at College of Horticulture, Marathwada Agricultural University, Parbhani during 2002-2003. The experiment was laid out in a randomized block design with 8 treatments, *viz*. T_1-Control, T_2-GA_3 40 ppm, T_3-GA_3 80 ppm, T_4-IAA 40 ppm, T_5-IAA 80 ppm, T_6-micronutrients mixture (Zn+Cu+B) 1 % one spray, T_7-micronutrients mixture (Zn+Cu+B) 1 % two sprays and T_8-waxol 6 %.

All recommended cultural practices had been followed after plantation of banana. The stock solutions of IAA and GA_3 were prepared by dissolving 1 g of respective growth regulator in 50 ml alcohol and added distilled water to make volume of 1 lit. The required concentration of micronutrients mixture (Zn+Cu+B) were prepared by directly mixing required quantity of micronutrient mixture in water and those spray solutions were used for spraying immediately after preparation. Spray was given at flag leaf stage i.e. just before flowering by using a hand sprayer. Growth regulators and micronutrients mixture on leaves of both the sides of plant were sprayed. Precautions were taken to avoid the drizzling of the sprays on the other treatments. After harvesting the banana, bunches were completely dipped in 6 per cent waxol solution for 30 to 40 seconds. The ripened fruits were peel with hands and pulp was chopped, blended to homogeneous mixture in a mortar and pestle and this mixture was used for chemical analysis. Observations were recorded and statistically analyzed as per the methods given by Panse and Sukhatme(1967).

RESULTS AND DISCUSSION

Effect on physical characters : The data presented in Table 1 that there was significant effect of plant growth regulators and micronutrients on weight of mature finger, weight of riped finger and per cent loss in weight during ripening. Non significant influence was noticed in pulp to peel ratio. The maximum weight of mature finger (185.60g) was found in micronutrient mixture 1 per cent two sprays followed by micronutrient mixture 1 per cent one spray (180.82 g). These two treatments were at par with each other and followed by IAA 80 ppm (173.38 g) and GA_3 80 ppm

(171.87 g). These treatments were statistically similar. Maximum weight of ripe finger (177.58g) was found in two sprays of 1 per cent micronutrients mixture followed by one spray of 1 per cent micronutrients mixture (171.74g). These treatments were at par with each other. Minimum weight of mature finger was recorded in waxol (152.12). These results were also supported by Chellapan (1983), Abdel kader *et al*. (1992) and Ulthaiah *et al*. (1993).

All the treatments significantly reduced the per cent loss in weight during ripening. Minimum reduction in per cent loss in weight (3.70%) during ripening was found with waxol followed by two sprays of micronutrients mixture (4.32%), IAA 80 ppm (4.36%), GA_3 80 ppm (4.71%) and one spray of micronutrients mixture (5.02%) which were at par. Maximum per cent loss in weight during ripening was found in control (6.75%). Highest pulp to peel ratio was obtained with micronutrients mixture one spray (2.89). The remaining treatments were similar to each other. Similar results were also reported by Chattopadhyay and Jana (1982). *Ulthaiah et al*. (1993), Patil and Hulmani (1998).

Effect on chemical characters : The data presented in Table 2 regarding TSS, total sugar, reducing sugar and Vit. C was significantly affected by plant growth substances and micronutrients mixture. Non significant influence was noticed on non-reducing sugar and pH. Maximum TSS was recorded with IAA 80 ppm (21.70%) which was at par with IAA 40 ppm (21.40 %), micronutrients mixture two sprays (21.25%) and micronutrients mixture one spray (19.72%). Maximum total sugar (16.61%) was recorded in IAA 80 ppm which was at par with two sprays of micronutrients mixture (16.19%), one spray of micronutrients mixture (16.04%), GA_3 80 ppm (16.01%), waxol (15.86%) and IAA 80 ppm (15.67%). Similar results were also reported by Aziz and Wahab (1970), Rao *et al.* (1971), Srinivasan (1971), Sharma (1976), Jadhav and Kadam (1990), Ghanta and Dwivedi (1993), Das (1995) and Deo (1996).

Maximum reducing sugar (12.90%) was observed due to application of IAA 80 ppm which was at par with one sprays of micronutrients mixture (12.70%), GA_3 80 ppm (12.65%), IAA 40 ppm (12.60 %) ,two sprays of micronutrients mixture (12.35%) and minimum in control (12.00 %). Maximum non-reducing sugar (3.84%) was observed in two sprays of micronutrients mixture and minimum in control (3.05 %). Similar results were also reported by Rao *et al.* (1971), Srinivasan (1971), Sharma (1976), Jadhav and Kadam (1990) and Ghanta and Dwivedi (1993).

Table 1. Effect of plant growth regulators and micronutrients on physical characters of banana (*Musa spp*) cv. Shrimanti.

Treatments	Weight of finger (g)		% loss in weight during ripening	Pulp to peel ratio
	Mature	Ripe		
Control	164.52	153.41	6.75	2.81
GA_3 40 ppm	166.66	157.38	5.57	2.71
GA_3 80 ppm	171.87	165.77	4.71	2.62
IAA 40 ppm	165.35	156.80	5.17	2.62
IAA 80 ppm	173.38	165.82	4.36	2.78
Micronutrients 1%, 1 spray	180.82	171.74	5.02	2.89
Micronutrients 1%, 2 spray	185.60	177.58	4.32	2.73
Waxol 6%	152.12	146.49	3.70	2.55
S. E.±	1.63	4.74	0.56	0.29
C. D. at 5%	4.80	13.94	1.64	NS

Table 2. Effect of plant growth regulators and micronutrients on chemical characters of banana (*Musa* spp) cv. Shrimanti.

Treatments	TSS (%)	Total sugar %	Reducing sugar %	Non reducting sugar %	Vit. C (mg 100 g^{-1} pulp)	pH
Control	19.99	15.05	12.00	3.05	0.72	5.26
GA_3 40 ppm	20.70	15.28	12.10	3.18	0.88	5.30
GA_3 80 ppm	20.68	16.01	12.65	3.36	0.98	5.32
IAA 40 ppm	21.40	15.67	12.60	3.07	0.80	5.30
IAA 80 ppm	21.70	16.61	12.90	3.71	0.77	5.37
Micronutrients 1%, 1 spray	20.82	16.04	12.70	3.34	0.69	5.28
Micronutrients 1%, 2 spray	21.25	16.19	12.35	3.84	0.73	5.34
Waxol 6%	19.72	15.86	12.05	3.81	0.70	5.35
S. E.±	0.40	0.32	0.22	0.23	0.30	0.10
C. D. at 5%	1.19	0.95	0.66	NS	0.08	NS

Maximum Vit. C (0.98) was observed in GA_3 80 ppm which was significantly superior over all the treatments and minimum in one spray of micronutrient mixture (0.69). Highest pH was recorded with IAA 80 ppm (5.37) and lowest in control (5.26). Remaining treatments were statistically similar to each other. Similar results were also reported by Lodh *et al*. (1971), Srinivasan (1971), Ghanta and Dwivedi (1993) and Deo (1996).

LITERATURE CITED

Abdel Kader, A. M. M., F. M. B. El-Makhtoun and M. B. Bastawros. l992. Effect of micronutrients foliar application on the vegetative growth and yield of Hindi banana (*M. cacendishii*). Egyptian J. agric. Res., 70(2): 613-624.

Aziz, A. B. A. and F. K. Wahab. 1970. Comparative studies on the different methods of artificial ripening of banana fruits. Curr. Sci., 39: 552-555.

Chattopadhyay, P. K. and A. K. Jana. 1982. Growth, yield and quality of Gaint Grovernor bananas as influenced by growth substances. South Indian J. Hort, Jan.-Feb. 85.

Chellapan, K. 1983. Effect of 2, 4-D and GA on the fruit development and post harvest physiology of banana. Ph. D. thesis, Tamil Nadu Agril. Univ., Coimbatore.

Das, P. K. l995. Effect of micronutrient on quality of certain banana cultivars. J. Agric. Sci. Soc. North-East India. 8(2): 211-215.

Deo, D. D. l996. Studies on performance of banana (*Musa paradisiaca*) types under Akola condition. M. Sc. (Agri.) thesis, Dr. PDKV, Akola.

Ghanta, P. K. and A. M. Dwivedi. 1993. Effect of some micronutrients on yield and quality of banana cv. Giant Governor, Envron. Ecol., 11(2): 292-294.

Jadhav, K. V. and B. A. Kadam. 1990. Effect of pre- harvest spray of growth regulators on growth, maturity, yield and quality of cv. Basrai of banana. Indian J. Hort. 47 (4) 310-314.

Lodh, S. B., P. Ravel, T. Selvaraj and R. R. Kholi. 197l. Biochemical changes associated with growth and development of dwarf Cavendish banana. Indian J. Hort., 28(1): 38-45.

Panse, V. G. and P. V. Sukhatme. 1967. Statistical Methods for Agricultural Workers, ICAR Publ. New Delhi.

Patil, S. N. and N. C. Hulmani. l998. Effect of post-harvest treatments on the storage of banana fruits. Karnataka. Agric. Sci., 11(4): 134-138.

Paul Thomson, V. B. Dalal, M. C. Pushpa and B. L. Amala. 1968. Harvesting, handling, marketing and transporting of banana for export from India. Fd. Pckr., 22(4): 1-6.

Rao, N. N. M., K. G. Shanmugavelu, C. Srinivasan and D. R. P. Tah. 1971. Effect of ethrel (2-chloroethyl phosphoric acids) on ripening of banana fruits. South Indian Hort., 19(1-4): l-8.

Sharma, D. D. 1976. Varietal differences in physico-chemical characteristics of the banana fruits. Indian Agri., 20(2): l15-119.

Srinivasan, C. l971. Effect of ethrel (2-chloroethyl phosphoric acids) on ripening of banana. Madras agric. J., 58 (9-10): 777-784.

Ulthaiah, B. C., K. M. Indiresh, M. J. Reddy and K. B. Rao. 1993. Performance of banana cultivars under West Coast Conditions. Agril. Res. J. Kerala, 30: 84-88.

J. Maharashtra agric. Univ., 34 (3) : 272-274 (2009)

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

S. M. Awatade[1], B. L. Thaware[2], S. G. Bhave[3], A. V. Mane[4] and B. B. Jadhav[5]
Department of Agricultural Botany, College of Agriculture, Dapoli - 415 712 (India)
(Received : 20-05-2007)

ABSTRACT

Forty genotypes were grouped into twelve clusters. Cluster-I was the largest comprising of seventeen genotypes followed by cluster II and cluster III having 9 and 5 genotypes, respectively. While clusters IV to XII were solitary. The average inter-cluster distance was maximum between cluster X and cluster XII (25.37) followed by cluster X and cluster XI (24.43) and cluster-IV and cluster X (23.62) indicated that these groups of genotypes were highly divergent from each other. The genotypes in above clusters revealed substantial differences in the means for important yield contributing characters suggesting that the genotypes belonging to these clusters form ideal parents for improvement in groundnut.

Key words : Genetic divergence, groundnut, genotypes.

Genetic improvement mainly depends upon the amount of genetic variability present in the population. The use of Mahalanobis's D^2 statistics for estimating genetic divergence have been emphasized by many workers (Murthy and Arunachalam, 1966) because it permits precise comparison among all possible pairs of the population in any given groups before effecting actual crosses. Therefore, the present investigation was undertaken for ascertaining the nature and magnitude of genetic diversity in forty genotypes of groundnut.

MATERIALS AND METHODS

The experimental material consisted of 40 genotypes of groundnut out of which 34 genotypes were from National Research Centre for Groundnut, Junagarh (Gujrat) and 6 varieties from Department of Agricultural Botany, College of Agriculture, Dapoli (MS). All genotypes were grown in a randomized block design with three replications at the Research Farm, Department of Agricultural Botany, College of Agriculture, Dapoli during *kharif*, 2006. The plot size was 2 x 1.2 m with spacing 30 x 10 cm. The recommended packages of practices were adopted. The observations were recorded on five randomly selected plants for thirteen characters *viz*., days to first flowering, days to 50 per cent flowering, days to maturity, plant height number of primary branches plant^{-1}, number of pods plant^{-1}, shelling percentage, pod length, 100-seed weight, number of kernels plant^{-1} kernel yield plant^{-1}, oil percentage and dry pod yield plant^{-1}. The analysis of genetic divergence using Mahalanobis (1936) D^2 statistics was carried out as described by Rao (1952).

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among the genotypes for all the characters indicating considerable variability in groundnut genotypes studied. The

Table 1. Grouping of 40 genotypes of groundnut into different clusters on the basis of D^2 statistics.

Cluster	Genotypes included	Name of the genotypes
I	17	RS 052, RS 074, RS 095, KANO, SUPER KHANDESH, RS 085, B 717, B 353, S 721, 1792, RCM 592, S 720, SPZ 469 RED (DIF), NAN 255, MASAMBIKA, NAN 251 and SB-11
II	9	RCM 597-2, COBO SABA 28-20, AMM 795, JL 24, AH 7121, NCAC 973, EC 6902, ROSADO and VRR 313
III	5	COLORADO MANFREDI, SAM COLL 106, SAM COL 173, 55-455 and RCM 705
IV	1	CHIMBUWILA-A-LL-2
V	1	Konkan Gaurav
VI	1	BMP 11
VII	1	B 704
VIII	1	SAM COL 83
IX	1	TAG 24
X	1	AH 7221
XI	1	TPG 41
XII	1	TKG 19 (A)

* Part of M. Sc. (Agri.) thesis submitted by senior author.

1. M. Sc. (Agri.) Student, 2. Professor of Agril. Botany, 3. Associate Dean, College of Forestry, 4. Assistant Professor of Agril. Botany, 5. Director of Research

Table 2. Intra and inter cluster divergence (D^2) and distance (D) = ($\sqrt{D^2}$) in groundnut genotypes.

Cluster	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
I	45.16 (6.72)	106.39 (10.31)	116.40 (10.79)	126.17 (11.23)	76.08 (8.72)	101.33 (10.07)	253.71 (15.93)	114.33 (10.69)	142.87 (11.95)	341.98 (18.49)	206.34 (14.36)	323.36 (17.98)
II		57.53 (7.58)	96.64 (9.83)	322.20 (17.95)	191.04 (13.82)	156.21 (12.50)	353.65 (18.81)	128.37 (11.33)	113.38 (10.65)	199.14 (14.11)	331.65 (18.21)	543.33 (23.31)
III			57.35 (7.57)	268.89 (16.40)	144.17 (12.01)	126.17 (11.23)	219.66 (14.82)	94.91 (9.74)	85.66 (9.26)	153.63 (12.39)	285.15 (16.89)	392.81 (19.82)
IV				0.00 (0.00)	87.51 (9.35)	104.28 (10.21)	161.45 (12.71)	286.45 (16.92)	284.26 (16.86)	557.68 (23.62)	287.11 (16.94)	207.64 (14.41)
V					0.00 (0.00)	96.86 (9.84)	179.67 (13.40)	127.21 (11.28)	119.89 (10.95)	370.58 (19.25)	105.37 (10.26)	158.59 (12.59)
VI						0.00 (0.00)	95.53 (9.77)	234.63 (15.32)	98.11 (9.91)	225.17 (15.01)	351.27 (18.74)	334.26 (18.28)
VII							0.00 (0.00)	319.68 (17.88)	200.90 (14.17)	273.06 (16.52)	448.11 (21.17)	238.70 (15.45)
VIII								0.00 (0.00)	126.69 (11.26)	277.48 (16.66)	123.40 (11.11)	278.46 (16.69)
IX									0.00 (0.00)	128.69 (11.34)	234.05 (15.30)	374.80 (19.36)
X										0.00 (0.00)	596.94 (24.43)	643.45 (25.37)
XI											0.00 (0.00)	184.12 (13.57)
XII												0.00 (0.00)

Table 3. Cluster means for thirteen characters in groundnut.

Character	Cluster												Population mean
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Days to first flowering	27.58	26.70	25.93	27.33	26.67	25.00	23.67	27.00	24.33	22.67	27.67	24.33	26.69
Days to 50% flowering	30.21	29.29	28.53	31.00	31.00	28.67	27.33	29.33	27.33	26.67	30.00	29.67	29.52
Days to maturity	110.43	108.62	106.8	110.33	107.00	106.33	102.67	109.00	104.33	100.33	109.33	106.33	108.61
Plant height (cm)	38.28	40.12	45.32	38.47	30.00	36.67	49.73	42.80	24.60	50.87	19.20	40.13	39.27
Primary branches plant^{-1}	4.39	4.17	4.38	4.07	5.67	4.07	4.27	4.07	4.53	4.00	6.13	5.20	4.40
Pods plant^{-1}	13.17	12.86	9.27	11.80	14.00	14.60	13.40	7.47	12.40	8.87	10.53	11.00	12.25
Shelling percentage	72.81	74.42	70.77	74.69	69.58	73.72	73.63	72.65	75.58	72.46	71.47	66.52	72.79
Pod length (mm)	24.15	23.66	32.97	22.87	27.67	22.47	28.73	32.27	26.60	28.67	31.20	33.53	26.07
100-seed weight (g)	40.27	38.11	40.8	39.00	46.33	32.00	41.33	59.00	43.67	41.00	64.67	68.00	41.66
Kernels plant^{-1}	21.37	21.85	19.76	20.60	19.23	22.20	20.80	14.00	20.27	16.33	14.13	12.93	20.77
Kernel yield plant^{-1} (g)	8.03	8.25	8.14	8.07	10.37	7.13	10.27	8.73	8.87	6.53	10.10	8.33	8.51
Oil percentage	47.68	49.49	48.86	45.02	47.10	46.98	46.00	49.06	49.03	50.12	48.04	45.83	48.19
Dry pod yield plant^{-1} (g)	12.15	10.95	11.60	10.80	12.60	9.27	14.33	11.50	11.73	9.00	12.53	12.53	11.68

range of D^2 values was from 4.83 (between RS052 and RS074) to 667.74 (between COBO SABA 28-20 and TKG 19(A). On the basis of D^2 values the forty genotypes of groundnut were grouped into twelve clusters (Table 1). The cluster I was largest cluster, which comprised of seventeen genotypes. Cluster II and cluster III had nine and five genotypes, respectively while cluster IV to cluster XII included one genotype and remained solitary. Reddy *et al*. (1987) grouped 20 genotypes into 6 clusters. Golakiya and Makne (1991) grouped 24 genotypes of groundnut into 6 clusters and Katule *et al*. (1992) grouped 18 groundnut genotypes into 8 clusters.

Average intra and inter-cluster D^2 values are presented in Table 2. An intra-cluster distance was maximum in cluster-II (7.58) followed by cluster III (7.57) and cluster I (6.72). High intra-cluster distance indicates wide genetic divergence among the constituent genotypes. The inter-cluster distance was maximum between cluster X and cluster XII (25.37) followed by cluster X and cluster XI (24.43) and cluster IV and cluster X (23.62) suggesting that these groups of genotypes were highly divergent from each other. The genotypes in above clusters revealed substantial differences in the means for important yield contributing characters, suggesting that the genotypes belonging to these clusters form ideal parents for initiating hybridization. The minimum inter-cluster distance was found between cluster I and cluster V (8.72) and cluster III and cluster IX (9.26) indicating that the genotypes of these clusters were genetically very close to each other.

Cluster VII recorded highest mean for dry pod yield plant-1 (Table 3). Cluster X had less days to flowering, days to 50 per cent flowering and days to maturity and exhibited highest mean for the character oil percentage. Cluster VI had maximum number of pods $plant^{-1}$. Cluster I had maximum days to maturity, better average for number of pods $plant^{-1}$, shelling percentage and number of kernels $plant^{-1}$. Cluster XII had maximum 100 seed weight and pod length. Cluster XI had least plant height and maximum number of primary branches $plant^{-1}$. Thus, the genotypes of outstanding mean performance from these clusters may be identified as potential parents and could be utilized in further improvement programme for developing new varieties.

The genotypes *viz.* B353, COBO SABA 28-20, CHIMBUWILA-A-LL2, RCM 705, BMPll, B704, SAM COL83 and AH7221 were identified as promising for further improvement in yield of groundnut.

LITERATURE CITED

Golakiya, P. R. and V. G. Makne. 1991. Genetic diversity in Spanish bunch groundnut. J. Maharashtra agric. Univ. 16 (3) : 337-339.

Katule, B. K, M. V. Thombare, A. D. Dumbre and B. B. Pawar. 1992. Genetic diversity in bunch groundnut. J. Maharashtra agric. Univ. 17 (2) : 302-303.

Mahalanobis, P. C. 1936. On the generalized distance in statistics. Proc. Nat. Inst. Sci. India. 2: 49-55.

Murthy, B. R. and V. Arunachalam. 1966. The nature of genetic divergence in relation to the breeding system in crop plants. Indian J. Genet. and Plant Breeding. 26A: 188-189.

Rao, C. R. 1952. Advances in Statistical Methods in Biometric Research. John Wiley and Sons. Inc. New York.

Reddy, V. R. G., B. N. Singh and B. Rai. 1987. Analysis of genetic divergence in spreading varieties of groundnut. Crop Impro. 14 (2) : 149-152.

J. Maharashtra agric. Univ., 34 (3) : 275-277 (2009)

Phule Utkarsha : A Promising Okra Cultivar

S. G. Bhalekar[1], U. T. Desai[2], D. S. Kakade[3], C. A. Nimbalkar[4] and B. G. Pawar[5]
National Agricultural Research Project (Plain Zone), Ganeshkhind, Pune - 41 1007 (India)
(Received : 31-12-2007)

ABSTRACT

The selection, GK-IV-3-3-3 named as 'Phule Utkarsha' derived from the cross between Parbhani Kranti and Varsha Uphar is a very promising okra cultivar and yielded 231.05 q ha^{-1} which was 43, 44 and 25 per cent more over Arka Anamika, Parbhani Kranti and Varsha Uphar, respectively. The variety exhibited better reaction against YVMV disease as mean per cent incidence was 0.20 per cent at all the locations under study. It is less susceptible to aphids, jassids and mites, and moderately susceptible to leaf minor and fruit borer. The fruits are dark green, attractive, shining, straight, slender with market appealing characteristics. It was relased as Phule Utkarsh for cultivation in Western Maharashtra.

Key words : Okra, hybridization, new variety.

Okra (*Abelmoschus esculentus* (L). Moench) is one of the popular vegetables. It is reach in vitamins, calcium, potassium and other minerals, besides many industrial uses and medicinal preparations. Fast growth within short period and the photoinsensitive nature enables to raise two okra crops in a year. Okra is popular vegetable getting good price in the market. However, its cultivation was confined with a few cultivars which show the incidence of YVMV disease from some quarters, a well recognized problem in the cultivation of okra. The virus has been reported to cause upto 94 per cent loss in yield (Singh, 1985). In view of this, the attempt has been made to evolve the new disease tolerant and high yielding genotype in the present investigation (Darlington and Wylie, 1955, Sujatha *et al.*, 1986, Thomburaj and Singh, 2001).

1. Asstt. Prof, of Horticulture, 3. Jr. Pathologist, 4. Asstt Prof. of Statistics, 5. Asstt. Floriculturist, 2. Ex-Head, Dept. of Horticulture, MPKV, Rahuri - 413 722.

MATERIALS AND METHODS

The present investigation was carried out at National Agricultural Research Project (Plain Zone), Ganeshkhind, Pune from *kharif* 1997 with screening and purification of present lines. In summer 1998, crossing of these lines was undertaken. F_1 and F_2 generations were raised in *kharif* 1998 and summer 1999, respectively for further study. The populations from F_2 to F_5 were screened during *kharif*/summer seasons at this station and the promising selections were tested in station and multilocation trials at Pune, Pimpalgaon Baswant, Kolhapur, Digraj and Rahuri during *kharif* and summer. All the trials were conducted in a randomized block design, with recommended cultural measures to raise normal crop. After harvesting, the data on fruit yield was recorded on plot basis. At harvest maturity the data were recorded on yield and yield contributing characters.

RESULTS AND DISCUSSION

The station trials conducted during *kharif* and summer seasons

Table 1. Mean yield (q ha^{-1}) performance of promising okra genotypes in multilocation and station trials.

Genotypes	Multilocation trials						Station trials K-2000 to K-2002	Mean
	NARP, Ganesh-khind	ARS, Pmple-gaon Bas-want	AICVIP, Rahuri	ARS, Kasbe Digraj	Agril. College, Kolha-pur	Pooled Mean		
GK-II-4-1-2	226.60	159.48	170.74	119.21	132.30	161.66	242.91	202.29
GK-IV-1-2-14	228.68	148.31	167.68	119.83	119.00	157.12	246.40	201.76
GK-IV-1-3-2	238.05	185.06	181.16	119.23	127.88	171.73	262.31	217.02
GK-IV-2-4-13	235.79	159.88	166.67	137.04	124.55	162.88	240.73	201.81
GK-IV-3-3-3	246.10	200.51	183.24	164.81	122.76	187.46	274.63	231.05
GK-IV-3-4-4	256.61	153.01	163.05	132.48	98.66	158.89	251.53	205.21
GK-IV-4-3-7	241.86	167.50	184.82	135.95	118.33	168.62	250.44	209.53
Varsha Uphar ©	222.76	163.86	155.78	103.62	108.52	148.17	220.21	184.19
Arka Anamika ©	196.52	154.91	116.89	103.07	124.54	136.68	185.86	161.27
Parbhani Kranti ©	186.29	148.09	102.87	103.85	104.70	129.62	190.48	160.05
S. E.±	98.88	4.88	5.04	4.98	10.62	4.78	6.17	5.48
C. D. at 5%	18.18	16.15	7.95	14.81	36.87	13.24	17.68	15.46

Table 2. Disease and pest reaction of promising genotypes of okra.

Genotypes	% incidence YVMV			Powdery mildew intensity (%)	Pests					
	Pune	Rahuri	Pimpalgaon Baswant		Av. numbers / leaf					% fruit borer infestation
					Aphids	Jassids	Leaf minor	Mites	White fly/ treat	
GK-II-4-1-2	0.69 (4.76)	0.28 (3.03)	1.07 (5.94)	17.69 (24.87)	9.47	9.94	6.89	13.00	2.99	7.84 (16.26)
GK-IV-1-2-14	1.27 (6.47)	0.19 (2.50)	1.87 (7.86)	18.72 (25.64)	13.98	7.05	15.07	27.33	5.77	5.09 (13.04)
GK-IV-1-3-2	0.65 (4.62)	0.14 (2.14)	0.47 (3.93)	18.09 (25.17)	12.00	5.19	4.63	12.90	0.66	2.93 (9.86)
GK-IV-2-4-13	1.41 (6.82)	0.19 (2.50)	1.57 (7.20)	20.90 (27.28)	8.02	5.00	10.67	25.33	3.99	3.47 (10.74)
GK-IV-3-3-3	0.16 (2.29)	0.14 (2.14)	0.30 (3.14)	15.99 (23.57)	5.36	4.72	7.57	21.30	2.22	5.15 (13.12)
GK-IV-3-4-4	0.97 (5.65)	0.00 (0.00)	2.20 (8.53)	18.04 (25.13)	10.05	17.18	8.02	15.50	1.88	4.33 (12.01)
GK-IV-4-3-7	1.68 (7.45)	0.14 (2.14)	1.97 (8.07)	23.28 (28.85)	7.05	16.10	9.47	14.11	1.33	7.73 (16.14)
Varsha Uphar (C)	1.68 (7.45)	1.94 (8.01)	9.33 (17.79)	28.20 (32.08)	23.74	11.50	14.89	22.77	4.44	6.24 (14.47)
Arka Anamika (C)	19.88 (26.48)	16.61 (26.05)	13.47 (21.53)	21.25 (27.45)	17.08	15.55	11.94	28.50	6.44	7.13 (15.49)
Parbhani Kranti (C)	7.11 (15.47)	4.93 (12.83)	10.77 (19.16)	24.63 (29.76)	21.10	10.69	15.09	19.19	4.77	7.52 (15.92)
S. E.±	1.62	1.98	4.08	1.83	2.66	1.96	2.05	4.78	0.22	1.14
C. D. at 5%	4.64	5.87	NS	NS	7.71	5.68	5.95	NS	0.67	3.29

Figures in parentheses are arcsine values

at Ganeshkhind, Pune, revealed that the Selection GK-IV-3-3-3 exhibited significantly highest yield 274.64 q ha^{-1} (Table 1) over the check cultivars Varsha Uphar (220.21 q ha^{-1}), Arka Anamika (185.86 q ha^{-1}) and Parbhani Kranti (190.48 q ha^{-1}).

The performance of this promising selection with check cultivars was also evaluated at five locations in the jurisdiction of Mahatma Phule Krishi Vidyapeeth. The pooled results of multilocation trials indicated that the Selection GK-IV-3-3-3 gave the highest mean yield (187.46 q ha^{-1}) in multilocation trials. The mean yield performance of promising okra selections in different trials (Table 1) revealed that the highest mean yield (231.05 q ha^{-1}) was recorded by Phule Utkarsha (GK-IV-3-3-3) followed by the Selection GK-IV-1-3-2 (217.02 q ha^{-1}). The lowest yield was recorded by check Parbhani Kranti (160.05 q ha^{-1}) followed by Arka Anamika (161.27 q ha^{-1}).

Table 3. Ancillary observations of promising genotypes of okra in *kharif*.

Genotypes	Day to 50 % flowering	Plant height (cm)	Nodes $plant^{-1}$	Fruit length (cm)	Fruit breadth (cm)	Av. Fruit weight (g)
GK-II-4-1-2	45.33	207.11	24.22	12.35	1.75	12.80
GK-IV-1-2-14	44.44	210.65	25.00	13.31	1.66	12.58
GK-IV-1-3-2	44.66	210.00	26.02	13.05	1.67	12.69
GK-IV-2-4-13	45.89	208.76	25.17	12.69	1.63	12.19
GK-IV-3-3-3	43.66	217.61	26.77	13.13	1.57	12.75
GK-IV-3-4-4	45.66	204.22	23.88	12.00	1.60	12.18
GK-IV-4-3-7	45.89	205.68	24.82	12.72	1.64	12.21
Varsha Uphar (C)	45.22	200.23	24.29	12.25	1.65	12.39
Arka Anamika (C)	50.11	186.14	20.60	11.30	1.69	12.15
Parbhani Kranti (C)	46.22	189.95	21.94	12.36	1.86	12.21
S. E.±	0.75	4.60	0.58	0.24	0.02	0.18
C. D. at 5%	2.23	13.66	1.73	0.73	0.05	NS

Table 4. Organoleptic evaluation of okra cultivars.

Characters	Preference		
	GK-IV-3-3-3	Parbhani Kranti	Arka Anamika
Fruit colour	9	7	6
Fruit length	8	7	7
Fruit shape	9	6	5
Taste of fruit	9.5	8.5	8
Shelf life of fruit	9	8	8
Genearl opinon	9	7	7

(on 0-10 hedonic scale).

The Selection GK-IV-3-3-3 showed mean 0.16 per cent incidence of YVMV at Pune, 0.14 per cent at Rahuri and 0.30 per cent at Pimpalgaon Baswant (Table 2). It had low intensity of powdery mildew (15.99 %), which was highest in Varsha Uphar (28.20 %). The Selection GK-IV-3-3-3 exhibited better performance in pest reaction and showed 5.36 average number of aphids per leaf, jassids (4.72), mites (21.30) indicating thereby less susceptibility and showed moderate susceptibility to leaf miner (7.57 %) and fruit borer (5.15 %).

The ancillary data (Table 3) revealed that the Selection GK-IV-3-3-3 (Phule Utkarsha) exhibited earliness in flowering (43.66 days) as compared to check cultivars. The plants were tall (217.61 cm) with more number of nodes (26.77) and medium fruit breadth (1.57 cm). The fruit length was highest in GK-IV-1-2-14 (13.31 cm) followed by GK-IV-3-3-3 (13.13 cm). The average fruit weight was highest in selection GK-IV-4-1-2 (12.80 g) followed by GK-IV-3-3-3 (12.75 g). While the check cultivar Arka Anamika was late in flowering (50.11 days), short in plant height (186.14 cm) with less number of nodes per plant and with fruit length of 11.30 cm and average fruit weight of 12.15 g.

The organoleptic evaluation of this new cultivar gained superior scores (More than 8 on 0-10 hedonic scale) over the check cultivars Prabhani Kranti and Arka Anamika in regards with fruit colour, length, shape, taste, shelf life and overall opinion (Table 4).

The new cultivar Phule Utkarsha has good fruit quality, more yield and better reaction to pests and diseases especially YVMV disease, hence it was released in 2003 for cultivation in Western Maharashtra by Mahatma Phule Krishi Vidyapeeth, Rahuri and notified by Central Sub-Committee for horticultural crops, ICAR, New Delhi in 2005.

LITERATURE CITED

Darlington, C. D. and A. P. Wylie. 1955. Cromosome Atlas of Flowering Plants. George Allen and Unwin, London. pp 519.

Singh, R. S. 1985. Disease of vegetable crops. Oxford and IBH Publ. Co., New Delhi, pp 346.

Sujatha, V. S., T. R. Madaan and V. S. Seshadri. 1986. Oil content and its quality in seeds of wild and cultivated species of Abelmoschus. Indian J. Agric. Sci., 55(9): 657-660.

Thamburaj, S. and N. Simgh. 2001. Textbook of Vegetables, Tubercrops and Spices. ICAR, New Delhi, pp 222.

J. Maharashtra agric. Univ., 34 (3) : 278-282 (2009)

Effect of Organic Manures and Chemical Fertilizers on Growth, Yield and Economics of Cabbage*

A. D. Jagtap[1], A. S. Kadam[2], D. D. Jagtap[3] and S. B. Patil[4]
Department of Horticulture, College of Agriculture, Latur - 413 512 (India)
(Received : 12-07-2008)

ABSTRACT

The studies on effect of conjoint use of organic manures and chemical fertilizers on growth, yield ,economics of cabbage and on soil properties showed that neither the recommended dose of inorganic fertilizer (160:80:80 N, P_2O_5 K_2O kg ha^{-1}) alone nor the organic sources alone (FYM, vermicompost and poultry manure) were effective enough to produce higher yield with better quality produce. The treatment 50 per cent N through poultry manure + 50 per cent N through urea had given significantly positive effect on growth, yield and economics of cabbage which was followed by the treatment 50 per cent N through FYM + 50 per cent N through urea. The combination of organic manures + inorganic fertilizers also gave earlier maturity than inorganic fertilizers alone. The soil fertility was favourably influenced by the application of organic manures in terms of increments in values of soil organic carbon, N,P,K status.

Key words : Cabbage, organic manures, chemical fertilizer.

Cabbage (*Brassica oleracea* (L.) Var. *capitata*) is an important cruciferous vegetable, which is commonly used as salad, cole slaw, boiled vegetable, cooked in curries and processed. It is also pickled as well as dehydrated. It is known to posses medicinal properties, since ancient times and used against ailments like gout, diarrhea, stomach and coeliac troubles.

Nitrogen is a key element influencing growth and productivity of vegetables. Vegetable crops needs nitrogen in large quantity as it constitutes 40-50 per cent of dry matter. The demand for nitrogen is high when growth is in rapid stage. It is well documented that the N deficiency restricts the yield and quality of the produce. On the other side the excessive N application results in luxuriant vegetative growth, delay in maturity, poor quality of produce and accumulation of potentially hazardous concentration of nitrates. It is urgent need of the day to replace or to optimize the dose of inorganic chemical fertilizers through organics in order to maintain the soil health, it's productivity and quality of produce. The beneficial role of added organic manures in improving soil physical, chemical and biological properties is well known which in turn helps in better nutrient absorption by plants resulting in better yields, judicious use of organic manures and inorganic fertilizers is of crucial importance for getting higher yield and better quality.

MATERIALS AND METHODS

The experiment was laid out in a randomized block design with ten treatments replicated thrice. The variety 'Golden Acre' was used for the study. The soil of the experiment site was medium black in colour with good drainage. The experiment framed was intended to study the effect of different sources of nitrogen *viz*., urea, FYM, vermicompost and poultry manure alone and in combination to study their effects on growth, yield and economics of cabbage and also on soil properties.

The treatment details are T_1-RDF (160:80:80 N, P_2O_5 K_2O kg ha^{-1}) N through urea (100%), T_2-100% N through FYM, T_3-100% N through poultry manure, T_4-100% N through vermicompost, T_5-75% N through FYM + 25% N through urea, T_6-75% N throught poultry manure + 25% N through urea, T_7-75% N through vermicompost + 25% N through urea, T_8-50% N through FYM + 50% N through urea, T_9-50% N through poultry manure + 50% N through urea and T_{10}-50% N through vermicompost + 50% N through urea.

Different organic sources used and its chemical composition are given as below.

Chemical composition of organic manures-

Source	N (%)	P (%)	K (%)
FYM	0.48	0.22	0.47
Vermicompost	1.20	0.68	0.76
Poultry manure	2.70	1.70	1.30

Five plants were randomly selected from each of the 30 plots leaving guard rows. The growth and yield observations were recorded at

*Part of M. Sc. (Agri.) thesis submitted by 1st author to MAU, Parbhani. (India).

1, 4. M. Sc. (Agri.) students, 2. Professor of Horticulture, 3. Assoc. Professor of Horticulture, MPKV, Rahuri.

an interval of 15 days. By economic analysis B:C ratio was calculated and by soil analysis N, P, K of soil was calculated.

RESULTS AND DISCUSSION

The data presented in Table 1 showed that, at 60 days after transplanting, the maximum plant height of 29.08 cm was obtained in treatment, integrating 50 per cent N through FYM + 50 per cent N through urea. Similar trends of results were also reported in increase in the height of the plants by integrated application of FYM with NPK in cabbage by Dixit, (1997). The maximum plant spread and maximum no. of leaves (4980 cm^2 and 37 respectively) were obtained in treatment receiving 50 per cent N through poultry manure + 50 per cent N through urea. Poultry manure in comparison to other organic nutrient sources contains uric acid having 60 per cent N which changes rapidly to ammoniacal forms and hence efficiently utilized for better plant growth (Smith, 1950).The results obtained on beneficial effects of organic manures can be substantiated with the findings in cabbage (Tarata *et al*. 1995) and in cauliflower (Singh *et al*. 1970).

The highest stem girth (8.63 cm) was obtained in treatments receiving inorganic fertilizers integrated with poultry manure, such that N supply was in equal proportion i.e. T_9 (50% N through poultry manure + 50% N through urea). The shortest duration of head initiation was recorded in

Table 1. Effect of different organic manures and chemical fertilizers on growth and yield of cabbage after 60 days of transplanting.

Treatment	Plant height (cm)	Plant spread (cm^2)	Leaves	Stem girth (cm)	Days for head initiation	Days for head maturity
T_1 : RDF (160:80:80 N, P_2O_5, K_2O kg ha^{-1}) N through urea (100%)	26.88	4276	35	8.51	39.07	31.87
T_2 : 100% N through FYM	23.68	3307	31	7.59	43.20	42.00
T_3 : 100% N through poultry manure	26.37	3994	34	7.73	38.60	35.40
T_4 : 100% N through vermicompost	24.56	4234	32	7.96	42.87	37.80
T_5 : 75% N through FYM + 25% N through urea	25.47	3706	32	7.78	43.20	38.86
T_6 : 75% N through poultry manure + 25% N through urea	25.13	4620	34	8.10	43.27	35.10
T_7 : 75% N through vermicompost + 25% N through urea	25.73	4413	33	7.16	42.60	36.13
T_8 : 50% N through FYM + 50% N through urea	29.08	3800	33	8.06	37.33	34.73
T_9 : 50% N through poultry manure + 50% N through urea	28.10	4980	37	8.63	37.80	31.40
T_{10} : 50% N through vermicompost + 50% N through urea	25.97	4877	35	7.27	40.40	34.40
S. E.±	0.47	134.24	0.59	0.34	0.33	0.26
C. D. at 5%	1.40	398.85	1.77	NS	0.98	0.78

Table 2. Effect of different sources of nitrogen on yield and yield contributing characters of cabbage.

Treatment	Stalk length (cm)	Core length (cm)	Polar diameter (cm)	Equatorial diameter (cm)	Compactness of head (%)	Volume of head (ml)	Weight of head (g)	Yield ha^{-1} (t)
T_1 : RDF N through urea (100%)	15.72	13.33	15.67	14.89	29.99	850	1073	29.29
T_2 : 100% N through FYM	11.18	9.59	12.91	13.05	36.03	638	787	20.94
T_3 : 100% N through poultry manure	14.81	12.79	15.31	14.93	28.10	780	969	26.49
T_4 : 100% N through vermicompost	12.17	10.43	13.97	13.61	34.51	640	924	22.82
T_5 : 75% N through FYM + 25% N through urea	12.03	10.35	13.63	13.57	32.29	658	803	21.08
T_6 : 75% N through poultry manure + 25% N through urea	13.66	11.89	14.19	14.00	33.12	725	928	24.29
T_7 : 75% N through vermicompost + 25% N through urea	12.71	10.93	14.12	13.91	29.15	658	796	21.10
T_8 : 50% N through FYM + 50% N through urea	16.35	14.35	16.98	16.23	26.89	989	1223	31.78
T_9 : 50% N through poultry manure + 50% N through urea	17.09	15.13	17.66	16.98	26.92	1073	1393	35.60
T_{10} : 50% N through vermicompost + 50% N through urea	14.46	13.19	14.93	14.71	32.01	840	1044	27.35
S. E.±	0.19	0.28	0.32	0.29	2.13	56.07	63.53	1.15
C. D. at 5%	0.58	0.83	0.94	0.87	NS	166.59	188.76	3.41

treatment T_8 (50% N through FYM + 50% N through urea) followed by T_9. Shortest duration for head maturity was recorded in treatment T_9. The results obtained on the beneficial effects of organic manures can be substantiated with findings in cabbage by Subhan, (1988). Significantly maximum stalk length, core length and diameter of head (Table 2) were obtained in treatment T_9 followed by T8 (50% N through FYM + 50% N through urea). It is seen from the data that the size of head was directly influenced by the total number of leaves produced by the plant. The increase in number of leaves might have helped to accumulate more carbohydrates resulting in increased diameter of head. Similar results were also obtained by Subhan (1988) and Dixit (l997) in cabbage. The maximum compactness of head was obtained in treatment T_2 (100% N through FYM).

Significantly maximum volume (1073 ml) and weight of head (1393 g) were recorded in treatment T_9 (50% N through poultry manure + 50% N through urea) which was at par with T_8 (50% N through FYM + 50% N through urea). The similar results were observed in cabbage by Mahendran and Kumar, (1997). The treatment T_9 recorded superior yields in terms of both yield per plant as well as yield per hectare. The contribution of poultry manure to increase in yields can be attributed to the balanced C:N ratio and enhanced availability of essential plant nutrients, hence increased rate and efficiency of metabolic activities resulting in high assimilation of proteins and carbohydrates. Similar findings were obtained in cabbage by Subhan

Table 3. Effect of different sources of nitrogen on economics of cabbage.

Treatment	Cost of cultivation (Rs. ha^{-1})	Gross monetary returns (Rs. ha^{-1})	Net monetary returns (Rs. ha^{-1})	Benefit: cost ratio
T_1 : RDF N through urea (100%)	48208	117146	68937	2.43:1
T_2 : 100% N through FYM	56011	83760	27748	1.49:1
T_3 : 100% N through poultry manure	54641	105960	51318	1.94:1
T_4 : 100% N through vermicompost	78647	91266	12798	1.16:1
T_5 : 75% N through FYM + 25% N through urea	52187	84053	31865	1.61:1
T_6 : 75% N through poultry manure + 25% N through urea	49991	47146	47155	1.94:1
T_7 : 75% N through vermicompost + 25% N through urea	68196	84263	16067	1.24:1
T_8 : 50% N through FYM + 50% N through urea	58710	127120	68409	2.16:1
T_9 : 50% N through poultry manure + 50% N through urea	55184	142413	87228	2.58:1
T_{10} : 50% N through vermicompost + 50% N through urea	63548	109400	45851	1.72:1
S. E.±	763.91	4583.47	3819.55	0.05
C. D. at 5%	2269.70	13618.13	11348.42	0.15

(Selling rate of produce per kg is Rs 4)

Rates of nutrients

Nutrients	Rates kg^{-1} (Rs.)	Nutrients	Rates kg^{-1} (Rs.)
Urea	5.00	FYM	0.50
Single super phosphate	5.00	Vermicompost	3.00
Murate of potash	7.00	Poultry manure	4.00

Table 4. Effect of different sources of nitrogen on chemical properties of soil at harvest.

Treatment	Available N	Available P	Available K
	(kg ha^{-1})		
T_1 : RDF N through urea (100%)	194.43	13.15	382.15
T_2 : 100% N through FYM	218.88	12.55	391.11
T_3 : 100% N through poultry manure	245.61	17.97	442.21
T_4 : 100% N through vermicompost	232.67	15.15	390.83
T_5 : 75% N through FYM + 25% N through urea	228.28	13.82	370.28
T_6 : 75% N through poultry manure + 25% N through urea	246.26	15.31	431.19
T_7 : 75% N through vermicompost + 25% N through urea	236.14	13.26	384.02
T_8 : 50% N through FYM + 50% N through urea	250.98	16.29	355.56
T_9 : 50% N through poultry manure + 50% N through urea	257.42	15.65	427.8
T_{10} : 50% N through vermicompost + 50% N through urea	247.11	13.46	379.95
S. E.±	1.85	0.76	2.15
C. D. at 5%	5.48	2.26	6.35

(1988), Dixit (1997) and Mahendran and Kumar (l997).

The data presented in Table 3 showed that, the lowest cost of cultivation was obtained in treatment T_1 (RDF N through urea) which was at par with T_6 (75% N through poultry manure + 25% N through urea). The cost of cultivation was low in T_1, because cost of urea required was less as compared to other organic manures. The highest gross monetary returns were obtained in treatment T_9 (50% N through poultry manure + 50% N through urea) followed by T_8 (50% N through FYM + 50% N through urea).

The higher gross monetary returns may be due to increased yield with the application of poultry manure and FYM. Similar trend of results was observed in cabbage by Yadav *et al.* (2002). The highest net returns were obtained in treatment T_9 (87228 Rs. ha^{-1}) followed by T_1 (68937 Rs. ha^{-1}). The higher net returns may be due to low cost of cultivation and high gross monetary returns in these treatments. The results obtained on beneficial effects of balanced nutrient application can be substantiated with the findings in okra (Sontakke et al. 1996), onion (Singh *et al*. 1997) and brinjal (Naidu *et al*. 2002). The highest benefit: cost ratio was obtained in treatment T_9 (50% N through poultry manure + 50% N through urea) which was at par with T_1 (RDF N through urea). The highest B:C ratio was obtained due to the more net returns with the application of poultry manure. The results on beneficial effects of organic manures can be substantiated with the findings in cabbage by Yadav *et al*. (2002) and okra (Sharma and Bhalla, 1995).

In case of a soil properties (Table 4) it was observed that, the maximum available nitrogen content was recorded in treatment T_9 (50% N through poultry manure + 50% N through urea) followed by T_8 (50% N through FYM + 50% N through urea). The C:N ratios of FYM, vermicompost and poultry manure were 16.00:1,14.68:1 and 12.53:1 respectively. The available nitrogen can be increased by the addition of nitrogenous fertilizers to the manures thereby reducing the C:N ratio. Similar findings were obtained by Sharma and Arya, (2001), Sreenivas *et al.* (2002), Amanullah and Somasundaram (2007).

The data pertaining to the available phosphorous status indicated variation due to the application of organic manures, incorporated solely and in combinations with inorganic fertilizers. The highest magnitude of available phosphorous (17.97 kg ha^{-1}) was obtained in the treatment T_3 (100% N through poultry manure followed by T_8 (50% N through FYM + 50% N through urea). The results obtained corroborated with the reports of Srivastava (l985), Jose *et al*. (1988), Shelke *et al*. (1999) and Khankhane and Yadav (2003).

Treatment T_3 (100% N through poultry manure) recorded highest magnitude of available potassium followed by T_6 (75% N through poultry manure + 25% N through urea). Additions of organic manures have beneficial effect on enhanced levels of available potassium due to the slow rates of decomposition as well as release of plant available nutrients. The present findings are in conformity with the reports of Srivastava, (1985), Sharma and Arya, (2001), Kannan *et al*. (2006), Amanullah and Somasundaram (2007).

LITERATURE CITED

Amanullah, M. M. and E. Somasundaram. 2007. Recycling of poultry manure. Agric. Update. 2 (1) : 25-26.

Dixit, S. P. 1997. Effect of nitrogen and FYM on the productivity of cabbage in dry temperate hill zone of Himachal Pradesh. Ann. agric. Res., 18(2): 258-261.

Jose, D., K. G. Shanmugavelu and S. Thamburaj. 1988. Studies on the efficacy of organic vs. inorganic forms of nitrogen in brinjal. Indian J. Hort. 45 (1) : 100-103.

Kannan, P., A. Saravanan and T. Balaji. 2006. Organic farming on tomato yield and quality. Crop. Res. 32 (2) : 196-200.

Khankhane, P. J. and B. R. Yadav. 2003. Comparative manurial performance of FYM, biogas slurry and sewage sludge. Annl. of Agric. Res. 24 (1) : 148-150.

Mahendran, P. P. and N. Kumar. 1997. Effect of organic manure on cabbage (*Brassica oleraceae* var. *capitata*). South Indian Hort. 45 (5-6) : 240-243.

Naidu, A. K., S. S. Kushwah. And Y. C. Dwivedi. 2002. Influence of organic manures, chemical and bio-fertilizers on growth, yield and economic of brinjal. South Indian Hort. 49 (Special) : 195-198.

Sharma, K. C. and P. S. Arya. 2001. Effect of nitrogen and farm yard manure on cabbage (*Brassica oleracea* var. *capitata*) in dry temperate zone of Himaichal pradesh. Indian J. agric. Sci. 71 (1) : 60-61.

Sharma, N. K. and P. L. Bhalla. 1995. Influence of integrated nutrient management on growth, yield and economics on okra (*Abelmoschus esculentus* (L.) Monech). Veg. Sci. 22 (1) : 1-4.

Shelke, S. R., R. N. Adsule and V. M. Amrutsagar. 1999. Nitrogen management through organics and inorganics in brinjal,. J. Maharashtra agric. Univ. 24 (3) : 297-298.

Singh, K., I. S. Gill and O. P. Verma. 1970. Studies on poultry manure in relation to vegetable production-I-cauliflower. Indian J. Hort. 27 : 41-47.

Singh, L., S. R. Bhonde and V. K. Mishra. 1997. Effect of organic manures and inorganic fertilizers on yield and quality of rabi onion. NHRDDF, News letter. 17 (3) : 1-3.

Smith, 1950. Poultry manure-A fertilizer. Poultry Digest 5 : 550-557.

Sontakke, M. B., V. D. Pillamari, A. S. Mandge and N. N. Shinde. 1996. Effect on N-level on yield of okra. J. Maharashtra agric. Univ. 21 (2) : 292-293.

Sreenivas, S. Muralidhar and M. S. Rao. 2002. Vermicompost available components of IPNSS in nitrogen nutrition of ridge gourd. Ann. agric. Res. 21 (1) : 108-113.

Srivastava, O. P. 1985. Role of organic matter in soil fertility. Indian J. agric. Chem. 18 (2) : 257.

Subhan, 1988. Effect of organic manures on growth and production of cabbage. Bull. Pene. Hort. 16 (4) : 37-41.

Tarata, G., N. Popandron, M. Podoleanu, M. Gaurilliue and T. Munteau. 1995. Studies on the effect of nitrogenous fertilizers on cabbage and cauliflower. Anale Institute de cercetari Pentru legomicultura 51 Horticulture, Vidrda 13 : 475-484

Yadav, V. S. B. D. Yadav and Y. K. Sharma. 2002. Effect of NICAST (organic manure) in comparison to recommended doses of manure and fertilizer in cabbage and onion. South Indian Hort. 49 (Special) : 157-159.

J. Maharashtra agric. Univ., 34 (3) : 282-285 (2009)

Genetic Variability, Correlation and Path Analysis in Linseed

T. E. Nagaraja[1], K. R. Ajit[2] and B. S. Golasangi[3]
Department of Genetics and Plant Breeding, College of Agriculture, Raichur - 584 101 (India)
(Received : 25-08-2008)

ABSTRACT

Genetic variability, correlation and path analysis was studied for ten characters. Wide range of PCV and GCV was observed for seed yield plant^{-1} while moderate for number of branches plant^{-1} and number of capsules plant^{-1}. The heritability estimates ranged between 57.8 per cent for 1000 seed weight and 93.7 per cent for days to flowering. The per cent mean genetic advance was high for days to flowering, plant height, number of branches plant^{-1}, number of capsules plant^{-1} and seed yield plant^{-1}. Seed yield plant^{-1} was positively and significantly correlated with number of branches plant^{-1}, number of capsules plant^{-1}, 1000 seed weight and harvest index at both genotypic and phenotypic levels. Genotypic correlation coefficients were higher than corresponding phenotypic one for most of the character combinations. Further, path coefficient analysis revealed that 1000 seed weight exhibited highest direct effect on seed yield plant^{-1} followed by harvest index and days to flowering. Indirect effect of harvest index on seed yield via 1000 seed weight was positive and more than that of direct effect.

Key words : Correlation, genetic advance, genetic variability, linseed.

Linseed or flax (*Linum usitatissimum* L.) is one of the oldest crops cultivated by man, belongs to the family linaceae with about two hundred species. The principal use of oilseed flax in the past has been for its oil, which is used in paints and coatings because of its quick drying; it forms a protective layer on the painted surfaces against environmental factors. The main aim of plant breeding programme is to improve the plant traits for agronomic, economic and industrial values.

Possibility of achieving improvement in any crop plant leans heavily on the magnitude of genetic variability and association between traits will provide a strong insight into control of those traits. The evaluation of germplasm is a pre-requisite to identify the superior sources for various traits and for their efficient utilization. An attempt has been therefore made in the present study to asses the genetic parameters, such as variability, heritability, genetic advance, character association and path coefficient analysis in 65 accessions of linseed.

MATERIALS AND METHODS

Sixty five genotypes of linseed representing a rich source of diversity for present study were used. The experiment was laid out in a randomized block design with three replications at Regional Agricultural Research Station,

1. Breeder and Head, AICRP on Sugarcane, Zonal Agricultural Research Station, V. C. Farm, Mandya - 571403, Karnataka 2. M. Sc. student, 3. Plant Scientist (Oilseed Project).

Raichur, during *rabi* 2005. Each experimental plot consisted of single row of five meter long with 30 cm distance between the rows. Data on ten characters were recorded from 5 plants per replication and the average was taken for analysis. Observations were recorded on days to flowering, plant height, number of branches plant^{-1}, number of capsules plant^{-1}, number of seeds capsules^{-1}, 1000 seed weight, harvest index, days to maturity, oil content and seed yield plant^{-1}.

Genetic variability parameters, correlation and path analysis were analyzed as proposed by Johnson *et al*. (1955b) and Dewey and Lu, (1958), respectively. The statistical analysis was carried out using computer software SPAR (Indian Agricultural Statistical Research Institute, Delhi).

RESULTS AND DISCUSSION

The analysis of variance revealed significant difference among the genotypes for all the 10 characters (Table 1). The character, seed yield plant^{-1} showed high genotypic and phenotypic coefficient of variance (Table 2) suggesting that this character is under the influence of genetic control. Moderate values of genotypic and phenotypic coefficient of variability were found for number of branches plant^{-1} and number of capsules plant^{-1}. Practically, heritability estimates are of greater value to the breeder, since they indicate the degree of dependence of genotypic value on phenotypic value. In general broad sense heritability was high for all the characters studied except number of seeds capsule^{-1} and 1000 seed weight. This indicated that the characters were least influenced by environment in the genotypes studied (Malik and Singh, 1995).

The estimates of heritability however, indicate only the effectiveness with which selection of genotypes can be made based on their phenotypic performance but fail to indicate the amount of progress expected from selection (Johnson *et al*. 1955a). High heritability coupled with high genetic advance was observed for days to flowering, plant height, number of branches, capsules and seed yield plant^{-1}. This indicated that substantial improvement for these characters could be achieved through direct selection and these traits could govern by additive type of genes. High and moderate heritability coupled with moderate genetic advance was observed for harvest index and 1000 seed weight, respectively. This indicated that those characters were less influenced by environment but governed by both additive and non-additive gene action. Hence, simple selection is suggested for further improvement in the later generations.

Genotypic correlation indicates the true genetic performance of genes actually governing the characters, where as phenotypic correlation do not indicate the magnitude and direction of genetic correlation. Both genotypic and phenotypic correlations were worked out for yield and yield component characters. Table 3 indicated that genotypic correlations were higher than the corresponding phenotypic correlations. Low phenotypic correlations can be explained due to masking or modifying effects of environment on genetic association between

Table 1. Genetic parameters for ten characters in linseed (*Linum usitatissimum* L.)

Characters	Range			Variance		Coefficient of variation		Heritability (%)	Genetic advance (GA)	Genetic advance as per cent mean (GAM)
	Min.	Max.	Mean	Phenotypic	Genotypic	Phenotypic (PCV)	Genotypic (GCV)			
Days to flowering	30.00	50.00	38.72	29.62	27.55	14.06	13.55	93.0	10.43	26.93
Plant height (cm)	28.73	49.43	36.31	27.65	21.93	14.53	12.94	79.3	8.62	23.74
Branches plant^{-1}	3.20	6.33	4.09	0.59	0.48	18.96	17.01	80.5	1.29	31.54
Capsules plant^{-1}	15.73	32.33	22.44	16.65	15.44	18.18	17.51	92.7	7.79	34.71
Seeds capsule^{-1}	7.13	9.33	8.31	0.39	0.15	7.65	4.75	38.36	0.51	6.13
1000 seed weight (g)	4.82	7.20	5.96	0.44	0.26	11.22	8.53	57.8	0.80	13.42
Harvest index	26.30	37.05	31.25	7.01	4.61	8.49	6.87	65.4	3.57	11.42
Days to maturity	95.67	122.00	107.32	48.75	37.75	6.49	5.72	77.8	11.16	10.80
Oil content (%)	35.93	43.30	40.43	2.29	1.97	3.75	3.48	86.1	2.69	6.65
Seed yield plant^{-1} (g)	0.69	1.81	1.13	0.056	0.053	26.57	20.79	61.3	0.38	33.62

Table 2. Phenotypic and genotypic (in parentheses) correlation coefficient between different traits in linseed.

Characters	Days to flowering	Plant height	Branches plant^{-1}	Capsules plant^{-1}	Seeds capsule^{-1}	1000 seed weight	Harvest index	Days to maturity	Oil content	Seed yield plant^{-1}
Days to flowering	1	0.226 (0.276)	0.122 (0.144)	0.173 (0.193)	0.080 (0.133)	-0.039 (-0.021)	0.001 (0.043)	0.875** (1.021**)	-0.091 (-0.115)	0.015 (0.054)
Plant height (cm)		1	0.298* (0.369*)	0.126 (0.144)	0.004 (-0.014)	0.065 (0.029)	0.075 (0.047)	0.300* (0.376*)	0.040 (0.059)	0.087 (0.065)
Branches plant^{-1}			1	0.719** (0.720)	0.101 (-0.139)	0.481** (0.461**)	0.494** (0.461**)	0.110 (0.172)	0.046 (0.072)	0.525** (0.509**)
Capsules plant^{-1}				1	0.089 (-0.057)	0.635** (0.723**)	0.661** (0.722**)	0.158 (0.203)	-0.012 (-0.001)	0.681** (0.762**)
Seeds capsule^{-1}					1	0.246 (-0.063)	0.256* (0.014)	0.037 (0.065)	-0.171 (-0.206)	0.245 (0.043)
1000 seed weight (g)						1	0.839* (0.928**)	-0.002 (-0.010)	-0.085 (-0.086)	0.935** (0.969**)
Harvest index							1	0.005 (0.050)	-0.082 (-0.098)	0.864** (0.929**)
Days to maturity								1	0.032 (-0.079)	0.059 (0.068)
Oil content (%)									1	-0.088 (-0.093)
Seed yield plant^{-1}										1

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

Table 3. Direct (diagonal) and indirect (above and below diagonal) effects of nine characters on seed yield in linseed at genotypic level.

Characters	Days to flowering	Plant height	Branches plant^{-1}	Capsules plant^{-1}	Seeds capsule^{-1}	1000 seed weight	Harvest index	Days to maturity	Oil content	Correlation coefficient with yield
Days to flowering	**0.100**	0.002	0.004	0.013	0.000	-0.016	0.007	-0.058	0.001	0.054
Plant height (cm)	0.028	**0.009**	0.011	0.010	0.000	0.022	0.008	-0.021	0.000	0.065
Branches plant^{-1}	0.014	0.003	**0.030**	0.049	0.000	0.349	0.074	-0.010	-0.001	0.509**
Capsules plant^{-1}	0.019	0.001	0.021	**0.068**	0.000	0.546	0.117	-0.012	0.000	0.762**
Seeds capsule^{-1}	0.013	0.000	-0.004	-0.004	**-0.001**	-0.048	0.002	-0.004	0.002	0.043
1000 seed weight (g)	-0.002	0.000	0.014	0.049	0.000	**0.756**	0.150	0.001	0.001	0.969**
Harvest index	0.004	0.000	0.014	0.049	0.000	0.701	**0.162**	-0.003	0.001	0.929**
Days to maturity	0.102	0.003	0.005	0.014	0.000	-0.008	0.008	**-0.057**	0.001	0.068
Oil content (%)	-0.011	0.001	0.002	0.000	0.000	-0.065	-0.016	0.004	**-0.008**	-0.093

Residual effect = 0.0964

characters. The observation are in conformity with the findings of Suresh Kumar and Chauhan (1979) who attributed this to the modifying effect of environment on the association of characters at the genic level. Genotypic and phenotypic association of seed yield was positive and significant with number ot branches plant^{-1}, number of capsules plant^{-1}, 1000 seed weight and harvest index. This suggests that selecting for these characters would improve the seed yield in linseed. Plant height exhibited significant positive association at both genotypic and phenotypic levels with number of branches plant^{-1} and days to maturity suggesting that taller plants with more number of branches would result in higher seed yield. Positive significant association of plant height with days to maturity and number of branches plant^{-1} was reported by Mahto and Mahto (1997). Number of branches plant^{-1} showed significant positive correlation with plant height, number of capsules plant^{-1}, 1000 seed weight and harvest index. This indicates, that selecting for these characters would increase the yield. Positive significant association of number of branches plant^{-1} with capsules plant^{-1} and 1000 seed weight was observed by Kapoor and Chawla (1983). Thousand seed weight showed significant positive association with number of branches plant^{-1}, number of capsules plant^{-1} and harvest index. Agarwal *et al*.

(l994) observed significant association of 1000 seed weight with number of branches and number of capsules plant^{-1}. Harvest index had significant positive association with number of branches plant^{-1}, number of capsules plant^{-1} and 1000 seed weight. Positive significant correlation of harvest index with capsules plant^{-1} was also reported by Chawla and Singh (l983) and Malik and Singh (1995). Number of capsules plant^{-1} showed positive significant correlation with number of branches plant^{-1}, 1000 seed weight and harvest index. Kapoor and Chawla (l983) reported positive significant association of this trait with branches plant^{-1} and 1000 seed weight. On the basis of results obtained in the present investigation, more emphasis has to be laid for improving yield by adopting selection on number of branches plant^{-1}, number of capsules plant^{-1}, 1000 seed weight and harvest index as they showed very high positive and significant association with yield plant^{-1}.

The economic character like seed yield depends on several component characters which are mutually related. Correlation explains the true association existing between the component characters with dependent character (seed yield). Slight change in any component will ultimately disturb the complex, hence character has to be analysed for its action which is done through path analysis, where the two types of action *viz*., direct effect of component characters on seed yield and indirect effect through other component characters on seed yield.

The study of genotypic path analysis (Table 3) revealed that 1000 seed weight and harvest index were most important as they had higher magnitude of direct effects on seed yield plant^{-1}, indicating that if other yield contributing characters are held constant, an increase in these characters individually will reflect in an increased yield. These results are in conformity with the findings of Mahto and Mahto (1998). Harvest index showed direct positive effect on seed yield. However, Singh and Mohto (1994) observed indirect effect of harvest index *via*., days to maturity was negative and low. Thousand seed weight had the highest positive direct effect on seed yield. However, its indirect effects through harvest index, capsules plant^{-1} and number of branches plant^{-1} were low and it is evident that 1000 seed weight recorded the highest significant positive association with seed yield. These results are also in conformity with Kapoor and Chawla (l983), who reported that capsules plant^{-1} had high positive indirect effect on seed yield via 1000 seed weight and harvest index, whereas Mahto and Rahman (l998) observed that its direct effect was positive and low.

Branches plant^{-1} showed low but positive direct effect on seed yield. However, indirect effect of branches plant^{-1} was more than direct effect through 1000 seed weight and harvest index. Similar kind of results were also reported by Muhammad Akbar *et al*. (2003).

From the study of path analysis, it can be concluded that 1000 seed weight and harvest index were the most important components in selection for high yield through their direct effects and indirect effects.

LITERATURE CITED

Agarwal, K. K., Tiwari, J. P and K. K. Jain. 1994. Correlation and regression analysis in linseed (*Linum usitatissimum* L.). Advance in Plant Sciaace, 7 (2) : 351-355.

Chawla, B. K. and Prakash Singh. 1983. Association among agronomical and quality traits in linseed (*Linum usitatissimum* L.). Madras Agric. J. 90 (40) : 228-232.

Dewey, P. R. and K. H. Lu. 1951. A correlation and path coefficient analysis of components of crested wheat grass seed production. Agron. J. 51 : 515-518.

Johnson, H. W., H. F. Robinson and R. E. Comstock. 1955a. Estimates of genetic and environmental variability in soybean. Agron. J. 47 : 314-318.

Johnson, H. W., H. F. Robinson and R. E. Comstock. 1955b. Genotypic and phenotypic correlations on soybeans and their implications in selection. Agron. J. 47 : 477-483.

Kapoor, C. J. and B. K. Chawla. 1983. Genetic parameters and associations among yield and yield components in linseed (*Linum usitatissimum* L.). Madras Agric. J. 70 (6) : 401-403.

Mahto, C. and M. H. Rahman. 1998. Genetic variability of some quantitative characters in linseed (*Linum usitatissimum* L.). J. Res. 10 (2) : 161-165.

Mahto, R. N. and Jay Lal Mahto. 1997. Correlation, regression and path co-efficient analysis in rainfed linseed. Madras Agric. J. 84 (2) : 84-86.

Mahto, R. N. and Jay Lal Mahto. 1998. Variability, correlation and path coefficient analysis in linseed. J. Res. 10 (1) : 25-29.

Malik, B. P. S. and S. Singh. 1995. Genetic variability, correlation and path analysis in linseed. J. Oilseeds Res., 12 (1) : 1-4

Muhammad Akbar, Tariq Mahmood, M. Anwar, Muhammad Ali, Muhammad Shafiq and Jafar Saum. 2003. Linseed improvement through genetic variability, correlation and path coefficient analysis. Internat. J. Agric. and Biol. 5 (3) : 303-305.

Singh, S. N. and Jay Lal Mahto. 1994. Path coefficient analysis in linseed. J. Oilseeds Res., 11 (1) : 115-117.

Suresh Kumar and B. P. S. Chauhan. 1979. Association analysis in the segregating populations of linseed. Indian J. Genet. 39 (3) : 506-510.

J. Maharashtra agric. Univ., 34 (3) : 286-288 (2009)

Development of Upland Fertility Restorer Strains Capable of Adequate Fertility Restoration in Cotton*

U. M. Borle[1] and S. S. Mehetre[2]
Department of Agril. Botany, Mahatma Phule Krishi Vidyapeeth, Rahuri - 413 722 (India)
(Received : 27-9-2008)

ABSTRACT

Out of 259 heterozygous plants tested from F_2 populations of different five male sterile based hybrids, 12 plants restored full fertility in hybrids. These twelve lines were named as RHCRr. 9907, 9914, 9923, 9926, 9930, 9931, 9934, 9941, 9949, 9953, 9965 and 9967. The marker character eye- spot was found in five newly developed lines.

Key words : Restorer strains, cotton.

Male sterility system is a method extensively used in crops like sorghum, maize, sunflower and pearl millet for hybrid seed production. Cytoplasmic male sterility (CMS) occurs in at least 150 species in higher plants (Kaul, 1988). Significant increase in agricultural production in such a crops has been achieved in last few decades by making use of heterosis which has become possible only because of cytoplasmic inheritance of male sterility. Different CMS systems have been identified based on the restorer genes required to correct the CMS condition. Most CMS systems require only one dominant restorer gene to restore fertility, although some CMS systems require either two independent or complementary dominant genes for restoration (Laughnan and Gabay-Laughnan, 1983; Zhang *et al*. 1997; Tang *et al*. 1998). Other studies demonstrated that multiple linked or unlinked restorer genes can give similar but distinct effects in the restoration of the same CMS system (Zhang and Stewart, 2001).

In cotton, several different sources of CMS have been reported including CMS-D2-2 (Meyer, 1975), CMS-hir (Jia, 1990), CMS-D8 (Stewart, 1992), CMS-D4 (Meshram *et al*., 1994), and CMS-C1 (Zhang and Stewart, 1999). Fertility can be restored to CMS-D2-2 by the D2 restorer in which the restorer factor (s) was introduced from the genome of *G. harknessii* Brandegee (D2-2). The CMS and fertility restoration system is very useful in hybrid seed production. The cost of hybrid seed production is less in male sterility method as compared to conventional methods. Inspite of exploitation of cytoplasmic male sterile lines for commercial utilization of heterosis both by public and private sectors, real breakthrough is yet to be achieved. Main reason for this is the source of restorer lines used by the breeders might be either common or having narrow genetic diversity. Hence, development of new restorers with diverse genetic background is a need of hour; without which exploitation of cytoplasmic male sterile lines in *G. hirsutum* L. cotton will not be achieved.

MATERIALS AND METHODS

About 2500 plants were grown as F_2 population of five different male sterility based hybrids *viz*. CZHHM-531, CZHHM-542, CZHHM-560-D,CZHHM-560-E and CAHH-468 received from the central zone trial Br.O5(a)-2 at All India Cotton Improvement Project MPKV, Rahuri. Total 259 plants from F_2 generation, that appeared to be most fertile and showed agronomical acceptable characteristics were tested for fertility restoration in male sterile hybrids.

Table 1. Range of performance of F_2 populations of five CMS based hybrids for different characters.

Characters	CZHHM -531	CZHHM -542	CZHHM -560-D	CZHHM -560-F	CAHH -468
Plant height plant^{-1} (cm)	75-140	55-150	80-155	55-125	50-120
Monopodia plant^{-1} (No)	0-5	0-3	0-5	0-4	0-3
Sympodia plant^{-1} (No)	10-21	7-22	6-21	5-19	4-19
Bolls plant^{-1} (No)	6-62	7-55	11-58	7-80	4-33
Seed cotton yield plant^{-1} (g)	10-210	25-195	20-175	20-185	10-85
2.5% span length (mm)	23.9-32.8	24.6-32.8	22.2-30.8	20.1-28.2	19.0-27.6
Uniformity ratio (%)	40-53	41-51	39-54	42-56	48-60

* A part of Ph. D. thesis submitted by senior author to MPKV; Rahuri.

1. Asstt. Maize Breeder, AICRP on Maize, Kolhapur. 2. Director of Research.

These hybrids were effected by using four male sterile lines *viz*. LRA-5166 A, LAXMI-A, SRT-1 A and 76 IH-20 A. The progenies of F_2 plants restoring fertility were grown in F_3 and F_4 generations along with their crosses effected with male sterile lines and the progenies showing segregation for sterility were discarded. In each generation the plants restoring fertility were selfed and the pure seed was obtained. The progenies which restored full fertility during F_4 generation were identified as new restorer lines. During conduct of experiment all recommended agronomic practices were adopted.

RESULTS AND DISCUSSION

In different F_2 populations of male sterile hybrids among 2500 plants grown, 259 were tested for fertility restoration in F_1 hybrids with male sterile female. Wide range of variability was observed for different qualitative and quantitative characters (Table 1). The highest plant height was recorded in the hybrid CZHHM-560-D (155 cm), while the lowest limit was recorded in case of CAHH-468 (50 cm). The hybrid CZHHM-542 recorded lowest monopodia plant^{-1} (0-3) and highest sympodia plant^{-1} (7-22). In case of bolls plant^{-1} the hybrid CZHHM-560 recorded the highest bolls plant^{-1} (7-80), while the hybrid CAHH-468 recorded lowest range (4-33). The hybrid CZHHM-531 recorded maximum seed cotton yield plant^{-1} (210 g), while CAHH-468 produced minimum (85 g) seed cotton yield plant^{-1}. The hybrids CZHHM-531 and CZHHM-542 recorded maximum span length (32.8 mm), while maximum uniformity ratio was reported by the hybrid CAHH-468 (60%) followed by CZHHM-560-F (56%).

Table 2. Segregation for fertility and sterility by different F_2 population in male sterile based hybrids.

F_2 population	Plants grown	Plants used for testing restoration	Plants restored		Plants which showed segregation
			Full fertility	Full sterility	
CZHHM-531	463	51	0	32	19
CZHHM-542	471	54	0	52	2
CZHHM-560-D	507	52	0	52	0
CZHHM-560-F	419	33	0	24	9
CAHH-468	640	69	1	31	37
Total	2500	259	1	191	67

Table 3. Restoration of fertility in F_3 progenies in CMS hybrids.

F_3 progeny	Progenies gorwn	Progenies themselves segregated (discarded)	Progenies tested for restoration	Progenies restored		Progenies which showed segregation
				Full fertility	Full sterility	
CZHHM-531	19	4	15	4	11	0
CZHHM-542	2	0	2	0	2	0
CZHHM-560-D	0	0	0	0	0	0
CZHHM-560-F	9	0	9	0	9	0
CAHH-468	38	4	34	10	24	0
Total	68	8	60	14	46	0

Table 4. Restoration of fertility of F_4 progenies.

F_4 progeny	Progenies gorwn	Progenies themselves segregated (discarded)	Progenies tested for restoration	Progenies restored		Progenies which showed segregation
				Full fertility	Full sterility	
CZHHM-531	4	2	2	2	0	0
CAHH-468	10	0	10	10	0	0
Total	14	2	12	12	0	0

Out of 259 plants tested, 191 plants restored sterility, 67 plants showed segregation for sterility: fertility, whereas, one plant restored full fertility in F_1 hybrids. The F_1 plants of CMS-D8 x D2 R were all fertile and had normal sized flowers and pollen shed, indicating that restoration of CMS-D8 by D 2R was complete (Zhang and Stewart, 2001). Similar results were also reported by Sheetz and Weaver (1980 b). During their studies, they have observed the male sterility associated with fertile and an intermediate type of phenotypes. Shrinivasan *et al.* (1972 a) reported that the control of male sterility was by single dominant or recessive gene as well as double recessive gene resulting the F_2 ratios of 3:1 and 15:1, respectively. The F_2 data indicated that more than one dominant restorer gene was involved in fertility restoration (Zhang and Stewart, 2001).

In the present studies (Table 2-4), out of 67 F_2 plants having restored fertility in F_1 hybrids, 8 progenies in F_3 and 2 progenies in F_4 were segregating and so discarded. Differential behaviour of fertility restoration is due to differences in the genetic constitutions of F_2 plants used for pollination to test fertility restorer genes. Sheetz and Weaver (1980 a) suggested that the enhancer factor 'E' is controlled by a single gene expressing dominance. According to Stewart (1992), the current genetic approach in the restoration of fertility to the *G. harknessii* cytoplasm assumes that there is one restorer gene and one enhancer gene in the presently available 'R' lines.

Out of 67 plants from F_2 which had shown segregation for sterility: fertility, finally eleven plants restored fertility in F_1. None of the restorer plant could be isolated from three F_2 populations of the hybrids, CZHHM-542, CZHHM-560-D and CZHHM-560-F. The reason for this may be that these hybrids may based on genetic male sterility system or the different sources of CMS system involved in these hybrids. The D2 restorer which can restore fertility to both CMS-D8 and CMS-hir, the D8 restorer cannot restore fertility to CMS D-D2 (Zhang and Stewart, 2001).

Out of twelve progenies, 10 progenies from the population of hybrid CAHH-468 and 2 progenies from the hybrid CZHHM-531 were isolated for fertility restoration in present investigations. These twelve progenies were named as RHCRr. 9907, 9914, 9923, 9926, 9930, 9931, 9934, 9941, 9949, 9953, 9965 and 9967. The marker character eye-spot was found in five newly developed restorer lines *viz*. RHCRr. 9907, 9930, 9934, 9941 and 9949. Meyer (1973 b) reported two fertility restorer lines DES-HAF-16 and 277, these were developed from the male fertile segregates of the crosses involving upland genotypes. Deltapine 16 and Delcot 277 carry the fertility restorer genes from *G . harknessii* and restores the fertility in any stocks with *G. harknessii* cytoplasm.

LITERATURE CITED

Kaul, M. L. H., 1988. Male sterility in higher plants. Springer-Verlag, Berlin, New York.

Laughnan J. R., and Gabay-Laughnan, 1983. Cytoplasmic male sterility in maize. Annu. Rev. Genet. 17: 27-48.

Meshram, L. D, R. R. Ghongage and M. W. Marawar, 1994. Development of male sterile system from various sources in cotton (Gossypium spp.). PKV Res. J. 18(1): 83-86.

Meyer, V. G., 1973b. Registration of sixteen germplasm lines of upland cotton. (Reg. No. GP 3 to GP 18). Crop. Sci. 13: 778-779.

Meyer, V. G., 1975. Male sterility from Gossypium harknessii. J. Hered. 66: 23-27.

Sheetz, R. H. and Jr. J. B. Weaver. 1980a. Inheritance of a fertility enhancer factor from Pima cotton when transferred into upland cotton with *G. harknessii* Brandegee cytoplasm. Crop Sci., 20: 272-275.

Sheetz, Richard H. and Jr. J. B. Weaver. 1980b. Pima fertility enhancer factor. Inheritance and use of hybrid cotton production. Beltwide Cotton Prod. Res Conf, P. 82.

Shreenivasan, K., V. Santhanam and S. Rajsekaran. 1972a. Inheritance of male sterility in G. hirsutum crosses. Madras Agric.J., 59: 438-440.

Stewart, James Mc. D. 1992. A new cytoplasmic male sterile and restorer for cotton. Beltwide Cotton Prod. Res. Conf., 2: 610.

Tang, H. V., R. Chang and D. R. Pring. 1998. Cosegregation of single genes associated with fertility restoration and transcript processing of sorghum mitochondrial orf107 and ur209. Genetics 150: 383-391.

Zhang, G., T. S. Bharaj. Lu. S. S. Virmani and N. Huang. 1997. Mapping of the Rf-3 nuclear fertility-restoring gene for W A cytoplasmic male sterility in rice using RAPD and RFLP markers. Theor. Appl. Genet. 94: 27-33.

Zhang, J. F. and J. McD. Stewart. 1999. Cytoplasmic male sterility based on Gossypium sturtianum cytoplasm (CMS-C1) : Characterization and genetics of restoration. Proc. 1999 Cotton Res. Meeting and summaries of cotton research in progress. Unic. Arkansas Agric. Exp. Stn., Spec. Rep. 193: 269-272.

Zhang, J. F. and J. McD. Stewart. 2001. CMS-D8 restoration in cotton is conditioned by one dominant gene. Crop Sci. 41: 283-288.

J. Maharashtra agric. Univ., 34 (3) : 289-291 (2009)

Screening of Sugarcane Varieties for Prediction of Salt Tolerance Through Callus

P. S. Yadav[1], D. V. Dahat[2], T. J. Bhor[3] and P. N. Harer[4]
College of Agriculture, Pune - 411 005 (India)
(Received : 19-10-2008)

ABSTRACT

All the three varieties showed decrease in growth with increase in concentration of NaCl. The variety Co-94012 showed highest mean fresh weight on all the NaCl concentrations but the callus on 1.5 per cent NaCl salt concentration failed to regenerate when transferred to regeneration medium. While variety Co-86032 and CoM-0265 ranked second and third respectively for the fresh weight growth on salt containing medium. Calli of both the varieties (Co-86032 and CoM-0265) tested on all the three NaCl salt concentrations regenerated successfully when transferred to regeneration medium supplemented with BAP, however, callus of Co 94012 tested on 1.5 per cent salt concentration failed to regenerate when transferred to regeneration medium. Based on regeneration study on 1.5 per cent salt concentration the varieties Co-86032 and CoM-0265 predicted salt tolergnce.

Key words : Callus, salt tolerance, sugarcane.

Genetic variation displayed in tissue culture regenerated plants and their progeny, termed as somaclonal variation (Larkin and Scowcroft, 1981), is a potential tool for crop improvement. Calli or cells in suspension may be challenged in culture with abiotic (salt, temperature, drought, herbicide), biotic (diseases and pests) stresses (Gahukar, 1999).

Production of sugarcane crop is restrained by several diseases and abiotic stresses like saliniy, drought and freezing. NaCl is a salt in saline soils. Plant cells resistant to 4-5 times higher salt concentration than normal have been isolated using cell culture techniques. The plants regenerated from them were proved tolerant to saline soil conditions (Singh, 2004). This suggests that NaCI can give improved salt tolerant culture, which is able to show a certain degree of correlation between response to salt in field and in culture. The present study was therefore, undertaken to assess the salt tolerance ability in three varieties of sugarcane through callus tested on NaCl medium.

MATERIALS AND METHODS

Callus induction : The sugarcane varieties Co-94012 and Co-86032 were collected from Agronomy Farm, College of Agriculture, Pune whereas the variety CoM-0265 was collected from Central Sugarcane Research Station, Padegaon. The explants used for callus induction were cylinders of leaf provided from the sheath of the youngest leaf primordia. Sugarcane tops of 4 to 5 months of age were used for obtaining desired leaf explant. The leaves were trimmed by hand and 6 cm long pieces were cut. The explants were sterilized by washing with 'Savlon' a liquid sterile detergent soap, for 5 minutes.

The leaf bits treated with 'Savlon' were then treated with 70 per cent alcohol for 3 minutes. Finally leaf bits were immersed in 0.1 per cent $HgCl_2$ solution for 8 minutes. Three serial washings with sterile double distilled water were given after every treatment to remove the traces of chemicals. Finally, the leaf cylinders having 1-2 internodes and 1-2 leaves were dissected and cut into pieces of 1-2 mm and cultured on MS (Murashige and Skoog, 1962) medium supplemented with 3 mg l^{-1}, 2, 4-D (2, 4-dichlorophenoxy acetic acid) and 20 g sucrose. The pH of media was adjusted to 5.8 with 0.1 N NaOH or 0.1 HCl and media was solidified with 8 g l^{-1} agar before autoclaving (20 min at 120°C). Cultures were kept in dark at 25 $\pm$ 1°C temperature.

***In vitro* salt treatment :** After proper callus growth and after two subcultures in MS media (Murashige and Skoog 1962) + 3 mg l^{-1}, 2, 4-D, the callus was transferred to the media supplemented with three levels of NaCl i.e. 0.5, 1.0, 1.5 and one control. The media MS + 3 mg l^{-1}, 2, 4 D was prepared and the respective amount of salt (i.e. 5, 10, 15 and 20 g) was added after boiling the media and then the media was autoclaved. Bottles were incubated in dark at 25 $\pm$ 1°C for 21 days. For each medium callus necrosis percentage was determined visually as percentage of necrosis of callus.

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

1. M. Sc. (Agri.) student 2. Asstt. Prof. 3. Sr. Res. Asstt. 4. Principal Scientist, Pulses Improvement Project, MPKV., Rahuri.

Embryogenic callus evaluation and callus growth : Distinction between embryogenic and no embryogenic callus was carried out on the basis of callus external aspect. Embryogenic calli are of glossed aspect, compact, nodular, globular in structure, while non-embryogenic callus are of wet aspects, translucent and of colour more brownish (Van Sint Fan *et al*. 1990).

Callus growth study was carried out after two subcultures of 21 days each. Calli were weighed before their transfer to fresh callus induction medium and they were weighed again after second subculture. The difference in weights has been taken as fresh weight growth of callus.

RESULTS AND DISCUSSION

The analysis of variance for the calli tested on different concentrations of NaCl showed highly significant differences due to varieties and treatments (Table 2).

The callus growth was reduced with increase in NaCl concentration (Table 1). The variety CO-94012 had highest mean fresh weight (0.205 g) over all the salt treatments followed by CO-86032 (0.156 g) and COM-0265 (0.145 g).

All the varieties survived on media with 0.5 per cent NaCl. But Co-86032 showed no necrosis or callus mortality even on 1.5 per cent NaCl culture media. Co-94012 showed callus mortality on both 1.0 and 1.5 per cent NaCl. In case of variety CoM-0265, the callus did not show mortality upto 1.0 per cent NaCl but only 83.33 per cent callus survived on 1.5 per cent NaCl medium. These results revealed significant differences among varieties for callus necrosis percentage which are in agreement with Naik and Babu (1988), Gandonou *et al*. (2005b) in sugarcane and Karadimova and Djambova (1993) in durum wheat. They observed that higher concentration of NaCl caused brown colouration and apparent necrosis and reduced callus growth. Similar, results were reported for four sugarcane genotypes, using cell suspension culture in vitro by Gonzalez *et al*. (1995).

The fresh weight of callus was reduced as the concentration of NaCl increased. At 0.5 per cent NaCl concentration fresh weight of callus was more in Co-94012 (0.223 g) followed by Co-86032 (0..193 g) and CoM-0265 (0.183 g). The gain in fresh weight of callus as compared to control was 86.54, 91.39 and 94.81 per cent for Co-86032, Co-94012 and CoM-0265. respectively. In higher NaCl concentration (1.5 %) the mean fresh weight of callus was 0.087, 0.129 and 0.088 g for Co-86032, Co-94012 and CoM-0265, respectively and when compared with control it was 39.01, 52.86 and 59.58 per cent of controls callus weight. Thus, Co-94012 and CoM-0265 appeared to be more tolerant to salt stress than Co-86032 for callus growth. There was

Table 1. Two way table for variety x treatment.

Variety	NaCl conc. (%) / fresh wt. of callus				
	0.5	**1.0**	**1.5**	**Control**	**Mean**
Co-86032	0.193	0.121	0.087	0.223	0.156
Co-94012	0.223	0.195	0.129	0.244	0.205
CoM-0265	0.183	0.115	0.088	0.193	0.145
		S. E.±		C. D. at 5%	
	Variety	0.009		0.02	
	Treatment	0.011		0.03	
	Interaction	0.018		N. S.	

Table 2. ANOVA for response of callus tested on different salt concentrations.

Source	Df	MSS due to gain in weight of callus	F cal
Variety (V)	2	0.01232	12.268**
Treatment (T)	3	0.0285	28.422**
VxT interaction	6	0.000505	$0.503^{N.S.}$
Error	24	0.0010	

** Significant at 1 per cent level of significance.

Table 3. Per cent callus survival on NaCl salt.

Variety	Test tubes inoculated			Test tubes survived			Per cent of test tubes survived		
	Nacl conc. (%)			Nacl conc. (%)			Nacl conc. (%)		
	0.5	**1.0**	**1.5**	**0.5**	**1.0**	**1.5**	**0.5**	**1.0**	**1.5**
Co-86032	12	12	12	12	12	12	100	100	100
Co-94012	12	12	12	12	11	9	100	91	75
CoM-0265	12	12	12	12	12	10	100	100	83

significant difference among different NaCl concentrations and among varieties.

Similar findings that were observed in sugarcane by Gandonou *et al.* (2005b) and in different crops like rice (Kavi Kishor, 1988 and Shankhdhar *et al*. 2003), in safflower (Radhika *et al*. 2003), in sorghum (Kolhe, 1997) and in bajra (Hapse, 2001), indicated that NaCl reduces callus growth and that genotypes respond differently to this stress.

Interaction effect : The interaction for variety and treatment was non significant, it means that there was no interaction between the salt media and the varieties (Table 2).

Regeneration studies : When the calli tested on NaCl media were cultured on regeneration media (MS + 2 mg l^{-1} BAP + 1 mg l^{-1} kinetin) the calli of Co-86032 and CoM-0265 survived on 1.5 per cent salt concentration and regenerated successfully, however, the calli of Co-94012 survived and regenerated only upto 1 per cent and not on 1.5 per cent.

From the present studies it was observed that the callus of varieties in the order of Co-94012, Co-86032 and CoM-0265 responded well to salt tolerance along with their high potential for embryogenic callus induction. The varieties tested on high levels of salt in media (1.0 or 1.5 per cent) which have shown higher fresh weight growth of callus and regenerated normally when cultured on regeneration medium (MS + BAP) can be considered to have ability to tolerate high levels of salt concentration. The variety Co-94012 showed higher mean performance in fresh weight of callus. But the embryogenic callus percentage was less hence regeneration ability on 1.5 per cent salt concentration was very poor. Thus the variety CoM 0265 and Co 86032 which has shown regeneration on 1.5 per cent salt concentration are considered to be salt tolerant genotypes. Thus, these varieties can be used for studying the physiological mechanism associated with in vitro salt tolerance and thereby selection of cultures in vitro to identify salt tolerant genotypes. Further studies on whole plant response of tolerant genotypes in a greenhouse, hydroponics and in the field are necessary.

LITERATURE CITED

Gahukar, S. J. 1999. Isolation of mutants resistant to biotic and abiotic stresses using biotechnological techniques in sugarcane. A Ph. D. thesis submitted to MPKV, Rahuri (M.S.).

Gandonou, Ch., T. Errabii, J. Abrini, M. Idaomar, F. Chibi and N. Skali Senhaji. 2005b. Response of sugarcane varieties to embryogenic callus induction and in vitro salt stress. Afr. J. Biotechnol. 4 (4) : 350-354.

Gonzalez , V., S. Castroni and M. Fuchs. 1995. evaluation de la reacccion de genotipos de ca a de azucar adifferentes de NaCl. Agronomia Tropical. 46 (2) : 219-232.

Hapse, D. D. 2001. *In vitro* studies of osmotic stresses on callus culture of Bajra (*Pennisetum glaucum* L Br). A M.Sc. thesis submitted to MPKV, Rahuri (M. S.)

Karadimova, M. and G. Djambova. 1993. Increased NaCl tolerance in wheat (*Triticum aestivum* L. and *Triticum durum* Desf) through *in vitro* selection. In vitro Cell Dev. Biol. 29 : 180-182.

Kavi Kishor, P. B. 1988. Effect of salt stress on callus cultures of Oryza saliva. J. Expt. Bot. 39 (199) : 235-240.

Kolhe, P. G. 1997. *In vitro* studies of osmotic and chemical stress on callus of *Sorghum bicolor* L. A M. Sc. thesis submitted to MPKV, Rahuri. (M. S.)

Larkin, P. J. and W. R. Scowcroft. 1981. Somaclonal variation- a novel source of variability from cell cultures for plant improvement. Theor. Appl. Genet. 60: 197-214.

Murashige, T. and F. Skoog. 1962. A revised media for rapid growth and bioassay with tobacco tissue culture. Physiologia Plantarium. 15: 473-497.

Naik, G. R. and K. H. Babu. 1988. Redifferentiation of NaCl tolerant sugarcane plants from callus derived resistant lines. Curr. Sci. 57(8): 432-434.

Radhika, K., M. Sujatha and T. Nageshwar Rao. 2003. Assessment of *in vitro* method for screening genotype for salt tolerance. Sesamum and Safflower Newslet. 18: 1-3.

Shankhdhar, D., S. C. Shankhdhar and P. C. Pant. 2003. Somatic embryogenesis and plant regeneration under saline conditions in Indian rice. Abst., 2nd Internat. Cong. of Plant Physiol., New Delhi, India, pp. 195.

Singh, B. D. 2004. Introduction to plant tissue culture. Principles of Biotechnol. 1st edition. Kalyani Publ. Ludhiana. pp. 1010.

Van, Sint Fan, N. Skali Senhaji and J. Bouharmount. 1990. Comparison de differences varieties de riz (*Oryza saliva* L.) pour leur aptitude. La culture *in vitro*. Belg. J. Bot. 123 (1/2) : 36-44.

J. Maharashtra agric. Univ., 34 (3) : 292-294 (2009)

Screening of Sugarcane Varieties for Prediction of Drought Tolerance Through Callus*

P. S. Yadav[1], D. V. Dahat[2], T. J. Bhor[3] and P. N. Harer[4]
College of Agriculture, Pune - 411 005 (India)
(Received : 19-10-2008)

ABSTRACT

Leaf sheath explant of three sugarcane varieties Co-86032, Co-94012 and CoM-0265 was used as explant for callus initiation. Callus was tested on 0.2, 0.4, 0.6, 0.8 and 1 M sucrose media. Comparison of genotypes was made on the basis of necrosis percentage and fresh weight growth of callus on various sucrose level. The variety Co-86032 and COM-0265 performed well showing growth of callus up to 0.8 and 1M respectively. However, CO-94012 failed to survive above 0.4 M sucrose level and there was 100 per cent callus necrosis on 0.6, 0.8 and 1.0 M sucrose levels. When calli tested on different sucrose levels were transferred on regeneration medium only the calli on 0.2 M sucrose level regenerated for all the three varieties. Based on response of callus to various sucrose level the varieties CoM-0265 and Co-86032 predicted drought tolerant.

Key words : Callus, drought tolerance, sucrose levels, fresh weight growth, osmotic pressure.

Sugarcane is a tropical crop, largely suffers from moisture stress during early growth phases, which usually corresponds to the summer months. Investigations made by number of workers showed that osmotic concentration of root cap, leaf sheath and stem could be utilized as one of the possible indices of relative drought resistance. High sucrose level increases the osmotic potential of the media and also regulates starch synthesis by osmoregulation of the media (Oparka and Wright, 1988). Sucrose along with agar is the major component in the media which affect the uptake of water by plant cells (Seetohul, 1995). It has been investigated by Khuri and Moorby (1995) that during growth of the plantlet and on autoclaving of media, sucrose level breaks down and increases osmotic potential of the media. Sucrose concentration creates osmotic potential gradient in the culture medium when used in high concentration, so it can be used to select the genotype for drought tolerance. The present study was therefore, undertaken to study the response of callus for different sucrose levels and thereby predict the drought tolerance of the three sugarcane genotypes.

MATERIALS AND METHODS

Callus induction : Three sugarcane varieties *viz*., Co-86032, Co-94012 and CoM-0265 were used for this study. The explants used for callus induction were cylinders of leaf provided from the sheath of the youngest leaf primordia. Sugarcane tops of 4-5 months of age were used for obtaining desired leaf explant. The leaves were trimmed by hand and 6 cm long pieces were cut. The explants were sterilized by washing with 'Savlon' a liquid sterile detergent soap, for 5 minutes and then treated with 70 per cent alcohol for 3 minutes. Finally bits were immersed in 0.1 per cent $HgCl_2$ solution for 8 minutes. Three serial washings with sterile double distilled water were given after every treatment to remove the traces of chemicals. Finally, the leaf cylinders having 1-2 internodes and 1-2 leaves were dissected and cut into pieces of 1-2 mm and cultured on to MS (Murashige and Skoog, 1962) medium supplemented with 3 mg l^{-1} 2, 4-D (2, 4 - Dichlorophenoxy acetic acid) and 20 g sucrose. The pH of media was adjusted to 5.8 and media was solidified with 8 g l^{-1} agar before autoclaving for 20 min. at 120°C. Culture were kept in darkness at 25 $\pm$ 1°C.

Table 1. Osmotic potential of sucrose and PEG 6000.

Sucrose concentration (M)	Sucrose concentration (g/1000 ml)	Bars (-)	PEG (g/1000 ml)	Bars (-)
0.2	68.46	6	78.490	1
0.4	136.92	12	151.020	3
0.6	205.38	18	202.130	5
0.8	273.84	25	279.297	9
1.0	342.30	>25	340.365	13

1 Bar = 1 x 10^5 Pa

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

1. M. Sc. (Agri.) student 2. Asstt. Prof. 3. Sr. Res. Asstt. 5. Principal Scientist, Pulses Improvement Project, MPKV., Rahuri.

***In vitro* treatment with different sucrose levels :** After proper callus growth and two subcultures in MS media + 3 mg l^{-1} 2, 4-D the callus was transferred to the media supplemented with five levels of sucrose *viz*., 0.2, 0.4, 0.6, 0.8, 1 M and control. The media MS + 3 mg l^{-1} 2, 4- D was prepared and the respective amount (i.e., 68.75, 136.92, 205.38, 273.84, 342.84 and 20 g) of sucrose was added before boiling and adjusting pH of media. Bottles were incubated in dark at 25 $\pm$ 1°C for 21 days. For each medium callus necrosis percentage was determined visually.

Embryogenic callus evaluation and callus growth : Distinction between embryogenic and no embryogenic callus was carried out as decribed by Van Sint Fan *et al*. (1990). Embryogenic calli were of glossed aspect, compact, nodular, globular in structure, while non-embryogenic callus are of wet aspects, translucent and of colour more brownish. Callus growth study was carried out after two subcultures of 21 days each. Calli were weighed before their transfer to fresh callus induction medium and they were weighed again after second subculture. The difference in weights has been taken as fresh weight growth of callus.

RESULTS AND DISCUSSION

When sucrose is used in higher concentrations, it acts as osmotic agent lowering the water potential in a way similar to soil drying as in case of PEG 6000, (Table 1). Promising somaclonal variants were obtained from *in vitro* selection for PEG tolerance in sorghum (Smith *et al.* 1985) and rice (Kavi Kishor and Reddy, 1985).

Table 2. ANOVA for response of callus for different levels of sucrose.

Source	Df	MSS due to gain in weight of callus	F cal
Variety (V)	2	0.0153	6.712*
Treatment (T)	5	0.2727	119.086**
V x T interaction effect	10	0.00982	4.292*
Error	36	0.00229	

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

Table 3. Variety x treatment two way table for response of callus to various sucrose levels.

Variety	Sucrose levels (M)					Control	Mean
	0.2	0.4	0.6	0.8	1.0		
Co-86032	0.228	0.227	0.164	0.054	0.018	0.393	0.191
Co-94012	0.414	0.222	0.000	0.000	0.000	0.461	0.183
CoM-0265	0.384	0.239	0.204	0.113	0.000	0.481	0.233
Mean	0.362	0.230	0.122	0.056	0.006	0.445	0.200

The analysis of variance for effect of different sucrose level on callus (Table 2) revealed that, the three varieties differed significantly for the growth of callus. The growth of callus on 0.2 M sucrose media for all the varieties was good but there was significant difference between callus weight on 0.2 M sucrose media and control (Table 3). Very less response was shown by all the three varieties above 0.6 M sucrose level.

With increase in level of sucrose, there was decrease in callus growth. The variety CoM-0265 had highest mean fresh weight (0.233 g), followed by Co-86032 (0.191 g) and Co-94012 (0.183) (Table 3). The gain in fresh weight of callus on 0.2 M sucrose media was 58.01 per cent, 89.80 per cent and 79.83 per cent for Co-86032, Co-94012 and CoM-0265 respectively corresponding to control.

When calli were cultured on the sucrose levels described earlier, the calli of Co-86032 survived upto 1.0 M but with very less fresh weight growth of only 0.018 g, the calli of variety CoM-0265 survived up to 0.8 M sucrose level with fresh weight growth of 0.113 g. But in case of variety Co-94012 the calli did not survive above 0.4 M sucrose media. The fresh callus weight growth on 0.4 M was only 0.222 g which was 48.15 per cent as compared to control. Thus callus of varieties Co-86032 and CoM-0265 proved to be osmotic stress resistance but callus of variety Co-94012 is susceptible to osmotic stress.

Narwood *et al*. (1999) and Whittakar *et al*. (2001) reported that sucrose accumulated in response to water stress and carbohydrate metabolism was shifted to favour the conversion of sugars to sucrose. If the selection is made *in vitro* on media containing sucrose as osmotic agent, it could be possible to derive drought resistant lines which can accumulate sucrose more efficiently under drought conditions. Earlier, reports

mentioned that sugars protect the cells during drought by two mechanisms. First, the hydroxyl groups of sugars may substitute for water to maintain hydrophilic interaction in membrane and protein dehydration. Thus sugars interact with proteins and membranes through hydrogen bonding, thereby preventing protein denaturation (Leopold *et al*. 1994). Soluble sugars, especially sucrose, accumulate in seeds, pollen and in drought tolerant vegetative tissues (Oliver and Bewley, 1997). In addition, sucrose may also serve as immediate energy source upon rehydration, since it can easily metabolizable reducing sugar. So, the cell lines selected on the media containing sucrose as osmotic agent can prove beneficial for surviving drought. Also, in case of sugarcane, at ripening stage moisture stress can have beneficial effect on sucrose accumulation because the rate of sucrose hydrolysis is lowered due to impaired growth and there is more accumulation of sugar (Yang, 1976).

When the calli tested on various levels of sucrose were cultured on regeneration media, only callus on 0.2 M had survived and regenerated in case of all the three varieties.

It could be possible to increase the sucrose content of the variety, if further studies are carried out for callus regeneration, field testing of the regenerated callus on higher sucrose levels in media, testing molecular fidality of genotypes using various markers and biotechnological and molecular techniques and practicing selection of tested genotypes under environmental drought conditions.

LITERATURE CITED

Kavi Kishor, P. B. and G. M. Reddy. 1985. Resistance of rice callus tissues to sodium chloride and polyethylene glycol. Curr. Sci. 59: 29-31.

Khuri, S. and J. Moorby. 1995. Investigations into the role of sucrose in potato cv estima microtubular production *in vitro*. Annals of Bot. 75: 295-303.

Leopold, A. C., W. Q. Sunh and L. L. Bernal. 1994. The glassy state in seeds: analysis and function. Seed Sci. Res. 21: 267-274.

Murashige, T. and F. Skoog. 1962. A revised media for rapid growth and bioassay with tobacco tissue culture. Physiol. Plant. 15: 473-497.

Narwood, M., M. R. Truesdale, A. Richter and P. Scott. 1999. Metabolic changes in leaves and roots during dehydration of the resurrection plant *Craterostigma plantagineum* (hochst). South Afri. J. Bot. 65: 421-427.

Oliver, M. J. and J. Bewley. 1997. Dessication tolerance of plants tissues: a mechanism overview. Hort. Rev. 18: 171-214.

Oparka, K. J. and K. M. Wright. 1988. Osmotic regulation of starch synthesis in potato tubers. Planta. 174: 123-126.

Seetohul. S. 1995. A study on the effect of carbohydrates in tissue culture of *Nicotiana tabaccum*. A thesis submitted to in B. Sc. (Hons) Degree in Agricul. Biotechnol., Univ. of Mauritius.

Smith, R. H., S. S. Bhaskaran and F. R. Miller. 1985. Screening for drought tolerance in sorghum using cell cultures. *In vitro* Cell Dev. Biol. 21: 541-545.

Van Sint Fan, N. Skali Senhaji and J. Bouharmount. 1990. Comparison de riz differences varieties de riz (*Oryza sativa* L.) pour leur aptitude. La culture *in vitro*. Belg. J. Bot. 123(1/2): 36-44.

Whittakar, A., A. Bochicchio, C. Vazzana, G. Lindsey and J. M. Farrart. 2001. Changes in leaf hexokinase activity and metabolite levels in response to drying in the desiccation tolerant species *Sporobolus stapfianus* and *Xerophyta viscosa*. J. Expt. Bot. 52(3): 961-969.

Yang, S. J. 1976. Influence of soil moisture on sugarcane production. Taiwan Sugar. 23: 161-166.

J. Maharashtra agric. Univ., 34 (3) : 295-297 (2009)

Response of Sugarcane Varieties for *In Vitro* Studies*

P. S. Yadav[1], D. V. Dahat[2], T. J. Bhor[3] and P. N. Harer[4]
College of Agriculture, Pune - 411 005 (India)
(Received : 19-10-2008)

ABSTRACT

Three sugarcane varieties, *viz*., Co-86032, Co-94012 and CoM-0265 differed in their callusing ability, regeneration capacity and rooting ability. The variety Co-86032 and CoM-0265 showed 100 per cent callusing ability while Co-94012 showed 98.67 per cent callusing ability. The three varieties took 6 to 8 days for callus induction. The fresh weight of callus did not differ significantly while dry weight of callus differed significantly. Per cent regeneration ability was observed from 81 .66 to 86.0 per cent, while per cent rooting varied between 75 to 83.33 per cent taking up to 15 days for rooting. On an average variety COM-0265 performed well for most of the characters studied.

Key words : Tissue culture, callus, sugarcane, varieties.

Sugarcane (*Saccharum officinarum* L.) is an important cash crop and it requires quite long time for its multiplication and also as it is a cross pollinated and heterogeneous crop, it is very difficult to maintain the genotypic purity of sugarcane (Nand and Singh 1994). However, rapid multiplication and germplasm preservation of sugarcane is possible through tissue (shoot tip) culture.

Genetic variability created by sexual crossing may not be adequate to allow improvement in particular desired character. Therefore, the use and exploitation of new methods like cell and tissue culture technique to broaden genetic base of higher plants are essential. Callus cultures are currently the most efficient means of plant regeneration, but callus induction, plantlet regeneration is a complex phenomenon influenced by a number of factors including genotype and plant growth regulators. Hence, the main objective of this study was to optimize culture media, culture conditions and explants type for *in vitro* callus induction and regeneration in sugarcane genotypes Co-86032, Co-94012 and CoM-0265.

MATERIALS AND METHODS

Three varieties of sugarcane *viz*., Co 86032, Co-94012 and CoM-0265 were used for this study. The explants used for callus induction were cylinders of leaf provided from the sheath of the youngest leaf primordia. Sugarcane tops of 4 to 5 months of age were used for obtaining desired leaf explant. The leaves were trimmed by hand and 6 cm long pieces were cut. The explants were sterilized by washing with 'Savlon' a liquid sterile detergent soap, for 5 minutes. Then the pieces were dipped in 70% alcohol for 1 minute. Finally the bits were immersed in 0.1 per cent $HgCl_2$ solution for 8 minutes. Three serial washings with sterile double distilled water were given after every treatment to remove the traces of chemicals. Finally the leaf cylinders having 1-2 internodes and 1-2 leaves were dissected and cut into pieces of 1-2 mm and cultured onto MS (Murashige and Skoog, 1962) medium supplemented with 3 mg l^{-1} 2.4-D.

The callus culture and the explants were incubated in complete darkness at 25±1°C in B.O.D. incubator. The callus was maintained by sub culturing it on a fresh medium after 30 days. While transferring, the callus was taken out in a petri dish and divided approximately into 50 mg pieces and placed onto a fresh MS medium.

Callus from second subculture were used for regeneration studies. Approximately 1 g of callus was cultured on a regeneration medium i.e. MS medium + 2 mg l^{-1} BAP + 1 mg l^{-1} kinetin. The culture bottles were incubated in a culture room, illuminated with two 40 watt tube lights (3000 lux), for 16 hours. The alternate period of 8 hours of dark and 16 hours of light was maintained with temperature of 28°C.

The shoots which were having length of 50 mm were transferred to rooting media of MS medium + 5 mg l^{-1} NAA to 0.5 mg l^{-1} IBA.

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

1. M. Sc. (Agri.) student. 2. Asstt. Prof. 3. Sr. Res. Asstt. 4. Principal Scientist, Pulses Improvement Project, MPKV., Rahuri.

RESULTS AND DISCUSSION

Callus induction : The callus was induced on leaf sheath explant using the modified MS media with 2, 4-D 3 mg l^{-1}, sucrose 20 g l^{-1} and agar 8 g l^{-1}, pH of medium was maintained at 5.8. Callus was obtained using similar media by Gandonou et al. (2005a). Niaz and Quraishi (2002) used MS medium with 3 mg l^{-1} 2,4 D which was optional for embryogenesis and found that, leaf portion showed maximum embryogenesis and proved better explant source than pith.

In the present investigation visible callus was first observed at the cut ends of the explants. The variety Co-86032 produced callus in six days and was earlier for callus induction followed by CoM-0265 (7.83 days) and Co-94012 (8.67 days). These results are in close agreement with those reported by Shete (1994). All the three varieties studied had high percentage of callus induction (98 per cent). The variety Co-86032 and CoM-0265 responded well than Co-94012. Burner (1992) and Gandonou *et al.* (2005a) reported genotype dependent callus induction in sugarcane. It is also reported in rice by Mikami and Kinoshita (1988) that induction of callus is genotype dependent.

No significant differences were observed among the three varieties for fresh weight of callus however, they differed significantly for the dry weight. From the data in Table 2, it was observed that there was a direct relationship between the volume of callus to fresh weight in the present investigation. Lal and Singh (1991) observed similar results for fresh weight of callus, while Shete (1994) observed similar results for both fresh and dry weight. Gahukar (1999) found that two varieties of sugarcane differed significantly for fresh weight of callus but did not differ for dry weight of callus.

Table 1. Performance of sugarcane varieties for different characters studied.

Variety	Days to callus initiation	Per cent callusing ability	Days required for regeneration	Per cent regeneration	No. of days for rooting	Per cent rooting
Co-86032	6.16	100 (90)	27.50	81.66 (65.69)	13.67	75 (60.20)
Co-94012	8.67	98.67 (83.46)	23.00	87.33 (69.99)	15.50	77 (62.67)
CoM-0265	7.83	100 (90)	25.667	86.00 (68.24)	13.50	83.33 (66.38)
S. E.±	0.1667	0.4597	0.6735	4.461	1.1344	4.294

* Values in paranthesis indicates transformation values.

Regeneration studies : Organogenesis can be brought out in callus by controlled initiation of organ primordia through manipulation of nutrients and hormonal constituents in the culture media. In the present study, development of green spots (shoot primordia) occurred after 5 to 6 days of culturing and shoots appeared after second week of incubation. The variety Co-94012 responded well to the regeneration medium and regenerated in 23 days followed by CoM- 0265 with 25.66 days, while variety Co-86032 took 27.5 days for regeneration. Similar results were reported by Hendre (1988) and Baksha *et al*. (2002). The media used for regeneration was MS basal media + 2 mg l^{-1} BAP + 1 mg l^{-1} kinetin. Gahukar (1999) and Baksha *et al*. (2002) used similar media for regeneration of sugarcane callus. The varieties differed significantly for days required for regeneration, this could be due to genotypic differences, plant growth hormones and media used for regeneration.

Table 2. Fresh and dry weight of callus and plants regenerated per gram of callus of sugarcane.

Variety	Fresh wt. of callus (g)	Dry wt. of callus (g)	Plants regenerated per gram of callus
Co-86032	1.497	0.370	36.67
Co-94012	2.130	0.183	22.33
CoM-0265	2.192	0.473	82.33
S. E.±	0.2647	0.1260	1.5634

There were no significant differences for the per cent regeneration ability of the three varieties (Table l). The results are in conformitity with those of Shete (1994) and Gandonou *et al*. (2005a).

There was significant difference for production of number of shoots per gram of callus among the varieties studied (Table 2). CoM-0265 produced highest number of plants per gram of callus (82.33) followed by Co-86032 (36.67), and variety Co-94012 regenerated only 22.33 shoots per gram of callus. These results are in agreement with those of Bhansali and Singh (1982), Fitch and Moore (1990) and Gandonou *et al.* (2005a).

Rooting studies : The rooting of regenerated shoots were obtained

in MS basal media supplemented with 5 per cent sucrose and 5 mg l^{-1} NAA and 0.5 mg l^{-1} IBA. The varieties showed differences in days required for rooting and percentage of rooting. The maximum days for rooting (15.50) were required for Co-94012, while other two varieties took about 2 days less (13.67 and 13.50 days) than it. The percentage of rooting was high (83.33 per cent) in CoM 0265 and it was followed by Co-94012 (77 per cent) and Co-86032 (75 per cent).

The difference in performance of each variety may be due to influence of cultivar on *in vitro* growth. Emphasis need to be given on refining growth regulator for specific cultivar. This technique also provides genetic variability through somaclonal variations. Thus to develop new cultivars from existing one and to broaden the genetic base, optimization of tissue culture studies is necessary for the crops like sugarcane which is a complex polyploidy, vegetatively propagated and where classical hybridization techniques are difficult due to lack of seed set.

LITERATURE CITED

Baksha, R., Alam, M. Z. Karim, S. K. Paul, A. S. Hossain and A. B. M. M. Rahman. 2002. *In vitro* shoot tip culture of sugarcane (*Saccharum officinarum* L.) variety Isd 28. Biotech. 1(2-4): 67-72.

Burner, M. D. 1992. Regeneration and phenotypic variability of plant cultured in vitro from mature sugarcane caryopsis. J. Amer. Soc. Sugarcane Technol. 12: 82-90.

Fitch, M. M. and P. H. Moore. 1990. Comparison of 2, 4-D and picloram for selection of long term totipotent green callus cultures of sugarcane. Plant Cell, Tissue and Organ Culture. 20: 157-163.

Gahukar, S. J. 1999. Isolation of mutants resistant to biotic and abiotic stresses using biotechnological techniques in sugarcane. A Ph. D. thesis submitted to MPKV, Rahuri (M.S.)

Gandonou, Ch., T. Errabji, M. Abrini, Idaomar and N. Skali Senhaji. 2005a. Effect of genotype on callus induction and plant regeneration from leaf explant of sugarcane (*Saccharum spp*.). Afr. J. Biotechnol. 4(11): 1250-1255.

Hendre, R. R. 1988. Molecular basis of differentiation in plant tissue culture with special reference to sugarcane. A Ph. D. thesis submitted to University of Pune, India.

Lal, N. and H. N. Singh. 1991. Correlation of fresh weight of callus to corresponding volumes in sugarcane. Indian J. Plant Physiol. 34(3): 261-263.

Mikami, T. and T. Kinoshita. 1988. Genotypic effects on callus formation from different explants of rice, *Oryza sativa* L. Plant Cell, Tissue and Organ Culture. 12(3): 311-314.

Murashige, T. and F. Skoog. 1962. A revised media for rapid growth and bioassay with tobacco tissue culture. Physiologia Plantarium. 15: 473-497.

Naik, G. R. and K. H. Babu. 1988. Redifferentiation of NaCl tolerant sugarcane plants from callus derived resistant lines. Curr. Sci. 57(8): 432-434.

Nand, L. and Singh, H. N. 1994. Rapid clonal multiplication of sugarcane through tissue culture. Plant Tissue Cult. 4: 1-7.

Niaz F. and A. Quraishi. 2002. Study on somatic embryogenesis in sugarcane. Biological Sci. 2(2): 67-69.

Scowcroft, W. R. 1977. Somatic cell genetics and plant improvement. Advance in Agron. 29: 39-81.

Shete, U. M. 1994. Tissue culture studies in sugarcane (*Saccharum officinarum* L). A M. Sc. thesis submitted to MPKV, Rahuri.

J. Maharashtra agric. Univ., 34 (3) : 298-300 (2009)

Studies on *Azotobacter* from Rhizosphere of Gerbera (*Gerbera jamesonii* H.)

A. B. Lele[1], N. B. Pawar[2] and S. V. Kolase[3]
College of Agriculture, Pune - 411 005 (India)
(Received : 28-05-2004)

ABSTRACT

The isolates studied were Gram negative, capsulated and non-spore forming. Old cultures were observed to produce light brown to dark blackish brown pigmentation. Tissue cultured hardened plantlets of gerbera (cv. Granada) were inoculated with purified cultures of *Azotobacter* spp. The inoculation of all the strains exhibited beneficial effect by improving the growth parameters very significantly, thereby indicating their efficiency in N-fixation. In pot culture experiment standard strains (AZT-11) obtained from Biological Nitrogen Fixation Scheme, College of Agriculture, Pune-5 was found to be the most superior followed by strain AZT-4.

Key words : Biological nitrogen fixation, gerbera, *Azotobacter*, rhizosphere.

In view of continuous increase in cost and scarcity of mineral fertilizers resulting from the use of high cost fossil energy, there is need for going into organic recycling and biological nitrogen fixation to improve soil fertility and productivity. The use of biofertilizers, apart from being a cheap source of nitrogen, can effectively ease the precarious situation created due to shortage of chemical fertilizers. The present investigation was planned with an aim to know the biological nitrogen fixation in important floricultural crop like gerbera.

MATERIALS AND METHODS

Ten isolates of *Azotobacter* (AZT-1 to AZT-1O) were obtained from the rhizosphere of gerbera grown in fields and polyhouses at different locations in Pune. One standard strain (AZT-11) procured for comparison from the BNF Scheme, College of Agriculture, Pune-5. Rhizosphere soil samples both from field and polyhouse cultivated plants of gerbera were used for isolation of *Azotobacter* according to the procedure described by Alexander (1977). Morphological tests like Gram staining, spore staining, capsule staining and shape were carried out. Plates of Jenson's agar were streaked and colonies were examined daily for pigmentation.

Plantlets of gerbera were inoculated by dipping the plant root ball in broth culture inoculum of *Azotobacter* isolates. After inoculation the plants were planted and irrigated lightly and the pots were kept in glasshouse. One treatment inoculated with standard culture and one uninoculated was also included for comparison. Recommended dose of NPK fertilizers were applied to all the pots which consisted of 200 mg N, 100 mg P and 300 mg K per liter of the substrate at monthly interval (Bose *et al*. 1999). The experiment was laid out in a randomized block design. Observations for the dry matter content of root and shoots, N content of shoot and soil were recorded.

RESULTS AND DISCUSSION

The organisms obtained from all the soil samples indicated the prevalence of *Azotobacter* in the rhizosphere of gerbera. Debnath (1997) has. reported the presence of *Azotobacter* in rhizosphere of floricultural crops grown in medium black soil of Western Maharashtra.

Of the eleven isolates, seven (AZT-1, 3, 5, 6, 8, 9 and 10) were found to be coccoid, two (AZT-11 and 4) were blunt rods and remaining two (AZT-2 and 7) were oval shaped. All the test isolates and the standard one were found to be Gram negative, capsulated and non-spore former. Beijerinck (1901) and Debnath (1997) have also described the morphological characteristics and staining reactions of the *Azotobacter* similar with the results of present investigation confirming the identity of *Azotobacter* isolates.

The isolates AZT-2, 3, 5, 6, 9, 10 and 11 were observed to be circular, AZT-1 and 4 irregular and AZT-7 and 8 were rhizoid. The colony margin of AZT-5 and 9 were undulated and that of AZT-2, 3, 6, 10 and 11 were found to be entire, AZT-1 and 4 were lobate while AZT-7 and 8 were curled. Study on types of elevation revealed that AZT-4 and 10 were umbonate; AZT-I. 3, 7 and 11 raised; AZT-2, 5, 8 and 9 convex and AZT-6 found

1. M. Sc. (Agri) student, 2. Professor of Plant Pathology and 3. Assistant Professor of Plant Pathology.

to be pulvinate.

AZT-1 and 11 produced brown pigment while AZT-3, 5 and 10 produced light brown pigment, further dark blackish brown pigment was also observed to be produced by the strains *viz*.. AZT-2, 6 and 7. The strains AZT-4, 8 and 9 also produced blackish brown pigment. Apte and Shende (1981) also reported occurrence of both pigmented and non-pigmented forms of *A. chroococcum*.

The data on effect of *Azotobacter* inoculation on shoot and root development were found to be significant indicating the difference due to the various isolates of *Azotobacter*. Maximum shoot length (35.0 cm) was recorded due to the inoculation with AZT-11 strain of *Azotobacter*, however, its effect was at par with AZT-4, 6, 7, 8, 9 and 10. Minimum shoot length (20.25 cm) was recorded in control (uninoculated). Maximum root length (29.90 cm) was observed in the inoculation treatment of AZT-11 followed by AZT-9 (28.50 cm). The lowest root length (17.75 cm) was recorded in control (Table 1). Maximum fresh weight (140.88 g) of shoot per plant was exhibited by AZT-11 and was at par with AZT-4. The lowest shoot fresh weight per plant (71.31 g) was recorded in control. The data on differences between fresh weight of root were observed to be significant and revealed AZT-11 (15.82 g) was found to be signillcantly superior over rest of the treatments followed by AZT-4 (14.72 g). The fresh weight of 11.56 g plant^{-1} was recorded in the uninoculated control which was significantly lower than rest of the treatments. Kulkarni and Konde (1990) in aster and Debnath (1997) in gladiolus have reported significantly higher root and shoot development due to *Azotobacter* inoculation.

Table 1. Effect of *Azotobacter* inoculation on growth parameters of gerbera (cv. Granada) in pot culture.

Treat-ment	Length (cm)		Fresh weight (g plant^{-1})		Dry weigth (g plant^{-1})	
	Shoot	Root	Shoot	Root	Shoot	Root
T_1	26.25	23.37	74.94	12.51	8.97	3.51
T_2	25.90	19.42	73.72	11.57	8.00	3.62
T_3	28.75	25.50	84.23	12.54	10.96	3.54
T_4	34.87	27.00	119.55	14.72	17.45	5.02
T_5	23.32	21.50	73.46	11.92	7.90	3.37
T_6	29.07	26.87	84.49	13.25	15.08	4.27
T_7	31.62	26.87	85.93	13.32	15.49	4.35
T_8	32.62	26.12	89.47	13.57	15.50	4.52
T_9	33.55	28.50	95.96	14.1	17.05	5.54
T_{10}	33.25	28.37	92.93	13.99	16.64	4.68
T_{11}	35.00	29.90	140.88	15.82	17.58	5.97
T_{12}	20.25	17.75	71.31	11.36	6.75	3.07
S. E.±	2.13	2.07	8.95	0.28	1.03	0.50
C. D. at 5%	6.14	5.96	25.79	0.81	2.97	1.46

T_1 to T_{10} = *Azotobacter* isolate, T_{11}=RDF, T_{12}= Uninoculated unfertilized control.

The highest dry weight of shoot (17.58 g) was obtained with treatment T_{11} which was at par with T_4 (17.45 g), T6, (15.08 g), T_7 (15.49 g), T_8 (15.50 g), T_9 (17.05 g) and T_{10}, (16.64 g). Significant higher dry root weight was recorded in the treatments *viz*., T_4 (5.02 g), T_9 (5.54 g) and T_{11} (5.97 g) over uninoculated control. Similar significant improvements in dry matter accumulation due to inoculation with *Azotobacter* have been reported by Sonawane (1983) in brinjal and Debnath (1997) in gladiolus.

Maximum N content of plants (4.02 %) was observed in the treatment of AZT-11; which was at par with AZT-4 (3.95 %) as against the N content of 2.69 per cent in uninoculated control. These results indicated that the treatments *viz.*, T_4, T_9, T_{10} and T_{11} were signillcantly superior over uninoculated control indicating the beneficial effect of *Azotobacter* inoculation (Table 2). Nitrogen content in brinjal (Sonawane, 1983) has also been reported to be increased in the plants due to

Table 2. Effect of *Azotobacter* inoculation on 'N' content of plant and soil.

Treat-ments	N' content of plant (%)	N' content of soil (%)
T_1	2.83	0.013
T_2	2.69	0.013
T_3	2.73	0.014
T_4	3.95	0.021
T_5	2.69	0.012
T_6	2.80	0.015
T_7	2.87	0.015
T_8	3.11	0.016
T_9	3.53	0.021
T_{10}	3.43	0.019
T_{11}	4.02	0.022
T_{12}	2.69	0.012
S. E.±	0.17	0.000
C. D. at 5%	0.48	0.001

azotobacterization. Debnath (1997) also observed significant increase in plant N content in gladiolus due to the inoculation of different strains of *Azotobacter*.

The data on N content of soil as influenced by various *Azotobacter* isolates presented in Table 2 revealed that, the treatment T_{11} was found to be superior (0.023 %) over all other treatments followed by treatments T_4 and T_9 which were at par with each other. The lowest percentage of soil N (0.012 %) was found in treatment T_{12} (control). Debnath (1997) reported saving of 75 kg ha^{-1} of fertilizer nitrogen over recommended dose in gladiolus crop due to *Azotobacter* inoculation. Thus above studies indicate the usefulness of *Azotobacter* in the growth of gerbera.

LITERATURE CITED

Alexander, M. 1997. Introduction to Soil Microbiology. John Wiley and Sons Ind., New York and London.

Apte, R. and S. T. Shende. 1981. Studies on *Azotobacter chroococcum*. Morphological, biochemical and physiological characteristics of *A. chroococcum*. Zbl, Bakt. II. Abt. 136: 548-554.

Beijerinck, M. W. 1901. Uber oligonitrophile Mikrpben : Zentbl. Bakt-Parasitkde. Abt. II. 7: 561-582.

Bose, T. K., R. G. Maiti, R. S. Dhua and P. Das. 1999. Gerbera In : Floriculture and landscaping. Naya Prokosh, 206 Bidhan Sarani, Culcutta-700 006, India. Pp. 530-547.

Debnath, S. 1997. Studies on *Azotobacter* with special reference to gladiolus. M. Sc. (Agri.) thesis submitted lo MPKV, Rahuri, (M.S.), India.

Kulkarni, R. G. and B. K. Konde. 1990. Effect of *Azotobacter* and *Azospirillum* with nitrogen on yield of aster. In : Proceedings of the VIIIth Southern Reg. Conf. on Microbial Inoculants, held at College of Agriculture, Pune during Feb. 5-6, (Abstr.). pp. 32.

Sonawane, P. M. 1983. Studies on the effect of different methods of azotobacterization under various levels of nitrogen on growth and yield of brinjal (*Solanum melongana* L.) cv. Manjri Gota. M. Sc. (Agri.) thesis submitted to MPKV, Rahuri, (M.S.). India.

J. Maharashtra agric. Univ., 34 (3) : 300-302 (2009)

Farmers Knowledge About Recommended Cultivation Practices of Chilli

H. D. Rajput[1], S. V. Supe[2], U. R. Chinchmalatpure[3] and C. P. Girase[4]
Yashwantrao Chavan Maharashtra Open University, Nasik - 422 005 (India)
(Received : 25-08-2007)

ABSTRACT

Majority of the respondents possessed medium level of knowledge (61.33 per cent) about recommended chilli cultivation practices. Majority of the respondents had knowledge about time of transplanting in field, interculture operations, age of seedling for transplanting, preparatory tillage, soil type, earthing up in main field, FYM application, varieties and spacing for chilli cultivation. Relational analysis revealed that education, land holding, area under chilli, socio-economic status and extension contact of chilli farmers were positively and significantly related with their knowledge of recommended production practices of chilli.

Key words : Knowledge; chilli; production practices.

The contribution to area and production of chilli in state is to the tune of 40 per cent and 30 per cent respectively. Khan *et al*. (1976) reported that the productivity of chilli is low due to infestation of pest and diseases. In Maharashtra, plant protection measures are the most important input to boost up production of chilli crop. Hence it was thought worthwhile to measure the farmers knowledge about recommended chilli practices.

MATERIALS AND METHODS

The study was conducted in Kuhi taluka Nagpur district of Maharashtra state as it covers more area under chilli crop. Fifteen (15) villages were randomly selected by lottery method. The list of chilli farmers from the selected villages was prepared and from them 150 chilli farmers were selected by adopting the procedure of proportionate random sampling. An interview schedule was prepared in light of the objectives of the study and data were collected by personal

1. and 4. Ph. D. Scholar, 2. Ex Head, Dept. of Extension Education PDKV, Akola. 3. Assistant Professor, Department of Extension Education, Dr. PDKV, Akola.

interview of the selected chilli farmers.

RESULTS AND DISCUSSION

Knowledge level : It is evident from Table 1 that majority of the chilli farmers (61.33 per cent) had medium level of knowledge of recommended chilli cultivation technology. There were 22.00 per cent and 16.67 per cent of the farmers having high and low level of knowledge respectively. The present findings corroborate the results of Salame (2000) and Wase (2001).

Practice wise knowledge level : Distribution of the respondents according to practice wise knowledge about chilli production technology (Table 2) revealed that majority of the respondents had knowledge about time of transplanting in field (88.67 %), interculture operations carried in chilli field (84.67 %), age of seedling at transplanting (81.33 %) and preparatory tillage (76.0 %), soil type used to grow chilli (72.0 %), earthing-up operation (70.67 %), FYM application (66.0 %), varieties of chilli (62.67 %), spacing to be used for chilli (50.0 %) and less than fifty per cent of the respondents were found to be having knowledge about fertilizer doses and its application (48.67 %), spraying and dusting (46.0 %), seed bed preparation and nursery management (41.33 %), important diseases (40.67 %), seedlings treatment before transplanting (30.67 %) and about important pests (28.0 %).

Thus, it can be concluded that majority of the respondents had knowledge about time of transplanting in field, interculture operations, age of seedling for transplanting, preparatory tillage, soil type, earthing up in main field, FYM application, varieties and spacing for chilli cultivation.

Relationship between selected characteristics and knowledge level : Personal, social, communication, economical and psychological characteristics play an important role in receiving the knowledge for chilli cultivation practices. With this in view, efforts were made to study the correlation, if any, between personal characteristics of the chilli farmers and their knowledge level.

From the present findings (Table 3) it could be inferred that knowledge level of the respondents increased with increase in their education, land holding, area under chilli, annual income, socio-economic status and extension contact. The variables namely age, sources of irrigation risk preference did not show any relation with knowledge of chilli farmers. It means that irrespective of age, source of irrigation and risk preference the chilli farmers possess knowledge about recommended chilli cultivation practices. Deotale (1989) and Phalke (1999) reported that the age was not related with knowledge of vegetable and potato. The present findings also support the findings reported by Wase (2001) who found that annual income, area under chilli and socio-economic status were significantly related with knowledge.

Based on the findings of the study, it can be concluded that majority of the respondents were aware about the recommended time of transplanting, interculture operations and age of seedling at transplanting. Followed by three fourth of respondents possessed

Table 1. Distribution of respondents according to their knowledge level of chilli cultivation practices.

Knowledge	Frequency	Per cent
Low	25	16.67
Medium	92	61.33
High	33	22.00
Total	150	100.00

Mean = 60.90, S. D. = 16.24

Table 2. Distribution of the respondents according to their practice wise knowledge about chilli production technology.

Practices	Knowledge (n=150) percentage
Preparatory tillage	76.00
Soil type	72.00
Seed bed preparation and nursery management	41.33
Varieties of chilli	62.67
Age of seedling for transplant	81.33
Month of transplanting	88.67
Seedlings treatment before transplanting	30.67
FYM application	66.00
Spacing	50.00
Fertilizers application	48.67
Interculture operation	84.67
Earthing up	70.67
Important pests	28.00
Important diseases	40.67
Chemical spraying and dustings	46.00

Table 3. Correlation between selected characteristics of chilli farmers with their knowledge.

Variables	Correlation coefficient ('r')
Age	-0.1559
Education	0.6305**
Land holding	0.2100*
Area under chilli	0.3145**
Source of irrigation	-0.0294
Annual income	0.2329**
Socio-economic status	0.3807**
Extension contact	0.2147**
Risk preference	0.0083

*,** Significant at 0.05 and 0.01 probability level

knowledge about soil type. More than half of the respondents possessed incomplete knowledge about plant protection measures, important pest and diseases, and seedling treatments of chilli production technology. Study revealed that majority of the chilli farmers had medium level of knowledge about recommended practices of chilli cultivation. Education, area under chilli, annual income, socio-economic status, extension contact and land holding found positively and significantly related with knowledge.

More than half of the respondents possessed incomplete knowledge about chilli cultivation practices (dipping seedlings in insecticide solution, plant protection measures, important pest and diseases, seed treatments). It is, therefore recommended that the extension agency should organize demonstrations on the crucial practices like dipping of seedling in insecticide solution, seed treatment, identification of important pests and diseases and handling of plant protection equipments. Field visits to the university research station to have a thorough acquaintance with recommended chilli production technology also help.

LITERATURE CITED

Deotale, S. L. 1989. Adoption behaviour and consistancy pattern of vegetable farmers in Nagpur district. M. Sc. (Agri.) thesis, Dr. PDKV, Akola.

Phalke, S. H. 1989. Production storage, and marketing problems in potato cultivation. M. Sc. (agri.) thesis, Dr. PDKV, Akola.

Khan, M. M., D. Rajagopal and P. Hanumappa. 1978. Plant protection practices and problems of chilli farmers in Kolar district. Maysore J. of Agri. Sci. 12: 163-169.

Salame, S. P. 2000. Constraints in adoption of chilli cultivation practices by farmers. M. Sc. (Agri.) thesis, Dr. PDKV, Akola.

Wase, R. B. 2001. Knowledge and adoption of farmers about Jayanti chilli cultivation. M.Sc. (Agri.) thesis, Dr. PDKV, Akola.

J. Maharashtra agric. Univ., 34 (3) : 302-305 (2009)

Growth and Progress of Mechanisation in Agriculture in Maharashtra State

S. V. Bhujbal[1], S. L. Sananse[2] and S. G. Borude[3]
Deptt. of Agril. Economics, Mahatma Phule Krishi Vidyapeeth, Rahuri - 413 722 (India)
(Received : 12-07-2008)

ABSTRACT

The number of tractors increased from 20577 in 1982 to 100785 in 2003 (increased about 370 %). The annual linear growth in absolute terms was 4113 tractors per year and compound growth rate (CGR) was 8.04 per cent. This showed that the growth of tractors in the state was quite fast. There was wide disparity in the growth of tractors in various regions of the state. There was high growth in Thane (Konkan) 37.64 per cent, Nagpur (Vidarbha) 37.34 per cent, and Latur (Marathwada) 32.12 per cent. However, the density was the highest in Kolhapur region (10.33 tractors) followed by Pune region (9.25 tractors) and the lowest in Latur (2.74 tractors). Among the top ten districts Ahmednagar had the maximum number of tractors (12709) and minimum in Sangli (4006). The density of tractors in Maharashtra in 2003 was quite low (5.71 tractors) as compared to India (16.56 tractors) and the world (19.0 tractors). The number of power tillers in the state were 704 in 1982 which increased to 9253 in 2003. The compound growth rate was 16.55 per cent per annum. This growth was much faster than that of tractors. The maximum number of power tillers were in Konkan (2038).

Key words : Tractors, power tillers, mechanisation, growth rate, density, disparity.

The use of self-propelled machines,like tractors and power tillers (hand tractors) is the basis of mechanisation in agriculture. Now a days tractors are manufactured with wide range of horse powers (HP) from 30 HP to 75 HP to suit different soil types, various farm operations, needs of cultivators and users purchasing powers. The Govt. of Maharashtra provided subsidy to the farmers (25 to 50 per cent) to purchase tractors since 1985 through loans by co-operative and commercial banks to encourage farmers to buy tractors and to boost farm mechanisation.

Power tillers are nothing but small two-wheeled hand tractors. They are self-propelled like big tractors with about 13 HP machine. They are generally used to carryout small or minor field operations like

1. Jr. Res. Asstt. 2. Statistician and 3. Ex. Prof. and Head Dr. BSKKV, Dapoli (India).

cultivating the soil, interculturing in wide spaced crops, and orchards. Power tillers are commonly used in rice fields for puddling and transplanting rice seedlings, where big tractors cannot be used. An attempt is made here to study growth and progress of tractors and power tillers in Maharashtra.

MATERIALS AND METHODS

The secondary data were collected from various published reports like, the census of Agriculture Implements and Machinery, Live-Stock Census, Season and Crop Reports and Epitome of Agricuture (Part- I) of the Department of Agriculture, Government of Maharashtra. The data regarding districtwise net sown area, number of tractors and power tillers for the census years 1982, 1987, 1992, 1997 and 2003 (Annonymous) were obtained from these sources. The data regarding number of tractors and net sown area for India were obtained from statistical Abstract of India 2004 and for the world from Statistical Year book of FAO.

The collected data were analyzed with the help of standard formulae of compound growth rate (CGR) and linear growth rate (LGR), whereas density of tractor (No. of tractors per 1000 ha.) was calculated as follows :

$$\text{Density} = \frac{\text{No. of tractors}}{\text{Net sown area}} \times 1000$$

RESULTS AND DISCUSSION

Growth rate : The number of tractors increased from 20577 in 1982 to 100785 in 2003 having about 370 per cent increase over the year 1982. Absolute linear growth rates were worked out. It was observed that annual growth rate of tractors was 4113 while in terms of percentage it was 8.04 per annum. This showed that number of tractors has been increased quite rapidly in the state mainly due to increase in irrigated area, area under sugarcane and area under fruits and vegetable crops. The maximum growth was during 1992-97 (15.13%) and 1987-92 (7.38%). The growth rate was minimum (3.98%) during the last segment of the period 1997-2003.

Absolute and per cent linear growth rates showed that the growth was 397 power tillers per annum. The compound growth rate worked out to be 16.55 per cent. This rate was really very high indicating that the number of power tillers have increased very fast, because being small in size (13 HP), their cost is relatively low and hence medium and small farmers afford to purchase them.They can provide work to these power tillers for more days in a year and get the required field operations done efficiently and quickly. It is observed that there was about 13 times increase in indices of power tillers during the period under study.

Temporal growth rates are also studied for different time periods such as 1982-87, 1992-97, and 1997-2003. For the first period from 1982-87 there was no growth and the number of power tillers remained constant at around 704 (0.05%) per annum. But in the subsequent periods growth was quite fast. It was 14.82 per cent per annum during 1987-92, 45.47 per cent during 1992-97 and 21.67 per

Table 1. Divisionwise growth and intensity of tractors and power tillers in Maharashtra (1982 and 2003).

Division	Tractors					Power tillers		
	1982 (No.)	2003 (No.)	Annual growth (%)	Net sown area (000 ha)	Tractors per 1000 ha in 2003	1982 (No.)	2003 (No.)	Annual growth (%)
Thane	95 (0.46)	846 (0.86)	37.64	821	1.03	114 (16.19)	2038 (22.03)	80.37
Nashik	6369 (30.89)	21371 (21.20)	11.15	2462	8.68	111 (15.77)	1383 (14.95)	54.57
Pune	4742 (22.90)	29137 (28.91)	24.50	3150	9.25	127 (18.04)	1452 (15.69)	49.68
Kolhapur	4217 (20.37)	16514 (16.39)	13.89	1599	10.33	98 (13.92)	1732 (18.72)	79.40
Aurangabad	1346 (6.50)	8381 (8.32)	24.89	2061	4.07	102 (14.49)	141 (1.52)	01.82
Latur	803 (4.36)	6993 (6.94)	32.12	2554	2.74	30 (4.26)	380 (4.11)	55.55
Amravati	2281 (11.02)	11141 (11.05)	18.50	3108	3.58	40 (5.68)	561 (6.06)	62.02
Nagpur	724 (3.50	6402 (6.35)	37.34	1892	3.38	82 (11.65)	1566 (16.92	86.18
Maharashtra	20577 (100.00)	100785 (100.00)	18.42	17647	5.71	704 (100.00)	9253 (100.00)	57.82

Figures in the parentheses indicate percentages to Maharashtra.

cent during the last period from 1997 to 2003. Thus the highest growth rate was during the period 1992-97. This also indicated that the growth of power tillers has been quite uneven over the period.

Density of tractors : The density of tractors refers to number of tractors per 1000 ha. net sown area. There has been continuous and steady increase in number of tractors over a period from 1982 to 2003. But the net sown area has been same around 178 lakh ha. As a result, the density of tractors has increased in different time periods from 1.21 to 1.92, 2.61, 4.58, and 5.71 from 1982 to 2003. Although there is continuous rise in the density of tractors from 1.21 to 5.71 tractors per 1000 ha. in the year 2003 the density is still quite low compared to other states in India and also national average.

Regional disparity in mechanisation : Table 1 revealed that in 1982 the maximum number of tractors were in Nashik division (6369) followed by Pune division (4742) and Kolhapur division (4217).The respective percentage shares were 30.89, 22.9 and 20.37 per cent. Thus nearly three-fourth (75 %) tractors were concentrated in these three divisions only. The minimum number was in Thane division because it receives very high rainfall (2500 to 4000 mm), a coastal and hilly region, rice is the main crop and small holdings.

Out of 100785 total number of tractors in 2003 the maximum number was in Pune division (29137) followed by Nashik division (21371) and Kolhapur division (16514) during 2003. The respective percentages were 28.91, 21.20 and 16.39 and total share was 66.50 per cent. It indicated that the share of these three divisions was reduced from 75 per cent to 66.5 per cent. The annual growth rates, maximum rate was in Nagpur division (37.34 %) followed by Latur division (32.12 %), Aurangabad division (24.89 %) and Pune division (24.50 %). The growth rates were relatively low in Nashik division (11.15 %) and Kolhapur division (13.89 %).Overall average growth rate for the state was 18.42 per cent during study period.

Kolhapur division had the highest density with 10.33 tractors per 1000 ha., followed by Pune division 9.25 and Nashik division 8.68, whereas density was the lowest in Latur division (2.74 tractors). The overall average density for the state came to 5.71 tractors.

The maximum number (127) of power tillers (18.04%) was in Pune division next being Thane (16.19%), Nashik (15.77%), Aurangabad (14.49%), Kolhapur (13.92%) and Nagpur division (l1.65%). In the year 2003, there was major shift in the number of power tillers. Out of 9253 power tillers maximum share was of Thane division (22.3%) followed by Kolhapur (18.72 %), Nagpur (16.92%), Pune (15.69%) and Nashik (14.95%). The highest rate was in Thane division (80.37%) followed by Nagpur division (86.18%), Kolhapur (79.40%),

Table 2. Top ten districts having tractors and power tillers (2003).

District	Tractors				Power tillers		
	No.	Per cent with total	Net sown area (000 ha)	Density of tractors (per 1000 ha)	District	No.	Per cent
Ahmednagar	12709	12.80	1147	11.08	Thane	1681	18.17
Pune	10999	10.91	972	11.32	Nashik	923	9.98
Nashik	10522	10.44	875	12.03	Kolhapur	855	9.24
Jalgaon	7198	7.14	853	8.44	Pune	601	6.50
Satara	6601	6.55	576	11.46	Ahmednagar	502	5.43
Kolhapur	5907	5.86	427	13.83	Satara	461	4.98
Solapur	5231	5.19	1071	4.88	Sangli	416	4.50
Aurangabad	4442	4.41	698	6.36	Jalgaon	372	4.02
Sangli	4006	3.97	596	6.72	Solapur	349	3.77
Buldhana	3082	3.06	691	4.46	Raigad	174	1.88
Total	70895	70.34	7906	8.97	Total	6334	68.47
Total State	100785	100.00	17647	5.71	Total State	9253	100.00

Table 3. Density of tractors : World, India and Maharashtra.

Census year	No. of tractors	Net sown area (000 ha)	Density No. of tractors (per 1000 ha)
World :			
1981	21756905	1342819	16.20
1991	26653214	1391565	19.00
2002	26854002	1396327	19.00
India :			
1992	1221800	142667	8.56
1997	1861300	142813	13.03
2003	2361200	142600	16.56
Maharshtra :			
1992	46313	17600	2.63
1997	81353	17761	4.58
2003	100785	17636	5.71

Amaravati (62.02%), Latur (55.55%), Nashik (54.57%), and Pune (49.68%), while the lowest rate was in Aurangabad division (1.8%). Overall annual growth rate for the state was 57.82 per cent. It was showed that the use of power tillers increased at faster rate in the state as compared to tractors (16.55% and 8.04% respectively).

Another observation was that there was more even distribution or less disparity of power tillers in different divisions of the state. At both the points of time (1982 and 2003) most of the divisions had more than 10 per cent share in the total number of power tillers, except Latur and Amaravati.

As stated earlier, power tillers are more suitable for rice cultivation. Thane division (Konkan region), Western part of Nashik , Pune and Kolhapur divisions and Bhandara (undivided) district of Nagpur division grow rice. Hence there was good number of power tillers in these divisions.

Top ten districts : Table 2 revealed that the maximum number of 12709 tractors found in Ahmednagar district, followed by Pune 10999, Nashik 10522, while Buldhana was the last in the list with 3082 tractors. The top ten districts possessed 70895 tractors and accounted to 70.34 per cent out of total. It proved that there is very skewed or lopsided distribution of tractors in the state. Kolhapur district had the highest density of 13.83 tractors per 1000 ha. followed by Nashik 12.03. Ahmednagar, Pune, and Satara had almost same density (11 tractors per 1000 ha). Lowest density was in Buldhana (4.46) and Solapur (4.88). Out of top ten districts, eight were from Nashik, Pune and Kolhapur divisions (i.e. Western Maharashtra). These divisions have high percentage of irrigated area (17.8%, 26.9% and 26.1% respectively). Similarly, these three divisions shared nearly 75 per cent of total area under sugarcane. Hence the number of tractors and their densities were very high in these three divisions compared to other divisions of the state. These observations are similar to the findings of Gajja et al. (1985) referred to above that irrigated area has strong and positive influence on tractor density.

Top ten districts having the highest number of power tillers are given in Table 2. Thane district had the maximum number of power tillers of 1681 (18.17%), followed by Nashik 923(9.98 %), Kolhapur 855(9.24%) , Pune 601(6.50%), Ahmednagar 502 (5.43%) , Satara 461 (4.98%), Sangli 416 (4.50%), Jalgaon 372 (4.0%), Solapur 349 (3.77%), and Raigad 174 (1.88%). All the ten districts shared 68.47 per cent of total number of power tillers in the state. It was also seen that the use of power tillers is not restricted to rice growing area but also in other districts like Ahmednagar, Jalgaon, Solapur, etc. This was due to the fact that power tillers are suitable for small and medium farmers to carryout small and simple field operations.

Comparative performance : The density of tractors of world, India and Maharashtra as given in Table 3 revealed that the density of tractors was 16.2 in 1981 and increased to 19 in 1991, 2002 in the world. As regards to India, it was increased from 8.56 to 16.56 during study period. It was the lowest in Maharashtra and recorded overall increase from 2.63 to 5.71 from 1981 to 2003, because of low irrigated area, use of animal power, etc. The similar results were observed by Singh and Singh (1993) and Shahare *et al*. (2003).

It could be concluded from the earlier discussion that the mechanisation in agriculture in the State of Maharashtra is making rapid progress through the use of tractors and power tillers. However, this mechanisation or tractorisation is more concentrated in Nashik, Pune, and Kolhapur divisions of the State which comprises of nine districts of western Maharashtra. Ahmednagar district has the maximum number of tractors followed by Pune and Nashik districts. However, Kolhapur district has the highest density. In comparison to the world and India, the density of tractors in Maharashtra is quite low. Power tillers which are more suitable for rice cultivation are found to be maximum in Thane division which forms the Konkan region. The growth of power tillers is faster than that of tractors. In the background of scarce human labour and rising wage rates, tractorisation has great future due to increasing need for tractors.

LITERATURE CITED

Annonymous. 1982, 1987, 1992, 1997. Season and Crop Reports. Department of Agriculture , Govt. of Maharashtra.

Gajja, B. L., J. C. Kalla and D. L. Vyas. 1985. Determinants of tractorisation in arid areas of Western Rajasthan. Agri. Situation in India. 40 (4) : 257-260.

Shahare, P. U., S. M. Mathur, K. G. Dhande and A. K. Dave. 2003. Tractors in India : Past and Present. Agri. Situation in India. LIX (10) : 623-627.

Singh Rajinder and Karam Singh. 1993. Demand for tractors in Punjab. Agri. Situation in India. XLVIII (7) : 549-555.

J. Maharashtra agric. Univ., 34 (3) : 306-310 (2009)

Applications of Optimization Techniques in Agricultural Engineering in India - A Review

M. D. Gholkar[1], C. T. Gore[2], S. S. Ramdasi[3], S. S. Patil[4], V. P. Patil[5] and D. T. Pacharne[6]
Dr. A. S. College of Agricultural Engineering, Mahatma Phule Krishi Vidyapeeth, Rahuri - 413 722 (India)
(Received : 28-4-2008)

ABSTRACT

Optimization techniques are used more or less frequently in all disciplines of agricultural engineering. The application of linear programming technique and experimental case studies is predominant in Indian Agriculture. However, there is wide scope to study the adaptability and effectiveness of the new optimization techniques such as genetic algorithm, neural network, and fuzzy systems etc. for various Agricultural engineering problems in India.

Key words : Agricultural engineering, optimization techniques.

Agricultural engineers and scientists have to solve complex real problems with minimum efforts or maximum gain fulfilling the objectives of the problems under limited resources. It is possible to fulfill the objectives through the application of optimization techniques.

In the present study, attempt is made to review the applications of optimization techniques in agricultural engineering. Though optimization techniques have been applied extensively in engineering and science fields, its applications has been limited for agriculture. Nevertheless, some researchers have attempted operations research to solve few problems related to agricultural engineering in India. The different research papers from Indian journals related with applications of different optimization techniques in agricultural engineering were studied.

REVIEW OF LITERATURE

Mehta (1969) applied graphical method of linear programming for optimizing machinery management on farm at Pantnagar. He found that linear programming technique can enable the farmers and the farm managers to increase the productivity of the tractors, combines and other farm machinery.

Maji (1976) used a linear programming model in order to accomplish crop planning and optimal allocation of resources including irrigation. 'Sensitivity analysis' and 'parametric programming' were used to find out the stability of model results with variations in the model parameters.

Acharya (1977) formulated simple mathematical programming model to determine optimum depth and spacing of subsurface drains so as to minimize the installation cost. Optimization can be done either using a simple graphical method or using elementary numerical method.

Singh and Shrivastava (1978) applied linear programming technique to make a plan for optimum use of water for village Kapgari, district Midnapore. They considered that optimum utilization of water is a function of topography, soil characteristics, climatic parameters, existing cropping patterns, available water resources, exiting productivity and socio-economic constraints in water resource development.

Tiwari (1978) applied equal and unequal plant models under heuristic methods for location allocation problems under capacity constraints for rice processing plant. He observed that the maximum weighted-distance lower bound heuristic gave the lowest mean error of 3.9 per cent and was used to solve the location allocation problems under capacity constraints.

Khepar (1982) applied stochastic method for optimum cropping pattern based on stochastic irrigation planning. They developed a model with a chance-constraint for rainfall and surface water supply which provides optimum cropping pattern with maximum returns.

Panda and Kaushal (1985) applied chance-constrained linear programming model under deterministic and stochastic method for irrigation planning at 5 per cent risk level and compared with existing situation. The study is carried out to indicate optimal cropping pattern and seasonal water release from canals and tube wells to maximize net annual return.

Rao (1985) applied linear programming model for resource

1., 2., 3., and 4. B. Tech. Student 5. Asstt. Professor 6. Professor and Head.

management planning for optimal profit in Kangsabati canal command (W.B.). He found that for maximum benefit an area of 286.74 ha should be grown under paddy to fulfill the feed requirements wheat, potatoes and mustard should be grown over areas of 93.78 ha, 65.73 ha and 73 ha respectively.

Senapati and Rao (1985) developed a mathematical model of linear programming for optimization of profit by water resource management of Bankura district (W.B.). They found that by application of the results of developed model the existing cropping intensity can be increased from 125.27 to 134.90 per cent and enhancing profit by 14.19 per cent in *kharif* and 112.48 per cent in *rabi* season.

Rank and Rao (1986) developed a non-linear programming model for agricultural resources management at Kharagpur (W.B.) and the results were compared with linear programming model. They found that the non-linear programming model is far superior to linear programming model as a management tool.

Shrivastava and Floo (1987) applied linear programming and Simulation model for optimization of hydro energy and irrigation from Bargi project by system analysis. LP model is used to regulate mean monthly supply while further refinement is carried out with simulation model. They found that optimal annual target for irrigation and energy as 3.10 T.M.C. and 176980 MWhr, respectively, which gives 76 per cent and 81 per cent successes for irrigation and energy, respectively.

Ashvini Kumar (1989) developed mathematical model of linear programming technique for optimal crop production policies for irrigated areas. The developed model gives crop combinations which provide the maximum protein content per unit area and meets the demand of dependent people under existing resources constraint.

Kanade (1989) applied linear programming model to determine optimal cropping pattern for a minor-2 in Mula Command. He suggested area for different crops for production maximization as follows: sugarcane 48.66 ha, *kharif* jowar 190.28 ha, *kharif* tur-114 ha, *kharif* groundnut- 20 ha, *rabi* jowar-40 ha, *rabi* wheat-80 ha and summer groundnut-34.37 ha.

Salokhe and Pariyar (1990) used linear programming technique to determine optimal farm plan for Tarai Belt. By adopting the suggested cropping pattern, the profit can be increased by 2.5 to 3.5 times the existing one and the cropping intensity increased from 135 to 280 per cent.

Ghatpande (1990) used various transportation models for optimizing of transportation cost for wheat and rice distribution system in Maharashtra.

Raman and Paul (1992) developed a linear programming model for selection of optimal cropping pattern. The model is very flexible to alter the constraints or add any more constraints according to the policy makers' decisions from time to time based on socio-economic considerations.

Salave (1992) used linear programming technique to determine optimal operational policy for Musalwadi section-1 of Mula left bank canal and suggested a new cropping pattern for the study area. The new cropping pattern suggested for maximization of profit is sunflower, maize and jowar fodder in *kharif*, gram in *rabi* and maize and jowar fodder in summer season along with sugarcane as perennial crop.

Kalaskar (1993) applied linear programming model to find out optimum diameter and cropping pattern for dug well in hard rock formations in Ahmednagar district. The optimum diameter of dug well was decided on the basis of well performance characteristics and benefit:cost ratio of wells and it was found to be 5-6 m. Optimum cropping pattern were worked out on the basis of water yield of wells and average market prices.

Rao and Achar (1995) applied structured analysis and design as a software design technique and dynamic programming for optimization of drainage systems. The programme developed using structured analysis and design is easier than the conventionally developed one. The programme is also time tested over several years.

Gorantiwar *et al*. (1996) applied optimization model based on linear programming technique for optimum area allocation for Mula left bank canal command area. They found that it was not possible to irrigate the area under different crops according to the existing cropping pattern if the crops are delivered with the water as computed by evaporation approach. Thus there is need for computing the water requirement of different

crops on the basis of some scientific approach for obtaining maximum crop production.

Singh (1996) applied a linear programming technique for optimization of agricultural benefits in Bijnor district. It is observed that by optimum utilization of land and water resources, it would be possible to increase the agricultural income of the district by almost 80 per cent.

Patil and Patkar (1997) applied linear programming technique for identification of most profitable cropping sequence to utilize discharge from solar photovoltaic (SPY) pumping system by optimization technique. They found that crop sequence of ridge gourd, garlic and water melon are best suitable under 0.41, 1.12 and 1.24 ha area proportion respectively with benefit:cost ratio of 6.47.

Ambast and Sen (1998) used a simulation model based on soil water balance approach to determine optimal size of on farm reservoir in rainfed rice low lands. They suggested to convert 20 per cent of watershed area into on farm reservoir to harness the excess rain in the region.

Bankar and Atre (1998) applied linear programming for deciding cropping pattern in Agadgaon watershed for minimizing soil loss with constraints on land and water resources and keeping the present income level intact. They further tried to develop cropping pattern for maximizing profit from the watershed for permissible level of soil loss as 9 t ha^{-1}.

Shirgure (1998) applied an interactive multi-objective linear programming to Bishunpur watershed (Bihar). He found that step method of interactive technique is suitable for watershed planning problems because of its simplicity and its capacity to accommodate the size of the problem.

Singh *et al.* (1998) used a multivariate approach for optimizing plot size and relative precision of experimental design in chickpea. They found that 5 sq. m. plot size and latin square design is most efficient than completely randomized design and randomized complete block design.

Verma and Shrivastava (2000) applied weighted goal programming for optimal operation of multiple reservoir systems of Mahanadi reservoir project. They observed that this technique satisfies various goals in accordance with the importance given in the form of weights to each goal. Weighted goal programming model for MRP is best suited as compared with previously developed HEC-3, MRPSIM and CDDP models.

Khandelwal and Shakya (2002) used linear programming technique for optimal use of harvested rain water in semi arid region to increase agricultural production. Gross returns, net returns on cost of cultivation and output input ratio at cost 'A' of all the prevailing crops, water requirements of the crops and probable available water in the structure by the end of estimated day of harvest were used to formulate the linear programming problem which have been solved by stepwise optimization technique.

Singh and Sharma (2002) applied linear programming technique for optimal crop planning and income maximization in waterlogged areas of Barak valley of Assam. They found that for getting maximum benefit, 28 per cent area must be allocated to pulses, 12.5 per cent for oilseeds and 14 per cent for vegetable during *rabi* and summer season.

Murli *et al*. (2004) applied dynamic programming model for irrigation scheduling of canal command. They observed that given model can effectively used for optimal allocation of water to achieve target yield of different crops through conjunctive water use planning in canal command.

Sidhu (2004) applied non-linear optimization technique for optimizing the use of different farm energy inputs like animal and manpower, fertilizers, seeds, irrigation, machinery and transportation etc. They observed that yield of wheat and cotton can be increased by 18.8 and 33 per cent with 17.9 and 20.9 per cent increase in energy input respectively. Yield of maize can be doubled with same energy inputs but in optimal way.

Singh *et al.* (2005) applied a linear programming model to optimize crop planning for Badliya command area in Rajasthan for maximizing crop benefits. They found that net return can be increased by 26.06 per cent by adopting optimal cropping pattern with existing water resources.

On analyzing the efforts of different research workers, it was found that linear programming technique can enable the farmers and the farm managers to increase the productivity of the tractors, combines and other farm

machinery. It had been tried to accomplish crop planning and optimal allocation of resources including irrigation; to determine optimum depth and spacing of subsurface drains so as to minimize the installation cost; to make a plan for optimum use of water for village by considering that optimum utilization of water is a function of topography, soil characteristics, climatic parameters, existing cropping patterns, available water resources, existing productivity and socio-economic constraints in water resource development. It can also be applied for optimization of conjunctive use of ground and surface water; for resource management planning for optimal profit in canal command; for optimization of profit in crop production by water resource management.

Linear programming and simulation model has been applied for optimization of hydro energy and irrigation; for optimization of cropping pattern in a canal command area; to determine optimal operational policy for canal and to suggest a new cropping pattern for the area; to determine optimal size of an farm reservoir in low lands; to find out optimum diameter of dug well in hard rock formations based on the well performance characteristics and benefit-cost ratio of wells; for identification of most profitable cropping sequence to utilize limited discharge such as from solar photovoltaic (SPY) pumping system.

Linear programming technique has been used for deciding cropping pattern in watershed for minimizing soil loss keeping the present income level intact; to develop cropping pattern for maximizing profit from the watershed for permissible level of soil loss; for optimal use of harvested rain water in semi arid region to increase agricultural production; for optimal crop planning and income maximization in waterlogged areas.

Chance-constrained linear programming technique has been applied under deterministic and stochastic method for irrigation planning and multi-objective linear programming has been applied for watershed planning problems because of its simplicity and its capacity to accommodate the size of the problem.

Transportation model has been used to optimize the cost of land leveling and for the quantity of soil to be removed from specific cut points and transported to particular points of fill. Similarly it has been used for optimizing of transportation cost for wheat and rice distribution system.

Non-linear programming model was found superior to linear programming model as a management tool; for optimizing the use of different farm energy inputs like animal and manpower, fertilizers, seeds, irrigation, machinery and transportation etc.

Dynamic programming and structured analysis design has been applied for optimization of drainage systems; for optimal allocation of water to achieve target yield of different crops through conjunctive water use planning in canal command.

Weighted goal programming was applied for optimal operation of multiple reservoir systems to satisfy various goals in accordance with the importance given in the form of weights to each goal. Weighted goal programming model for MRP is best suited as compared with previously developed HEC-3, MRPSIM and CDDP models.

Heuristic methods can be applied for location allocation problems under capacity constraints for rice processing plant.

Among the different sectors of agricultural engineering, the different optimization techniques are extensively used in irrigation and drainage engineering and soil water conservation engineering. In farm machinery and power and agricultural process engineering, the optimization techniques are rarely used. Most frequently tackled problems are of allocation of land and water resources for optimum benefits. Linear programming technique has been frequently used to develop different optimization models because large numbers of problems can be represented as LP models and sensitivity analysis can be handled easily through LP. The other optimization techniques are used rarely.

There are several other new techniques of optimization such as genetic algorithm, neural network, fuzzy systems etc. practiced in other fields. But these are not yet used in Indian agriculture. So there is wide scope to study the adaptability and effectiveness of these techniques for agricultural conditions.

It is clear from the literature reviewed that the optimization techniques are used more or less regularly in all disciplines of agricultural engineering. The application of linear programming

technique and experimental case studies is predominant in India.

LITERATURE CITED

Acharya, M. S. 1977. Optimization of depth and spacing of subsurface drains, ISAE, XV Annual Convention.

Ambast, S. K. and H .S. Sen. 1998. Determination of optimal size of on farm reservoir in rain fed rice lowlands using soil water balance approach, J. IWRS, 18 (4) : 32-38.

Ashvini Kumar. 1989. Optimal crop production policies for irrigated areas, J. IWRS, 9 (3) : 27-31.

Bankar, S. R. and A. A. Atre. 1998. Application of linear programming for crop planning in watershed. J. Maharashtra agric. Uni. 23 (2) : 159-161.

Ghatpande, S. D. 1990. Optimization of transport cost for wheat and rice distribution system in Maharashtra, M. Tech. (Ag. Engg.) thesis submitted to M. P. K. V., Rahuri.

Gorantiwar, S. D., P. S Pampattiwar and V. R Salave. 1996. Optimum area allocation plans for distributory-4 of Mula Left Bank Canal, Proceed of Internat. Agric. Eng. Conf. at pune during 9-12 Dec. P. 517- 527.

Kalaskar B. D. 1993. Optimal diameter and cropping pattern for dug well in hard rock formations, M. Tech. (Ag. Engg.) thesis submitted to M. P. K. V., Rahuri

Kanade D. B. 1989. Optimal cropping pattern for a command of minor using linear programming technique, M. Tech. (Ag.Engg.) thesis submitted to M. P. K. V., Rahuri

Khandelwal, M. K. and S. K. Shakya. 2002. Increasing agricultural production through optimal use of harvested rainwater in semiarid region, J. A. E, 39 (1) : 49-56.

Khepar S. D. 1982. Stochastic irrigation planning for optimal cropping pattern, Abst. of Pap., ISAE, XIX Annual Conv.

Maji C. C. 1976. Optimal cropping system and irrigation efficiency in an existing canal area, J. A. E, 13 (4) : 151-156.

Mehta M. M. 1969. Linear programming applied to farm machinery management, J. A. E, 6 (2) : 56-60.

Mishra A. L. 1982. Optimization of conjunctive use of ground and surface water, ISAE.

Murli, K. G., Radhey Shyam, and V. Jha. 2004. Dynamic irrigation scheduling model for a canal command, J. A. E, 41 (1) : 31-37.

Panda, S. N. and M. P. Kaushal. 1985. Stochastic irrigation planning: An application of chance constrained linear programming, J. A. E, 22 (2) : 93-106.

Patil, N. R. and Y. S. Patkar. 1997. Identification of profitable cropping sequence to utilise discharge from SPY pumping unit by optimization technique, B. Tech. Project Report submitted to M. P. K. V.Rahuri.

Raman Harihar and J. V. Paul. 1992. Selection of cropping pattern using linear programming technique, Indian J. A. E, 2 (2) : 125-131.

Rank, H. D. and K. A. Rao. 1986. Application of non-linear programming to agricultural resources management, Dept. of Agric. Eng., IIT, Kharagpur.

Rao, P. V. and K. R. T. Achar. 1995. Structured software design approach for optimization of drainage systems, J. A. E (India) 76 : (135-140).

Rao, Y. P. 1985. Resource management planning for optimal profit- a case study, J. A. E, 22 (4) : 50-65.

Salave, V. R. 1992. Optimal operational policy for Musalwadi Section-1 of Mula Left Bank Canal, M. Tech. (Ag. Engg.) thesis submitted to M. P. K. V., Rahuri

Salokhe, V. M. and M. P. Periyar. l990. Optimal farm planning by linear programming for Tarai Belt, JAMA, Africa & Latin America, 21 (4) : 78-80.

Senapati, S. C., Y. P. Rao. 1985. Water resources management planning for optimal profit, IS AE (Abstract of papers),

Shirgure, P. S. 1998. An interactive multi-objective LP approach to watershed planning: A case study, Indian J. SWC, 26 (3) : 258-263.

Shrivastava, D. K. and A. N. Floo. 1987. Optimization of hydro-energy and irrigation from Bargi project by systems analysis, J. IWRS. 7 (4) : 21 -30.

Singh, J. and R. C. Shrivastava. 1978. A plan for optimum use of water for Kapgari village, ISAE. (XVI).

Sidhu H. S. 2004. Optimization of energy usage in different crop production system, J. A. E. 85 : 1-4.

Singh, A. K. and A. K. Sharma. 2002. Optimal crop planning and income maximization in waterlogged areas of Barak valley of Assam, Indian J. Soil Cons., 31 (3) : 253-258.

Singh, A. K. J. Singh, R. C. Purohit and R. Singh. 2005. Optimal crop planning for Badliya command area in Rajasthan for maximizing crop benefits- a case study, Indian J. Soil Cons., 33 (2) : 166-169.

Singh, N. 1996. Optimization study of agricultural benefits in Bijnor district, J. IWRS, 2 (4) : 25-34.

Singh, V. P., M. L. Lakhera, U. J. Upadhyaya and N. M. Patel. 1998. Optimum plot size in multivariate approach and relative precision of experimental designs in chickpea, J. Maharashtra agric. Univ. 23 (2) : 111-114.

Tiwari, J. P. 1978. A heuristic method for location- allocation problem under capacity constraints and its application to rice processing plant, Synopses of Doctoral Thesis, IIT, Kharagpur.

Verma, M. K., R. K. Shrivastava. 2000. Optimal operation of multiple reservoir systems by wetted goal programming, J. IWRS, 20 (1) : 27-34.

J. Maharashtra agric. Univ., 34 (3) : 311-314 (2009)

Laser Induced Changes in Structural and Electrical Properties of CdSe Thin Films on Silver Substrate

A. N. Joshi[1] and P. A. Joshi[2]
Department of Physics, A. S. College of Agril. Engineering
Mahatma Phule Krishi Vidyapeeth, Rahuri 413 722 (India)
(Received : 20-01-2008)

ABSTRACT

The CdSe thin films are used for various characterisations such as XRD, surface morphology and electrical properties. These films have been successfully synthesized using an electrodeposition technique. Electrodeposition provides control over CdSe stoicheometry at room temperature. In study of laser excited changes in I-V characteristics of Ag/CdSe junction, it has been observed that there was increase in charge carrier concentration across the junction and hence the conductivity of CdSe was found to be increased as the excitation period increases. Silver substrate seems to be suitable for the junction formation. Photo excitation by laser of CdSe junctions was found to be significant.

Key words : CdSe thin films, laser induced changes, properties, silver substrate.

Most of the CdSe films electrodeposited in aqueous acidic bath usually contains large concentration of elemental selenide (Gutierrez. and Ortega, 1989; Pandey *et al*. 1991) which weakly crystallized and micrographs showed cauliflower like appearance which remained unchanged after annealing (Tomkiwicz *et al*. 1982). Samarth *et al*. (1990) have studied crystalline structure of CdSe in Wurtzite form. Among the II-VI compounds, Cadmium Selenide (CdSe) is a promising semiconductor material for the heterojunction solar cell opto-electronic devices, photo-detector devices and PEC Solar Cells (Modes, 1993).

In the present report, it was planed to fabricate junctions onto metal substrates. CdSe thin films were synthesized via. D.C. electrodeposition technique due to its various advantages over other methods. These films were then characterized for X-ray diffraction (XRD) for structural studies. The microstores were carried out to study the surface morphology of deposits. I-V characteristics were measured to study the change in conductivity across the junction. Then laser excited changes in I-V characteristics of metal/CdSe junction also studied. For photo excitation studies Red and Green He-Ne lasers were used as these photons have sufficient energy greater than the band gap of CdSe. The results obtained are reported and discussed in the present report.

1. Guest lecturer, 2. Lecturer, Art, Science and Commerce College, Rahuri.

MATERIALS AND METHODS

Experimental procedure : A conventional three electrode system with SCE as a reference electrode, silver as a working electrode and graphite plate as a counter electrode was utilized. Reference electrode was used to sense the applied potential. The deposition was carried out under potentiostatic condition using EG and G (model 362) scanning potentiostat.

Preparation of bath : The electrolytic bath was prepared by using analytical grade (50mM) $CdSO_4$ and (10mM) SeO_2 compounds, dissolved in 100 ml. of double distilled water. These concentrations were decided by optimizing rates of deposition for individual constituents. The total bath composition was used to get CdSe deposited thin films. The pH of the electrolyte was found in between 3 and 4 i.e. acidic in nature.

Substrate cleaning : The silver substrates was rubbed with carborandom powder and washed with soap solution by tap water and then cleaned ultrasonically. The back side was coated with insulating tape.

Electrodeposition setup : Electrodeposition setup consists of a conventional three electrode system with saturated calomel electrode

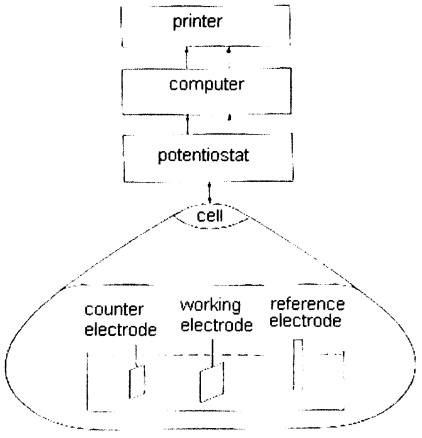

Fig. 1. Schematic electroposition set up of alloy.

(SCE) as the reference electrode, the graphite as counter electrode and silver as working electrode. In this system the sample was electrodeposited in a "vertical cell" when the electrode (working, counter and reference) were suspended vertically from the top of the cell. The electrolysis was accomplished potentiostatically in 35 ml cell; three electrodes were connected directly to the scanning potentiostat with the help of plug keys.

The backside of the substrate was covered with insulating tape. The distance between graphite and plate (Anode) and silver substrate was 0.6 cm. The deposition was carried out at potentiostatic condition. Schematic electro deposition set up as shown figure 1.

Characterization technique :

XRD Pattern : This pattern of CdSe film was recorded on Phillips PW-3710 diffractometer using CuKa radiation. The presence of sharp peaks shows that the film is polycrystalline in nature. The basis of X-ray diffraction is Bragg's law which is defined as $2d\sin\phi = n\lambda$. The values of d obtained from X-Ray difractograms were compared with standard d-values from ASTM data values of CdSe

Experimental set-up for I-V characteristics studies : Many researchers attempted to form the junction of metal and semiconductor and I-V characteristics across these junctions were studied. The photoexcitation enhances the charge carriers across these junctions and hence the conductivity. The schematic diagram to study the photoinduced changes in the I-V characteristics of these materials is as shown in figure 2. The contacts were made by air drying silver paste and connections were made as shown in figure. The potential was varied and current and voltage measured in dark. The He-Ne Red laser (A, = 362.8 nm, power = 2 mW) and Green laser the (A, = 55 nm, power - 0.9 mW) were normally incident in the window contact and I-V were measured for different period of excitation.

Surface morphology : The surface morphology of CdSe deposited on silver substrate was studied with Meltzer optical microscope (Magnification 500X) with close circuit T. V. arrangement.

RESULTS AND DISCUSSION

The cathodic polarization curve of CdSe deposited on silver substrate shown in figure 3 deposited at -0.7 V vs. SCE. The deposition was carried out to obtain sticky more adherent filme. The variation of current density with deposition time during deposition of CdSe thin films onto silver substrate is shown in figure 4. The current density for CdSe thin film deposition onto silver substrate decreased suddenly from 18.2 to 13 mA/cm at zero seconds and was attributed to the formation of thick double layer from 50 to 250 seconds and there was decrease in surface resistance; after this decrease in current density still remains constant from 250 to 1400 seconds due to steady flow of ions across the electrodes (Fig. 4). The thickness of the film is important factor which decided the one of the processing parameters i.e. period of deposition.

Thickness was measured by weight difference method.

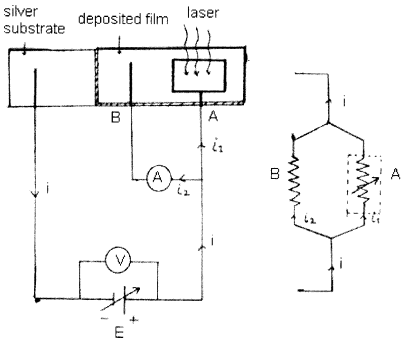

Fig. 2. Experimental set-up to measure photo induced changes in I-V characteristics of heterojunctions.

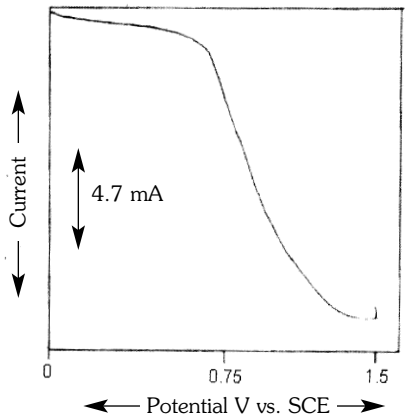

Fig. 3. Cathodic polarization curve for deposition of CdSe to silver substate.

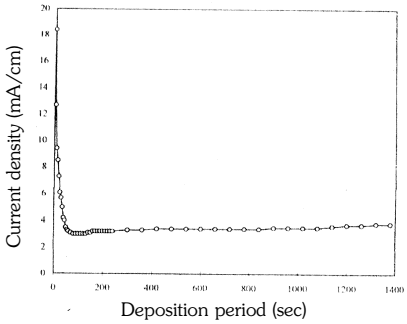

Fig. 4. Cathodic polarization curve for deposition of CdSe to silver substate.

$$\text{Thickness} = \frac{\text{Difference in weights}}{Ap}$$

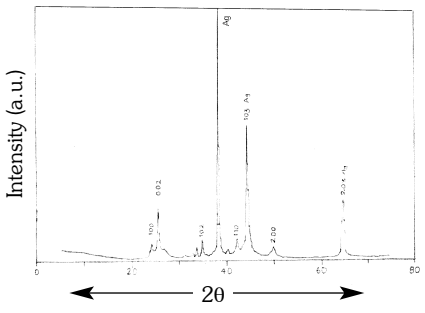

Fig. 5. XRD pattern of CdSe deposited on silver substrate

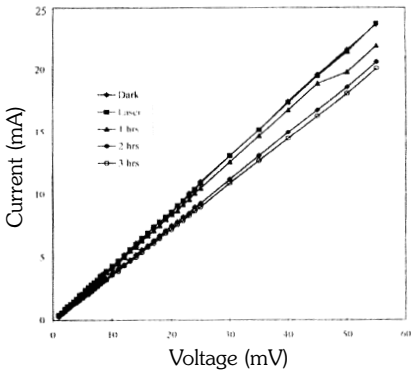

Fig. 6. Laser excited changes in I-V characteristics of Ag/CdSe junction. (Red He-Ne)

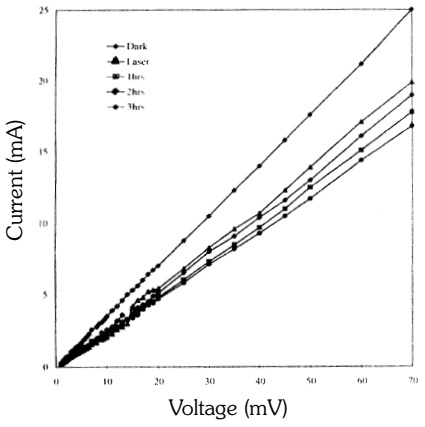

Fig. 7. Laser excited changes in I-V characteristics of Ag/CdSe junction. (Green He-Ne)

Characterization of CdSe thin films : XRD measurement: X-ray diffraction of CdSe film was recorded on Philips PW- 3710 diffractrometer using CuKa radiation. X-ray diffraction pattern of well developed CdSe films on silver substrate was obtained. Figure 5 shows X-ray diffraction patterns of CdSe deposited on silver substrate. The presence of (002), (102), (103), (110), (200), (203) peaks in figure (5) indicated hexagonal structure of CdSe. The peak at 29 = 25.46 corresponds to diffraction from (002) plane of CdSe hexagonal phase (ASTM data), the stable structure of CdSe at room temperature.

Thermoelectric power measurements (TEP) : It was found that the polarity of thermoelectric voltage of CdSe film was positive towards hot end, indicating the CdSe as n-type conductivity which was same as reported earlier (Liu and Kamat, 1993). It was also observed that as the temperature difference increased there was increase in induced e.m.f. That was attributed to the increase in carrier concentration and / or mobility of charge carriers with rise in temperature.

Laser excited changes in I-V characteristics metal / CdSe junction : The metal CdSe junction was fabricated by D.C. electrodeposition technique. As shown in the circuit diagram (Fig. 2), the current was divided into two paths. The actual current was recorded in ij path, normal junction, to measure the change in irradiated junction.

I-V characteristics of Ag / CdSe junction : The Ag/CdSe junction was used to measure the I-V characteristics and plotted (Fig.6). For I-V characteristics in dark showed the linear curve obtained at room temperature when these junctions were irradiated by red laser. That was attributed to decrease in resistance across the excited junction. That might be due to the increase in charge carriers when CdSe with band gap of 1.72 eV was excited by the energetic red laser Helium Neon Laser (Photon energy = 2.01 eV). These carriers were accelerated due to the applied potential and hence the resistance across the junction decreasesed. The same phenomenon was observed (Fig. 7) when these junctions were excited using the green He-Ne laser but wider change is observed for green laser than red laser. This may be due to the greater photon energy of green laser than red laser.

Surface morphology : It was observed that the films deposited on silver were homogeneous, uniform and well covered the substrate. The grain size of the film increased when annealed at 300° C for 120 minutes.

Electro-deposition technique proved to be efficient for deposition of CdSe. By this technique CdSe films of required stoichiometry with hexagonal crystal structure have been successfully synthesized. Silver substrate seems to be suitable for the junction formation. CdSe was found to be photosensitive because as photoexcitation increased it showed significant change in I-V characteristics.

ACKNOWLEDGEMENT

We have great pleasure to express our thanks to Professor S. H. Pawar former Co-coordinator;

School of Energy studies Shivaji University, Kolhapur for suggesting this project & his expert guidance throughout the project work. It gives us great pleasure to acknowledge our thanks to Dr. S.V. Chaudhari, Reader, Arts, Science and Commerce College, Rahuri Dist., Ahmednagar for his valuable guidance and suggestions for writing this report.

LITERATURE CITED

Gutierrez, M. T. and J. Ortega. 1989. Photoelectrochemical study of electro-deposited polycrystalline CdSe in ferro-ferricyanide system J. Electrochem. Soc., 136, [8], 2316-2320.

Hodes, G., 1993. Size-quantized nano-crystalline semiconductor films Israel. J. of Chemi. 33, 95-106.

Liu, D. and P. V. Kamat. 1993. Photochemical behavior of thin. CdSe and coupled, semiconductor Dims. J. TiO. 2. /CdSe. J. Phys. Chem., 10769: 97.

Pandey, R. K., S. R. Kumar, J. N. Rooza. and S. Chandra. 1991. "Photoelectro-chemical and solar cell studies of n-CdSe film grown by repeated cycle of electrodeposition" J. Thin Solid Films pp. 200 (1), PP 1-9.

Samarth, N., H. Luo,. J. K. Furdyna., S. B. Qadri., Y. R. Lee., A. K. Ramdas and N. Otsuka. 1990. Molecular beam epitaxy of CdSe and the derivative alloys $Z_{n1-x}Cd_xSe$ and $Cd_{1-x}Mn_xSe$. J. Electron. Mat. 19(6): 543-547.

J. Maharashtra agric. Univ., 34 (3) : 314-318 (2009)

Prediction of Reference Evapotranspiration for Konkan Region of Maharashtra

P. M. Ingle[1], U. S. Kadam[2], R. T. Thokal[3] and R. G. Manjarekar[4]
Dr. Balasaheb Sawant Kokan Krishi Vidyapeeth, Dapoli - 415 712 (India)
(Received : 25-08-2008)

ABSTRACT

The results showed that when the Epan model is compared with Penman Monteith model it over estimates reference evapotranspiration by 3.22 per cent (3.20 mm day^{-1}), which, is very less than other models. Similarly the lesser RMSE was found for Blaney criddle (B-C) model (0.52). The smaller Mean bias Error (MBE) value for ETo was also found for Epan model, similarly the higher correlation coefficient of 0.94 was found between the Epan and Penman Monteith (PM-56) model followed by B-C model (0.85). The estimation also showed that the 't' value was least for Epan model followed by B-C model, which indicates that Epan model shows better performance with PM-56 model. The B-C model also had less deviation with Epan values. In absence or lack of meterological data the Epan model followed by B-C model gave less disagreement with P-M model.

Key words : Evapotranspiration, model.

Evapotranspiration is a major component in agriculture water management, irrigation scheduling as well as water resources planning (Vazquex and Feyen, 2004). Successful irrigation scheduling mainly depends on the accurate estimation of evapotranspiration. The measurement of evapotranspiration by lysimeter or field studies is time consuming and costly affair. Therefore, scientists have resorted to estimation of ET from climatalogical parameters. The ASCE task committee on standardization of references ET and water management committee of the irrigation association studied the different major reference evapotranspiration equations and recommended the FAO-56 Penman Monteith (PM-56) equation as a standard equation (Allen *et al*. 1999).

In present study the models based on temperature, radiation and combination of both (temperature and radiation) were tested which require less data as compared to PM-56 model, so that in absence of PM-56 model the other models could be utilized. The FAO-56 Penman Monteith (PM-56) model was taken as the bench mark for comparison of reference evapotranspiration with pan evaporation model (Epan), Blaney-Criddle model (B-C), Hargreaves-Samani model (H-S) and Radiation model (FAO-24).

MATERIALS AND METHODS

The study was carried out at Dapoli, located at 15° 6' N to 20° 22' N latitude and 72° 39 'E to 73°

1. Assistant Professor. 2. Head, Department of Irrigation & Drainage Engineering, 3. Associate Professor, 4. Technical Assistant.

48' E longitudes and at altitude of 250 m near the coastal area of Maharashtra State. The climatic conditions are typically coastal (hot and humid) with average annual rainfall of 3423 mm (Mahale, 2004). The temperature of the region ranges from 7.5 °C to 38.5 °C. The relative humidity varies from 55 to 99 per cent (Savane and Kubal, 2005). The topography is hilly, undulating and soils are of lateritic type.

To estimate reference evapotranspiration the daily data from year 1985 to 2005 (21 years) was collected from the Department of Agronomy, College of Agriculture Dapoli. The data contains Anemometer height (wind measurement height), wind speed, air temperature (minimum and maximum), relative humidity (minimum and maximum) and sunshine hours. The different evapotranspiration models were used for estimation of reference evapotranspiration.

Pan evaporation model (Epan) : Evaporation from pan provides a measurement of the combined effect of temperature, humidity, wind speed and sunshine on the reference crop evapotranspiration (Doorenbos and Pruitt, 1977). For computation of reference evapotranspiration the pan factor was taken as 0.7. For the class A evaporation pan, the Kp varies between 0.35 to 0.85, the average Kpan is 0.7 (Brouwer and Heibloem, 1986).

Hargreaves-Samani model (H-S) : The Hargreaves-Samani (1985) model is one of the older evapotranspiration models. The model is computationally simple and can be used over a variety of climates with minimal amount of climatic data (Hargreaves and Allen, 2003).

Blaney-Criddle model (B-C): Blaney and Criddle (1950) developed model for arid farm lands of Western U.S. The model was designed to use monthly values only which gave erroneous results which were due to the use of temperature as the sole climatic variable. For daily calculation the model was revised by Jensen *et al*, (1990).

Radiation model (FAO-24) : The radiation model was first introduced by Doorenbos and Pruitt (1977) as a modification of Makkink (1957) method. It was suggested that this model be used where the data of air temperature and solar radiation is available even though lack of wind and humidity data and where the quality data is a question. However, the radiation model derived by Jenson performs much better with measured data (Jensen *et al*. 1990).

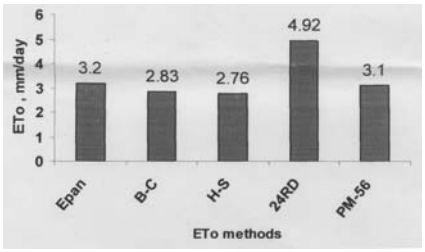

Fig. 1. Average reference evapotranspiration for various models.

Penman-Monteith model (PM-56) : Penman-Monteith model is Penman family based model. The Penman family models are generally considered among the most accurate ET models in virtually any climate. The Penman-Monteith model is recommended as the sole ETo method for determining reference evapotranspiration if data are available (Allen *et al*. 1998).

The results of each evapotranspiration model were compared with PM-56 model. The association between the models was tested by performance indicators like the Root Mean Square Error (RMSE), Mean Bias Error (MBE),

Table 1. Input data requirement for various models.

Models	Data requirement	Para-meters	Rank
Pan Evaporation (Epan)	Epan, Pan coefficient	2	1
Hargreaves Samani (H-S)	Air Temp. (Min. Max. Mean), Exteraterrestrial radiation	4	2
Blaney Criddle (B-C)	Air Temp. (Mean), Crop -specific coefficient, Consumptive use factor, Sunshine Hours, Minimum Humidity, Daytime Wind speed. Mean per cent of annual daytime hours.	8	3
Radiation method (FAO-24RD)	Solar radiation, Slope of saturated vapor pressure curve, Psychometric constant, Relative humidity (mean), mean daytime wind speed, constants	9	4
Penman-Monteith (FAO-56)	Net radiation, Soil heat flux, Slope of saturated vapor pressure curve, Psychometric constant, Saturation vapor pressure, Actual vapor pressure, Air Temp. (Min., Max. Mean), Mean daily wind speed, Altitude, Latitude, Relative sunshine duration, Sunshine Hours etc.	16	5

Coefficient of correlation (r) and 't' test. Jacovides and Kontoyiannis (1995) suggested that model assessment based on RMSE and MBE alone may be misleading in the absence of 't'-values. So for the present study the 't'-values were also calculated.

RESULTS AND DISCUSSION

The data requirement for PM-56 method is more than other methods used in present study. The methods and ranks based on the less data required (Rank 1) and high data required (Rank 5). The ranks for various ETo models is given in Table 1.

The reference evapotranspiration was calculated using different methods. The 21 years (Fig 1) average reference evapotranspiration (ETo) estimated by PM-56 (Penman-Monteith) was 3.10 mm day^{-1}, Epan model was 3.2 mm day^{-1} and radiation model was of 4.92 mm day^{-1}. The Blaney-Criddle model (B-C) and Hargreaves-Samani model (H-S) showed less ETo as the models are temperature based and wind speed and RH are not considered.

It is seen that the ETo estimated by Evaporation pan (Epan) and radiation model (FAO 24) was overestimated by 3.22 per cent (3.20 mm day^{-1}) and 58.61 per cent (5.11 mm day^{-1}) respectively over P-M model. The ETo computed by Blanney- Criddle (B-C) and Hargreaves -Sammani (H-S) models were underestimated by 8.74 per cent and 11.13 per cent respectively over P-M model. In case of radiation model, the predicted ETo was very high as compared to PM-56, which may be due to long duration of bright sunshine hours during some of the months of the year. i.e. during the March, April, May and October. Similar result were also observed by Rao and Rajput, (1993).

Root Mean Square Error (RMSE) measures the average difference that involves the square of the departure and therefore, becomes sensitive to extreme values. If the RMSE values are smaller, the better is the model performance. The magnitudes of RMSE values are useful to identify model performance but not the degree of under or overestimation by individual model. It is observed (Fig 2) that the RMSE values ranged from 0.52 to 1.95. Smaller the value of RMSE better is the model performance. The maximum RMSE value of 0.95 and 1.95 was recorded for radiation model and Epan model respectively. The lesser RMSE value was observed for B-C model and H-S model, which shows better performance over other models and indicates less error with Penman- Monteith model.

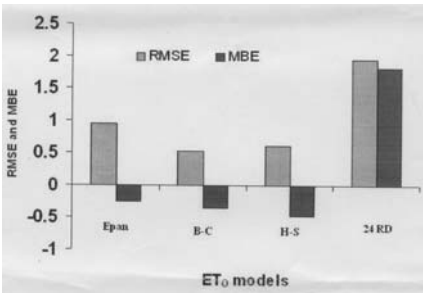

Fig. 2. Root Mean Square Error and Mean Bias Error for various models.

Table 2. Correlation matrix for different models.

Models	Epan	B-C	H-S	Radiation	PM-56
Epan	1	-	-	-	-
B-C	0.89	1	-	-	-
H-S	0.63	0.67	1	-	-
Radiation	0.65	0.54	0.80	1	-
PM-56	0.94	0.85	0.62	0.67	1

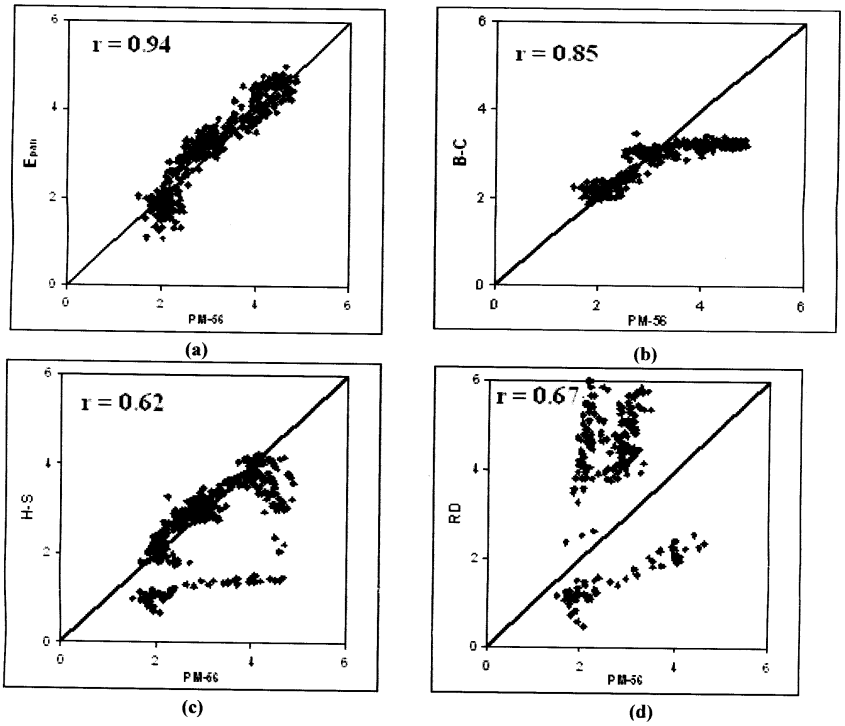

Fig. 3. Comparison of various ETo models with Penman-Monteith model.

The Mean Bias Error (MBE) positive values indicate overestimation and vice versa and the absolute values is an indicator of model performance i.e. smaller the value better is the performance (Jacovides & Kontoyiannis, 1995). The MBE value is a performance indicator which illustrates the overestimation or underestimation of reference evapotranspiration by other models with the standard method. The positive MBE values indicate overestimation and negative value indicates under estimation. The absolute value is an indicator of model performance. It is observed (Fig 3) that the MBE values ranged from -0.35 to 1.82. Based on MBE values the B-C and H-S models under estimates the reference evapotranspiration while Epan and radiation models over estimate the values when compared with Penman-Monteith model. The smaller MBE value for ETo was found for Epan model, which indicates that Epan model shows better agreement with PM-56 model.

The coefficient of correlation (Table 2) showed that the higher correlation coefficient of 0.94 was found between the Epan and Penman-Monteith model followed by B-C model (0.85). The least correlation was found for radiation model and H-S model with 0.67 and 0.62 respectively. The comparison among the different models with PM-56 model showed that the coefficient of correlation was maximum for Epan model. The coefficient of correlation value indicated that the Epan model predicted ETo near to the PM-56 model followed by B-C model (Fig 4). The linear relationship was observed between the Epan and PM-56 model with strong correlation (0.94). The ETo values for Epan and PM-56 model showed nearly stable values. This indicated that the pan evaporation provides a measurement of the combined effect of temperature, humidity, wind speed and sunshine on reference crop evaporation (Doorenbos and Pruitt, 1977). According to Rao and Rajput (1993) during the deficit rainfall year for Dapoli region, the ETo estimated by modified Penman and radiation methods were quite higher while the Penman-Monteith and Kimberly-Penman equations estimated ETo nearer to the corrected Epan values. Similarly when the pan evaporation rates were on the lower side, little higher estimations were made by the Penman- Monteith and Kimberly-Penman method (Fig 3a). When the B-C model compared with PM 56, the ETo values formed two separate clusters at the lower and upper ends of lines (Fig. 3b).The clusters at the lower ends of the figures are values of ETo for the winter and summer season while the cluster at the upper end of the line are the ETo values for the rainy season. The underestimated values of ETo were predicted for rainy season using B-C model. As B-C model is temperature based model and in rainy season the temperature of the region was lowered down due to high rainfall, underestimation of ETo values were observed. Similarly H-S model and radiation model were also compared with PM-56 model (Fig. 3c, 3d). The H-S model also formed clusters which also showed deviation in prediction of ETo values with PM-56 model. The radiation model overestimates the ETo values when compared with PM-56 model.

Table 3. Ranking to various ETo model based on performance indicator.

Model	Rank					
	Data requirement	Per cent deviation	RMSE	MBE	Coeff. of correlation	t' value
Epan	1	1	3	1	1	1
B-C	2	2	1	2	2	2
H-S	3	3	2	3	4	3
Radiation	4	4	4	4	3	4

According to Jacovides and Kontoyiannis (1995) the model based on RMSE and MBE alone may be misleading in the absence of 't' value. The 't' value for different models was computed. The 't' value of 0.48 was least for Epan model followed by B-C model (2.75). The highest 't' value was observed for radiation model. The 't' values also showed that the Epan model perform very well with Penman-Monteith model as compared to other models.

Based on performance indicators such as number of parameters required for computation of ETo, per cent deviation, RMSE, MBE, coefficient of correlation (r) and 't' value, the ranking for various ETo model was done. From Table 3 it is evident that Epan performed well for almost all indicators except the RMSE and ranked first. The B-C model followed second rank and showed very less RMSE value as compared

to Epan model when compared with Penman-Monteith models. The H-S model showed moderate ranking. The radiation model ranked last with other model. Based on the ranking and performance indicator the Epan model has less deviation and close agreement with Penman Monteith model. Similar results were also observed by Rao and Rajput, (1993) for humid place like Dapoli, the Penman-Monteith and Kimberly-Penman equations estimated ETo nearer to the corrected Epan values.

The study concluded that for Dapoli station the Penman-Monteith equation was in conformity with the measured Epan values. The Blaney-Criddle model also had less deviation with Epan values. The highest deviations in the estimation was observed in between Penman-Monteith and radiation model. The study supported that in absence or lack of meterological data the Epan model followed by Blaney-Criddle model gave very less disagreement with Penman-Monteith model.

LITERATURE CITED

Allen R. G., I. A. Walter, R. Elliott, B. Mecham, M. E. Jensen, D. Itenfisu, T. A. Howell, R. Snyder, P. Brown, S. Echings, T. Spofford, M. Hattendorf, R. H. Cuenca, J. L. Wright and D. Martin. 1999. Issues, requirements and challenges in selecting and specifying a standardized ET equation. The ASCE Task Committee on Standardization of Reference ET and/or the Water Management Committee of the Irrigation Association.

Allen, R. G., L. S. Pereira, D. Raes and M. Smith. 1998. Crop Evapotranspiration - Guidelines for computing crop water requirements. FAO Irri. and Drain. Pap. 56. Food and Agric. Org., Rome.

Blaney, H. F., and W. D. Criddle. 1950. Determining water requirements in irrigated areas from climatological and irrigation data. Soil Conser. Service Tech. Paper 96. Soil Conservation Service. U.S. Deptt. of Agriculture: Washington DC.

Brouwer C. and M. Heibloem. 1986. Irrigation water needs, Irrigation Water Management FAO Training Manual, 3, II-11, Food and Agriculture Organization, Rome.

Doorenbos, J., and W. O. Pruitt. 1977. Guidelines for predicting crop water requirements. FAO Irri. and Drain. Paper 24 , Rome, Italy.

Hargreaves, G. H. and R. G. Allen. 2003. History and evaluation of Hargreaves evapotranspiration equations. J. of Irri. and Drain. Eng. 129(1): 53-63

Hargreaves, G. H. and Z. A. Samani. 1985. Reference crop evapotranspiration from temperature. Applied Engineering in Agriculture 1 (2) : 96-99.

Jacovides, C. P. and H. Kontoyiannis. 1995. Statistical procedures for the evaluation of evapotranspiration computing models. Agric. Water Manage, 27, 365-371.

Jensen, M. E., R. D. Burman and R. G. Allen. 1990. Evapotranspiration and Irrigation Water requirements. ASCE Manuals and Reports of Engineering Practice 70. New York : ASCE.

Mahale, D., R. T. Thokal, B. G. Malandakar, D. D. Satavlekar, S. B. Nandgude, A. G. Powar and M. R. More. 2004. Effect of soil and water conservation measures on groundwater recharge in Priyadarshani watershed, Integrated Water Resources : Planning and Management. : 349-356.

Makkink, G. F. 1957. Testing the Penmen formula by means of lysimeters. J. of the Institution of Water Eng. 11(3): 277-288.

Rao, G. G. S. N., and R. K. Rajput. 1993. Evapotranspiration estimates for crop water requirements under different Agro-climatic conditions in India. J. Water Manage. 1(2): 93-97

Savane, A. B., and D. S. Kubal. 2005. Development of rainfall frequency-duration relationship for Dapoli region, B. Tech thesis, College of Agric. Eng. and Tech. Dr. B.S.K.K.V., Dapoli, Ratnagiri, Maharasthra.: 18.

Vazquex, R. F. and J. Feyen. 2004. Potential evapotranspiration for the distributed modeling of Belgian catchments. J. of Irrigation and Drain. Eng. 130(1): 1-8.

J. Maharashtra agric. Univ., 34 (3) : 319-321 (2009)

Effect of Irrigation Scheduling and Fertigation Levels on Growth and Yield of Watermelon (*Citrullus lanatus* Thunb.)

U. S. Kadam[1], A. D. Deshmukh[2], P. M. Ingle[3] and R. G. Manjarekar[4]
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli - 415 712 (India)
(Received : 25-08-2008)

ABSTRACT

The maximum yield (454.38 and 420.56 q ha^{-1}) was obtained with irrigation level I_2 (0.3PE) and fertigation level F_1 (80% RD). The yield was 51.99 and 40.68 per cent higher in irrigation level I_2 and fertigation level F_1 respectively, as compared to conventional method. The irrigation and fertilizer levels showed significant effect on yield. However, the interaction between irrigation and fertilizer combination was found to be non significant. The total quantity of water applied through drip irrigation system for I_2 was 326.71 mm and for conventional method of irrigation was 600 mm, which showed 45.22 per cent water saving over control. The maximum benefit cost ratio (2.18) was observed due to irrigation level I_2 (0.3 PE) and fertigation level F_1 (80% RD).

Key words : Watermelon, irrigation, fertigation, WUE, yield, B:C ratio.

The information available on scheduling of irrigation water in watermelon under summer conditions is limited. During summer, evapotranspiration demand is high and hence timely application of irrigation is important. Besides water, the most critical input which seriously affects the growth and yield of crop, especially vegetable crop like watermelon is plant nutrients i.e. fertilizers. As the fertilizer is costly input, the saving of fertilizers by avoiding the wasteful losses during field application can reduce the production cost. This can be achieved well by applying fertilizers through irrigation water whenever the crop is grown with drip method of irrigation. Fertigation technique applies both water and fertilizer at a low rate to the vicinity of the plant root zone, resulting in the higher yield and better quality of crops. By keeping these points in mind, the present study was undertaken to determine the water and fertilizer requirement, their use efficiency in watermelon through drip irrigation method and benefit cost ratio.

MATERIALS AND METHODS

The experiment was carried out at the Instructional Farm of Department of Irrigation and Drainage Engineering, Dr. A. S. College of Agril. Engg., MPKV., Rahuri on clay soil during the period from December, 2004 to April, 2005. The topography of the experimental field was uniform and levelled. The EC and pH of the experimental plot were 0.549 dSm^{-1} and 8.20, respectively. The available N, P and K were 426.87, 25.82 and 685.48 kg ha^{-1}, respectively. The quality of water was of class C_3S_1. The experiment was carried out in split plot design with three main plot treatments and four sub plot treatments with control treatment replicated thrice. The treatment included main plot treatment : I_1 : Irrigation at 0.2 PE by drip irrigation method, I_2 : Irrigation at 0.3 PE by drip irrigation method and I_3 : Irrigation at 0.4 PE by drip irrigation method. The

Table 1. Water and fertilizer use efficiency as influenced by different treatments.

Treatments	Yield (q ha^{-1})	Depth of water applied (cm)	WUE (q ha^{-1} cm)	Saving in water (%)	Quantity of fertilizer applied (kg ha^{-1})	Fertilizer use efficiency (FUE)
Irrigation levels :						
I_1	362.37	25.02	14.48	58.29	200	181.19
I_2	454.38	32.67	13.78	45.55	200	227.19
I_3	339.09	39.82	8.51	33.64	200	169.54
Fertilizer levels :						
F_1	420.56	32.50	12.94	45.83	160	262.85
F_2	402.12	32.50	12.37	45.83	200	201.06
F_3	375.49	32.50	11.55	45.83	240	156.45
F_4	342.95	32.50	10.55	45.83	200	171.47
Control	298.94	60.00	4.98	4.98	200	149.47
	Irrigation levels	**Fertilizer levels**	**Interaction (I x F)**			
S. E.±	9.54	13.30				
C. D. at 5%	37.48	39.50	N.S.			

1. Head, Department of Irrigation and Drainage Engineering, 2. M. Tech (A.E.) student, 3. Assistant Professor and 4. Tech. Asstt.

integrated factors derived from crop coefficient (Kc), pan factor (Kp) and wetted area (Wa) were 0.2, 0.3 and 0.4.

Sub-plot treatment included 80, 100 and 120 per cents of recommended dose through water soluble fertilizers and compard with application of N through drip and P, K by band placelnent according to recommended dose. A suitable control with conventional method of irrigation (Ridges and furrows) was maintained.

The twelve treatment combinations of three irrigation schedules and four fertilizer levels were studied in split plot design with three replications and one control treatment replicated thrice. The experimental plot was 20 x 48 m with 40 x 1 m treatment plots. The length and width of control plot was 48 x 2 m.

The seeds of watermelon (Cv. Sugerbaby) were sown on 29th December, 2004 by dibbling method in the pits of 30 x 30 x 30 cm. To bring the economy in drip unit cost, the plant spacing of 0.5 x 2.0 m was kept. One lateral commanded two rows of watermelon plants.

Water soluble fertilizer of grade (19:19:19) and urea (46% N) was used for fertigation levels of F_1, F_2 and F3. While, urea (46% N), single super phosphate (16% P_2O_5) and murate of potash (60 % K_2O) were used for treatment with fertigation level F_4 and conventional method of irrigation . The recommended dose of fertilizer (NPK) for the watermelon is 100:50:50 kg ha^{-1}. Water soluble fertilizers were applied at sixth day interval as per different treatments. The fertilizer dose was divided into eight splits including 9 per cent at sowing and rest of seven of 13 per cent each. The dose for top dressing was also divided into eight equal splits . In control, single super phosphate and murate of potash and half dose of urea were applied by band placement as a basal dose at the time of sowing. Remaining half dose of urea was applied after one moth of sowing as top dressing. The fertilizer use efficiency (FUE) was calculated using standard method.

The effect of fertigation levels and irrigation levels on growth and yield contributing parameters *viz*., length of vine, diameter of fruit, weight of fruit, number of fruits, specific gravity of fruit and yield of fruit were observed.

RESULTS AND DISCUSSION

It is seen that the maximum 600 mm depth of irrigation was applied for control treatment followed by 398.12, 326.17 and 250.28 mm as in irrigation levels I_3, I_2 and I_1 respectively through drip system. The maximum saving of water in I_1 (58.29 per cent) was achieved with drip irrigation system over the control. It was observed that yield per hectare of watermelon differed significantly due to irrigation levels. The yield of 454.38 q ha^{-1} was recorded in I_2 (0.3 PE), which was significantly superior to I_1 (0.2PE) and I_3 (0.4 PE). The treatments I_1 and I_3 were at par with each other. The minimum yield of 339.08 q ha^{-1} was observed in irrigation level of I_3. Similarly, it was revealed that mean yield per hectare of watermelon differed significantly due to fertilizer levels. The maximum yield (420.56 q ha^{-1}) was observed in F_1 (80 per cent RD) and was significantly superior over fertilizer levels F_3 and F_4. Treatment F_1 and F_2 were at par with each other. Treatment F_2 was superior

Table 2. Cost analysis for different treatment combinations.

Particulars	I_1F_4	I_1F_2	I_1F_1	I_1F_3	I_2F_2	I_2F_3	I_2F_1	I_2F_4	I_3F_3	I_3F_1	I_3F_4	I_3F_2	Control
Cost of production (Rs. ha^{-1})	40396	49200	46923	51486	49200	51486	46923	40396	51486	46923	40396	49200	33506
Yield (q ha^{-1})	327	380	399	344	471	448	497	402	335	366	300	354	299
Gross monetary returns (Rs. ha^{-1})	98100	114000	119700	103200	141300	134400	149100	120600	100500	109800	90000	106200	89700
Net incom (Rs. ha^{-1})	57704	64800	72777	51714	92100	82914	102177	80240	49014	62877	49604	57000	56104
B:C ratio	1.43	1.32	1.55	1.01	1.8	1.62	2.18	1.99	0.96	1.34	1.23	1.16	1.68

Cost of production = seasonal fixed cost Rs. 8890/-, Variable and fertilizer cost, rental value Rs. 1000 ha^{-1} and interest on working capital 10%, selling price Rs. 300 q $^{-1}$.

over treatment F_4 but at par with treatment F_3. The minimum yield (342.95 q ha^{-1}) was observed in F_4 and was at par with F_3. The interaction effect between irrigation levels and fertilizer levels was found to be non-significant in respect of mean yield per hectare. In control treatment, the yield per hectare of fruit was observed to be 298.94 q ha^{-1}, which was minimum as compared to other treatments.

From Table 1, it was revealed that WUE ranged from 4.98 to 14.48 q ha^{-1} cm due to different treatments. It was revealed that maximum WUE was reported in treatment with irrigation level I_1 (0.2 PE) and with fertigation level F_1 (80 per cent RD). The increase in WUE was due to reduction in total water used. The saving in irrigation water was to the extent of 58.29 per cent in case of irrigation level I_1 (0.2 PE) in drip irrigation system and 45.55 in irrigation level I_2 as compared with conventional method of irrigation. In other words, within the same quantity of water, about 58.29 and 45.55 per cent additional area could be brought under irrigation. The above results are in close conformity with those reported by Sivanappan (1979) for okra (bhendi), Dukure (1991) for okra and Surve (1998) for cucumber.

The maximum value of FUE (262.85) was observed in fertigation level F_1 (80 per cent RD), followed by F_2 (100 per cent RD), F_4 (N through drip and P, K by band placement) and F_3 (120 per cent RD), whereas in case of irrigation levels FUE was observed maximum (227.19) in I_2 (0.3 PE), followed by I_1 (0.2 PE) and I_3 (0.4 PE). The drip irrigation treatment registered maximum values of FUE as compared to those obtained with conventional method of irrigation (Table 1).

The maximum B:C ratio was observed in treatment combination I_2F_1 (2.18) and least in treatment combination I_3F_3 (0.96) for drip irrigation system (Table 2). In control the B:C ratio was found to be 1.68.

The study revealed that there was 28.89 per cent increase in yield and 20 per cent saving in fertilizer over control. The highest water use efficiency (WUE) (14.48 q ha^{-1} cm) was found in treatment with irrigation level I_1 (0.2 PE) whereas in case of fertigation level highest value of WUE (12.94 q ha^{-1} cm) was recorded in F1 (80 % RD). The highest (227.19) fertilizer use efficiency was recorded in irrigation level I_2 whereas in case of fertigation level highest value (265.85) was recorded for F_1. The maximum B:C ratio of 2.18 was found in treatment combination I_2F_1 (0.3 PE and 80 % RD).

LITERATURE CITED

Dukure, M. V. 1991. Efficiency of liquid nitrogen fertilizer through twin drip (biwall) irrigation for okra. M. Sc. (Agri.), thesis, MPKV, Rahuri (M.S.)

Sivanappan, R. K., C. R. Muthukrishnan, P. Natrajan, and S. Ramdas. 1979. Response of bhendi to drip irrigation system. South Indian Hort. 33(3/4): 98-100

Surve, U. S. 1998. Efficiency of liquid fertilizer through drip irrigation for cucumber. M. Sc. (Agri) thesis, MPKV, Rahuri (M.S.).

J. Maharashtra agric. Univ., 34 (3) : 322-324 (2009)

Impact of Genetic and Non-genetic Factors on Growth and Production Traits in Deccani Lambs

Y. B. Kandalkar[1], B. R. Ulmek[2], D. Z. Jagtap[3], M. G. Mote[4] and S. A. Dhage[5]
Department of Animal Science and Dairy Science, Mahatma Phule Krishi Vidaypeeth, Rahuri - 413 722 (India)
(Received : 25-08-2008)

ABSTRACT

Records on 524 lambs pertaining to Deccani were utilized to assess the impact of certain genetic and non-genetic factors on growth and production traits. Results revealed that estimated overall least squares means were 3.33 ± 0.04, 13.93 ± 0.21, 19.30 ± 0.25, 21.90 ± 0.27, 23.41 ± 0.28 kg and 472.85 ± 7.58 g for body weight at birth, 3, 6, 9, 12 months of age and greasy fleece yield of first clip, respectively. The effects of sire, sex and season were significant on body weights at all ages. The effect of year on body weights at all ages were non-significant except 3 months body weight. The effect of sire, sex and year were significant on greasy fleece yield of first clip. However, season had non-significant effect on greasy fleece yield of first clip.

Key words : Genetic and non-genetic factors, growth traits, production traits, Deccani lambs.

Deccani is a dual purpose breed of Western India. Growth and wool production are important economic traits in sheep. In view of recent hike in meat prices in the Indian Market, a well quantum jump in the export of mutton in recent years, the sheep farmers have started realizing the significance of fast growing lambs.

Growth traits in sheep are good indicator of their adaptability to particular environmental conditions. Such studies are also of great interest to the sheep breeders in view of the correlation between growth performance and age at purberty. In the present study, an attempt has been made to evaluate the production performance and certain factors affecting the performance in Deccani sheep.

MATERIALS AND METHODS

The data for the present investigation were recorded on 524 lambs born during the year 1995-99 at Network Project on Sheep Improvement, Mahatma Phule Krishi Vidyapeeth, Rahuri. The animals were maintained under the project are improved for growth and wool production traits through selection. Standard managemental practices were followed. The traits considered were live body weights at birth (WB), 3 (W3), 6 (W6), 9 (W9) and 12 (W12) months of age along with greasy fleece yield of first clip (GFY1). The data on growth and wool production were classified according to sire, sex, season and year. The least-square analysis procedure were adopted using LSMEMW programme (Harvey, 1990). Modified Kramer's (1957) Duncun Multiple Range test was used for comparison of significant sub-class means.

RESULTS AND DISCUSSION

The least square means and analysis of variance for body weights and greasy fleece yield of first clip along with standard error are presented in Table 1 and 2.

Growth traits : The overall least-squares means for body weights at birth 3, 6, 9 and 12 months age were 3.33 ± 0.04, 13.93 ± 0.21, 19.30 ± 0.25, 21.90 ± 0.27 and 23.41 ± 0.28 kg, respectively. These findings are in close agreement with results reported by Tomar *et al*. (2000) in Bharat Merino for birth weight. Similar results for 3 and 6 months body weights in Deccani and 9 and 12 months body weights in Kheri was reported by Singh *et al*. (2005).

Effect of sire : The effect of sires on birth weight, 3, 6, 9 and 12 months body weight was highly significant ($P < 0.01$). The significant effect of sires on all body weights indicated that superior sires could be used effectively for improvement of these traits. Similar significant ($P < 0.01$) differences in all body weights due to genetic merit of sires were recorded by Tomar *et al*. (2000) in Bharat Merino.

Effect of sex : The effect of sex on body weights at birth, 3, 6, 9 and 12 months age was found to be highly significant ($P < 0.01$). The male lambs weighed heavier than female lambs at all ages. The differences in birth weight of male and female lambs could be due to difference in sex harmones related to growth of lamb. Similar results have been reported by Dass and

1. Ph. D. student, 2. Asso. Dean, College of Agriculture, Pune 3. Head, 4 and 5. Asstt. Professors, College of Agriculture,

Table 1. Least squares means of body weight (kg) at different stages of age and greasy fleece yield of first clip (g) in Deccani sheep.

Effect	N	Body weight (kg) at different stages of age										Greasy fleece yield (1st clip)	
		Birth		3 months		6 months		9 months		12 months			
		Mean	S. E.	Mean	S. E.	Mean	S. E.	Mean	S. E.	Mean	S. E.	Mean	S. E.
Over all mean	524	3.33	0.04	13.93	0.21	19.30	0.25	21.90	0.27	23.41	0.28	472.85	7.58
Sex of lamb :													
Male	253	3.41^{a}	0.04	14.46^{a}	0.22	20.24^{a}	0.26	23.34^{a}	0.28	25.22^{a}	0.30	492.84^{a}	8.22
Female	271	3.24^{b}	0.04	13.40^{b}	0.22	18.36^{b}	0.26	20.47^{b}	0.29	21.60^{b}	0.30	452.85^{b}	8.26
Season of birth :													
Main season	477	3.24^{b}	0.03	13.60^{b}	0.19	18.71^{b}	0.21	21.35^{b}	0.23	22.86^{b}	0.24	465.92	6.22
Off season	47	3.41^{a}	0.05	14.26^{a}	0.29	19.88^{a}	0.36	22.46^{a}	0.39	23.96^{a}	0.41	479.77	12.03
Year of birth :													
1995	84	3.43	0.06	14.45^{a}	0.31	19.71	0.39	22.28	0.42	23.82	0.44	530.09^{a}	13.10
1996	126	3.34	0.05	13.77^{bc}	0.29	19.37	0.36	22.14	0.39	23.75	0.41	447.88^{b}	12.12
1997	76	3.38	0.05	13.97^{bc}	0.28	19.36	0.35	22.04	0.38	23.48	0.40	433.27^{b}	11.80
1998	81	3.26	0.05	13.52^{c}	0.30	19.04	0.38	21.72	0.41	23.21	0.43	435.32^{b}	12.66
1999	157	3.22	0.06	13.94^{b}	0.32	19.01	0.40	21.33	0.44	22.79	0.46	517.68^{a}	13.72

Similar superscript did not differ significantly from each other.

Singh (2002) in Marwari.

Effect of season of birth : Season of birth had significant ($P < 0.01$) effect on body weight at birth 3, 6, 9 and 12 months. The off season (April to September) born lambs were heavier than main season (October to March) born lambs at all ages. It might be due to the abundant availability of green and nutritious grass and forages during off season to the ewes which has resulted in better development of foetus as well as lambs. Significant effect of season of birth on all body weights has been reported by Kulkarni and Deshpande (1986) in Deccani and its crossbred and Mishra *et al*. (2006) in Garole, except Kulkarni and Deshpande (1986) for birth and Mishra *et al*. (2006) for 12 months body weights.

Effect of year of birth : The body weights of lambs did not differ due to effect of year of birth except body weight at 3 months age. The effect of year of birth was highly significant ($P < 0.01$) on 3 months body weight.

The DMRT revealed that overall 3 months body weight for different years differed significantly. The lambs borned in year 1995 were significantly heavier from lambs borned in rest of the years. The lambs born in year 1996, 1997, 1998 and 1999 were at par, except lambs born in year 1998 and 1999. This may be due to reason that preweaning growth rate is largely a function of the mothering ability of the dam. Similar results were reported by Mishra *et al*. (2006) in Garole for all body weights, except 3 months body weight.

Production trait : The overall least-squares means of greasy fleece yield of first clip was found to be 472.85 $\pm$ 7.58 g. The result obtained was in close agreement with findings of Lal *et al*., (2000) in Muzaffarnagri.

Effect of sire : The greasy fleece weight of first clip was significantly ($P < 0.05$) influenced by effect of sire. The significant effects of sire on greasy fleece yield of first

Table 2. Least squares analysis of variance of body weights at different stages of age and greasy fleece yield of first clip (g) in Deccani sheep.

Source of variation	d. f.	MSS					
		Birth	3 months	6 months	9 months	12 months	GFY1
Sire	33	0.18**	5.85**	8.28**	9.79**	10.78**	8120.20*
Sex	1	3.27**	135.04**	431.75**	1007.93**	1593.29**	194925.60**
Season	1	1.09**	15.84**	50.71**	45.49**	44.77**	7124.03
Year	4	0.20	7.78**	2.32	2.95	3.52	155917.07**
Error	484	0.09	2.20	4.01	4.66	5.17	5077.14

** = $P < 0.01$ and * = $P < 0.05$

clip indicated that superior sire could be used effectively for improvement of this trait. Similar significant differences in greasy fleece yield of first clip due to genetic merit of sires was also recorded by Tomar *et al*. (2000) in Bharat Merino.

Effect of sex : The average greasy fleece yield of first clip recorded for males and females were 492.84 ± 8.22 and 452.85 ± 8.26 g, respectively. The effect of sex was highly significant ($P < 0.01$) on greasy fleece yield of first clip. The effect of sex on greasy fleece yield of first clip was also reported highly significant by Dass and Singh (2002) in Marwari which is in consonance with present finding.

Effect of season of birth : Season of birth had non-significant effect on greasy fleece yield of first clip. Similar result was recorded by Ganai (1992) in Marwari.

Effect of year of birth : The least squares means of greasy fleece yield of first clip ranged from a minimum of 433.27 ± 11.80 g in the year 1997 to a maximum of 530.09 ± 13.10 g in year 1995 for greasy fleece yield of first clip.

Year of birth was significant ($P < 0.01$) source of variation for greasy fleece yield of first clip. The lambs born in year 1995 and 1999 as well as in year 1996, 1997 and 1998 were at par to each other for greasy fleece yield of first clip, while all three years 1996, 1997 and 1998 showed significantly lower greasy fleece yield of first clip than lamb born in the year 1995 and 1999.

The year to year variations usually occur due to droughts, environmental changes and changes in the age structure of the folk. These variations suggest that the wool production per head could be increased to a certain limit by nutrition, along with selective breeding. The result was supported by the findings of Dass and Singh (2002) in Marwari.

LITERATURE CITED

Dass, G, and V. K. Singh. 2002. Improvement of Marwari sheep in hot arid climate. Indian J. Anim. Sci. 72(3): 253-256.

Ganai, N. 1992. Selection indices for genetic improvement of Marwari sheep. M. V. Sc. thesis, Rajasthan Agril. Univ., Bikaner (India).

Harvey, W. R. 1990. User's Guide for LSMLMW. Mixed model least squares and maximum likelihood computer programme, PC-2 Version. Ohio State Univ., Columbus (Mimeograph), USA.

Kramer, C. Y. 1957. Extension of multiple range test to group correlated adjusted means. Biometrics. 13: 13-18.

Kulkarni, A. P. and K .S. Deshpande. 1986. Genetic studies on weaning weight and subsequent body weights in Deccani sheep and its crosses. Indian J. Anim. Sci. 56(11): 1180-1181.

Lal, N., B. S. Misra, P. K. Singh and S. N. Shukla. 2000. Growth rate and wool production in Muzaffarnagri sheep and its exotic grades. Indian J. Small Ruminants. 6(2): 68-72.

Mishra, A. K., A. L. Arora, S. Kumar and V. K. Singh. 2006. Performance evaluation of Garole sheep in semi-arid region of Rajasthan. Indian J. Anim. Sci. 76(5): 393-397.

Singh, V. K., A. K. Mishra and S. Kumar. 2005. Genetic improvement of sheep for wool and mutton production in India. A review. Indian J. Anim. Sci. 75(3): 356-364.

Tomar, A. K. S., B. S. Mehta, J. Jaishankar and G. Singh. 2000. Genetic studies on growth and greasy fleece yield in Bharat Merino sheep. Indian J. Anim. Sci. 70(5): 537-539.

J. Maharashtra agric. Univ., 34 (3) : 325-327 (2009)

Utilization of Jack Fruit (*Artocarpus heterophyllus* Lam.) Pulp in Manufacture of Milk Pudding

A. P. Holmukhe[1], S. V. Joshi[2], V. A. Toro[3], V. B. Kadav[4] and Ujjwala Kanake[5]
Department of Animal Husbandry and Dairy Science
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli 415 712 (India)
(Received : 27-09-2008)

ABSTRACT

The jackfruit pulp could be successfully utilized for preparation of milk pudding using gelatin as gelling agent. Base material used for the pudding was sweetened condensed milk. Milk pudding made with 15 per cent jackfruit pulp and gelatin 2.0 per cent of the base material was found superior over rest of the treatments.

Key words : Jackfruit pulp, milk pudding, gelatin, sensory quality.

Indian dairy industry is seeking new product ideas and technologies for diversification to meet the expanding consumer's requirements and to increase profitability. Today, demand for milk products is increasing among all the classes of consumers and particularly novelty products are preferred.

Milk pudding is one of the milk products having prime importance in the world consumer market. It is quite popular in western countries as dessert market. It is produced abroad more frequently at industrial as well as at home level. In India it is yet considered as a luxury and it is most consumed in parties. However, slowly the demand of this product is also increasing in Indian market.

Jackfruit (*Artocarpus heterophyllus* Lam.) is a crop commonly grown in humid western coastal track of India .It is found near the household gardens and in various plantations. It has high nutritive value as well as delectable taste. Thus, for producing novelty milk product, the present investigation was undertaken to standardize the technique of manufacturing milk pudding using jackfruit pulp.

MATERIALS AND METHODS

Sweetened condensed milk (2.5: 1) was used as base material for the milk pudding. Jackfruit pulp and gelatin (as stabilizer) were used at different levels as per treatments. Soft flesh type jackfruit was used for the extraction of pulp.

Due to great variation in the chemical and ingredient composition and nature of milk pudding, control treatment could not be included in the trial. Some preliminary trials were conducted to determine the range of stabilizer (gelatin) and jackfruit pulp for incorporation in milk pudding. The trials three levels of gelatin (1, 1.5 and 2.0 per cent)and four levels of jackfruit pulp (5, 10, 15 and 20 per cent) were selected on the basis of preliminary trials for further studies in seven replication.

Gelantin was dissolved in 50 ml of water by heating. The dissolved gelatin was mixed with 200 g of sweetened condensed milk. Jackfruit pulp was added at different levels in the above mixture and mixed well. The mixture was then kept in a refrigerator for setting for 3-5 hours.

The treatment wise samples of sweetened condensed milk, jackfruit pulp and pudding were analyzed chemically as per the following methods: Fat-IS :1224 (Part-I) 1977; protein, total solids and ash-IS :1479 (Part -II) 1961; titratable acidity -IS :1479 (Part -1) 1960 and total sugars Ranganna (1986). The sensory evaluation of product was carried out using nine point hedonic scale as per IS : 6273 (Part - II)1971. The data were statistically analyzed according to Snedecor and Cochran (1994) using factorial randomized block design.

RESULTS AND DISCUSSION

Table 1 represents the average chemical composition of jackfruit pulp and sweetened condensed milk. The chemical composition of sweetened condensed milk observed in the study is comparable to that

Table 1. Chemical composition of pudding ingredients (per cent).

Ingredient	Fat	Protein	Ash	Sugar	Total solids	Acidity	Lactose	Fibers
Jackfruit pulp	0.21	1.67	0.97	16.07	23.92	0.23	-	1.43
Sweetened condensed milk	8.67	8.18	1.18	42.39	72.83	0.25	11.07	-

1 and 5. M. Sc. (Agri.) students, 2. Asstt. Professor, 3. Professor, 4. Agril. Officer.

reported by Arora (1987), De (1993) and Rajadhyax *et al*. (2000). The data revealed that jackfruit has high nutritive value. It is a good source of minerals and sugars. The composition of jackfruit pulp are in agreement with those reported by Bhore, *et al*. (1980) and Bhatia *et al.* (1995).

The data pertaining to the chemical composition and quality of milk pudding as influenced by different levels of jackfruit and gelatin are presented in Table 2. There were significant decrease in fat, protein, total sugar and total solids content of milk pudding with the increase in the level of jackfruit pulp. This is obviously due to lower content of these nutrients in jackfruit as compared to condensed milk, the major base ingredient of pudding. The titratable acidity of milk pudding was not significantly influenced by the level of jackfruit pulp.

Apparently there were significant decrease in the fat, total sugar and total solids content in milk pudding due to increase in the level of gelatin. There was slight significant increase in the protein content of milk pudding due to increase in the gelatin level , which may be due to the fact that gelatin is a proteinaceous material (Anglemier and Montgomery, 1976).

The average score for all parameters of sensory quality (Table 3) at any level of jackfruit was near about 7.0 indicating that the sensory quality of all samples of pudding was good irrespective of the treatments. The pudding with 5 per cent level of jackfruit pulp was more soft and loose as compared to pudding with higher levels of jackfruit pulp. It also had comparatively weak body and lacked characteristic gel structure and there was no uniform distribution of jackfruit particles in the body. Increase in the levels of jackfruit pulp to 15 per cent significantly improved to body and texture of pudding. Further increase in the level of jackfruit pulp upto 20 per cent, however, produced slight inferior quality pudding with rough body and reduced jelling effect. There was significant variation in scores obtained by pudding at different levels of jackfruit. Upto 15 per cent level of jackfruit pulp showed characteristic clean, moderate jackfruit flavour, but at higher pulp levels i.e. above 15 per cent score was reduced due to very strong aroma of jackfruit. The overall acceptability score was determined on the basis of average of score obtained for different sensory attributes *viz*. colour and general appearance, body and texture and flavour. Average highest overall acceptability score of 8.007 was recorded at 15 per cent level of jackfruit pulp.

Gelatin produced considerable variation in general appearance of different levels. The pudding at 1.0 per cent and 1.5 per cent level had slightly loose and soft body. The general appearance was significantly improved by increasing the level of gelatin to 2.0 per cent. The gelatin at 1.0 per cent and 1.5 per cent level was not effective in producing desired viscosity and jelling effect in the product. At this level, body of the pudding was not firm and texture showed lack of smoothness. The body and texture of pudding was significantly improved at the level of 2.0 per cent of gelatin. There was significant variation in score obtained by pudding at different levels of gelatin. The highest overall acceptability score was recorded at 2.0 per cent level of gelatin.

From result of the present study

Table 2. Chemicals composition of pudding (per cent).

Constituent	Levels of jackfruit pulp (per cent)				Level of gelatin (per cent)		
	5	10	15	20	1.0	1.5	2.0
Fat	8.271^{a}	7.799^{b}	7.367^{c}	6.699^{d}	7.635^{a}	7.534^{a}	7.433^{b}
Protein	8.043^{a}	7.727^{b}	7.404^{c}	6.968^{d}	7.405^{a}	7.536^{b}	7.667^{c}
Total sugar	41.136^{a}	39.572^{b}	38.208^{c}	36.779^{d}	39.217^{a}	39.135^{a}	38.420^{b}
Total solids	70.6987^{a}	66.967^{b}	65.171^{c}	63.323^{d}	66.821^{a}	66.409^{b}	66.388^{b}
Titratable acidity	0.269	0.269^{b}	0.266^{c}	0.265^{d}	0.246^{a}	0.265^{a}	0.292^{b}

Mean with different subscript in a row differed significantly ($P < 0.01$)

Table 3. Sensory quality of milk pudding (9 point hedonic scale).

Constituent	Levels of jackfruit pulp (per cent)				Level of gelatin (per cent)		
	5	10	15	20	1.0	1.5	2.0
General appearance	6.525^{a}	6.506^{a}	7.756^{c}	6.980^{b}	6.424^{a}	6.984^{b}	7.418^{c}
Body and texture	6.623^{a}	7.559^{c}	8.226^{d}	7.248^{b}	6.969^{a}	7.361^{b}	7.913^{c}
Flavour	6.302^{a}	7.921^{c}	8.041^{d}	7.398^{b}	7.184^{a}	7.486^{b}	7.576^{c}
Overall acceptability	6.483^{a}	7.329^{c}	8.007^{d}	7.208^{b}	6.859^{a}	7.277^{b}	7.636^{c}

Mean with different subscript in a row differed significantly ($P < 0.01$)

it may be concluded that the jackfruit pulp could be successfully utilized for preparation of milk pudding using gelatin as the jelling agent. The best acceptable quality pudding can be prepared by using 15 per cent jackfruit pulp and 2.0 per cent gelatin.

LITERATURE CITED

Anglemier,A. F. and M. W. Montegomery. 1976. In "Principles of Food Science, Part-I, Food Chemistry" Edited by Fennema, O. R. Marcel Dekker, Inc. New York and Basel : 238-239.

Arora, K. L. 1987. Quality of sweetened condensed milk manufactured in India, Indian Dairyman. 39(9): 415-417.

Bhatia, B. S., G. S. Siddapa and G. Lab. 1995. Composition and nutritive value of jackfruit. Indian J. Agric. Sci. 55(4): 303-305.

Bhore, D. P., S. M. Ghunk and V. G. Shelke. 1980. A promising type of jackfruit (*Artocarpus hetrophyllus* Lam.). J. Maharashtra agric. Univ. 5(1): 81-82.

De, Sukumar 1993. Outlines of Dairy Technology. Oxford University Press, New Delhi.

IS : 1479 (Part-I) 1960. Methods of test for dairy industry. Rapid examnination of milk. Indian Standards Institution, Manak Bhavan, New Delhi.

IS : 1479 (Part-II) 1961. Methods of test for dairy industry. Chemical analysis of milk. Indian Standards Institution, Manak Bhavan, New Delhi.

IS : 6273 1971. Guide for sensory evaluation of food (Part-I) and (Part-II). Indian Standards Institution, Manak Bhavan, New Delhi.

IS : 1224 (Part-I) 1977. Determination of fat by Gerber's method (Revised). Indian Standards Institution, Manak Bhavan, New Delhi.

Rajadhyax, M. B., V. A. Toro and S. V. Joshi. 2000. Utilization of tender colour for preparation of milk pudding. Indian J. Dairy Sci. 53(6): 419-423.

Ranganna, S. 1986. Analysis and quality control for fruit and vegetable products. 2nd Education Tata McGraw Publ. Co. Ltd, New Delhi.

Snedecor, G. W. and W. G. Cochran. 1994. Stastical Methods. 6th Ed. The Iowa State College Press. Anines, Oxford and IBA Publi. Co. Calcutta.

J. Maharashtra agric. Univ., 34 (3) : 327-329 (2009)

Preparation of *Kalakand* Fortified with Mango Pulp

Archana Dongale[1], V. A. Toro[2], S. V. Joshi[3], V. B. Kadav[4] and P. V. Jadhav[5]

Dept. of Animal Science and Dairy Science

Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli - 415 712 (India)

(Received : 27-09-2008)

ABSTRACT

Kalakand fortified with 5, 10 and 15 per cent mango pulp was prepared by using cow and buffalo milk. Addition of mango pulp reduced the fat content while the total solids increased in the cow milk and buffalo milk *kalakand*. The highest acidity observed in plain *kalakand* showed decreasing trend with increasing level of mango pulp. From overall acceptability it is clear that buffalo milk was superior to cow milk for preparation of *kalakand* with or without mango pulp.

Key words : *Kalakand*, mango pulp chemical quality, sensory quality.

The studies on quality fortification of *kalakand* using fruit juice/pulp are rare. In view of availability and popularity of Alphonso mango in konkan region, there is great scope for its use in fortification of milk product like *kalakand* for producing novelty product. Alphonso mango is most popular and choicest fruit of tropics and also known as the 'king of fruit' because of its high palatability, excellent taste, flavour and nutritive value. Alphonso is one of the leading commercial cultivars of mango with good source of vitamins 'A' and 'C'. Attempts were, therefore, made to study the chemical and sensory quality of *kalakand* prepared with different level of mango pulp.

1. M. Sc. (Agri.) student 2. Ex. Professor 3. Asstt. Professor 4. Sr. Res. Asstt. 5. Sr. Surveillance Officer.

MATERIALS AND METHODS

For the preparation of *kalakand*, cow and buffalo milk was received from the herd maintained at the Dairy farm, College of Agriculture, Dapoli, where as Alphonso mango pulp and other ingredients like sugar, citric acid etc. were purchased from the local market.

The *kalakand* was prepared as per the procedure given by De (1999) with slight modifications using two types of milk *viz*. cow milk

(T_1) and buffalo milk (T_2), with three levels of mango pulp (L_1-5%, L_2-10% and L_3-15%) and trial was conducted with six replications.

The fat content of milk was determined by using standard gerber method as per IS: 1224 (part-I), 1977. The acidity of milk was estimated according to IS: 1479 (part-I), 1960. The total solids content of milk and *Kalakand* were determined by gravimetric method as per IS: 1479 (part-II), 196.1. The fat and the acidity content of all the samples of *kalakand* were estimated by the method given by Choudhary (1959) and by subtracting per cent total solids from 100, moisture was calculated. The fat, total solids, acidity, total sugars, reducing sugars and non reducing sugar of mango pulp were determined as per the procedure given by Ranganna (1986).

The sensory attributes of *kalakand* prepared by using cow and buffalo milk with different levels of mango pulp were evaluated by conducting sensory evaluation by panel of ten judges. Colour and appearance, flavour, body and texture and overall acceptability were assessed by nine point hedonic scale as per IS : 6273 (part-II), 1971. The data obtained from six replications were analyzed according to the method described by Snedeccor and Cochran (1994).

RESULTS AND DISCUSSION

The chemical analysis indicated that cow and buffalo milk used for *kalakand* preparation had average fat content 4.45 and 6.06 per cent, total solids 13.27 and 15.53 per cent and acidity 0.14 and 0.12 per cent, respectively. All these values lie within the range of legal standards for cow and buffalo milk as described by PFA rules 1976.

Table 1. Chemical quality of *Kalakand* (per cent).

Constituent	Level of mango pulp (per cent)				Types of milk	
	0	5	10	15	T_1	T_2
Moisture	31.24[a]	30.00[a]	28.97[a]	27.73[b]	34.67[a]	24.29[b]
Total solids	68.76[a]	70.00[a]	71.03[a]	72.27[b]	65.32[a]	75.71[b]
Fat	24.72[a]	23.96[a]	22.76[b]	21.39[c]	20.17[a]	26.25[b]
Titratable acidity	0.47[a]	0.42[b]	0.39[b]	0.37[c]	0.42	0.40

Means with different alphabets in row differed significantly ($P < 0.01$).

Table 2. Organoleptic quality of *Kalakand* (Nine point hedonic scale).

Characteristics	Level of mango pulp (per cent)				Type of milk	
	0	5	10	15	T_1	T_2
Colour and appearance	6.88[a]	7.36[b]	7.47[b]	7.76[b]	7.25	7.49
Flavour	6.84[a]	7.20[a]	7.23[a]	7.46[b]	7.03	7.33
Body and texture	6.83	7.07	7.10	7.30	6.87[a]	7.28[b]
Overall acceptability	6.85[a]	7.21[a]	7.26[b]	7.50[b]	7.05[a]	7.36[b]

Mean with different alphabets in a row differed significantly ($P < 0.01$).

The average chemical composition of Alphonso mango pulp used in the present study showed fat conteni 0.84 per cent, total solids 30.73 per cent, acidity 0.42 per cent, total sugar 14.96 per cent and reducing and non reducing sugars 4.45 and 10.51 per cent, respectively . The analytical figures were similar to the values reported by Joshi and Roy (1989), Patil (1990) and Desai (1992).

The data pertaining to chemical composition and quality of *kalakand* as influenced by different types of milk and levels of mango pulp are presented in Table-1.

There was significant decrease in moisture and fat content of *Kalakand* with the increase in the level of mango pulp. This is obviously due to lower contents of these constituents in mango pulp as compared to the type of milk used for *kalakand* preparation, whereas decrease in acidity from 0.47 to 0.37 per cent which may be due to slightly lower acidity of mango pulp (0.42%) compared to plain *kalakand* and its addition at later stage of *kalakand* preparation. The total solids content of *kalakand* increased with the increase in the level of mango pulp. This is due to higher total solid content in pulp as compared to total solids content of original milk from which *kalakand* was prepared.

There was decrease in the moisture content of *kalakand* due to type of milk and this decrease is obviously due to initial lower moisture content in buffalo milk (T_2) than cow milk (T_1). There was increase in the total solids and fat content of *kalakand* which is due to the initial higher percentage of these constituents in buffalo milk (T_2) compared to cow milk (T_1), whereas differences in titratable acidity of *kalakand* due to types of milk were non-significant.

The average score for all the parameters of sensory quality (Table 2) at any level of mango pulp was above 7.0 indicating that the sensory quality of all the samples of *Kalakand* was good irrespective of the treatment, whereas the *kalakand* without mango pulp did not like much to the judges as compared to the other samples.

Body and texture characteristics of *kalakand* have great influence on its acceptability. A good quality *kalakand* has hard grains with granular appearance. The variation in body and texture score due to different level of mango pulp was non-significant. It may be due to the fact that the type of milk and acidity developed by addition of citric acid has the greatest influence on body and texture of *kalakand*. Addition of mango pulp at later stage of *kalakand* preparation did not have much impact on the body and texture. *Kalakand* prepared by using cow and buffalo milk showed the significant differences for body and texture. *Kalakand* from buffalo milk was preferred most to that of cow milk *kalakand*. Buffalo milk *kalakand* had bigger grains with better appeal than the cow milk *kalakand* which had small sandy grains and more dry surface.

The data pertaining to sensory score of flavour revealed that differences in values for flavour showed significant variatioo due to addition of mango pulp. *Kalakand* with 15 per cent mango pulp was superior over rest of treatments due to typical appealing alphanso flavour, whereas the variation in sensory score of flavour due to type of milk was non significant.

The data revealed that there was non-significant variation between type of milk in respect of colour and appearance of the product. However, the addition of mango pulp significantly improved the colour and appearance of *kalakand*. The *kalakand* without mango pulp irrespective of type of milk recorded the lowest score (6.88) which were significantly increased with increase in the level of mango pulp. The highest score was obtained at the level of 15 per cent mango pulp. However, all the levels of mango pulp were statistically at par with each other.

The overall acceptability score was determined on the basis of average of the total score obtained for different sensory attributes *viz*. general appearance, body and texture, and flavour. The higher acceptability score of 7.50 was recorded at 15 per cent level of mango pulp, as this product at the level showed attractive yellowish colour of mango and typical appealing flavour of alphanso. *Kalakand* prepared from cow and buffalo milk did not have significant variation in respect of appearance and flavour. Whereas in respect of body and texture, buffalo milk *kalakand* had acceptable bigger grains with better appeal. The highest overall acceptability score was recorded for *kalakand* prepared from buffalo milk (7.36).

From the result of present study it may be concluded that the buffalo milk produced better quality *kalakand*. Fortification of *kalakand* with mango pulp improved sensory quality and acceptability of the product. The optimum level of mango pulp for fortification was found to be 15 per cent for both cow and buffalo milk *kalakand*.

LITERATURE CITED

Chaudhari, A. C. 1959. Practical dairy science and laboratory methods. Scientific Book Agency, Culcutta.

De, Sukumar. 1999. Outlines of dairy technology. Oxford University Press, New Delhi.

Desai, S. R. 1992. Preparation of fruit yoghurt using cow milk. M. Sc. (Agri.) thesis submitted to Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli.

IS: 1479 (Part-I) 1960. Methods of test for dairy industry. Rapid examination of milk. Indian Standards Institution, Manak Bhavan, New Delhi.

IS: 1479 (Part-II) 1961. Methods of test for dairy industry. Chemical analysis of milk. Indian Standards Institution, Manak Bhavan, New Delhi.

IS: 6273 (Part-II) 1971. Guide for sensory evaluation of food. Indian Standards Institution, Manak Bhavan, New Delhi.

IS: 1224 (Part-II) 1977. Determination of fat by Gerber method (Revised). Indian Standards Institution, Manak Bhavan, New Delhi.

Joshi, G. D. and S. K. Roy. 1989. Effect of integrated post harvest handling on quality and shelf life of alphonso mango fruits. Maharashtra J. Hort. 4 (2) : 96

Patil. S. A. 1990. Evaluation of mango (*Mangifera indica* L.) cvs. Alphonso, Ratna, Pairi and Kesar fruits for physico-chemical, composition, storage and processing. M. Sc. (Agri.) thesis submitted to Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli

Ranganna, S. 1986. Handbook of analysis and quality control for fruit and vegetable products. Tata Mc. Graw Hill Publi. Co. Ltd. New Delhi.

Snedccor, W. G. and G. W. Cochran. 1994. Statistical Methods. East - West Press Pvt. Ltd., New Delhi.

RESEARCH NOTES

J. Maharashtra agric. Univ., 34 (3) : 330-331 (2009)

Effect of Different Concentrations of Sucrose on Micropropagation of Sugar Beet (*Beta vulgaris* L).

Plants meet their energy requirements autotrophically by photosynthesis. However, in tissue culture, the explants lack this autotropic ability since the normal functions of the chloroplasts are either absent or blocked as reported by Maretzki *et al.* (1974). Success in the technology and application of in *vitro* methods is due largely to a better understanding of the nutritional requirements of cultured cells and tissues as reported by Thorpe (1978). The two factors, which most frequently determine the success of cell cultures, are explant origin and the general nutritional milieu. The nutritional milieu consists of inorganic salts, a carbon and energy source, vitamins and phytohor-mones (growth regulators).

Fully organized, green shoots in culture also show better growth and proliferation with the addition of suitable carbon source in the medium. The carbohydrate sources used in plant tissue culture are mainly sucrose, fructose and glucose and to a lesser extent maltose, galactose, mannose and lactose (Gautheret, 1959). The best and mostly used source of carbohydrate for plant tissue culture is sucrose at a concentration of 2-5 per cent. The quantity of carbohydrate absorbed and its fate dependens on the type of carbohydrate supplied and on the explant (Butenko, 1968). It is imperative to supply external carbon sources to produce enough carbohydrate in order to promote cell growth and subsequent regeneration. Another importance of sucrose in tissue culture is its role as an osmoticum. Sucrose along with agar is the major component in the media to affect the uptake of water by plant cells.

The main objective of conducting this experiment was to standardize the concentration of sucrose for the micropropagation of sugar beet varieties Palma and DS 4061.

The experiment was carried out at Biotechnology Laboratory of Vasantdada Sugar Institute, Pune. Seeds of sugar beet varieties, Palma and DS 4061 were obtained from Danisco Seed Company of Denmark.

Media preparation : In all stages the medium used was MS (Murashige and Skoog, 1962). pH of the medium was adjusted to 5.8 before autoclaving and the medium was gelled with agar 0.8 per cent. The medium was dispensed in jam bottles (45 ml bottle^{-1}) and sterilized by autoclaving at 121°C for 20 minutes.

Surface disinfection and seed germination (stage I) : Seeds were washed and then soaked in distilled water for 12 hr. Soaked seeds were surface disinfected with an aqueous solution of mercuric chloride (0.1%, w/v, 3 min) followed by repeated washings with sterile distilled water under aseptic conditions and then placed aseptically on hormone-free Murashige and Skoog's (1962) medium containing 2 % sucrose. Seeds were incubated at 25 ± 2 °C.

Multiple shoot induction (stage II) : Using a scalpel, the shoot meristems were excised from

Table 1. Effect of different concentrations of sucrose on micropropagation of two varieties of sugarbeet Palma and DS 4061.

Sucrose conc. (%)	Variety	Number of shoots explant^{-1}	Height of longest shoot (cm)	Fresh weight of culture (g)
0	Palma	4.00 ± 0.00	2.4 ± 0.06	0.44 ± 0.02
	DS 4061	3.00 ± 0.00	3.13 ± 0.12	0.46 ± 0.02
1	Palma	5.99 ± 0.14	3.7 ± 0.26	1.59 ± 0.20
	DS 4061	8.00 ± 1.24	4.84 ± 0.19	1.79 ± 0.06
2	Palma	9.33 ± 0.54	4.7 ± 0.10	2.49 ± 0.06
	DS 4061	9.33 ± 0.54	4.47 ± 0.12	1.75 ± 0.21
3	Palma	13.22 ± 0.09	5.00 ± 0.24	3.64 ± 0.15
	DS 4061	16.70 ± 0.26	4.67 ± 0.11	3.78 ± 0.06
4	Palma	9.77 ± 0.36	4.10 ± 0.11	2.47 ± 0.18
	DS 4061	11.33 ± 1.08	4.24 ± 0.21	2.63 ± 0.34
5	Palma	7.55 ± 0.18	3.30 ± 0.24	1.52 ± 0.29
	DS 4061	7.11 ± 0.39	3.85 ± 0.03	1.92 ± 0.19

• Evaluation was done after 20 days in culture.

the 30-day-old *in vitro* grown plant under aseptic condition in the laminar flow. These dissected meristems were transferred to MS medium + cytokinin (BAP) for shoot induction. The culture vessels were kept on the shelf in the culture room. The cultures were maintained at 25 ± 2°C with 12 hr daylight. The photoperiod was maintained by an automatic timer system and light intensity of 1000 lux.

Inoculation on media with different sucrose concentrations (stage III) : The MS media was prepared with different concentrations of sucrose (0, 1, 2, 3, 4, and 5 %). Axillary shoot cuttings were excised from the *in vitro* cultures obtained in stage II (meristem culture). During excision, the large leaves were discarded to ensure an unvarying growth of the new shoots. The shoots cutting were then inoculated on the fresh MS media and cultured for 20 days.

Statistical design : The experiment was conducted using a completely randomized design with three replications and repeated three times. Pooled analysis was carried out and conclusions were drawn on the basis of pooled data over three experiment.

ANOVA revealed significant differences among the different concentrations of sucrose on multiple shoot formation, height and fresh weight of culture. (Table 1). In both the cultivars number of shoots, height and fresh weight significantly increased as the concentration of sucrose increased from 0 to 3 per cent. The highest number of shoots, 13.22 and 16.7 were induced on medium containing 3 per cent sucrose in 20 days in varieties palma and DS 4061 respectively. The number of shoots was significantly reduced in both the cultivars when sucrose concentration in media was further increased (4 and 5 %).

The highest level of growth in the presence of 3 per cent sucrose (30 gm liter^{-1}) in the medium indicates the signaling role of sucrose on micropropagation and the threshold effect.

It can thus be concluded that for getting more number of shoots and good plant growth in micropropagation of sugar beet the sucrose concentration in the culture medium should be 3 per cent.

ACKNOWLEDGEMENT

Authors are grateful to Danisco Seed Company, Denmark for providing the seed for the research work. Facilities provided by the Director General, VSI are gratefully acknowledged.

S. S. Salokhe
A. R. Zaware
Y. S. Nerkar

Vasantdada Sugar Institute
Manjari (Bk.), Pune-412 307 (India)
December 10, 2005.

LITERATURE CITED

Butenko, R. G. 1968. Nutrition in tissue. In: Plant Tissue Culture and Plant Morphogenesis. (Ed M. K. Chailekhyan), Israel Prog, for Scientific Translation 31-33.

Gautheret, R. J. 1959. In: La Culture des Tissus Vegetaux, Techniques et Realisation. Paris, Masson et Cie.

Maretzki, A., M. Thom and L. G. Nickell. 1974. Utilization and metabolism of carbohydrates in cell and callus cultures. In: Tissue Culture and Plant Science, (Ed. H.E. Street) Acad. Press, London. 329-361.

Murashige, T. and F. Skoog. 1962. A revised media for rapid growth and bioassy with tobacco tissue culture. Physiol. Plant. 15: 473.

Seetohul, S. 1995. A study of the effects of carbohydrates in tissue culture of *Nicotiana tabacum*. Dissertation for requirement of B.Sc, University of Mauritius, Mauritius.

Thorpe, T. A. 1978. Plant tissue culture, Methods and Application in Agriculture. Acad. Press. 23.

J. Maharashtra agric. Univ., 34 (3) : 331-332 (2009)

Effect of Nitrogen Levels on Forage Yield of Promising Varieties of Multicut Oat

Oat (*Avena sativa* L.) is an important winter forage crop of gramineae family. Owing to its excellent growth habit, better palatability, quick regrowth and good quality forage, it has become a promising forage crop for the livestock feeding. Multicut ability of oat reduces the cost of establishing new crops. Forage plants especially the multicuts are heavy feeders of plant nutrients and remove large

Table 1. Green forage, dry matter and crude protein yields of multicut oat varieties as influenced by nitrogen levels (Total of two cuts).

Treatment	Green forage yield (q ha^{-1})	Dry matter yield (q ha^{-1})	Crude protein yield (q ha^{-1})
Varieties :			
JHO-2002-1	414.6	83.6	9.3
JHO-2002-3	458.2	77.9	8.6
RO-19	505.4	90.7	9.8
OS-317	416.4	75.9	8.3
UPO-212	454.8	52.6	9.1
S. E.±	4.9	0.9	0.2
C. D. at 5%	13.9	2.6	0.5
Nitrogen levels (kg ha^{-1}) :			
0	285.3	44.8	5.2
40	399.6	70.0	7.6
80	538.0	101.4	11.4
120	576.7	112.3	12.0
S. E.±	4.4	0.8	0.1
C. D. at 5%	12.5	2.3	0.4

amount of nutrients from the soil. Nitrogen is an essential primary nutrient for profuse plant growth that plays a pivotal role in quantitative as well as qualitative improvement in productivity of forage under multicut condition (Kumar *et al*. 1997). Now a days many new improved genotypes of oat are developed and hence it felt necessary to exploit the green forage yield of these genotypes with different nitrogen levels. Information on response of effect of nitrogen on multicut oat varieties under irrigated condition is very limited. Keeping these in view, the present study was undertaken.

The field experiment was conducted at Forage Crops Research Project, MPKV, Rahuri during *rabi* season of 2004-05. The experiment was laid out in factorial randomized block design with three replications. Treatments comprised of five oat varieties (JHO-2000-1, JHO-2002-3, RO-19, OS-317 and UPO-212) and four nitrogen levels (0, 40, 80 and 120 kg ha^{-1}). The soil of the experimental field was clayey in texture, low in available nitrogen (208 kg ha^{-1}), medium in phosphorus (10.14 kg ha^{-1}) and high in available potash (432 kg ha^{-1}). The crop was fertilized with 60 kg P and 40 kg K per hectare. The half quantity of N and full dose of P and K were applied as basal dressing. The remaining half dose of N was top dressed 30 days after sowing. The first cut was taken at 60 days after sowing and second cut at 50 per cent flowering.

Varieties : The differences in green forage, dry matter and crude protein yield were differed significantly due to varieties (Table 1). The variety RO-19 recorded significantly higher green forage (505.4 q ha^{-1}) and dry matter yield (90.7 q ha^{-1}) than other varieties; however, for crude protein yield it was at par with JHO-2002-1 (9.3 q ha^{-1}). Similar results were also reported by Gill and Malik (1983) and Kumar *et al*. (1997).

Nitrogen levels : Data presented in Table 1 revealed that, with increasing level of nitrogen from 0 to 120 kg ha^{-1} significantly increased green forage, dry matter and crude protein yields. An increase of green forage, dry matter and crude protein yields by 102.14, 150.67 and 130.77 per cent were observed by 120 kg N ha^{-1} over control. These results are in agreement with those reported by Kumar *et al*. (1997), Singh *et al*. (1998), Hasan *et al*. (2000) and Sharma and Bhunia (2001).

Thus, it could be concluded that for higher productivity of multi-cut oat, variety RO-19 should be grown with application of 120 kg N ha^{-1}.

S. H. Pathan
R. L. Bhilare
A. D. Kadlag

Mahatma Phule Krishi Vidyapeeth,
Rahuri-413722 (India)
November 11, 2007.

LITRERATURE CITED

Gill, P. S. and B. S. Malik. 1983. Response of oat varieties to soil moisture regime and nitrogen levels. Forage Res. 9 : 151-154.

Hasan, B., W. A. Shah. and B. Hasan. 2000. Biomass, grain production and quality of oats (*Avena sativa*) under different cutting regimes and nitrogen levels. Cereal Res. Communication. 28 (1-2) : 203-210.

Kumar, Y., B. L. Sharma, G. L. Yadav and P. K. Sharma. 1997. Nitrogen management in fodder crop of double cut oat (*Avena sativa*). Indian J. Agron. 42 (2) : 313-315.

Sharma, S. K. and S. R. Bhunia. 2001. Response of oat (*Avena sativa*) to cutting management, method of sowing and nitrogen. Indian J. Agron. 46 (3) : 563-567.

Singh, R., B. R. Sood, V. K. Sharma and N. S. Rana. 1998. Effect of cutting management and nitrogen on forage and seed yields of oat (*Avena sativa*). Indian J. Agron. 43 (2) : 362-366.

J. Maharashtra agric. Univ., 34 (3) : 333-334 (2009)

Response of Nitrogen Levels to Single Cut Oat Genotypes

Oat (*Avena sativa* L.) is an important winter forage crop grown under irrigated condition of North, North west and central parts of India. At present, country has nearly 40 per cent short supply of forage production, which needs to be bridged in order to achieve the goal of white revolution. Forage is the chepest source of animal feed. In view of these facts, there is an urgent need of increasing good quality forage supply by adopting improved agronomic techniques, among which the improved genotypes and balance fertilizer use are one of them. Nitrogen is an essential primary nutrient for profuse plant growth that plays a pivotal role in productivity of forage production (Kumar *et al*. 1997). Now a days many new improved genotypes of oat are coming up as forage varieties. It is therefore, necessary to exploit the green forage yield of these genotypes under different nitrogen levels. Keeping these in view, the present study was undertaken.

The field experiment was conducted at Forage Crops Research Project, MPKV, Rahuri during *rabi* season of 2006-07. The experiment was laid out in factorial randomized block design with three replications. Treatments comprised of five oat genotypes (JHO-2004-4, UPO-04-1, Kent, OS-6 and RO-19) and four nitrogen levels (0, 40, 80 and 120 kg ha^{-1}). The soil of the experimental field was low in available nitrogen (219.5 kg ha^{-1}), medium in phosphorus (16.8 kg ha^{-1}) and high in available potash (438.7 kg ha-1). The crop was fertilized with 60 kg P_2O_5 and 40 kg K_2O per hectare. The N was applied into three equal splits. The 1/3 quantity of N and full dose of phosphorus and potassium were applied as basal dressing. The remaining two splits of N were top dressed at 25 and 45 days after sowing. The cut was taken at 50 per cent flowering.

The data presented in Table 1 revealed that the yield attributes and green forage, dry matter and crude protein yield were differed significantly due to genotypes. The genotype UPO-04-1 being at par with kent and OS-6 recorded significantly higher plant population per metre row length than other genotypes. However, significantly higher plant height was registered by genotype RO-19 as compared to other genotypes. The genotype kent noticed significantly more leaf : stem ratio than other genotypes except genotype OS-6. The genotype UPO-04-1 being at par with RO-19 recorded significantly higher green forage (292.04 q ha^{-1}) and dry matter yield (53.64 q ha^{-1}) than other genotypes; however, genotype RO-19 recorded significantly higher crude protein yield (4.89 q ha^{-1}) than all other genotypes. The higher yield recorded by genotype UPO-04-1 might be due to maximum plant population per metre row length. Similar results were also reported by Pathan *et al*. (2005).

An increase in level of nitrogen from 0 to 120 kg ha^{-1}, showed progressive increment of yield attributes and green forage, dry matter and crude protein yield. An application 120 kg N ha^{-1} being at

Table 1. Yield contributing characters and green forage, dry matter and crude protein yield of single cut oat genotypes as influenced by nitrogen levels.

Treatment	Plant population m^2	Plant height (cm)	L:S ratio	Green forage yield (q ha^{-1})	Dry matter yield (q ha^{-1})	Crude protein yield (q ha^{-1})
Varieties :						
JHO-2004-04	91.58	109.25	0.860	271.32	48.21	4.41
UPO-04-1	94.17	99.78	0.893	292.04	53.64	4.39
Kent	93.75	111.07	0.895	260.55	45.21	3.83
OS-6	93.83	124.93	0.680	250.37	41.84	3.79
RO-19	92.17	129.70	0.843	289.21	52.13	4.89
S. E.±	0.23	0.70	0.012	5.95	0.78	0.08
C. D. at 5%	0.65	2.00	0.035	17.03	2.23	0.22
Nitrogen levels (kg ha-1) :						
0	93.00	100.04	0.777	188.95	34.61	2.72
40	93.13	114.43	0.822	274.05	46.69	3.91
80	93.13	122.00	0.852	310.82	55.32	4.92
120	93.00	123.32	0.885	316.97	56.20	5.50
S. E.±	0.20	0.62	0.011	5.32	0.70	0.07
C. D. at 5%	NS	1.79	0.032	15.23	1.99	0.20

par with 80 kg N ha^{-1} recorded significantly higher yield attributes *viz*., plant height and leaf: stem ratio than all other levels of nitrogen, however, plant population did not differ significantly due to different nitrogen levels. The application of 120 kg N ha^{-1} produced significantly higher green forage yield (316.97 q ha^{-1}), dry matter yield (56.20 q ha^{-1}) and crude protein yield (5.50 q ha^{-1}) than all other levels of nitrogen except 80 kg N ha^{-1} where it was found at par for green forage and dry matter yield. An increase of green forage, dry matter and crude protein yields by 102.14, 150.67 and 130.77 per cent respectively was observed by 120 kg N ha^{-1} over control. This might be due to higher magnitude of yield attributes at 120 kg N ha^{-1}. These results are in agreement with those reported by Kumar *et al*. (1997), Singh *et al.* (1998), Sharma and Bhunia (2001) and Pathan *et al*. (2007).

Thus, it could be concluded that for higher productivity of single cut oat in terms of quantity and quality, variety RO-19 should be grown with application of 80 kg N ha^{-1}.

S. H. Pathan
R. L. Bhilare

Mahatma Phule Krishi Vidyapeeth,
Rahuri- 413 722 (India)
October 14, 2007.

LITERATURE CITED

Kumar, Y., B. L. Sharma, G. L. Yadav and P. K. Sharma. 1997. Nitrogen management in fodder crop of double cut oat (Avena sativd). Indian J. Agron. 42 (2): 313-315.

Pathan, S. H., R. M. Gethe, R. M. Manjare and A. D. Kadlag. 2005. Response of multicut oat to spacing and nitrogen for green forage yield. Forage Res., 31 : 150-151.

Pathan, S. H., R. L. Bhilare, K. B. Nawale and V. T. Jadhav. 2007. Response of multicut oat varities to nitrogen levels. Forage Res., 32 : 269-270.

Sharma, S. K. and S. R. Bhunia. 2001. Response of oat (*Avena sativa*) to cutting management, method of sowing and nitrogen. Indian J. Agron. 46 (3): 563-567.

Singh, R., B. R. Sood, V. K. Sharma and N. S. Rana. l998. Effect of cutting management and nitrogen on forage and seed yields of oat (*Avena sativa*). Indian J. Agron. 43 (2) : 362-366.

J. Maharashtra agric. Univ., 34 (3) : 334-336 (2009)

Effect of Temperature on Growth and Spore Germination of *Colletotrichum capsici* and Disease Development in Chilli

Anthracnose of chilli caused by *Colletotrichum capsici* is known to cause extensive losses in chilli (Mishra, 1988; Ratnaparakhi, 1988; Patil *et al.* 1993). Severity of disease is dependent on growth of pathogen, its sporulation and spore germination of the fungus, which are reported to be influenced strongly by the temperature. (Singh *et al*. 1977, Mazlan and Sarion, 1980, Chung and Lee, 1986, Alabi and Emechabe, 1992, Thakur and Khare, 1993; Mishra and Gupta 1994).

Considerable variation for requirement of optimum temperature for fungal growth, sporulation, spore germination, disease initiation and spread may exist. Present study was therefore, undertaken to find out optimum temperature requirement of *C. capsici* on the above aspects in the Marathwada region of Maharashtra State.

To study the effect of temperature on mycelial growth of *C. capsici*, 5 mm (diameter) growth of *C. capsici* from seven-day-old culture on PDA in petri dish was cut with sterilized cork borer and was transferred at the center of sterilized and solidified PDA medium in petriplates under aseptic condition. The plates were inverted, covered and incubated at 5, 10, 15, 20, 25, 30 and 35°C in BOD incubators. Observations regarding mean colony diameter of fungus were recorded on 4th and 7th day of incubatian.

Germinability of conidia of *C. capsici* was studied at aforesaid temperatures, by slide germination technique (Chung and Lee, 1986). Standard cavity glass slides were used for this purpose. In each cavity slide 0.1 ml sterilized water was added. The cavities were uniformly dusted with freshly harvested conidia of *C. capsici*. The slides thus prepared were transferred to sterilized petriplates with moist blotter and were incubated in BOD

incubators at temperatures ranging from 5 to 35°C.

For studying pathogenic effect of *C. capsici in vitro* at temperatures ranging from 5 to 35°C apparently healthy leaves and fruits of various developmental stages of chilli (Cv, Parbhani Tejas) were collected from field. These were surface sterilized for 2 minutes in 0.1 per cent mercuric chloride solution and were subsequently rinsed in three changes of sterilized water under aseptic condition and then spores of *C. capsici* was separately dusted on them, these were transferred in petriplates with moist blotter. These plates were incubated in BOD incubators. The development of symptoms on inoculated leaves and fruits was recorded by daily observations. There were 3 replications for each of above experiment.

Table 1. Growth, conidial germination and symptom expression of *C. capsici* as influenced by incubation temperatures.

Temperature (°C)	Mean colony diameter (mm)			Mean conidial germination on (%)		Days required after inoculation for symptom expression
	4 days	7 days	Per day	Hours of incubation		
				24	48	
5	5.00 (12.90)	5.00 (12.90)	0.00	0.00 (0.00)	0.00 (0.00)	-
10	5.50 (13.56)	6.66 (15.00)	0.24	16.54 (24.65)	24.29 (29.47)	15
15	7.66 (16.11)	14.66 (22.54)	1.38	37.94 (38.01)	43.23 (41.10)	13
20	20.16 (26.71)	34.33 (35.85)	4.19	48.73 (44.25)	53.05 (46.76)	9
25	25.73 (30.46)	45.63 (42.48)	5.80	75.33 (60.23)	80.72 (63.96)	7
30	27.83 (31.82)	49.00 (44.43)	6.29	81.13 (64.24)	83.94 (66.38)	8
35	9.33 (17.76)	17.33 (24.58)	1.76	46.79 (43.16)	50.01 (45.00)	12
S. E.±	0.64	0.59	-	0.80	0.75	-
C. D. at 5%	1.96	1.81	-	2.58	2.33	-

C. capsici grew well from the temperature ranging from 10 to 35°C as evidenced from increase in colony diameter is observed up to 30°C temperature. Its growth was not observed at 5°C up to 7 days. Maximum growth was observed at 30°C which was at par with 25°C and significantly superior to rest of the temperatures (Table 1). It is seen from the study made by earlier workers that there is a difference of opinion for the optimum temperature required for growth and sporulation of *C. capsici*. (Mazlan and Sarian, 1980; Chung and Lee 1986; Alabi and Emechebe, 1992; Thakur and Khare 1993 and Mishra and Gupta 1994). Variation in requirement of temperature range can be due to variation in isolates of *C. capsici*.

C. capsici germinated readily in the temperature range of 10 to 35°C. Conidial germination up to 48 hours of incubation was not seen at 5°C. Maximum conidial germination was observed at 30°C, which was significantly more than rest of the temperatures and followed by 25, 20, 15 and 10°C. Observations of present study are more or less similar to those observed by Chung and Lee (1986), Mishra and Gupta (1994) but differ from the observations made by Alabi and Emechebe (1992) and Thakur and Khare (1993), who reported that 25°C temperature was most favorable for maximum growth and sporulation. This variation seems to be because of variation in the physiology of the isolate.

It is seen from results that temperature influenced incubation period of anthracnose disease and also development of symptoms on leaves and fruits. Symptoms could not develop up to a fortnight at 5°C while developed readily at the temperature range of 10 to 35°C. Minimum incubation period of 7 days was required at temperature of 25°C and was slightly more for 20 and 30°C. Maximum incubation period was observed for 10°C. These observations are in conformity with Manale (1984), Austuti and Suhardi (1986) and Datar (1995) who reported that temperature between 20-30°C was conducive for fruit rot development in chilli.

D. G. Hingole
B. P. Kurundkar

Depart. of Plant Pathology
College of Agriculture,
Badnapur - 413 202 (India)
September 1, 2007.

LITERATURE CITED

Alabi, O. and A. M. Emechebe. 1992. Effect of temperature on growth and

sporulation of cowpea brown blotch pathogen (*Colletotrichum capsici*). Samaru J. Agric. Res., 9: 99-102.

Austuti, E. B. and F. Suhardi. 1986. The effect of storage temperature and fruit maturity on incidence of anthracnose of chilli pepper. Bull. Penelition Hort. 13(1): 40-45.

Chung, B. K. and S. B. Lee. 1986. Effect of conidial number and nutrition on the germination of conidia in *Colletotrichum capsici* causing red pepper anthracnose. Korean. J. Pl. Prot., 25(1): 41-46.

Datar, V. V. 1995. Pathogenicity and effect of temperature on six fungi causing fruit rot of chilli. Indian J. Mycol. Pl. Pathol., 25(3): 195-197.

Manale, V. B. 1984. Investigations on anthracnose of chilli. (*C. capsici*.) M. Sc. (Agri.) thesis, Marathwada Agril. Univ., Parbhani (M.S.), pp 1-76.

Mazlan, S. and M. Sarian. 1980. Anthracnose of chilli in Malesia. Biology of pathogen and varietal susceptibility. Pertanika. 3(1): 47-52.

Mishra, A. and O. M. Gupta. l994. Influence of environment on growth and sporulation of *Colletotrichum dematum*. Indian J. Mycol. Pl. Pathol., 24(2): 85-87.

Singh, R. P., P. N. Singh and D. R. Singh. 1977. Note on fruit rot disease of chilli. Indian J. Mycol. Pl. Pathol., 23(2): 188-190.

Thakur, M. P. and M. N. Khare. 1993. Factors affecting sporulation and conidial germination of two species of *Colletotrichum* from mung. Indian J. Mycol. Pl. Pathol., 23(2): 188-190.

J. Maharashtra agric. Univ., 34 (3) : 336-337 (2009)

Effect of Land Treatments on Growth and Yield of Maize (*Zea mays*)

Among the various major limiting factors in crop production, water management plays an important role. Major source of water for rainfed agriculture is rainfall during *kharif* season. However, rainfall is erratic characterized by uneven distribution and inadequacy for crop production. Therefore, to increase crop production in rainfed and dry land farming it is necessary to adopt the soil and water conservation measures like strip cropping, contour farming, contour and graded bunding, terracing, trenching, mulching etc. Use of vegetative bunds and various land treatments increases the moisture intake and yield of crop were reported by Agrawal (1991). Bharad *et al*. (1995) also reported increase in yield by about 55.6 per cent of millet in treatment of contour cultivation with vetiver key line over the sowing along the slope. Keeping these in view, the present experiment was conducted.

The field experiment was conducted during *kharif* season of 1998-99, on Model Watershed, (Agro ecological and Environment Centre) at Dr. PDKV, Akola to evaluate the effect of land treatments on growth, yield attributes and yield of maize crop. The experiment was laid out in a randomized block design with five replications. Treatments comprised of four land treatments (T_1 - sowing along the slope, T_2 - contour sowing along the vetiver hedge at 1 m VI, T_3 - sowing along the graded bund at 1 m VI and T_4 - sowing across the slope). The soil of the experimental field was silt clay loam, medium deep with 1.7 per cent land slope. The sowing of maize (cv. Cargill-633) was done on 8th July 1998 and harvested on 21st Nov. 1998. Other agronomic practices were followed as per recommendation. The rainfall received during *kharif* 1998 was 796.7 mm in a 44 rainy days and well distributed.

Growth and yield attributes : The plant height (160.93 cm) and number of functional leaves (12.36) were significantly more in vetiver hedge treatment (T_2) followed by

Table 1. Growth attributes of maize as influenced by land treatment.

Treatment	Plant height (cm)	Functional leaves plant^{-1}	Leaf area dm^2 plant^{-1}	Dry matter plant^{-1} (g)	Days to 50% tasseling
T_1	147.43	11.08	44.92	149.73	52.60
T_2	160.93	12.36	56.48	158.28	52.40
T_3	155.23	11.90	54.33	154.14	52.60
T_4	154.11	11.66	52.41	153.12	52.80
S. E.±	0.34	0.11	0.16	0.14	0.40
C. D. at 5%	1.05	0.34	0.48	0.43	NS

Table 2. Yield attributes and yield of maize as influeced by land treatments.

Treatment	Grains plant^{-1}	Weight of grains plant^{-1} (g)	Test weight (g)	Grain yield (q ha^{-1})	Fodder yield (q ha^{-1})	Grain to fodder ratio
T_1	460.80	138.00	310.88	51.85	81.48	0.63
T_2	483.60	148.80	330.24	58.24	91.75	0.63
T_3	477.80	144.30	321.04	56.38	88.60	0.63
T_4	466.60	140.20	318.16	53.52	86.76	0.61
S. E.±	3.60	1.50	2.63	0.77	0.91	0.01
C. D. at 5%	11.09	4.23	8.10	2.37	2.80	NS

graded bund treatment than sowing across and along the slope treatments (Table 1). As numbers of leaves are higher in vetiver hedge, the leaf area was also significantly higher in vetiver hedge treatment followed by graded bund treatment than sowing across and along the slope treatments. Increase in number of functional leaves in vetiver hedge was also reported earlier (Anonymous 1998). The dry matter production was significantly more in vetiver hedge treatment followed by graded bund treatment than sowing across and along the slope treatments. This was due to more height, more number of functional leaves, and more photosynthetic area which results into more dry matter accumulation in vetiver hedge treatment and graded bund treatment. Days to 50 per cent tasselling did not differ significantly due to land treatment. The data presented in Table 2 revealed that, the value of yield attributes *viz*., number of grains, weight of grain per plant and test weight were significantly higher with contour sowing along the vetiver hedge at 1 m VI (T_2) than all other treatments under study.

Yield of maize : The grain and fodder yields of maize were significantly increased under vetiver hedge treatment followed by graded bund treatment as compared to sowing across and along the slope treatments. An increase of grain and fodder yield by 12.32, 8.87, 3.22 and 12.60, 8.73, 6.76 per cent were observed by contour sowing along the vetiver hedge, sowing along graded bund and sowing across the slope over sowing along the slope respectively. The increase in yield of maize in vetiver hedge and graded bund treatment was due to more conservation of rain water, less runoff, more moisture storage in soil profile resulted in to more moisture available to crop and higher yield. Grain to fodder ratio did not differ significantly under study. These results are in conformity with the findings of Bharad *et al*. (1995), Gund *et al*. (1995) and Chaplot *et al*. (1998).

J. B. Patil
I. A. Khan
A. G. Jadhav
P. P. Kharade
J. P. Kharade

Padmabhushan Vasant Dada
College of Agriculture,
Ambi-Talegaon Dabhade,
Pune - 410 506 (India)
July 30, 2007.

LITERATURE CITED

Agrawal, A. J. 1991. Studies on different system for rainwater management. M. Tech. Thesis submitted to Dr. P.D.K.V., Akola.

Anonymous 1998. Agresco report, C.R.S. P.K.V., Akola. Report on research work done by Vidharbha Soil Conservation and Demonstration Scheme.

Bharad, M. B., M. B. Nagdeve, S. K. Kohale and S. M. Taley. 1995. Contour system for *in-situ* soil and moisture conservation. PKV, Res. J. 19(1): 1-3.

Chaplot, P. C., P. K. Singh, S. C., Mahnot and G. S. Chauhan. 1998. Effect of *in-situ* moisture conservation practices on runoff, soil loss and productivity of sorghum. Indian J. agric. Sci., 68(9): 627-628.

Gund, M. D. and A. G. Durgade. 1995. Influence of contour and *subabul* live bund on runoff, soils loss and yield of pearl millet + pigeon pea intercropping. Ind. J. Soil Consev. 23(2): 171-173.

J. Maharashtra agric. Univ., 34 (3) : 338-339 (2009)

Evaluation of Yield Stability in Soybean Based Intercropping System Under Rainfed Agriculture

Soybean (*Glycine max* L.) is the most important and potential oil seed crop to meet the increasing demand of the edible oil. The production is not coping with the national requirements. The crop can be increased by adopting the intercropping and sequential cropping system (Reddy *et al*. 1985) in rainfed situation in black soil areas.

The success or failure of winter crops depends on the residual soil profile moisture. Intercropping is receiving greater emphasis in Indian agriculture because of the increasing evidence, the intercropping practices give stabilized yield advantage, especially under adverse weather condition and substantially increases economic returns. An intercropping of pigeonpea, sorghum, maize and rajmabean in soybean having different growth habits, canopy adoption and rooting patterns can easily be accommodated with least competition. Therefore, the field experiments were conducted to evaluate yield stability in soybean based intercropping system under rainfed agriculture.

A field experiment was conducted for two years during rainy season of 2004 and 2006 at Agricultural Research Station, Gadhinglaj Dist. Kolhapur on a typic haplustert with pH 7.5, available N 210.07 kg ha^{-1}, P_2O_5 20.83 kg ha^{-1} and 474.87 kg ha^{-1} K_2O. Nine treatment combinations were laid out in a randomized block design with three replications. The gross and net plot sizes were 7.20 x 4.80 m^2 and 3.60 x 3.60 m^2, respectively. The varieties DS-228 of soybean, BSMR-736 of pigeonpea, CSH-14 of hybrid sorghum, MPQ-13 of maize and Varun variety of rajmabean were used in the investigation. Soybean and rajmabean were sown at 30 x 10 cm, pigeonpea 45 x 20 cm, sorghum 45 x 15 cm and maize 60 x 20 cm following soybean + pigeonpea 3:1 row ratio, soybean 30-60 x 10, pigeonpea 120 x 20 cm, soybean + hy. sorghum 3:1 row ratio soybean 30-60 x 10, hy. sorghum 120 x 15 cm, soybean + maize 3:1 row ratio soybean 30-60 x 10 maize 120 x 20 cm and soybean + rajmabean 3:1 ratio soybean 30-60 x 10 and rajmabean 120 x 10 cm. Soybean was fertilized with recommended fertilizer dose of 50:75 kg N, P_2O_5 ha^{-1}, pigeonpea and rajmabean 25:50 kg N, P_2O_5 ha^{-1} as basal dose and hy. sorghum 80:40:40 N, P_2O_5 and K_2O kg ha^{-1} and maize 120:60:60 N, P_2O_5 and K_2O kg ha^{-1}. Half dose of

Table 1. Mean yield monetary returns, soybean equivalent yield and LER influenced by different treatments (Pooled mean).

Treatments	Yield (kg ha^{-1})		M. R. (Rs ha^{-1})		Soybean equivalent yield (kg ha^{-1})	LER	B:C ratio
	Soybean	Intercrop	Gross	Net			
Sole soybean	2269	-	22685	5658	2269	1	1.34
Sole rajmabean (Varun)	-	1511	16828	8222	1683	1	1.95
Sole pigeonpea (BSMR-736)	-	1407 (1691)	24123	12952	2412	1	2.16
Sole hy. sorghum (CSH-14)	-	3016 (4997)	18691	3906	1869	1	1.19
Sole maize (MPQ-13)	-	5488 (3314)	27343	11338	2734	1	1.71
Soybean + rajmabean (3:1)	1677	496	24937	10038	2494	1.22	1.52
Soybean + pigeonpean (3:1)	1816	1052 (1175)	36468	20874	3647	1.55	2.35
Soybean + hy. sorghum (3:1)	1624	1355 (2132)	24508	7837	2450	1.15	1.47
Soybean + maize (3:1)	1513	2552 (1676)	28409	11609	2811	1.14	1.71
S. E.±	-	-	874	877	91.23	-	-
C. D. at 5%	-	-	2629	2671	270.89	-	-

Market price	2004 (Rs. q-1)		2006 (Rs. q-1)	
	Grain	Fodder	Grain	Fodder
Soybean	900	-	1000	-
Sorghum	500	50	600	50
Pigeonpea	1500	50	2000	50
Maize	400	50	600	50
Rajmabean	1500	-	2000	-

Figures in parenthesis indicates fodder yield.

nitrogen and full dose of phosphorus and potash were applied as a basal dose and remaining half dose of nitrogen as a top dressing was applied thirty days after sowing.

Soybean equivalent yield : The soybean equivalent yield (Table 1) was found to be significantly influenced by different intercropping systems during both the years and also in pooled results. The pooled data showed that the intercropping of soybean + pigeonpea (3:1) produced significantly the highest soybean equivalent yield of 3647 kg ha^{-1} followed by soybean + maize (3:1), 2811 kg ha^{-1}. This might be due to the higher yield of pigeonpea and maize as an intercropping due to the long duration, which could capitalize on the resources after harvest of soybean. Similar results were also reported by Danawale *et al*. (1996), Dudhade *et al*. (2002)and Gare *et al*. (2004). It is observed that yield stability was greater with intercropping than sole cropping. The reduction in soybean yield might be due to greater competition between the component crops. These finding are in concurrence with results of Willey (1979), Tomar *et al.* (1987) and Nimje (1995).

Gross monetary returns : The gross monetary returns were found to be influenced significantly by the different intercropping systems (Table 1). The intercropping of soybean + pigeonpea 3:1 row ratio recorded significantly highest gross monetary returns in both the years. Pooled results also showed that the intercropping of soybean + pigeonpea 3:1 row ratio gave significantly higher gross monetary returns (Rs. 36468 ha^{-1}) followed by soybean + maize 3:1 row ratio (Rs. 28409 ha^{-1}).

Net monetary returns : The net monetary returns were influenced significantly by the different intercropping systems (Table 1). The intercropping of soybean + pigeonpea 3:1 row ratio recorded significantly highest net monetary returns during both the years. As regards to the pooled results the intercropping of soybean + pigeonpea 3:1 row ratio recorded significantly highest net monetary returns (Rs. 20874 ha^{-1}) than rest of the treatments followed by sole pigeonpea (Rs. 12952 ha^{-1}). The higher economic returns due to pigeonpea intercropping might be due to its higher yield as an intercrop, as compared to sole soybean.

Land equivalent ratio : The LER values (Table 1) for intercropping systems indicated that the soybean + pigeonpea 3:1 row ratio recorded maximum LER, 1.49 and 1.61 in 2004 and 2006 respectively. The pooled data showed that the similar results (1.55 LER) recorded by the soybean + pigeonpea 3:1 row ratio.

Benefit cost ratio : Maximum B:C ratio was recorded by the soybean + pigeonpea 3:1 row ratio intercropping system in both the years and pooled results 2.49, 2.21 and 2.35 respectively.

Considering trends of soybean equivalent yield of 3647 kg ha^{-1}, gross monetary returns (Rs. 36468 ha^{-1}), net monetary returns (Rs. 20874 ha^{-1}) and LER 1.55 showed that soybean + pigeonpea 3:1 row ratio appears to be the most productive, efficient and profitable intercropping system under rainfed condition of sub-montane zone of Maharashtra.

B. N. Gare
S. M. More
A. V. Burli
S. S. Dodake

Agricultural Research Station,
Gadhinglaj - 416 502 (India)
May 20, 2008.

LITERATURE CITED

Danawale, N. J., S. H. Shinde and P. S. Pol. 1996. Crop row ratio in pigeonpea - soybean intercropping system. J. Maharashtra agric. Univ; 21 (3) : 479-480.

Dudhade, D. D., S. R. Dhonde and L. N. Tagad. 2002. Studies on intercropping of tur and Soybean. J. Maharashtra agric. Univ; 27 (2) : 228-229.

Gare, B. N., S. M. More, M. G. Jadhav, and A. V. Burli. 2004. Effect of pigeonpea and sorghum intercropping on yield of soybean under rainfed condition in sub-montane zone of Maharashtra. J. Maharashtra agric. Univ; 29 (2) : 170-172.

Nimje P. M. 1995. Effect of spatial arrangement and phosphorus fertilization in pigeonpea (*Cajamts cajan* (L.)) soybean (*Glycine max* (L.)) intercropping system. Indian J. Agron. 40 (3) : 380-385.

Reddy, M. S., M. Natarajan, M. R. Rao, R. W. Willey and C. K. Ong. 1985. Cropping system for rainfed situations with particular reference to ICRISAT a experince. Pap. presented at Nat Symp. on cropping system, held at Kernal on April 3-5 : pp. 13.

Tomar, R. W., M. S. Upadhya and R. A. Sharma. 1987. Effect of planting patterns in pigeonpea + soybean intercropping system. Indian J. Agron. 32 (4) : 322-325.

Willey, R. W. 1979. Intercropping, its importance and research needs Part-1 competition and yield advantage. Field Crop Abst. 32 (1) : 1-13.

J. Maharashtra agric. Univ., 34 (3) : 340-341 (2009)

Effect of Integrated Nitrogen Management on Growth and Yield of Spring Planted Sunflower (*Helianthus annuus*)

Loss of nitrogen is imperative and hence its rational application at right stages of crop growth is desired for higher productivity (Reddy and Giri, 1997). Similarly there is a need to promote use of organic manures in addition to inorganic fertilizers for sustained management of soil fertility and productivity. Several studies have established the ill effects of continuous use of inorganic fertilizers alone on the soil physico-chemical properties and environment besides their higher costs. Thus judicious use of both organic and inorganic sources of nutrients can alone lead to sustained management of soil fertility and productivity.

The field experiment was conducted at the Crop Research Farm, the Department of Agronomy of the Allahabad Agricultural Institute-Deemed University during the spring season of 2005. The treatments consisted of providing 50 or 75 per cent N through urea in combination with 50 per cent and 25 per cent N through FYM or poultry manure, which was compared to 100 per cent N provided through urea, FYM or poultry manure. In addition to nitrogen, the recommended doses of phosphorus and potassium were applied in all the treatments. The treatments were laid out in a randomized block design and replicated thrice. The soil of the experimental plot was sandy loam with a pH of 7.5, low in organic carbon, available nitrogen (180 kg ha^{-1}) and phosphorus (8 kg ha^{-1}) but high in potassium (246 kg ha^{-1}). Morden variety of sunflower was sown at a spacing of 40 x 30 cm. The plant growth was assessed by measuring the plant dry weight and calculating the CGR and RGR at regular intervals. The effect of various treatments on the yield was assessed by measuring the diameter of capitulum, number of seeds/ capitulum, seed yield, test weight and oil percentage.

The growth contributing characters *viz*., plant dry weight, crop growth rate and relative growth rate differed significantly amongst the various treatments. The maximum plant dry weight (33.50 g), crop growth rate (25.83 g day^{-1} m^{-2}) and relative growth rate (0.096 g g^{-1} day^{-1}) were recorded by the application of 50 per cent N through urea and 25 per cent N each through poultry manure and FYM, followed by an application of 75 per cent N through urea + 25 per cent N through poultry manure. The minimum plant dry weight (15.63 g), crop growth rate (11 .82 g day^{-1} m^{-2}) and relative growth rate (0.075 g g^{-1} day^{-1}) were observed under control (recommended dose of N through urea alone). Dayal and Agarwal (1999) have reported that application of FYM increases the

Table 1. Effect of growth, yield attributes and yield of spring planted sunflower in relation to integrated nitrogen management.

Treatments	Plant dry weight (g)	Crop growth rate (g g^{-1} day^{-1})	Relative growth rate (g g^{-1} day^{-1})	Diameter of capitulum (cm)	No. of seeds capitulum^{-1}	Test weight (g)	Seed yield (q ha^{-1})	Oil content (%)
Control (RDF-60, 40, 20 N, P, K* ha^{-1})	15.63	11.82	0.075	9.28	339.00	29.50	14.33	36.00
100% N FYM (12 t ha^{-1})	16.07	12.17	0.076	9.28	374.93	31.81	15.20	36.67
100% N poultry manure (1.98 t ha^{-1})	17.53	13.32	0.078	9.48	380.78	33.07	15.67	40.00
50% N urea + 50% N FYM	21.00	16.06	0.083	10.10	399.00	33.83	16.00	46.67
50% N urea + 50% N poultry manure	21.67	16.53	0.084	10.10	414.44	35.17	16.17	50.00
75% N urea + 25% N FYM	23.63	18.10	0.086	10.29	451.89	36.17	16.30	51.60
75% N urea + 25% N poultry manure	24.20	18.49	0.087	10.61	501.67	39.83	17.23	56.67
50% N urea + 25% each FYM + poultry manure	33.50	25.83	0.096	12.20	502.33	42.83	18.90	58.67
S. Ed.±	0.31	0.26	0.002	0.35	7.90	0.44	0.34	0.88
C. D. (P=0.05)	0.67	0.56	0.005	0.76	16.95	0.94	0.74	1.88

*Blanket dose for all treatments, RDF-Recommended Dose of Fertilizer.

water holding capacity of soil and also checks the leaching of nitrogenous fertilizers. Therefore, application of FYM in combination with nitrogenous fertilizers might have increased the nitrogen use efficiency, leading to higher availability of nitrogen to plants, resulting in increased plant dry weight accumulation and hence enhanced CGR and RGR of sunflower.

The maximum diameter of capitulum (12.20 cm), number of seeds capitulum^{-1} (502.33) and test weight (42.83 g) were recorded for an application of 50 per cent N through urea and 25 per cent N each through FYM and poultry manure, followed by the application of 75 per cent N through urea and 25 per cent N through poultry manure. The minimum diameter of capitulum (9.28 cm), number of seeds capitulum^{-1} (339) and test weight (29.50 g) were observed under control (recommended dose of N through urea alone). Shakatwat and Bansal (1999) have reported that application of gobar gas slurry with nitrogenous fertilizers not only supplements nitrogen but also increases the availability of micronutrients which ultimately increases the seed yield of sunflower. Therefore, yield increment due to FYM application might be attributed to the higher micronutrient availability and higher applied nitrogenous fertilizer use efficiency due to reduced leaching losses of nitrogen.

The maximum seed yield (18.90 q ha^{-1}) and oil percentage (58.67%) were recorded for the application of 50 per cent N through urea and 25 per cent N each through FYM and poultry manure and the values obtained were significantly higher than all other treatments. This may be attributed to the favourable influence of all the yield contributing characters *viz*., diameter of capitulum and seeds capitulum^{-1}. The higher seed yield and oil percentage obtained in the plots applied with one fourth dose of the recommended dose of nitrogen through FYM and one fourth through poultry manure, in combination with half dose of the recommended dose of nitrogen through urea might be due to increased nitrogen use efficiency of applied nitrogenous fertilizers (Rao *et al*. 1985). Besides higher nitrogen use efficiency, the increment in yield can also be attributed to the enhanced availability of micronutrients through organic manures, which lead to better crop growth, higher dry matter accumulation and enhanced seed and oil yield of sunflower.

It can be concluded that, for obtaining better growth and yield of sunflower, 50 per cent of the recommended dose of nitrogen should be provided through FYM and poultry manure in addition to 50 per cent of the recommended dose of nitrogen through urea in addition to the recommended doses of phosphorus and potassium.

Ganesh Kumar Singh
Thomas Abraham
Rajesh Singh
Harbhajan Singh

Department of Agronomy,
College of Agriculture, Allahabad Agricultural Institute-Deemed University,
Allahabad - 211 007 (India)
September 27, 2008.

LITERATURE CITED

Dayal, Devi and S. K. Agarwal. 1999. Response of sunflower genotypes (*Helianthus annuus* L.) to nutrient management. Indian J. of Agric. Sci. 69 (1) : 10-3.

Rao, C. M., M. S. Raju, B. B. Reddy and Y. K. Rao. 1985. Response of sunflower variety plant populations. J. of Oilseeds Res. 2 (2) : 295-297.

Reddy, G. P. and Gajendra Giri. 1997. Influence of time of seeding pollination and nitrogen on yield of sunflower (*Helianthus annuus* L.). Indian J. of Agron. 42 (3) : 506-511.

Shakawat, R. P. and K. N. Bansal. 1999. Effect of different organic manuars and nitrogen level on growth and yield of sunflower. Indian J. Agric. Sci. 69 (1) : 8-9.

J. Maharashtra agric. Univ., 34 (3) : 342-343 (2009)

Productivity of Greengram as Influenced by Various Micronutrient Applications on Vertisols

Increased use of high analysis fertilizer materials and continuous multiple cropping with fertilizer responsive varieties of crops have accelerated the depletion of their reserves in the soils, often leading to significant responses to their application. Very little use of organic manure is another reason for obtaining the responses to micronutrients application for high productivity of the crops. No information on micronutrient need of greengram in the soils of Marathwada region is available. The present investigation, therefore, undertaken to get better insight into different micronutrients *viz*.; zinc, boron, sodium and iron nutrition on greengram crop in relation to yield and economics.

A field experiment comprising of ten treatments and three replications was conducted during *kharif* seasons of 1999, 2000 and 2001 at Agril. Research Station, Badnapur on vertisols having 0.49 per cent organic carbon, 35 kg ha^{-1} available 'P' and 391 kg ha^{-1} available 'K' with 0.56, 6.0, and 3.3 ppm of available Zinc, Boron, Sodium and Ferrous respectively. The treatments comprising control (no macro and micro nutrients) recommended dose of fertilizers (RDF i.e. 25 kg N + 50 kg P_2O_5 ha^{-1}), RDF with 15 kg and 25 kg $ZnSo_4$ ha^{-1}, RDF with borax at 5 and 10 ha^{-1}, RDF with 1 and 2 kg sod. Molybdate ha^{-1} and RDF with 1 and 2 kg chelated iron ha^{-1} which were applied in the soil at the time of sowing.

Greengram variety BM-4 was sown with a spacing of 30 x 10 cm on 6th July, 3rd July and 24th June of 1999, 2000 and 2001 respectively. The total rainfall during the crop period (in 1999, 2000 and 2001) was 321, 578 and 384 mm respectively. The crop was harvested at maturity.

An application of recommended dose of fertilizer (25 kg N + 50 kg P_2O_5 ha^{-1}) to greengram either alone or along with micronutrients increased the seed yield (Table 1) significantly over control (no fertilizer application) during all three years of experimentation and in pooled results. The yield differences due to different micronutrient treatments were found to be non significant during each individual years of experimentation.

In pooled analysis the application of micronutrients *viz*.; zinc (15 and 25 kg ha^{-1}) and boron (5 and 10 kg ha^{-1}) with recommended dose of fertilizers gave significant increase in greengram yield over the application of recommended dose of fertilizer alone or along with other micronutrients. These results are in close conformity with the findings of Sarkar *et al.* (1998).

The channelization of photo-synthesis during reproductive stage might have been influenced with zinc by way of its involvement in electron transfer (Baker *et al*. 1982) and activation of enzymes (Okhi

Table 1. Seed yield of greengram as influenced by different nutrient combinations (pooled).

Treatment	Seed yield kg ha^{-1}				GMR (Rs. ha^{-1})	NMR (Rs ha^{-1})	C:B ratio
	1999-2000	2000-2001	2001-2002	Pooled mean			
T_1 Absolute control (No macro/micro)	207	570	373	383.3	7666	2666	1:1.53
T_2 N:P 25:50 kg ha^{-1} (RDF)	261	841	536	546.0	10920	4420	1:1.68
T_2 + ZnSO4 15 kg ha^{-1}	285	993	656	644.7	12894	6169	1:1.91
T_2 + ZnSO4 25 kg ha^{-1}	292	988	652	644.0	12880	6005	1:1.87
T_2 + Borex 5 kg ha^{-1}	275	919	652	615.3	12306	5706	1:1.86
T_2 + Borex 10 kg ha^{-1}	283	918	649	616.7	12334	5634	1:1.84
T_2 + Sod. Molybdate 1 kg ha^{-1}	266	861	580	569.0	11380	4830	1:1.73
T_2 + Sod. Molybdate 2 kg ha^{-1}	273	779	587	546.3	10926	4326	1:1.65
T_2 + FeSO4 1 kg ha^{-1}	280	792	583	551.7	11034	4506	1:1.69
T_2 + FeSO4 2 kg ha^{-1}	290	817	612	573.0	11460	4910	1:1.74
S. E.±	11	58	40	16.9	-	-	-
C. D. at 5%	33	173	120	49.7	-	-	-
C. V. %	8	12	12	12.6	-	-	-
Mean	271	848	588	569	-	-	-
Pooled data	Year	Year x treatment					
S. E.±	22.67	71.70	-	-	-	-	-
C. D. at 5%	64.12	202.76	-	-	-	-	-

1978). Similarly higher yield with boron than sodium molybdate and chelated iron might be due to greater assimilation of carbohydrate and protein synthesis as the former acts in N assimilation (Nicholas *et al*. 1954) and increased intensity of photosynthesis. Most inefficient response of chelated iron was possibly due to absence of specific role of this element on greengram by reduction in uptake and translocation of chelated iron as high dose of "P" applied to the legume (Tandon 1982).

The yield data was subjected to economic analysis which showed that the application of zinc sulphate @ 15 kg ha^{-1} with recommended dose of fertilizers was found most beneficial treatment in respect of gross monetary returns (Rs. 12894 ha^{-1}) C:B ratio (1:1.91) and net monetary returns (Rs. 6169 ha^{-1}). This was closely followed by borax 5 kg ha^{-1} by giving gross monetary returns (Rs. 12306 ha^{-1}), C:B ratio (1:1.86) and net monetary returns (Rs. 5706 ha^{-1}). Singh and Yadav (2000) reported that sulphur and zinc were most remunerative and economical micronutrients in greengram crop. The similar results were also reported by Lal and Jaiswal (1981).

B. V. Asewar
A. S. Jadhav
S. B. Pawar
S. S. Gosalwad

Department of Agronomy,
Marathwada Agricultural University,
Parbhani - 431 402 (India)
September 27, 2008.

LITERATURE CITED

Baker, N. R. P., T. T. Fernyhough and Meek. 1982. Light dependent inhibition of photosynthetic electron transport of zinc. Plant Physiol. 56: 217-222.

Lal, R.B., and P.C. Jaiwal. 1981. Influence of sulphur fertilization on grain yield and economics of urd cultivation. Indian J. of Agron., 26: 329-330.

Nicholas, D. J. D., A. Nason and W. D. Meleroy. 1954. Molybdenum and nitrate reductase. J. of Bio. Chem. 207: 241-251.

Okhi, K. 1978. Zinc concentration in soybean as related to growth, photosynthesis and carbonic anhydrase activity. Crop Sci. 18: 79-82.

Sarkar, R. K., B. Bhattacharya, A. Chakraborty and B. Bala. 1998. Growth and productivity of greengram in relations to micronutrients application on rice fallow land. India J. of Agron. 43(3): 555 - 559.

Singh, U. and D. S. Yadav. 2000. Economics of summer greengram (*Phaseolus radiatus* L.) cultivation as influenced by sulphur and zinc levels. Legume Res. 23(1): 67-68.

Tandon, P. K. 1982. Effect of zinc, iron and phosphorus supply on three rice varieties. Indian J. of Agron. 27(2): 167 - 170.

J. Maharashtra agric. Univ., 34 (3) : 343-345 (2009)

Heterosis and Heritability Studies in *Sorghum bicolor* (L.) Moench

Major portion of grain and fodder production of sorghum in Maharashtra comes from kharif season, because of higher productivity. *Rabi* sorghum is mainly grown on residual moisture after the cessation of monsoon rains. Present study was carried out with the objective to find out the extent of heterosis and heritability exhibited in cross combinations, for ten economically important characters in *rabi* Sorghum.

Four cytoplasmic male sterile lines *viz*., 18-3 A, 104 A, 296 A, 2077 A were crossed to eight testers *viz*., JD-1, Ruchira, M 35-1, LM 97-1, SPV 1359, CS 3541, CSV 15 and SPY 839 (cultivated varieties) in line x tester design during *kharif* 1998 to generate a total of 32 hybrids. These 32 hybrids with parents were planted in a RBD with three replications in a single row of 6 m length during 1998-1999 *rabi* season under irrigation at MPKV, Rahuri. Rows were spaced at 45 cm and plant to plant spacing was kept at 15 cm. Observations were recorded on five randomly chosen competitive plants for ten economically important characters. For days to 50 per cent flowering, the number of days required from date of sowing to anthesis of nearly 50 per cent of panicles in entire row was considered. Line x tester analysis was carried out according to Kempthorne (1957). The heterosis over the checks and heritability in narrow sense were estimated as per the standard procedure.

The analysis of variance revealed highly significant differences among parents vs crosses, which can be taken as a measure of heterosis, for all the characters except number of leaves plant^{-1} and panicle breadth. The values of heterosis expressed as per cent increase over better parent (BP), over mid parental value (MP) and over standard checks (SC) *viz*., SPV 1359 for grain yield traits and Ruchira for fodder yield traits. The magnitude and direction of heterosis differed in different cross combinations. For plant height, three crosses had significant positive standard heterosis over Ruchira. The cross combination 2077A x SPV 1359 recorded maximum positive standard heterosis over Ruchira (18.43%). However, none of the crosses had shown significant positive heterotic effect for stem thickness over Ruchira. Standard heterosis over Ruchira was significant and positive in only two cross combinations for leaf length and one for leaf breadth. Significant negative heterosis for flowering is an indication of earliness. All the 32 crosses recorded significant negative heterotic effects over SPV 1359. Nine crosses showed significant negative heterotic effects over Ruchira. Eleven crosses recorded significant and positive heterosis over standard check SPV 1359 for panicle length. For grain weight panicle-1, standard heterosis over check SPV 1359 was significant and positive in eight crosses. Best combinations were found to be 296A x Ruchira (93.26%) and 104A x Ruchira (76.55%) with high standard heterotic values over SPV 1359. For 1000 grain weight, none of the crosses was found to have significant and positive heterotic effects over SPV 1359. None of the crosses was found to be superior over Ruchira for green fodder yield plant^{-1} and dry fodder yield plant^{-1}. These results are in conformity with the findings reported by Amsalu and Bapat (1990) and Mistry and Patil (1994). Heritability estimates provide information on the transmission of the characters from parents to offspring. Heritability in narrow sense (Table 1) was high for plant height, days to 50 per cent flowering, panicle length, 1000-grain weight and moderate for leaf length, leaf breadth, grain weight panicle^{-1} and green forage yield plant^{-1}, while it was low for stem thickness, panicle breadth and dry fodder yielc plant^{-1}. Shelke (1995) reported similar results, for the above traits. The crosses showing high heterosis for grain weight panicle^{-1} and dry fodder yield plant^{-1} also showed high heterosis for other components like panicle length, 1000-grain weight, stem thickness, leaf length, leaf breadth and green fodder yield plant^{-1}. The crosses showing high heterosis for one or two characters also showed high heterosis for other characters indicating the role of component heterosis in selection of hybrids. It showed the similarities in the inheritance of these traits and distinct possibilities exist to pickup hybrids giving heterosis simultaneously for these characters. The *per se* performance had reflection in highly heterotic crosses. Therefore, the *per se* performance of the hybrids needs to be considered in selection, in addition to heterotic effects. The crosses 18-3 A x JD-1, 104 A x JD-1, 18-3 A x CSV-15, 296 A x Ruchira, 18-3 A x Ruchira, 104 A x Ruchira, 2077 A x SPV 1359, 2077 A x SPV839 showed superior performance than the checks, need to be further studied and exploited.

Table 1. Range, means and heritability in narrow sense (h^2) for 12 caracters in sorghum.

Character	range		h^2 (n.s) (%)
	Parents	Crosses	
Plant height (cm)	91.53 - 259.73	141.6 - 275.86	61.36
Stem thickness (cm)	4.11 - 5.99	4.66 - 6.12	27.49
No. of leaves plant^{-1}	8.60 - 12.13	9.53 - 13.80	10.09
Leaf length (cm)	54.30 - 76.26	62.2 - 79.33	38.23
Leaf breadth (cm)	4.60 - 6.94	5.38 - 7.20	36.84
Days to 50% flowering	55.80 - 81.20	59.43 - 76.0	80.02
Panicle length (cm)	12.63 - 25.96	17.53 - 28.66	79.38
Panicle breadth (cm)	12.30 - 25.84	13.33 - 21.36	26.65
Grain weight ear^{-1} (g)	8.84 - 49.04	14.66 - 73.63	35.84
1000 - grain weight (g)	18.63 - 41.60	12.40 - 66.52	77.39
Green fodder yield plant^{-1} (g)	55.66 - 568.33	104.66 - 438.66	29.74
Dry fodder yield plant^{-1} (g)	16.14 - 166.16	30.35 - 130.61	22.31

K. Sumalini
J. S. Desale

Mahatma Phule Krishi Vidyapeeth,
Rahuri - 413 722 (India)
October 19, 2008.

LITERATURE CITED

Amsalu, A. A. and D. R. Bapat. 1990. Heterosis studies in sorghum. J. Maharashtra agric. Univ. 15(3): 229-302.

Kempthorne, O. 1957. An Introduction to

Genetic Statistics. John Wiley and Sons Inc., New York., USA.

Mistry, P. K. and F. B. Patil. 1994. Heterosis for forage yield and its components in sorghum. Forage Res. 20(2 and 3): 132-136.

Shelke, G. V. 1995. Heterosis and combining ability studies for grain and forage traits in sorghum (*Sorghum bicolor* (L.) Moench) by line x tester analysis. M.Sc. (Agri.) thesis submitted to MPKV, Rahuri.

J. Maharashtra agric. Univ., 34 (3) : 345-346 (2009)

Preparation of Fruit Flavoured Milk Shake

Milk blending with different fruit juices increase the acceptability as well as palatability of consumers. With the purpose of increasing palatability and acceptability of milk, this study was undertaken.

The experiment was conducted at Department of Animal Husbundry and Dairy Science, Dr. Balasaheb Sawant, Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (M.S.) during the year 2000-2001. The milk shake was prepared as per the procedure given by Sharma and Gupta (1978) with slight modification.

The milk shake was evaluated organoleptically by the panel of judges with help of nine point hedonic scale given by Amerine *et al.*, (1965). The fat content of milk shake was determined by using the standered Gerber method as described in IS:1224 (Part-I), 1977, total solids content was determined by gravimetric methods as per IS:1479 (Part-II),1961 and titratable acidity of milk shake as per cent was determined according to IS:1479(Part-I),1960. The data generated was analysed statistically with completely randomized design. The treatments include 5, 10, 15 and 20 per cent pineapple and jammun juice maintaining suitable control.

The fat per cent was decreased with increasing the level of pineapple syrup and jamun juice. These observations were comparable with those of Sharma and Gupta (1978) and Kshirsagar (1996) for plain milk shake and Varpe (1992) in milk shake fortified with mango pulp, respectively.

The total solids of milk shake fortified with pineapple syrup showed increasing trend with increase in the level of pineapple syrup. Further it was observed that higher level of jamun juice gave lower per cent of total solids. It was within the range of what was reported by Varpe (1992) and Kshirsagar (1996), milk shake prepared by blending with fruit pulp.

The water per cent of milk showed decreasing trend in pineapple flavoured milk shake and reverse trend i.e. increasing in jamun flavoured milk shake. Considerably less percentage of water was determined in present case as was reported by Sharma and Gupta (1978), Varpe (1992), Kshirsager (1996).

The titratable acidity of milk shake under study showed increased trend with increasing the level of pineapple syrup and jamun juice. The highest acidity was observed at 20 per cent. The acidity was more in jamun flavoured milk shake as compared to pineapple flavoured milk shake. The results of acidity of plain milk shake were very well comparable with those of Varpe (1992) and Kshirsagar (1996).

The pineapple milk shake was superior to jamun flavoured milk shake in respect to colour and appearance. Milk shake containing pineapple syrup at the rate of 15 per cent recorded the maximum score 7.98. While the milk shake flavoured with jamun juice at 10 per cent level recorded highest score (7.19) The control samples recorded lowest score (6.73).

The flavour scores for pineapple and jamun differed significantly from each other showing their influence on the flavour of milk shake. The highest score of 7.96 was obtained by pineapple milk shake at the level of 15 per cent. The flavour at 20 and 5 per cent level reported strong aroma and mild flavour, respectivly. Milk shake fortified with jamun juice at 10 per cent showed maximum score of the product i.e. 7.34. The increase in the level of jamun juice at 15 and 20 per cent caused decreased in score, which may be

due to the slight astringent aroma of jamun.

The consistency of milk fortified with pineapple and jamun juice was increased in the level of both pineapple and jamun juice. Higher level of pineapple (20 per cent) and jamun juice (15 and 20 per cent) gave excessive thick consistency to milk shake, with the score of 7.08 for pineapple and 6.83 for jamun. Milk shake without addition of any fruit flavour (control) showed very less acceptability and score of 6.80 only which may be due to thin consistency.

The effect of fortification of pineapple and jamun juice at different levels on overall acceptability of milk shake showed that milk shake prepared by 15 per cent pineapple syrup scored highest point 7.82.

Acceptability of milk shake flavoured with jamun with 10 per cent was superior (7.19). Among all the treatments milk shake without addition of any fruit flavour (control) obtained very low score (6.70). On the basis of result obtained, it can affirmatively be stated that 15 per cent level of pineapple syrup was found most acceptable by the judges followed by 10 per cent level of jamun juice.

V. B. Kadav
S. V. Joshi
V. V. Sagvekar
P. B. Sanap

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth,
Dapoli - 415 712 (India)
August 25, 2008.

LITERATURE CITED

Amerine, M. A., R. M. Panghorn and, R. B. Rossier.,1965. Principles of sensory evaluation of food. American Press, London.

Kshirsagar, D. V. 1996. Studies on blending of milk shake with different fruit flavouring agents. M.Sc. (Agri.) thesis submitted to Dr. Balasaheb Sawant Kokan Krishi Vidyapeeth, Dapoli.

Sharma A. K. and S. K. Gupta. 1978. Manufacture of milk shake. Indian Dairyman. 30 (8) : 585.

Varpe, N. K. 1992. Studies on blending of milk shake with different fruit pulp. M.Sc. (Agri.) thesis submitted to Dr. Balasaheb Sawant Kokan Krishi Vidyapeeth, Dapoli.

J. Maharashtra agric. Univ., 34 (3) : 346-347 (2009)

Field Evaluation of Botanicals and Chemical Insecticides for Castor Leaf Miner (*Liriomyza trifolii* Burgess) under Rainfed Condition

Castor (*Ricinus communis* L.) is an important non-edible oilseed crop grown throughout the world. The total castor seed and oil production of the world is 13.27 and 5.47 lakh MT, respectively. In India, it is grown mainly under rainfed conditions over an area of 7.13 lakh ha with annual production of 8.50 and 3.36 lakh MT of castor seeds and oil, respectively.

The crop is infested with a number of insect pests (Rai. 1976), of which the most important are serpentine leaf miner (*Liriomyza trifolii* B.), semilooper (*Achoea janata* L.) and tobacco caterpillar (*Spodoptera litura* F.). The serpentine leaf miner is a polyphagous pest feeding on seventy nine host plants belonging to various vegetables, ornamentals and field crops (Srinivasan *et al*. 1995). It has high potential for the development of resistance to commonly used pesticides. Moreover, this pest is assuming importance on castor in recent years because of the wide host range, ability to survive and multiply over wide range of seasonal conditions and low sensitivity to commonly used insecticides. Present investigation was therefore, undertaken with an objective to assess the efficacy of different insecticides and bio-pesticides in controlling the serpentine leaf miner on castor.

The field experiment was conducted at ZARS, MPKV, Solapur (MS) during *kharif* 2007-2008 with eight treatments including absolute control (Table 1). The susceptible cultivar DCS-9 was sown in the plots of 3.80 x 5.40 m^2 at 90 x 30 cm spacing with three replications. Two pesticide sprays were given at 30 and 45 DAS. The observations on the incidence of leaf miner i.e. number of mines $plant^{-1}$ were recorded in top, middle and bottom leaves of five randomly selected plants in each plot. Seed yield was also recorded at harvest. The data

were analyzed by following Panse and Sukhatme (1967).

The results revealed the significant differences among treatments in respect of both leaf mines due to leaf miner after both the sprays and seed yield at harvest (Table 1). However, significantly highest damage (24.28 and 25.28 mines plant^{-1}) was recorded by absolute control over rest of the treatments. Among the treatments, 45 SC spinosad 0.018 per cent recorded the minimum leaf damage of 13.55 and 15.28 mines plant^{-1} after first and second sprayings, respectively and thus controlled the leal miner very effectively. This was followed by 50 WP carbaryl 0.2 per cent (14.39 and 17.28 mines plant^{-1}). So also, the significantly highest seed yield of 1072.10 kg ha^{-1} was obtained from 0.018 per cent spinosad followed by 0.05 per cent triazophos (1015.30 kg ha^{-1}). These two treatments were statistically at par with each other in respect of seed yield.

Significant yield losses due to defoliator were reported (Anonymous, 2006). The susceptibility of cv. DCS-9 to serpentine leaf miner on castor was reported by Boreddy *et al.* 2003. Efficacy of insecticides on defoliator was supported by Ahuja *et al*. (1998) and Shingh and Kanujia (2003) reported NSKE to be less effective against the defoliator which is in agreement with the present findings. It was also reported that the commonly recommended insecticides for the control of insect pests in castor *viz*., monocrotophos, acephate and quinalphos increased the incidence of leaf miner. Only methyl oxydemeton 0.05 per cent, dimethoate 0.05 per cent and neem formulation (neem guard 0.5%) contained the infestation as that of untreated control (Anonymous, 2006). The botanicals were found to be less effective over the chemical treatments, which is in agreement with the results of Singh and Kanujia (2003). Overall results indicated that the two sprayings of 0.018 per cent spinosad at 30 and 45 DAS are effective for the control of serpentine leaf miner and increasing the seed yield of castor under dry land conditions.

Table 1. Efficacy of pesticides for the control of leaf miner on castor.

Treatment	Concentration	Average leaf mines plant^{-1}		Seed yield (kg ha^{-1})
		Ist spray	IInd spray	
Carbaryl 50 WP	0.2%	14.39	17.28	651.4
Endosulfan 35 EC	0.05%	17.17	15.33	641.7
Triazophos 40 EC	0.05%	16.11	15.39	1015.3
Spinosad 45 SC	0.018%	13.55	15.28	1072.1
Fipronil 5 SC	0.01%	15.50	19.39	527.9
Neem seed extract	5%	15.50	18.11	360.6
Bacillus thuringiensis	0.1%	16.17	16.28	334.6
Control	-	24.28	25.28	73.1
S. E.±	-	0.98	1.77	22.79
C. D. at 5%	-	2.98	5.38	69.12
CV %	-	10.25	17.26	6.75

V. B. Akashe
M. A. Gud
S. K. Shinde
J. R. Kadam

Zonal Agricultural Research Station
MPKV, Solapur-413 002 (India)
September 27, 2008.

LITERATURE CITED

Ahuja, B. D., A. Noor and B. N. Mathur. 1998. Efficacy of some insecticides against castor semilooper, *A. janata* L. on castor. J. Ins. Sci., 11 (2) : 141-144.

Anonymous, 2006. Research Achievements in castor. AICRP on castor. Directorate of Oilseeds Res., Hyderabad, pp. 111.

Boreddy, Y., H. Bassapa, Harvir Singh and D. Rajasekhar Reddy. 2003. Preferential incidence of serpentine leaf miner on castor cultivars. ISOR Natl. Sem.: Stress Management in Oilseeds, Jan. 28-30, pp.111-113.

Panse, V.G. and P. V. Sukhatme. 1967. Statistical Methods for Agricultural Workers, ICAR, New Delhi. pp. 145-146.

Rai, B. K. 1976. Pests of oilseed crops in India and their control. Indian Council of Agril. Research, New Delhi, pp. 121.

Singh, A. N. and K. R. Kanujia. 2003. Residual toxicity of some biopseticides against *Spilarctia obliqua* (Walker) on castor. Indian J. Ent, 65 (2) : 297-298.

Srinivasan, K., C. A. Viraktamath, M. Gupta and G. C. Tiwari. 1995. Geographical distribution, host range and parasitoids of serpentine leaf miner, *Liriomyza trifolii* B. in South India. Pest Manage. in Horti. Ecosystem, 1 : 93-100.

J. Maharashtra agric. Univ., 34 (3) : 348-348 (2009)

Performance Testing of Parabolic Concentrating Type Solar Cooker in Konkan Region of Maharashtra

In the parabolic concentrator type solar cooker, temperature of the order of 45°C can be obtained by concentrating solar radiation on the focal point of cooker. The concentrating type solar cooker could be most viable option for cooking different types of food materials due to less cooking time required as compared to box type solar cooker. The acceptability of solar cooker depends on the time required to cook the food material (Rai, 1995). Keeping this in view, experiment was conducted on performance evaluation of concentrating cooker at Dapoli in Konkan region of Maharashtra. The solar energy is abundantly available in the region for the period of seven to eight months of year; excluding the four monsoon months of heavy rainfall. The climate of Dapoli (latitude 17°45' N, Longitude 73° 26' E and altitude 250 m from MSL) is hot and humid. The average minimum and maximum temperatures of Dapoli ranges from 11.4 to 32.7° C; whereas average relative humidities of the region varies from minimum 43.7 to maximum 95.2 per cent. The cooker manufactured by Eco-Solar System (India) Ltd. Pune, model Eco Sun 1400, having diameter 1.4 m and focal length of 28 cm was used for testing. Aluminum sheets of thickness 0.4 mm having reflectivity about 90 per cent were used in cooker as a reflector. The total surface area of reflector was 2.20 m^2.

The cooker was tested in the month of March during morning session of the day to cook 300 g rice (with 760 ml water), 200 g lentil dal (with 730 ml water) and to boil 1.5 litre water in the pot of 2 litre capacity painted black from outside. Pot was covered with lid while cooking rice and dal. The cooker was tested for nine successive days. On each day, all the three tests (water boiling, dal cooking and rice cooking) were carried out in specific sequence one followed by other *viz*., water boiling, dal cooking and rice cooking. The starting time was sharply observed for individual tests and kept same on each test day. The water boiling test was started at 9 am; dal cooking test was started at 10 am, while rice cooking test was started at 11 am on each test day. During the test, cooker was facing towards sun and its position was adjusted from time to time to get maximum solar reflection at focal point.

The various parameters recorded during test were lapsed time, solar intensity, ambient temperature and water temperature.

At the start of water boiling test, in the morning session, solar intensity was low hence atmospheric temperature was also low. As the time lapsed, solar intensity was started increasing and temperature of water kept for boiling was also increased. The solar intensity during water boiling test was varied between 34000 to 60200 lux with average value of 47100 lux. While cooking dal, solar intensity varied between 70500 to 90800 lux with average value of 80650 lux. For rice coking test the solar intensity varied between 91000 to 102400 lux with average value of 96700 lux. The average time required to boil water, to cook dal and rice using solar concentrator cooker was 40, 45 and 25 min respectively. The time required to boil water was found more, compared to time required to cook rice, due to lower solar intensity during morning hours. Dal also took more cooking time compared to rice because of hard texture and lower solar intensity in the morning hours. The quality of cooked rice and lentil dal found acceptable for human consumption. Similar results were also recorded by Nahar (2002).

H. T. Jadhav

College of Agricultural Engineering
and Technology
Dapoli - 415 712 (India)
February 25, 2008.

LITERATURE CITED

Nahar, N. M. 2002. Performance and testing of hot box storage solar cooker, J. of Energy Conversion and Manag. 44 (8) : 1323-1331.

Rai, G. D. 1995 . Solar Energy Utilization. Khanna Pub., Delhi, pp 523-524.

J. Maharashtra agric. Univ., 34 (3) : 349-350 (2009)

Effect of Drying Technique, Time and Drying Rate on Oyster Mushroom

The study on dehydration of mushroom was undertaken to develop appropriate processing technology in order to extend the marketability and availability of mushrooms to consumers. The present research work was carried out at Department of Agricultural Process Engineering, Faculty of Agricultural Engineering, M.P.K.V., Rahuri. The oyster mushroom of *Pleurotus sajor caju* variety was taken for study.

Freshly harvested mushroom was cleaned manually to remove trashes of wheat straw and other undesirable matter. Whole fresh mushroom was used for dehydration. The four pretreatments applied to fresh mushroom were : control (without any pretreatment); $CaCl_2$ treatment by soaking mushroom in 0.5 per cent solution for 10 minutes (Sonar and Sonawane, 2000); sulphuring treatment by burning 2 g sulphur powder per kg of mushroom for 2 hours in fumigation chamber (Chavan *et al.* 1993) and combination of above two (soaked in 0.5 per cent calcium chloride solution for 10 mintes, then spread on blotting paper to drain off solution and finally sulphuring was carried out by burning 2 g sulpur power per kg of soaked mushroom for 2 hours in a fumigation chamber).

The drying of mushroom was carried out using tray dryer. The dryer used for study was having 12 aluminium trays of size 800 x 400 mm and temperature range of 50 to 250°C. The two temperatures used for drying were 50°C (Gopale, 2000) and 60°C (Pruthi *et al*. 1978). The mushroom drying was carried using intermittent tray drying method, the special case of tray drying in which drying (dryer on) and tempering (dryer off) were carried out alternately upto the end of drying process. This method minimizes the problem of case hardening and also reduces energy required for drying as some drying is carried out during tempering (dryer off). Three cases of intermittent drying *viz*., 1 h drying and 0.5 h termpering, 1 h drying and 1 h termpering and 1.5 h drying and 1 h termpering were used during study.

In all, twenty four treatments (combinations of 4 pretreatments x 2 temperatures x 3 cases of intermittent drying) were used for mushroom dehydration. The sample size of each treatment was kept constant (500 g of fresh mushroom). Each treatment was replicated thrice. Loss in weight of mushroom samples during drying was recorded at 15 min. interval for first hour and half an hour interval thereafter upto the end of drying. The weight was recorded by weighing two marked pieces of mushroom. Data recorded was used to determine the moisture content and drying rate using standard formulae.

The decrease in moisture content was noted down with respect to total drying time. Total drying time includes both drying (dryer on) and tempering (dryer off) periods, whereas effective drying time includes only drying (dryer on) period.

The total drying time required to prepare dehydrated mushroom using different treatments varied between 7½ to 8 h and 6 to 7 h for drying temperatures 50 and 60°C respectively. Whereas the effective drying time required to prepare dehydrated mushroom using different treatments varied between 4 to 5½ h for 50°C and 3 to 4½ h for 60°C. The minimum total drying time (6 h) was recorded for 60°C drying temperature; while effective drying time was also minimum (3 h) for 60°C drying temperature.

It was observed that the total drying time required for preparation of dehydrated mushroom, was more than that required in continuous drying method. This was because during tempering the dryer was off and hence actual heat supplied for drying was zero. Till some useful drying was took place during tempering using available heat in the dryer. The effective drying time required was lower for 1:1 h intermittent drying cycle as tempering time in this case was more and some useful drying was carried out during tempering. Also the drying time was found minimum for mushrooms with control and sulphuring pretreatments. The moisture content of mushroom was decreased with total as well as effective drying time and moisture reduction trends were similar in all the treatments. The moisture content decreased rapidly during initial stages of drying due to high

initial moisture content of fresh mushroom. But it decreased slowly towards the end of drying. It was also observed that moisture removed during tempering was less as compared to that during drying.

The drying rate varied for different treatments from 762.32 to 322.67 g/h-100 g of d. m. and 1076.56 to 516.25 g/h-100 g of d. m. for 50 and 60°C drying temperatures respectively. The drying rate was maximum (1076.56 g/h-100 g of d. m.) for CaCl2 solution + sulphuring, 60°C, 1.5:1 h treatment; while it was found minimum (322.67 g/h-100 g of d. m.) for control, 50°C, 1:0.5 h treatment. It was observed that the drying rate was higher initially at the start of drying process. As the drying time advanced, the drying rate decreased. At higher moisture content initially the drying rate was also higher. The drying rate then decreased with decrease in moisture content. The drying rate decreased rapidly during initial stages of drying. But it decreased slowly towards the end of drying. It was also observed that the drying rate was less during tempering as compared to that of during drying. The relationship between drying rate and total drying time for all treatments was appeared to be exponential in nature.

H. T. Jadhav

College of Agricultural Engineering and Technology
Dapoli - 415 712 (India)

February 25, 2008.

LITERATURE CITED

Chavan, U. D., R. N. Adsule and S. S. Kadam. 1993. Processing of Ber III: Preperation of dried ber, powder and tuty fruity. Beverage and Food World. 20 (4) : 28-29.

Gopale, M. S. 2000. Studies on dehydration of mushrooms (*Pleurotus sajor caju*). M. Tech. (Agril. Engg.) thesis. Mahatma Phule Krishi Vidyapeeth, Rahuri (India), pp. 74-77.

Pruthi, J. S., M. Gopalkrishnan and A. V. Bhat. 1978. Studies on the dehydration of tropical paddy straw mushroom (*Volvariella volvaced*). Indian Food Packer. 32 (3) : 107-115.

Sonar, D. J. and A. S. Sonawane. 2000. Influence of pretreatments on drying characteristics and quality of banana slices. B.Tech. (Agril. Engg.) thesis, Mahatma Phule Krishi Vidyapeeth, Rahuri(India), pp. 9-11.

J. Maharashtra agric. Univ., 34 (3) : 350-351 (2009)

Constraints in Adoption of Dairy Enterprise in Pune District of Western Maharashtra

India has emerged as the world's largest milk producing country, producing 14 per cent of the world's milk production and 57 per cent of Asia's total milk production. Though India possesses about 15 per cent of the world's livestock, the productivity of cattle is very low. Pune is one of the major milk producing districts in Maharashtra. The milk producers are mostly maintaining crossbred cows and buffaloes for milk production activity. However, the rural milk producers have several problems in adopting the dairy enterprise. Keeping this view in mind the present investigation was undertaken to study the constraints perceived by dairy farmers in Pune district of Western Maharashtra.

The present study was conducted during the year 2006-07 in Pune district of Western Maharashtra. Four blocks *viz*.; Baramati, Indapur, Daund and Shirur were selected for the study. Three villages were randomly selected from each block. Fifteen dairy farmers having crossbred cows and buffaloes were selected from each village. The data were collected by survey method with specially designed questionnaire. The socio-economic indicators of different categories of dairy farmers were studied by the tabular method of analysis.

The results revealed that mal practices in purchase and sale of milch animals (86.67 per cent), long distance of market place (75.56 per cent), non-availability of nearby regular weekly market (71.67 per cent), financial difficulties in running the business (64.44 per cent) were the major constraints. Gavali (2001) had reported the similar results. Yadav *et al*. (1995) also reported weak financial status as a main constraint.

High cost of feed and fodder

(93.89 per cent), high wage rate of labour (77.78 per cent), non availability of green fodder through out the year (65.56 per cent) and lack of knowledge about scientific feeding of animals (64.44 per cent) were the major constraints in maintenance of milch animals. Yadav *et al*. (1995), Dixit *et al*. (2004), Singh and Chauhan (2006) reported similar constraints.

In marketing of milk, it was revealed that 58.33 per cent farmers preferred to supply milk to private dairy traders rather than cooperative dairy society. The reason being the attractive price and timely payment given by the private dairy traders. The low price of milk (68.89 per cent), marginal profit in preparation of milk products at home (59.44 per cent) and unsuitable time of milk collection (50.56 per cent) were the other constraints in marketing of milk. Dixit *et al*. (2004), Singh and Chauhan (2006), Ravikumar *et al*. (2006) reported similar constraints. Most of the farmers expected facility and incentives from milk societies for fodder seed and grass sets (87.22 per cent), loan for purchase of animals (71.11 per cent), veterinary services (50.56 per cent) and feed and concentrates (41.67 per cent). Yadav et al. (1995) also reported similar findings.

It can be concluded from present study that the high cost of feed and fodder, high wage rate of labour, low price for milk, non availability of green fodder throughout the year and lack of knowledge about scientific feeding of animals, were the major constraints in adoption of dairy enterprise in Pune District of Western Maharashtra.

V. K. Kauthale
D. L. Sale

BAIF Development Research Foundation, Urlikanchan, Pune - 412 202 (India)
December 07, 2008.

LITERATURE CITED

Dixit, P. K., J. P. Dhaka, M. S. Sajeesh and M. K. Aravinda Kumar. 2004. Economics of milk production in Kerala-An inter-regional empirical study, Indian J. of Agri. Econ. 59 (3) : 646.

Gavali, A. V. 2001. An economic analysis of cooperative dairy industry in Western Maharashtra, Ph.D. thesis submitted to MPKV, Rahuri.

Mahendra Singh and Anil Chauhan. 2006. Constraints faced by dairy owners in adoption of scientific dairy farming practices, Indian J. of Dairy Sci. 59, 1, 49-51.

Ravikumar, S., V. Jagadeeswary and P. V. K. Sasidhar. 2006. Constraints in adoption of dairy production technologies, Indian Vet. J., February, 82 : 185-186.

Yadav, D. B., S. L. Mali and M. G. Nema. 1995. Constraints of dairy enterprise, Indian J. of Agri. Econ. 50 (3), PP 355.

J. Maharashtra agric. Univ., 34 (3) : 351-353 (2009)

Correlation Studies of Quantitative Characters with Dry Fruit Yield in Chilli

Yield is a complex character which depends upon many determining characters. Therefore, the knowledge on the correlation coefficient of yield and its component characters is of vital importance for planning an effective selection strategy. The phenotypic correlation indicates the extent of observed relationship between the two characters, while genotypic correlation provides information about linkage for the genes controlling the pair of characters. Hence genotypic correlation coefficient studies provide an opportunity for critically assessing the relationship of these characters with yield. The correlation over the wide range of environment is likely to give true picture about the relationship, which will help the breeder to formulate strategies for indirect selection. Therefore, the present study was undertaken to establish correlations among the economic parameters in chilli (*Capsicum annum* L.).

The experimental materials for the present study comprised of six diverse parents *viz*., Phule Jyoti, Jayanti, Arka Lohit, Phule Suryamukhi, G-4 and Surakta and their 15 hybrids. Trial was conducted in a randomized block design with three replications during *kharif*, 2003 at Botany farm, College of Agriculture, Pune. Each entry was represented by single row of 4.5 m length spaced at 60 x 45 cm distance between rows and within plants. The fertilizer dose of

Table 1. Simple correlation among the different quantitative characters with dry fruit yield in chilli.

Chracters	Days to 50% flowering	Days to maturity	Primary branches plant^{-1}	Secondary branches	Plant height (cm)	Plant spread (cm)	Fruit length (cm)	Fruit girth (cm)	Fruits plant^{-1}	Dry fruit weight plant^{-1} (g)
Days to 50% flowering	1.0000	0.3993*	-0.0523	-0.1377	0.0737	-0.1549	-0.2609	0.1920	0.1324	-0.0966
days to maturity		1.0000	-0.3074	-0.5077	0.3450*	0.1573	0.1030	0.0032	-0.5276**	0.3081*
Primary brnaches plant^{-1}			1.0000	0.7279**	-0.4244**	0.0099	-0.0137	0.3082*	0.4145**	-0.2783
Secondary branches plant^{-1}				1.0000	-0.3887**	-0.1135	0.0756	0.1185	0.5914**	-0.2007
Plant height (cm)					1.0000	0.1522	0.2475	-0.1096	-0.3239	0.6370
Plant spread (cm)						1.0000	0.5665**	-0.0843	-0.2213	0.2689
Fruit length (cm)							1.0000	-0.3835*	-0.2317	0.5004**
Fruit girth (cm)								1.0000	0.0962	-0.4521**
Fruit plant^{-1}									1.0000	-0.3819*
Dry fruit weight plant^{-1} (g)										1.0000

75:120:60 kg NPK ha^{-1} was applied during field preparation and plant growth. Regular plant protection measures were undertaken to protect the crop from insect pests and disease. All the cultural operations like thinning and weeding was carried out as per the recommendations. The observations were recorded on five randomly selected plants from each replication for ten characters and correlation coefficients were calculated according to Singh and Chaudhary (1977).

From the correlation studies (Table 1), it was evident that the character dry fruit weight plant^{-1} exhibited significant positive association with plant height, fruit length and days to maturity. Kaul and Sharma (1988), Warade *et al*. (1996), Ahmed *et al*. (1997), Gandhi (1998), Sreelathakumary and Rajamony (2000) reported similar findings. The characters fruit girth and number of fruits plant^{-1} exhibited negative and significant association with dry fruit weight plant^{-1}. Results of Kaul and Sharma (1988) and Gandhi (1998) were contradictory to the present findings.

Among the association between component characters days to 50 per cent flowering showed significant positive association with days to maturity, whereas it showed negative and non significant association with fruit length, fruit girth, plant spread and numbers of secondary branches plant^{-1}. Days to maturity showed positive and significant association with plant height and days to 50 per cent flowering. These results were in agreement with the results of Nair *et al.* (1984).

Number of primary branches plant^{-1} exhibited significant and positive association with number of secondary branches, fruit girth and number of fruits plant^{-1}. Plant height exhibited significant positive association with days to maturity where as plant spread was positive and significantly associated with fruit length. The fruit length exhibited significant positive association with plant spread. Sarma and Roy (1995) reported the similar findings. Fruit girth showed significant positive association with number of primary branches plant^{-1}. Nair *et al*. (1984) and Sarma and Roy (1995) reported contradictory results. Numbers of fruits plant^{-1} showed significant positive association with number of primary and secondary branches plant^{-1}. These results were in contradictory with Jayashankar *et al.* (1987) and Gandhi (1998).

Thus it could be clearly inferred from the above discussion that plant height, fruit length and days to maturity are the major dry fruit yield contributing character in chilli which showed positive and significant association with dry fruit weight plant^{-1}. Therefore, due emphasis should be given to these characters to evolve high yielding genotypes of chilli for dry fruit yield.

D. B. Lad
R. G. Satish
P. K. Jagtap

Mahatma Phule Krishi Vidyapeeth
Rahuri - 413 722 (India)
December 31, 2008.

LITERATURE CITED

Ahmed N., J. Nayeema and M. J. Tanaki. 1997. Character association in hot pepper. Ejggplant News Letter. 16 : 68-71.

Gandhi S. D. 1998. Heterosis and combining ability studies in chilli (*Capsicum annuum* L.). M. Sc. "Thesis submitted to

M.P.K.V., Rahuri.

Jayashankar, S., I. Iulappan and R. Armugum. 1987. Association analysis in the segregation generation of hot pepper. South Indian Hort., 35 (3) : 202-205.

Kaul, B. L. and P. P. Sharma. 1988. Heterosis for morphological fruits and green fruits yield in sweet pepper. Veg. Sci. 15 (2) : 171-180.

Nair, P. M., M. K. George, N. Mohankumarrin, V. Gopinathanair and P. Saraswathy. 1984. Studies and correlation and path analysis in *Capsicum annuum* L. South Indian Hort. 32 (4) : 212-218.

Sarma, R. N. and A. Roy. 1995. Variation and character association in chilli. Ann. Agric. Res., 16 (2) : 179-183.

Singh, R. K. and B. D. Chaudhary. 1977. Variance and covariance analysis in "Biometrical methods in quantitative genetic analysis". Kalyani Publ. New Delhi, pp. 39-68.

Sreelathakumary and L. Rajamony. 2002. Variability, heritability and correlation studies in chilli (*Capsicum* spp.) under shade. Indian J. Hort., 59 (1) : 77-83.

Warade, S. D., M. M. Dhumal and K. D. Shinde. 1996. Correlation studies in chilli. J. Maharashtra agric Univ. 21 (1) : 55-57.

J. Maharashtra agric. Univ., 34 (3) : 353-355 (2009)

Effect of Organic Amendments on Soil Nutrient Availability, Uptake and Yield of Soybean

Soybean (*Glycine max*) is an important leguminous and pulse crop grown in Maharashtra on 15.6 lakh hectares with total production of 19.5 lakh metric tonnes with the productivity of 12.53 kg ha^{-1} (Anonymous, 2004). Soybean fixes atmospheric nitrogen in soil which maintains soil fertility. Organic amendment plays a major role in improving the soil physical condition, nutrient availability, nutrient uptake and yield of crop. *Azotobacter* a nitrogen fixing bacteria is one of the constituents of organic amendment Purna-11. Therefore, the present experiment was conducted to study the effect of Purna-11 on nutrient availability, uptake and yield of soybean.

A field experiment was conducted with eight treatmnent combinations (T_1-Control, T_2-RDF, T_3- RDF + Purna-11 @ 60 kg ha^{-1}, T_4-50 per cent RDF + Purna-11 @ 150 kg ha^{-1}, T_5-50 per cent RDF + Purna-11 @ 300 kg ha^{-1}, T_6-Purna-11 @ 300 kg ha^{-1}, T_7- Purna-11 @ 500 kg ha^{-1}, T_8-FYM @ 10 t ha^{-1}) with four replications in RBD during *kharif* 2004-2005, on College farm, MAU, Parbhani. The experimental soil was clayey in texture having pH 7.8, EC 0.35 dSm^{-1}, $CaCO_3$ 5.4 per cent, organic carbon 0.5 per cent, low in available N, P and high in available K. The composition of Purna-11 (organic amendment) was organic carbon 32.4, nitrogen 2.6, phosphorus 1.4 and potassium 0.43 per cent, Fe 550 ppm, Zn 1561 ppm, Mn 146 ppm and Cu 390 ppm. The crop was sown during *kharif* 2004 and all the necessary cultural operations and plant protection measures were

Table 1. Availability of nutrients (kg ha^{-1}) at different stages as influenced by organic amendment (Purna-11).

Treatment	Flowering				Pod formation				Harvest			
	N	P	K	S (mg kg^{-1})	N	P	K	S (mg kg^{-1})	N	P	K	S (mg kg^{-1})
	(kg ha-1)				(kg ha-1)				(kg ha-1)			
T_1	181.3	19.90	413	15.66	176.3	18.54	385	16.23	154.7	18.45	367	13.37
T_2	194.2	20.94	414	18.48	191.9	19.78	429	19.66	181.2	21.19	433	15.55
T_3	197.3	28.25	442	19.25	199.0	29.91	477	20.05	185.6	23.77	475	15.63
T_4	188.1	19.32	457	18.31	181.8	23.97	416	19.60	168.5	19.48	405	15.28
T_5	184.1	21.02	442	18.32	188.5	24.79	418	19.97	165.3	23.73	480	15.51
T_6	190.9	20.00	452	17.13	185.7	24.46	410	18.38	161.0	22.16	449	14.61
T_7	188.8	21.07	442	17.62	188.3	24.95	406	18.53	178.6	22.59	469	14.91
T_8	200.6	22.89	476	18.08	192.8	26.09	490	19.42	185.0	22.31	489	15.18
S. E.±	1.33	1.42	13.61	0.24	0.89	1.04	13.70	0.16	2.82	1.79	12.65	0.15
C. D. at 5%	3.92	4.19	40.6	0.714	2.61	3.07	40.02	0.47	8.29	5.38	37.78	0.45

carried out. The soil and plant samples were collected at flowering, pod formation and harvest stage. The crop was harvested after 90 days of sowing and recorded the yield. The soil samples were analysed for available N (Subbiah and Asija, 1956), P, K (Jackson, 1967) and S (Williams and Steinbergs, 1959). The N, P and K in plant samples were determined as outlined by Piper (1966), and sulphur estimated as per the procedure given by Tandon (1993) and uptake of nutrients was computed.

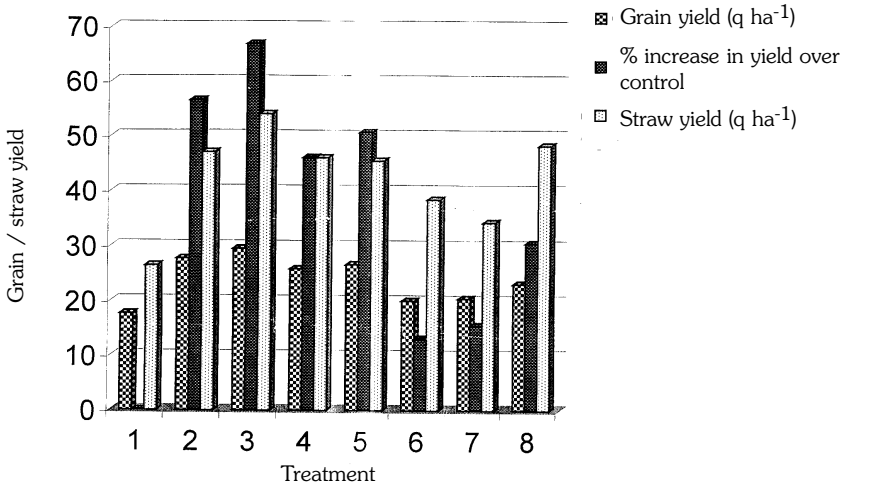

Fig. 1. Grain and straw yield of soybean as influenced by organic amendments.

The data (Table-1) indicated decrease in availability of N with increase in period of crop growth. Significantly higher availability of N (200.6 kg ha^{-1}) was recorded at flowering with an application of FYM @ 10 t ha^{-1} (T_8) over other treatments except an application of recommended dose in combination with Purna-11@ 60 kg ha^{-1} (T_3). While at the time of pod formation, significantly higher availability of nitrogen (199 kg ha^{-1}) was recorded with treatment T_3 over all other treatments. Similar pattern was recorded at the time of harvest. The data (Table-1) also showed maximum availability of P both at flowering and pod formation stage (29.9 kg ha^{-1}) with an application of RDF in combination with Purna-11 @ 60 kg ha^{-1} (T_3) followed by significant decrease with other treatments. The highest availability of K (476 kg ha^{-1}) at flowering and pod formation (490 kg ha^{-1}) stage was recorded with an application of FYM @ 10 t ha^{-1}. While the application of RDF + Purna-11 @ 60 kg ha^{-1} showed the highest availability of S at all the stages followed by application of RDF. Maximum N availability recorded with FYM @ 10 t ha^{-1} (T_8) at flowering and with RDF + Purna-11 @ 60 kg ha^{-1} (T_3) at pod formation and harvest stage may be due to favorable effects of organic amendment which released available nitrogen on mineralization. The phosphorus, potassium and sulphur availability in soil recorded in the present study confirm the findings of Tiwari *et al*. (2002) and Ravankar *et al*. (2000).

The total uptake of N (202.7 kg ha^{-1}) was significantly higher with the application of RDF along with Purna-11 @ 60 kg ha^{-1} (T_3) over all other treatments (Table-2). Similarly, maximum uptake of P, K and S was noticed with the addition of RDF along with Purna-11 @ 60 kg ha^{-1}. Maximum nutrient uptake recorded with RDF + Purna-11 @ 60 kg ha^{-1} (T_3) may be attributed to the fact that integration of organic amendments with RDF resulted in higher availability and thereby higher uptake of nutrients in soybean (Giri and Rana, 2003).

The data on grain and straw yield of soybean (Fig-1) indicated that addition of RDF in combination with Purna-11 @ 60 kg ha^{-1} (T_3) produced significantly higher grain (29.53q ha^{-1}) and straw (53.9 1q ha^{-1}) yield over other treatments. Similarly, the treatment T_3 showed maximum per cent increase in grain yield (66.83) over control. Thus, application of RDF in combination with Puma-11 @ 60 kg ha^{-1} was superior to other treatments. This might be attributed to higher nutrient availability and their uptake resulted in better proliferation and development of roots that favored the crop to extract soil moisture and nutrients from greater volume of the

Table 2. Total uptake of nutrients (kg ha-1) by soybean as influenced by organic amendment.

Treatments	Nitrogen	Phosphorus	Potassium	Sulphur
T_1	114.0	11.6	43.8	6.0
T_2	187.5	24.61	79.1	12.8
T_3	202.7	28.9	87.7	14.5
T_4	172.5	21.7	72.6	10.8
T_5	179.5	23.0	75.5	12.1
T_6	131.7	15.5	54.8	8.1
T_7	134.8	15.1	53.4	8.2
T_8	155.3	19.9	66.5	10.2
S. E.±	2.32	0.81	2.467	0.39
C. D. at 5%	6.83	2.38	7.264	1.16

soil and ultimately produced higher yields (Ravankar *et al*. 2000).

B. R. Gajbhiye
C. V. Mali

Department of Soil Science and
Agril. Chemistry,
College of Agriculture,
Parbhani - 413 402 (India)
September 27, 2008.

LITERATURE CITED

Anonymous. 2004. State wise data on area and production of soybean. Project coordinators Report (1999-2000). AICRP on soybean. Nat. Res. Center for Soybean, Indore, PP. 1-7.

Giri, G. and D. S. Rana. 2003. Intigrated nutrient management in oil seeds for balanced nutrition. Farmers Forum. 3 (1) : 18-22.

Jackson, M. L. 1967. Soil Chemical Analysis Prentice Hall of India Pvt. Ltd, New Delhi, PP46, 128, 152 and 283.

Piper, C.S. 1966. Soil and Plant Analysis, Hans, Publ. Mumbai.

Ravankar. H. N., D. M. Patil, N. B. Mohod and P. W. Deshmukh. 2000. Effect of organics and inorganics on yield and nutrients availability under soybean-wheat sequence in vertisol. P.K.V. Res. J. 31 (2) : 75-79.

Subbiah, B. V. and J. Asija. 1956. A rapid procedure for estimation of available nitrogen in soils. Curr. Sci. 25 : 259-262

Tiwari, A., A. K. Dwivedi and P. R. Dixit. 2002. Long term influence of organic and inorganic fertilization on soil fertility and productivity of soybean-wheat system in a vertisol. J. Indian Soc. Soil Sci., 50(4): 472-475.

Tandon, H. L. S. 1993. Methods of Soil, Plants, Water and Fertilizers Analysis, FDCO, New Delhi, PP. 190-205.

Williams, C. H. and A. Steinbergs. 1959. Effect of pyrite and organic manures on sulphur nutrition of crops. Aust.J. Agric. Res. 10 : 340.

J. Maharashtra agric. Univ., 34 (3) : 355-356 (2009)

Intercropping of Niger in *Kharif* Prosomillet (*Panicum milliaceum* L.) with Organic and Inorganic Sources of Nutrients

Intercropping system is an age-old practice of growing simultaneously two or more crops in the same piece of land at the same time or in the same season. It has been a common practice followed by the farmers in India, Africa, Sri Lanka and West Indies (Ayyangar and Ayyer, 1942). The basic idea of intercropping is not only to grow two or more crop species together which can exploit the resources better than either of them grown separately, but also when two or more crops occupy the same field, the inherent risk in agriculture and more so, under dry land conditions are buffered to some extent called as "biological insurance" (Ayyer, 1963).

Aiyer (1949) reported that the resources with regard to the plant nutrients present in the soil or added to it as manure were utilized to the fullest extent in mixed stand than when components were grown separately. The different crops having varying root depths to extract moisture and nutrients from different soil layers. The periodical income and distribution of labour requirement throughout the year is of great help to poor cultivators. Efficient utilization of nutrient, moisture, space and solar energy can be derived through mixed or intercropping system. Yield advantages in intercropping system are mainly because of differential use of growth resources by the component crops. The main way of complimentarity occur when the growth pattern of component crops differ in time.

The field experiment was conducted at the Agronomy farm of Dr. B. S. K. K. V., in Dapoli Maharashtra during *kharif* season of 2007-2008, on lateritic soil. The farm is located in tropical region on 17°N latitude and 73°E longitude at an elevation of 250 meter above the mean sea level. The variety used for the experiment was Vari No. 10 and JNC-6 of proso millet and niger respectively. The treatments consisted of five row ratios (1:1, 2:1, 3:1, 1:2, 1:3) along with sole crop of proso millet and niger and two sources of nutrients i.e. organic (5 t ha-1 through FYM (W_1) and inorganic (50 % of recommended N and 100 % of P + K through Sampurna (19:19:19) and remaining 50 % N top dressed through urea (W_2). There were 14 treatment combinations replicated thrice in a randomized block design. The plot size was 4.8 x 3.6 meter. Seed rate used were 5 and 3 kg ha-1 for both the crops respectively. All recommended agronomic practices were followed for raising the crop.

Line sowing of proso millet was done in nursery with well prepared raised bed of size 5 x 1 meter. After 15 days 1 kg N for 100 sq. m. area was given, and transplanting was done after 20 days in main plot leaving rows for niger sowing. On the same day niger was sown in line in main plots. The total rainfall of 4260 mm was received from June to October. Growth, yield attributes and yield were studied and based on these characters the most efficient intercropping was evaluated. The data indicated significant differences due to different row ratios and sources of nutrients and their interaction effects.

Table 1. Mean value of yield of proso millet and niger as affected by different treatments.

Treatments	Prosomillet				Niger		
	1000 grain weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)	1000 grain weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
Sole proso millet	1.85	12.52	68.17	15.49	-	-	-
Sole niger	-	-	-	-	2.93	4.38	46.13
Proso millet + Niger 1:1	1.80	7.76	56.77	12.42	3.54	2.30	21.57
Proso millet + Niger 2:1	1.73	8.67	61.20	14.33	2.92	2.01	18.18
Proso millet + Niger 3:1	1.62	11.20	66.02	14.50	2.78	1.80	15.20
Proso millet + Niger 1:2	1.74	8.16	54.25	10.93	3.02	3.29	26.67
Proso millet + Niger 1:3	1.75	4.90	38.65	11.96	3.21	4.12	29.95
S. E.±	0.06	0.66	3.16	0.84	0.06	0.06	0.72
C. D. at 5%	NS	1.94	9.26	2.47	0.17	0.17	1.10
Sources of nutrients :							
Organic	1.70	7.89	55.24	12.93	2.96	2.96	23.68
Inorganic	1.80	9.88	59.79	13.61	3.17	3.17	28.89
S. E.±	0.04	0.38	1.82	0.49	0.03	0.03	0.41
C. D. at 5%	NS	NS	NS	NS	0.10	0.10	NS

Proso millet : Grain yield level of sole proso millet (Table 1) was significantly more than their respective intercrop ratios of 1:1, 2:1, and 1:3. The proso millet + niger in 3:1 row ratio was found at par with sole proso millet and these treatments were significantly better than rest of the treatment. Grain yield of proso millet was found to increase due to application of inorganic sources of nutrient over the application of organic source of nutrient. Straw yield of proso millet + niger in 3:1 row ratio was found at par with sole proso millet followed by 2:1 row ratio. Similar trends were found in case of harvest index.

Niger : It was observed that test weight (Table 1) was significantly higher in 1:1 row ratio over remaining treatments, followed by 1:3 row ratios. Test weight of niger was significantly higher due to application of inorganic sources of nutrients over the application of organic source of nutrient. The grain and straw yield of niger was affected due to different row proportions. Significantly highest grain and straw yield was recorded under sole crop of niger. Among the intercropping systems proso millet + niger in 1:3 row ratio recorded significantly higher weight of grains and straw per hectare followed by proso millet + niger in 1:2 row ratio over rest of the treatments. The grain yield was found to be increased due to inorganic sources of nutrients over organic source of nutrient. Similar findings were earlier reported by Reddy *et al*. (1983) and Thorat *et al*. (1986b).

A. N. Ugale
A. C. Sawant
P. G. Chavan

Department of Agronomy,
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth,
Dapoli - 415 712 (India)
August 27, 2008.

LITERATURE CITED

Aiyer, A. K. Y. N. 1949. Mixed cropping in India. Indian J. Agric. Sci. 19: 439-523.

Ayyanger, G. N. R. and Ayyer. 1942. Mixed cropping a review. Madras Agri. J. 30: 3-13

Ayyer, A. J. Y. N. 1963. Principales of crop husbandry in India. Bangalore press, pp. 406.

Reddy, V. C., B. K. Linga Gowda, M. G. Rajappa and A. S. Kumar Swamy. 1983. Intercropping of finger millet under rainfed condition. Mysore J. of Agric. Sci. 17: 5-7.

Thorat, S. T., S. P. Sonune and S. A. Chavan. 1986b. Intercropping of some pulse and oil crop in *kharif* ragi. J. Maharashtra agric. Univ. 11(2): 268-271.

J. Maharashtra agric. Univ., 34 (3) : 357-358 (2009)

Distribution of Available Boron in the Selected Surface and Sub-Surface Soils of Terai Zone of West Bengal in Relation to Physico-Chemical Properties

Increasing attention is being paid to the role of micronutrients in agriculture. Experiments and agricultural practice have proved that micro-nutrients are common constraints to crop production and that soils defficient in micro elements are wide spread in India. Micronutrient element Bo is receiving a considerable attention in acidic soils of Terai zone of West Bengal due to its deficiency (Pakrashi, 1991). Basic information regarding distribution of Bo in soils of this area, which are responsible for poor crop growth, is very meager to make any definite recommendation. Hence, the present investigation was carried out to study status of boron in the surface and sub-surface soils of Terai zones of West Bengal.

Soil samples were collected from various locations of Inceptisols and Entisols of Terai zones of West Bengal. Air-dry soil samples passed through 2 mm sieve were analyzed for mechanical analysis by hydrometer method (Dey, 1956), pH by glass electrode pH meter (1:2 soil: water), organic carbon by Walkley and Black's wet digestion method, (Jackson 1973). Hot water soluble boron was determined calorimetrically using Azomethine-H-indicator following the methods of Wolf (1971). Correlation co-efficient (r) value was calculated by following the procedures as described by Gomez and Gomez (1976).

The pH of the soils ranged from strongly acidic (4.4) to slightly acidic (6.6) in reaction (Table 1). However, the pH of the surface soils was found lower in comparison with the subsurface soil of the same site. The organic carbon status of the soil samples ranged from low (0.22%) to

Table 1. Distribution of available Boron content along with the relevant physico-chemical properties of selected surface and sub-surface soil of Terai Zone.

District sampling site	Depth (cm)	Physico-chemical properties				HWS Boron (ppm)
		pH	OC (%)	Clay (%)	Clay + silt (%)	
Cooch-behar :						
Sitalkuchi	0-15	5.0	1.02	13	24	0.32
	15-30	5.1	0.88	16	29	0.35
Dinhata	0-15	4.9	1.12	12	28	0.24
	15-30	5.0	0.90	18	35	0.26
Patchhara	0-15	6.2	1.12	14	34	0.50
	15-30	6.5	0.89	16	41	0.26
Talapakha	0-15	6.1	0.92	19	46	0.37
	15-30	6.3	0.66	25	50	0.20
Kumarganj	0-15	5.9	1.42	26	59	0.51
	15-30	6.0	1.15	31	65	0.35
Hoglabari	0-15	6.0	0.90	9	45	0.40
	15-30	6.2	0.66	13	49	0.30
Dharmabari	0-15	5.4	0.88	18	60	0.41
	15-30	5.7	0.62	19	63	0.38
Thingabari	0-15	6.6	0.43	20	79	0.43
	15-30	6.9	0.23	21	80	0.39
Salbari	0-15	5.6	0.85	18	72	0.38
	15-30	6.0	0.67	20	73	0.32
Tofanganj	0-15	5.9	1.02	15	45	0.36
	15-30	6.4	0.85	18	42	0.33
Jalpaiguri :						
Falakata	0-15	5.0	0.78	10	32	0.30
	15-30	5.6	0.66	15	30	0.30
Moynaguri	0-15	5.0	0.41	19	34	0.33
	15-30	5.5	0.30	22	35	0.34
Hasudanga	0-15	5.4	1.10	16	38	0.34
	15-30	6.0	0.88	20	40	0.38
Mal	0-15	5.1	0.87	12	42	0.33
	15-30	5.6	0.62	15	45	0.37
Alipurduar	0-15	6.1	1.00	15	72	0.36
	15-30	6.5	0.78	19	80	0.41
Lalitbari	0-15	5.1	0.35	11	23	0.30
	15-30	5.6	0.25	16	33	0.38
Kumarpur	0-15	4.9	0.80	11	64	0.31
	15-30	5.5	0.64	16	70	0.40
Rajgonj	0-15	4.9	0.38	10	27	0.28
	15-30	5.4	0.25	14	35	0.33
Dhupguri	0-15	6.2	0.33	13	33	0.38
	15-30	6.6	0.22	17	40	0.41
Patkidaha	0-15	6.2	1.40	13	32	0.53
	15-30	6.7	1.10	18	39	0.51

Table 2. Correlation coefficient (r) between HWS boron content and some relevant soil characteristics.

Agro-climatic zone	Depth (cm)	Correlation coefficient (r) between HWS boron content and some relevant soil characteristics			
		pH	OC (%)	Clay (%)	Clay + silt (%)
Terai zone	0-15	0.7613**	0.4629*	0.4916*	0.3109
	15-30	0.6536**	0.2256	0.1160	0.3447

*,** Significant level of 5 and 1% respectively.

high (1.42%) and soils of surface layer showed higher organic carbon content (0.33 to 1.42%) than the sub-surface layer (0.22 to 1.15%). Clay content varied from (9 to 31%) and it has also been found that the per cent clay increases with depth. Whereas, clay plus silt also showed the same trend of result as that of clay. Available boron content ranged from 0.24 to 0.53 ppm. Relatively higher amount of HWS boron were found in the sub-surface layer than the surface layer of the same locations, except a few sites, where surface layer contain higher available boron. The content of HWS boron in soils of the districts of Coochbehar ranged from 0.24 to 0.51 ppm with a mean value of 0.392 ppm. Whereas, the same in the soils of the district of Jalpaiguri ranged from 0.28 to 0.53 ppm with mean value of 0.346ppm. Similar observations have also been reported by Saha (1992).

The statistical analysis (Table 2) showed that, there was a positive and significant correlation between pH, organic carbon, clay content and HWS boron of the surface soil but a positive and non significant correlation found between organic carbon, clay, clay plus silt and HWS boron in sub-surface soils. Similar relationship has also been reported by Bansal *et al*. (2003) and Chaudhary and Sukla (2004).

P. Debnath
M. K. Mahata
S. K. Ghosh

Dept. of Soil Science and Agril. Chemistry
Bhidan Chandra Krishi Vishwavidyalaya
Mohanpur - 741 252 (India)

July 8, 2008.

LITERATURE CITED

Bansal, R. L., V. K. Nayyar and J. S. Brar. 2003. Available boron status of soils in Central Plain Region of Punjab. J. Res. PAU. 2 : 172-176.

Chaudhary, D. R and L. M. Sukla. 2004. Profile distribution of boron forms in relation to soil characteristics in acid soils of Western Rajasthan. Annals Agric. Res. 24 : 314-321.

Dey, P. R. 1956 . Report of the committee on physical analysis, 1954-55, Soil Sci. Soc. Am. Proc. 20 : 167-169.

Gomez, K. A and A. A. Gomez. 1976. Statistical procedures for agriculture research. 2nd ed IRRI. Los Banos. Philippines.

Jackson, M. L. 1973. Soil Chemical Analysis, Prientice Hall of India Pvt. Ltd. New Delhi.

Pakrashi, A. C. 1991. Studies on the availability of boron in acid soils of North Bengal in relation to growth and nutrition of green gram (*Vigna radiata* cv. B_1). Ph. D. thesis, Bidhan Chandra Krishi Viswavidyalaya, West Bengal.

Saha, A. R. 1992. Studies on boron in acid soils of North Bengal in relation to growth and nutrition of green gram (*Vigna radiata* var. Pusa Baisakhi). Ph. D. thesis, Bidhan Chandra Krishi Viswavidhyalaya, West Bngal.

Wolf, B. 1971. The determination of boron in soil extracts, plant materials, compost, manures, water and nutrient solution. Commun. Soil. Sci. Plant Anal. 2 : 363-374.

J. Maharashtra agric. Univ., 34 (3) : 358-360 (2009)

Quality of Milk Supplied by Producers to Co-operative Societies in Nagpur (Maharashtra)

Milk has a high nutritive value. It supplies proteins, minerals, vitamins and furnishes energy giving lactose and milk fat. Water, salt, sugar, wheat flour, blotting paper, baking soda, washing soda, caustic soda, urea and formalin have been known to be used as adulterants (Kumar *et al.* 1998). To find out the exact source of adulteration of milk, it is necessary to check it at producer level. Therefore, the present study was carried out to find out the intensity of adulteration in milk at producers level.

For the present study, in all 240 samples were collected from

Table 1. Quality parameters of milk collected from different levels.

Source	Phase	No. of sample analyzed	Specific gravity		Acidity		Fat		S. N. F.		Total solids	
			Average	SE ±	Per cent average	SE ±	Per cent average	SE ±	Per cent average	SE ±	Per cent TS	SE ±
Co-operative society level	I	80	1.0265	±2.76	0.144	±2.184	3.89	±0.0511	8.204	±0.0772	12.100	±0.120
	II	80	1.0263	±2.69	0.137	±1.682	3.82	±0.0529	8.143	±0.0753	11.969	±0.121
	III	80	1.0259	±2.51	0.146	±2.121	3.78	±0.0510	8.02	±0.0719	11.795	±0.115
Total		240	1.0262	±1.54	0.142	±1.186	3.83	±0.0300	8.122	±0.0435	11.955	±0.0694
Production level		80	1.0272	±2.41	-	-	4.05	±0.0726	8.416	±0.0784	12.470	±0.145

producers at co-operative society level and 80 samples were from production level, and they were analysed for physio-chemical quality and detection of adulteration in milk. The raw milk sample from individual producer was collected in society and were also collected from the milking animals at production level. The samples were collected at one month interval in 3 phases from co-operative society level and single time at production level. The kit was developed for chemical analysis. Physico-chemical and milk adulteration analysis was done on the platform of dairy co-operative society. Acidity, specific gravity and fat test were determined as per the procedure recommended in BIS Handbook of Food analysis [sp. 18 (part xi) 1981]. SNF test was determined by using Zeals lactometer at 84°F by using ISI formula,

$$\text{SNF per cent} = \frac{\text{CLR}}{4} + 0.22\,F + 0.72$$

where,

CLR = Corrected lactometer reading

F = Fat per cent of milk

After the analysis of milk samples, other information of milk producer was collected. The data was analyzed and studied critically from different angles considering the averages obtained separately from different phase of work. Standard error was calculated as per the formula given by Panse and Sukhatme(1978).

Physico-chemical quality of milk : The results obtained are depicted in Table 1, revealed that no significant variation in average specific gravity at each level of collection was recorded. The range of average specific gravity was 1.02 to 1.03 at both levels of sample collection. These findings are in agreement with (Lavania (1969) and Karpude *et al*. (1987). Average acidity of milk collected at co-operative society level was 0.142 per cent. Maximum samples (76.66%) recorded acidity in the range of 0.13 to 0.18 per cent. Acidity below 0.13 per cent was recorded by 18.75 per cent samples however, above 0.18 per cent was recorded by 4.58 per cent samples indicating long storage of milk at producers level. Similar findings have been reported by Reddy *et al*. (1989) and Kothawade (1999).

The average fat content of the milk at society level was 3.83 per cent and at production level it was 4.05 per cent. Low fat content than PFA standard was recorded in 21.66 per cent and 7.50 per cent samples collected at society level and production level respectively. The average SNF content was 8.122 per cent and 8.416 per cent at co-operative society level and production level respectively. The low percentage of SNF content in milk at production level might be due to inadequate feeding and also due to different class of animals for milk production. The average total solids content in milk collected at society level was 11.95 per cent which was lower (12.47 per cent) than total solids in milk collected at production level. The average total solids content at society level were below the PFA standard. From the total samples studied 56 and 35 per cent collected at society and production level respectively recorded lower total solids than PFA standard. The low total solids content at society level could be due to adulterating milk with water and low SNF content of milk. These results obtained are on similar line with the finding by Wathore (1998). Highest per cent (25.83) adulteration was recorded by addition of sugar followed by sodium bicarbonate 17.08 per cent, starch 12.91 per cent and urea 4.16 per cent. The majority of producers

supplied cow milk or mixed milk to society. There was decrease in specific gravity from production to cooperative society level. Mixing of morning and evening milk with addition of various preservatives or neutralizers maintains the average acidity within the acceptable limit. The low fat, SNF and TS content is due to dilution of milk, inadequate feeding of milch animals and maintaining different class of animals.

R. B. Aher
P. V. Bhire
M. G. Mote

Department of Animal Husbandry and Dairying,
College of Agriculture,
Nagpur - 440001 (India)
May 20, 2008.

LITERATURE CITED

B.I.S. 1981. Handbook of Food Analysis SP : 18 (Part XI) Bureau of Indian Standards, Manak Bhavan, Bahadur Shaha Zafar Marg, New Delhi-110 001.

Karpude, A. A., S. D. Rathi, N. V. Jogalekar and U. M. Ingle. 1987. Adulteration of milk sold in Parbhani town. Asian J. Dairy Res. 6 (2) : 83-86.

Kumar, R., D. K. Singh and N. K. Chawla. 1998. Adulteration or contamination of milk demystified. Indian Dairyman 50 (7) : 25-33.

Kothawade, U. D. 1999 : Comparative study of quality of milk sold by organised dairies in Nagpur city. M.Sc. (Agri.) thesis submitted to Dr. P.D.K.V., Akola.

Lavania, G. S. 1969. Quality of milk as supplied to the town Baraut (Meerut), U.P. Indian J. Dairy Sci. 22 (3) : 181-186.

Panse, V. G. and P. V. Sukhatme. 1978. Statistical Methods for Agricultural Workers. Indian Council of Agri. Res., New Delhi., 1 : 43-44.

Reddy, I. S., R. K. Reddy, B. T. Jairam and D.Venkayya, 1989. Bacteriological quality of cow milk. Indian J. Dairy Sci. 42 (3) : 650-652.

Wathore, D. K. 1998. Studies on chemical and bacteriological quality of milk sold in Nagpur city. M.Sc. (Agri.) thesis submitted to Dr. P.D.K.V., Akola.

J. Maharashtra agric. Univ., 34 (3) : 360-361 (2009)

Effect of N, P and K on Productivity and Nutrient Uptake in Pearlmillet Wheat Cropping Sequence

Pearlmillet-wheat cropping sequence has gained popularity in hot and humid agro climatic condition of scarcity zone of Ahmednagar district. Cropping sequence is traditionally a low cost input agriculture system. Information on nutrient management on individual crops is available, while cropping system, it is lacking. Moreover, the single nutrient approach has been replaced by multinutrient to prove balanced nutrients to boost up crop productivity and nutrient use efficiency. The nutrient management in cropping system is more efficient and judicious than individual crop, as following crop uses residual nutrients. Keeping these considerations in view, the present field investigation was undertaken, during 2006-07.

A field experiment was conducted for two consecutive seasons (2006-2007) on inceptisol in scarcity zone of Ahmednagar district of Maharashtra. The soil was low in organic carbon (0.53), medium in nitrogen (205.17 kg ha^{-1}), low in available phosphorus (15.42 kg ha^{-1}) and high in available potassium (538.34 kg ha^{-1}). The experiment was laid out in a randomized block design with six replications and five treatments. The treatment consisted of N (60 kg ha^{-1}), P_2O_5 (30 kg ha^{-1}) and K_2O (30 kg ha^{-1}) along with control and N (120 kg ha^{-1}), P_2O_5 (60 kg ha^{-1}) and K_2O (40 kg ha^{-1}) in pearlmillet and wheat crop respectively. The half dose of N was applied at top dressing 30 days after sowing to pearlmillet crop and 25-30 days after sowing to wheat crops. Pearlmillet (cv. Saburi) was sown in the second week of June followed by wheat (cv. 'NIAW-301') in the second week of November during *kharif* and *rabi* respectively. Drillling was carried out at 45 x 15-cm row spacing in pearlmillet and wheat of 22.5 cm. *Azotobactor* and PSB were used for seed treatment wherever applicable as per treatments. The chemical analysis of soil and plant were carried out in laboratory by adopting standard procedure as described by Jackson(1973). The grain yield of pearl millet increased significantly with increasing levels of N up to 60 kg ha^{-1}. On an average, application of 60 kg N ha^{-1} increased the grain yield by 6.81 q ha^{-1} over absolute control. These findings were

Table 1. Nutrient uptake, yield and monetary returns and B:C ratio of pearl millet - wheat cropping sequence.

Treatment details	Pearlmillet			Wheat			Pearl millet yield (q ha^{-1})		Wheat yield (q ha^{-1})		Gross monetary returns (Rs. ha^{-1})	Net monetary returns (Rs. ha^{-1})	B:C ratio
	N	P	K	N	P	K	Grain	Straw	Grain	Straw			
Control (No fertilizers)	51.32	10.24	56.52	95.87	11.56	81.33	10.83	16.27	18.67	28.97	333954	8938	1.35
N	82.62	12.52	89.74	136.41	16.76	117.68	17.64	26.65	28.34	42.51	52292	23808	1.81
N & P	98.54	15.42	99.64	151.26	19.20	132.38	22.76	33.85	35.35	53.03	65789	35068	2.13
N & K	112.32	24.35	114.21	158.16	19.38	139.68	24.91	37.36	36.64	55.08	67564	40084	2.57
N, P & K	134.66	24.52	138.62	189.60	22.11	161.4	28.83	43.25	42.67	64.41	81044	49726	2.58
SE. m. ±	7.12	0.81	3.26	12.24	0.75	3.54	0.05	0.21	0.57	0.76	1.113	0.80	0.02
C. D. at 5%	21.88	2.47	9.88	25.53	1.57	7.39	0.15	0.64	1.69	2.24	3.28	2.37	0.08

Rates : -Rs q^{-1}. Pearl millet - 700/-, Wheat - 1300/-, Straw 50/-

confirmed with the results of Varma (1996) and Yadav *et al*. (1997). Application of P showed marked response up to 30 kg P_2O_5 ha^{-1} only (Table-1). This might be attributed to more P fixing capacity of soil. Pearlmillet remained unaffected by potash application. This might be due to suffifficient potash reserve and high potash buffering capacity of soil. Similar results were also reported by Patel (1991).

The yield of wheat increased significantly with increasing levels of N (Table- 1), and a linear response to N was observed up to 120 kg ha^{-1}. The application of N, P and K recorded significantly higher grain yield of pearlmillet (28.83 q ha^{-1}) and wheat (42.67 q ha^{-1}) followed by the treatment involving application of N and K to both the crops. (Table- 1) However, these two treatments were at par with each other for both the crops. Similar results were obtained in case of stalk/fodder yield of pearl millet and wheat, respectively. The available nitrogen (189.60 kg ha^{-1}), phosphorus (24.52 kg ha^{-1}), potassium (161.44 kg ha^{-1}) and organic carbon (0.53%) content was observed due to application of 100 % RDF followed by N and K.

The data on economic studies of Pearlmillet - wheat cropping sequence under all recommended package of practices revealed that gross monetary returns were significantly higher due to application of 100 per cent RDF (Rs.81044 t ha^{-1}) and followed by treatment T_4. However, treatment T_5 has highest net returns and B:C ratio occurred due to 100 per cent RDF to both the crops were (Rs. 49726 t ha^{-1} and 2.58) followed by other treatments. Thus, it could be possible to achieve maximum productivity and monetary returns from pearlmillet- wheat cropping sequence with the application of RDF to both the crops.

R. B. Hile
S. M. Todmal
A. G. Wani

Department of Agronomy
Mahatma Phule Krishi Vidyapeeth,
Rahuri - 413 722 (India)
July 12, 2008.

LITERATURE CITED

Jackson, M. L. 1973. Soil chemical analysis. Prentice Hall Pvt. Ltd, New Delhi.

Patel, A. M. 1991. Response of nitrogen through manures and fertilizers alone and their combinations on pigeonpea. A M.Sc. thesis submitted to MPKV, Rahuri (India).

Verma, O. P. S. 1996. Integrated nutrient management in pearlmillet under rainfed conditions. Indian J. Agron. 41 (1) : 58-60.

Yadav, R. P., R. K. Sharma and V. K. Shrivastava. 1997. Fertility management in pigeonpea based intercropping system under rainfed conditions. Indian J. Agron. 42 (1) : 46-49.

J. Maharashtra agric. Univ., 34 (3) : 362-363 (2009)

Studies on Physical Properties of Soil and Yield of Okra as Influenced by IPNS

The application of compost to soil increased the size of water stable aggregates more than 0.25 mm. (Bavaskar and Zende, 1973) and infiltration rate (Alok Kumar and Tripathi, 1990).

An application of organic manures in combination with inorganic fertilizer and blofertilizer proved to obtain better yield. Amarchandra (1998) obtained highest marketable yield of cabbage (729.36 q ha^{-1}) by the application of 50 per cent NPK and 5 tonnes poultry manure over the control (241.80 q ha^{-1}) and other treatments.

Keeping this in mind the present investigation was undertaken to study the effect of IPNS (Integrated Plant Nutrient Supply) on physical properties of soil and yield of okra.

The experiment was laid out in a randomized block design with three replications and ten treatment combinations. The fertilizers were applied as per recommended dose for Okra. i.e. 100:50:50 NPK kg ha^{-1}. The organic manures *viz*., FYM @ 10 t ha^{-1} and SW-PMC @ 10.15, and 20 t ha^{-1} were applied along with recommended dose of NPK. The *Azospirillum* was applied @ 30g kg^{-1} seeds of okra. Soil samples were analysed in respect of bulk density, hydraulic conductivity, soil moisture at 33 and 1500 kpa and water stable aggregates, as influenced by different treatments.

Application of recommended dose of fertilizers with without organic sources decreased bulk density of soil and on par with each other. Bulk density was decreased due to organic sources which improved porosity and void ratio. Similar results were also recorded by Nimje and Seth (1970).

The hydraulic conductivity was increased due to organic manures and was higher in treatment T_9 (SW-PMC 20 Mg ha^{-1} and BF) and T_{10} (SW-PMC 20 Mg ha^{-1}), while it was lower in treatment T_2 (RDF 100:50:50 kg ha^{-1}). This might be due to influence of more organic matter and porosity of soil as reported by Alok kumar and Tripathi (1990).

There was gradual increase in soil moisture with increase in organic matter. The treatment with combination of organic manures and inorganic fertilizers showed gradual increase in available water. Thus addition of organic sources found to be beneficial for increasing available moisture. This might be due to improvement of soil physical properties like pore space, improvement in soil structure, decrease in bulk density and increase in water holding capacity as reported by Acharya *et al*. (1988) The application of organic manures (FYM and SW-PMC) in combination with inorganic fertilizers and bio-fertilizers showed significantly better aggregation. Application of SW-PMC was found better than FYM since organic matter acts as a cementing agent. Similar results were also obtained by Bawaskar and Zende (1973) and Shiralipour *et al*. (1992).

The conjoint use of organic manures, inorganic fertilizer and bio-fertilizers showed siunificanl increase in the yield of okra.

The combined use of organic manures, inorganic fertilizers and biofertilizer (NPK + 10 M t ha^{-1} FYM+ *Azospirillum*) recorded the highest fruit yield of 92.71 q ha^{-1}. However, recommended dose of fertilizer along with biofertilizer recorded 86.29 q ha^{-1} fruit yield. The conjoint use of organic manures, inorganic fertilizers and biofertilizer enhanced the fruit yield of okra. However, integration without biofertilizer did not increase the yield. This might be related with the use ol *Azospirillum*, which increased the plant height, girth and number of leaves, root growth and volume, which in-turn enhance the uptake of water and thereby nutrients resulting in better plant height, girth and ultimate fruit yield. Thus the present study proved, use of IPNS (Integrated Plant Nutrient Supply) is beneficial for soil in terms of physical properties and thereby to increase the yield of okra.

K. A. Jadhav
A. S. Patil
N. B. Mane Deshmukh

Mahatma Phule Krishi Vidyapeeth,
Rahuri - 413 722 (India)
May 20, 2008.

LITERATURE CITED

Acharya C. L. S. K. Bishnoi, H. S. Yaduvanshi. 1988. Effect of long term application of fertlizers and organic, inorganic amendments under

continuous cropping soil physical and chemical properties of alfisol J. Indian Soc. Soil Sci. 58 (7) : 509-11.

Alok Kumar and R. P. Tripathi. 1990. Bffect of continuous use of manures and fertilizers on physical properties of soil under paddy-wheat-cowpea cropping System, Crop. Res. 3 (1) : 7-13.

Bawaskar, V. S. and G. K. Zende. 1973. Soil fertility under continuous manuring and copping. Indian J. agric. Sci. 43 (5) : 492-499.

Nimje, P. M. and J. Seth. 1970. Effect of phosphorus, farm yard manure and nitrogen on some soil properties in soybean maize sequence. J. agric. Sci. 10 : 555-559.

Shiralipour. A. P. Mcconnel and D. B. Smith. 1992. Physical and chemical properties of soil as affected by municipal solid waste and compost application. Biomass and Bioenergy. 3 (3) : 216-266.

J. Maharashtra agric. Univ., 34 (3) : 363-364 (2009)

Efficacy of Synthetic Insecticides and Biopesticides Against *Maruca vitrata* on Pigeonpea

The larvae of *M. vitrata* web the leaves and inflorescence and feed inside the flowers, flower buds and pods (Sharma. 1998). The moth and larvae of *M. vitrata* are photo negative and nocturnal (Usua and Singh, 1979). Patnaik *et al*. (1986) reported 8.2 to 15.9 per cent pod damage resulting in 3.7 to 8.9 per cent loss in grain yield.

Hazardous and unlimited application of insecticides is causing a serious threat of insect resistance as well as residual effect. In the light of above, investigations on efficacy of some synthetic insecticides and biopesticides against legume pod borer i.e. *M. vitrata* was undertaken.

The field experiment was conducted during *kharif* season of 2001 at the instructional farm of PGI, MPKV, Rahuri. Thirteen treatments alongwith untreated control in three replications were imposed in a randomized block design. The crop was raised by sowing 'ICPL-87' variety with a plot size of 3.9 x 2.7 m and plant spacing of 30 x 15 cm. Insecticide treatment included endosulfan, monocrotophos, dichlorvos, profenophos, acephate, lambda cyhalo-thrin, cartap and spinosad. Three sprays each were applied using hand operated knapsack sprayer with the spray fluid @ 500 l ha^{-1} for each spray. The first spray was given at 50% flowering and subsequent sprays were given at 15 days interval. The fungal and bacterial insecticides treatment in the study were *Metarrhizium anisopliae* (MVD_1), *Beauveria bassiana* (MVD_2) and *Bacillus thuringiensis*. Neem seed kernel extract (NSKE) was prepared by sun drying neem seeds, grinding them to coarse powder using grinder and soaking for overnight then filtering through muslin cloth and later using for application. The efficacy of each treatment was evaluated by selecting ten plants randomly from each plot for recording larval count of *M. vitrata*. Observations were recorded a day before and 3 and 7 days after insecticide application. The data obtained were subjected to statistical analysis. The significance of treatment was assessed by determining critical difference (C.D.) at 5 per cent level of significance. The larval numbers were transformed into n + 0.5 for further statistical analysis.

The data obtained (Table 1) clearly revealed that larval population of *M. vitrata* continued to increase from DBT to 1 DAT and declined thereafter in the untreated control. At 1 DAT the population in all the treatments was significantly lower than in control. The plots treated with dichlorvos 500 g a.i. ha^{-1} recorded the lowest number of larvae i.e. 4.56 and proved to be significantly superior to rest of the treatments except monocrotophos 200 g a.i ha^{-1} (4.65) to which, it was at par. However, the effectiveness of monocrotophos is in agreement with Bhat *et al*. (1988). Similarly Prince and Chambnya (1983) suggested spraying of monocrotophos 250 g a.i ha^{-1} for maximum reduction of *M. vitrata* at flowering stage.

This was followed by endosulfan 350 g a.i. ha^{-1} and acephate 500 g a.i. ha^{-1} by recording 5.55 larvae per plant which is in conformity with findings of Degri and Chaudhary (1998). Next, in the order of effectiveness were cyhalothrin, cartap and profenophos.

Table 1. Efficacy of synthetic insecticide and biopesticide against *M. vitrata*.

Treatment	Dose	Larval population / plant				Mortality at 1 DAT (%)
		1 DBT	1 DAT	3 DAT	7 DAT	
Endosulfan	350 g a.i. ha^{-1}	9.48 (3.16)	5.55 (2.46)	2.18 (1.64)	0.73 (1.11)	41.45
Monocrotophos	250 g a.i. ha^{-1}	8.38 (2.98)	4.65 (2.27)	2.09 (1.61)	0.73 (1.11)	44.51
Dichlorvos	500 g a.i. ha^{-1}	10.32 (3.29)	4.56 (2.25)	2.09 (1.61)	0.58 (1.04)	55.81
Profenophos	500 g a.i. ha^{-1}	9.04 (3.09)	6.00 (2.55)	3.26 (1.94)	0.84 (1.16)	33.62
Acephate	300 g a.i. ha^{-1}	9.48 (3.16)	5.55 (2.46)	3.26 (1.94)	1.43 (1.39)	41.45
Lambda Cyhalothrin	15 g a.i. ha^{-1}	9.48 (3.16)	6.00 (2.55)	2.81 (1.82)	0.84 (1.16)	36.70
Cartap	500 g a.i. ha^{-1}	9.04 (3.09)	6.00 (2.55)	3.26 (1.94)	1.43 (1.39)	33.62
Spinosad	12.5 g a.i. ha-1	9.04 (3.09)	6.79 (2.70)	3.70 (2.05)	1.66 (1.47)	24.88
NSKE	25 kg ha^{-1}	9.04 (3.09)	7.68 (2.86)	3.70 (2.05)	1.43 (1.39)	15.04
MVD1	5 x 1012 spores ha^{-1}	9.04 (3.09)	7.28 (2.79)	2.81 (1.82)	0.98 (1.22)	19.46
MVD2	5 x 1012 spores ha^{-1}	8.38 (2.98)	7.68 (2.86)	3.26 (1.94)	1.43 (1.39)	8.35
Bacillus thuringiensis	500 g ha^{-1} (formulated)	9.04 (3.09)	7.68 (2.86)	3.70 (2.05)	1.43 (1.39)	15.04
Untreated control	-	9.04 (3.09)	9.35 (3.14)	5.11 (2.37)	2.49 (1.73)	-3.42
S. E.±	-	0.06	0.08	0.03	0.05	-
C. D. at 5%	-	NS	0.24	0.11	0.16	-
C. V. %	-	4.69	6.96	3.53	7.05	-

Figures in parentheses are means after n + 0.5 transformation. DBT : Day before treatment, DAT : Day after treatment

Almost a similar trend was noticed at 3 DAT. On 7 DAT the lowest population of larvae of *M. vitrata* was recorded in the treatment of dichlorvos(0.58). It was however, at par with monocrotophos (0.73), endosulfan (0.73), cyhalothrin (0.84) and profenophos (0.84). Amatobi (1994) reported that cyhalothrin (0.008%) was effective against legume pod borer.

In the present investigation, MVD1 (0.98) was found to be promising against *M. vitrata* among biopesticides, but cannot be compared due to lack of literature. *Bacillus thuringiensis* and NSKE were inferior to synthetic insecticides against *M. vitrata*. It was in contrast to the finding of Singh *et al*. (l985) who reported the effectiveness of neem seed powder and neem seed kernel extract. Hence, the experimental evidence obtained after the study of efficacy of synthetic insecticides and biopesticides clearly implies that dichlorvos was throughout superior over other treatments.

S. M. Ankali
C. S. Patil
K. A. Jadhav
Y. T. Jadhav

Mahatma Phule Krishi Vidyapeeth
Rahuri - 413 722 (India)
May 20, 2008.

LITERATURE CITED

Amatobi, C. J. 1994. Filed evaluation of some insecticides for the control of insect pest of cow pea (*Vigna unguiculata*) in the Sudan savannah of Nigeria. Internatl. J. of Tropical Pest Manag, 40 : 13-17.

Bhat, N. S. G. T. T. Majunatha, G. G. Nagabhushana and V. P. Deshpande. 1998. Chemical control of cowpea pod borers. Indian J. Plant Prot. 16 : 2, 197-200.

Degri, M. M. and J. P. Chaudhary. 1998. The chemical control of cowpea pod borer *M. testulalis* on cowpea in Bauchi. Nigeria. J. Econ. Ent., 60 : 148-151.

Patnaik, H. P., A. P. Samalo and B. N. Samalo. 1986. Susceptibility of some early varieties of pigeonpea for pod borers under protected conditions. Legume Res. 9 : 7-10.

Prince, M. and R. I. Chambnya. 1983. Insecticidal evaluation and timing of spray application for insect control in cowpea in Tanzania. Trop. Grain Leg. Bulletin, 28 : 4-8.

Sharma, H. C. 1998. Bionomics, host plant resistance and management of legume pod borer, *M. vitrata*. A review. Crop Prot. 17 : 373-386.

Singh, R. P. Y. Singh and S. P. Singh. 1985. Field evaluation of neem (*Azadirachta indica* A.) seed kernel extracts against the pod borers of pigeonpea, *Cajanus cajan* (L.) Millsp. Indian J. Ent., 47 : 111-112.

Usua, E. and S. R. Singh. 1979. Behaviour of cowpea pod borer, *M. testulalis* (Geyer). Nigerian J. Ent., 3 : 231-239.

J. Maharashtra agric. Univ., 34 (3) : 365-366 (2009)

Prevalence and Distribution of Stem Rust (*Puccinia graminis* f. sp. *tritici*) Pathotypes in Central and Peninsular India

The climatic conditions of Central and Peninsular India are very congenial for the wheat stem rust (*Puccinia graminis* f. sp. *tritici*). Monitoring the rust flora for successful incorporation of *Sr* genes in wheat breeding programme for their effective deployment in the all zones is necessary along the puccinia path. Thus investigations were carried out by collecting stem rust samples from off- season and *rabi* season grown wheat of different states during 2004-05 and 2005-06.

Stem rust infected samples of wheat were collected / received from farmers fields of Tamil Nadu, Karnataka and Maharashtra States of India during 2004 to 2006. Total 101 samples were inoculated on seven day old seedlings of universally susceptible wheat variety, Pusa-4 to raise fresh crop of inoculum. The rust inoculum in the form of urediospores from the established samples was further used for inoculating the seedlings of differential hosts of "OAB" set (Bahadur *et al*. 1985). Host pathogen interactions were recorded after 15 days by following standard method of Stakman *et al*. (1962). The virulence of each of the isolate was identified by binary notation system (Bahadur *et al*. 1985) and per cent frequency distribution of each of the pathotype was worked out and consolidated state wise. The reaction of *Sr* genes in differential sets is presented in Table 1.

Entire work was carried out under glasshouse conditions at Regional Wheat Rust Research Station, Mahabaleshwar. The prevalence and frequency pattern of different pathotypes of stem rust in Central and Peninsular India revealed that in Tamil Nadu during off-season pathotypes 40,40-1, 40A, 42, 122, 295, 117-2, 117-3, 117-5 and 117-6 were detected during 2004-2005, while pathotypes 40, 40-1, 40A, 122 and 117-3 were detected during 2005-2006. Pathotype complex 40 was reported most frequently during both years under study, while it was followed by complex 117 during 2004-05 and pathotype 122 in 2005-2006 in Tami Nadu during off-season. During *rabi* 2004-05

Table 1. Reaction of *Sr* geneline in "OAB" set to the reported pathotypes.

Sr. geneline	Pt. 40 (104G13)	Pt. 40-1 (62G29-1)	Pt. 40A (62G29)	Pt. 42 (19G35)	Pt. 117-2 (33G3)	Pt. 117-3 (167G3)	Pt. 117-5 (166G2-2)	Pt. 117-6 (37G19)	Pt. 122 (7G11)	Pt. 295 (7G43)
"O" set :										
Sr-24	R	S	R	R	R	R	R	R	R	R
Sr-25	R	R	R	R	R	R	R	R	R	R
"A" set :										
Sr-13	R	R	R	S	S	S	R	S	S	S
Sr-9b	R	S	S	S	R	S	S	R	S	S
Sr-11	R	S	S	R	R	S	S	S	S	S
Sr-28	S	S	S	R	R	R	R	R	R	R
Sr-8	R	S	S	S	R	R	R	R	R	R
Sr-9e	S	S	S	R	S	S	S	S	R	R
Sr-30	S	R	R	R	R	R	R	R	R	R
Sr-37	R	R	R	R	R	S	S	R	R	R
"B" set :										
Marquis	S	S	S	S	S	S	R	S	S	S
Eiticorn	R	R	R	S	S	S	S	S	S	S
Kota	S	S	S	R	R	R	R	R	R	R
Reliance	S	S	S	R	R	R	R	R	S	S
Charter	R	S	S	R	R	R	R	S	R	R
Khapli	R	R	R	S	R	R	R	R	R	S

Pt = pathotype, R = resistant, S = susceptible

stem rust was not reported from Maharashtra and Karnataka. During rabi 2005-06 it was reported in Karnataka state only in which pathotypes 40 (4.0%), 40-1(6.0%) 40A (60%), 122 (26%) and 117-3 (4.0%) were reported during analysis. According to statewise frequencies, in Karnataka state the pathotype 122 (53.84%) was reported with highest frequency during 2005-06. The pathotypes 40(15.38%),40-1(15.38%), and 40-A(15.38%) were reported with similar frequency. The stem rust was also not reported in Maharashtra state during 2005-06.

The data from Table 1 revealed that the most resistance genes in "OAB" set are *Sr* 25 and *Sr* 30. It is therefore, necessary to incorporate these genes in future breeding programme. The pathotype complex 40 and 117 were also reported by Lokhande and Patil (1996), Mutkekar *et al.* (1987). Patil *et al*. (l992) also reported presence of pathotypes complex 40, 117 and 122 in nature. The reappearance and disappearance of pathotypes 117 and 122 is always observed in nature (Lokhande and Patil 1996).

R. J. Patil
G. G. Khot
V. S. Shinde
S. R. Lohate
A. M. Tirmali
B. P. Kurundkar

Regional Wheat Rust Research Station,
Mahabaleshwar - 412 806 (India)
August 25, 2008.

LITERATURE CITED

Bahadur, P. S., Nagrajan and S. K. Nayar. 1985. A proposed system for virulence designation in India 2. *Puccinia graminis* f. Sp. *tritici*. Proceed. the Indian Acad. of Plant Sci. 95 : 29-33.

Lokhande, S. B. and R. J. Patil. 1996. Prevalence and distribution of physiological races of stem rust (*Puccinia graminis* f. Sp. *tritici*) in Penninsular and Central India during 1993-94 and 1994-95. Cer. Rust and Pow. Mill. Bull. 24 (1&2) : 79-80.

Mutkekar, M. L., A. R. Kalekar, J. V. Patil and R. T. Sapkal. 1987. Prevalence and distribution of physiological races of wheat in Penninsular India during 1984-86. Cer. Rust and Pow. Mill. Bull. 15 (2) : 69-71.

Patil, R. J., R. T. Sapkal and M. L. Mutkekar. 1992. Prevalence and distribution of physiological races of stem rust (*Puccinia graminis* f. Sp. *tritici*) in Penninsular India during 1986-87 and 1988-89. Cer. Rust and Pow. Mill. Bull. 20 (1&2) : 50-51.

Stakman, E. C., D. M. Steward and D. M. Loegering. 1962. Identification of physiologic races of *Puccinia graminis* var. *tritici* U.S. Dep. Agric. Res. Ser. Bull. pp 53.

J. Maharashtra agric. Univ., 34 (3) : 366-368 (2009)

Influence of Wrapping Material, Storage Temperature and Duration on Post Harvest Life of Tuberose (*Polianthes tuberosa* L.) cv. Local Double

The wrapping and storage of cut flowers is aimed to restrict the change in metabolic activities in order to conserve the water status and sugars in the petal cells with a view to maintain the fresh weight and dry weight of the cut flowers during the storage and the protection of flowers from physical damage.

The cut spikes of tuberose were harvested in the morning when lower most two basal florets were fully opened. Spikes were cut uniformly with 60 cm length, basal leaves were removed and weighed in the laboratory.

The fresh cut spikes of tuberose cv. Local Double were kept in plastic bottles holding 200 ml pulsing solution (250 mg lit^{-1} 8-HQC + 3 % sucrose) for 45 minutes, then after three spikes were wrapped (40 x 15 cm) with polyethylene 100 gauge (W_1), news paper (W_2), tissue paper (W_3) and without wrapping (W_4) and immediately kept them in cold storage rooms at 2°C (C_1), 5°C (C_2) and 10°C (C_3) temperature respectively. Spikes were removed from the cold storage after 4^{th} (D_1), 6^{th} (D_2), 8^{th} (D_3) and 10^{th} (D_4) days' storage duration, respectively. After cold storage treatments experimental material was kept in plastic bottles of 300 ml capacity holding distilled water in the laboratory at room temperature.

The experiment was laid out in completely randomized design. Observations were recorded on per cent of weight after cold storage,

per cent of weight at the end of vase life, per cent of open florets and per cent of unopened florets at the end of vase life, uptake of water, longevity of single open floret, useful vase life of spike, total vase life of spike, total post harvest life of spike and visual quality of flower.

The significantly minimum loss in weight after cold storage (3.99%) and at the end of vase life (15.32%) was observed at 5°C dry cold storage temperature with polyethylene wrapping (3.93, 14.99% respectively) at 4 days storage duration (3.48, 11.72%, respectively) in cut tuberose spikes. Low cold storage temperature slowdown the transpirational loss of water and respirational loss of carbohydrate which reduces the loss of weight during storage. Shankar and Bhattacharjee (2003) in rose and Singh *et al*. (2003) in gladiolus also reported similar results.

The significantly maximum per cent of opened florets (57.98%, 58.93% and 60.64% respectively) and minimum unopened florets percentage (42.01%, 41.06 and 39.35% respectively) of tuberose spike was recorded at 5°C dry cold storage temperature with polyethylene wrapping after 4 days storage duration. While, minimum per cent of florets opening and maximum percentage of unopened florets was recorded at 2°C dry storage temperature without wrapping and 10 days of cold storage duration. The opening of florets in tuberose spikes is directly related to the normal metabolic activities mainly respiration and carbohydrate content in cut spikes. Prolonged storage leads to desiccation and unopening of florets and depletion of stored carbohydrates and water loss which increase with increase in duration (Kumar *et al*. 2003b). This leads to decrease in bud opening of cut spikes which stored for longer duration. These findings are in agreement with those obtained in tuberose by Kumar *et al*. (2003 a and b) while in gladiolus by Patil *et al*. (1994) and Singh *et al*. (2003).

The significantly higher water uptake was observed at 5°C dry cold storage temperature (67.91 ml), polyethylene wrapping (69.40 ml) and 4 days storage duration (73.93 ml). The water uptake decreated in cut spikes which stored for longer duration because the ability of xylem cells to absorb water was continuously decreased as the duration of storage increased (Katwate *et al*. 1995). These results corroborate well with those reported by Kumar et al. (2003 a), Kumar *et al*. (2003 b) in tuberose and Patil *et al*. (1994) and Singh *et al*. (2006) in gladiolus.

The significantly maximum longevity of single open floret was recorded at 5°C dry cold storage temperature (2.69 days), W_1-polyethylene wrapping (2.74 days) and 3.14 days in 4 days cold storage duration while minimum in 2°C cold storage temperature (2.57 days), no wrapping (2.63 days) and 10 days cold storage duration (2.19 days). Similarly, significantly maximum useful vase life (6.81 days, 7.10 days and 7.44 days), total vase life (8.88 days, 9.14 days and 9.58 days) and total post harvest life (13.81 days, 14.10 days and 15.90 days) of tuberose spikes was recorded in treatment of 5°C dry cold storage temperature with polyethylene wrapping and 4 days storage duration respectively while minimum useful vase life, total vase life and total post harvest life were found in 2°C cold storage temperature without wrapping (control) with 10 days cold storage duration. The transpirational loss of water and respirational loss of carbohydrate is slowdown due to low temperature and polyethylene wrapping maintained the weight as well as cell turgidity of cut spikes after cold storage at the end of vase life (Kumar *et al*. 2003 a). This further continued to more water uptake and less depletion of carbohydrate in the flower spikes (Singh *et al*. 2006). Similar results were also obtained by Katwate *et al*. (1995), Kumar *et al*. (2003 b), Kumar *et al*. (2003 c) in tuberose while Madaiah and Reddy (1994), Patil *et al*. (1994), Singh *et al*. (2003) and Patil and Prasant (2003) supported above results.

The increase in duration of storage without wrapping decreased the useful vase life and deteriorated the flower quality. The flower quality i.e. turgidity, shining and freshness, was excellent in polyethylene wrapping spikes stored for 4 days in cold storage at different storage temperatures. The better cut flower quality of the spikes was observed in tissue paper than newspaper wrapping and unwrapping condition. Low temperature and wrapping material maintain the freshness, shining and quality of cut flowers which has been positively correlated with the turgidity and the respiratory substrates in the flowers which influence the vase life. A loss of turgidity and carbohydrates in the flower tissue would lead to flower fading and ultimately withering, hence for longer vase life continuous uptake of water is

necessary. These results are in close association with those reported by Singh *et al*. (2006) in gladiolus and Shankar and Bhattacharjee (2003) in cut rose.

Sudha D. Patil

B. K. Dhaduk

Dept. of Floriculture and Landscaping
ASPEE, College of Horticulture and Forestry
Navsari - 396 450 (India)
October 19, 2008.

LITERATURE CITED

Katwate, S. M., M. T. Patil and B. R. Singh. 1995. Influence of low temperature storage on longevity of cut spikes of tuberose. J. Maharashtra agric. Univ., 20 (2) : 289-290.

Kumar, V., S. K Bhattacharjee, R. Kumar, R. L. Misra and K. P. Singh. 2003 a. Post harvest life and quality of tuberose spike as affected by colouring agents and storage. J. Ornam. Hort., 6 (2) : 119-125.

Kumar, V., S. K. Bhattacharjee, R. L. Misra and Suchitra. 2003 b. Influence of pulsing followed by duration of dry cool storage on vase life of tuberose spikes. Ann. Agric. Res., (New series), 24 (3) : 639-644.

Kumar, V., S. K. Bhattacharjee, Suchitra and K. P. Singh. 2003 c. Influence of pulsing and dry cool storage on cut spikes of tuberose cv. 'Double'. J. Applied Hort., 5 (1) : 16-20.

Madaiah, D. and T. V. Reddy. 1994. Influence of polyethylene packaging on the post harvest life of tuberose florets cv. 'Single'. Karnataka J. Agri. Sci., 1 (2) : 154-157.

Patil, M. T., S. M. Katwate, B. R. Singh, P. N. Kale and A. B. Deokar. 1994. Influence of low temperature storage on longevity of cut spike of Gladiolus cv. Suchitra. J. Maharashtra agric. Univ., 19 (1) : 142-143.

Patil, V. S. and S. G. Prasant. 2003. Post-harvest physiology of gladiolus. Nat. Symp. on recent advances in Indian Floriculture, pp. 374-376.

Shankar, M. V. and S. K. Bhattacharjee. 2003. Efficacy of various wrappings for packaging on vase life of cut roses. J. Ornam. Hort., 6 (2) : 147-148.

Singh, A., P. Kumar and J. Kumar. 2006. Standardization of postharvest technologies in gladiolus cut spikes. Ph.D. thesis. Dep. of Hort., C.C.S. University, Meerut.

Singh, K., P. J. Singh and J. S. Arora. 2003. Studies on dry refrigerated storage of gladiolus spikes. J. Ornam. Hort., 6 (2) : 107-109.

J. Maharashtra agric. Univ., 34 (3) : 369-371 (2009)

INDEX TO AUTHORS

Volume 34, 2009

J. Maharashtra agric. Univ., 34 (3) : 372-373 (2009)

TABLE OF CONTENTS

Volume 34, 2009

J. Maharashtra agric. Univ., 34 (3) : 374-374 (2009)

FORM IV

1.	Place of Publication	:	College of Agriculture, Pune - 411 005 (Maharashtra State)
2.	Periodicity of its Publication	:	Thrice in a year
3.	Printer's Name Nationality Address	: : :	S. R. Gupta Indian Flamingo Business Systems 19, Laxminagar Commercial Complex No. 1 Shahu College Road, Pune - 411 009
4.	Publisher's Name Nationality Address	: : :	Dr. P. N. Harer Indian College of Agriculture, Pune - 411 005
5.	Editor's Name Nationality Address	: : :	Dr. P. N. Harer Indian College of Agriculture, Pune - 411 005
6.	Names and Address of Individuals, who own the Journal and partners or share holders holding more than one per cent of the total		The Registrar, 1. Mahatma Phule Krishi Vidyapeeth, Rahuri - 413 722 2. Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola - 444 104 3. Marathwada Agricultural University, Parbhani - 431 402 4. Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli - 415 712

I, Dr. P. N. Harer, hereby declare that the particulars given above are true to the best of my knowledge and belief.

Date of Issue : September, 2009

Date of Publication : September 1, 2009

P. N. Harer
Editor-in-Chief

FIGURES - Identify graphs, line drawings and photographs with consecutive Arabic numbers, as Fig. 1, Fig. 2. Place figures after tables. Photographs must be clear, glossy prints. Original graphs and drawings must be in Indian ink or equivalent on plain, white drawing paper. Letter in Indian ink with a lettering guide large and bold enough to permit reduction. Each figure should be referred to in the text. The title of paper and fig. number should be placed in pencil on the back of each fig. for identification.

TRADE OR BRAND NAMES - Trade or brand names are not used in permanent literature. State trade or brand names only in parentheses. The active ingredient, chemical formula, purity and diluent or solvent may be stated in the text. Capitalize the first letter of trade or brand names.

ABBREVIATION - In both text and tables except for the first word in a sentence long words or terms used repeatedly should be abbreviated usually without a period (e.g. a.m. ppm. m. °C, N, P, K, K_2SO_4). Use standard abbreviations. Names of organic chemicals and other terms, abbreviated for the reader's convenience should be spelled out first with parenthetical abbreviation used.

ARABIC NUMERICALS - Use Arabic numericals in all cases except the beginning of sentence or where the use would be unclear.

SEPARATES / REPRINTS - Ten copies will be supplied free of cost.

ADVERTISEMENT - Advertise of Agro-based industries will be published on Cover Page No. 2 and 3 full page at the cost of Rs. 4000/- and 3000/- respectively.

CORRESPONDENCE - Business correspondence, remittances, subscriptions, change of address etc. should be addressed to The Editor-in-Chief, Journal of Maharashtra Agricultural Universities, College of Agriculture, Pune - 411 005, INDIA.

The correspondence regarding exchange of journal should be done with the Dean, Faculty of Agriculture of respective Agricultural University in Maharashtra State (India).

Journal of Maharashtra Agricultural Universities is published thrice in a year preferably in the month of January, May and September. The Journal is devoted to papers on original research in any branch of Agricultural Sciences. The contribution of papers is open to the subscribers only.

SUBSCRIPTION RATES :

(1)	Student subscriber	Rs. 100/– per annum
(2)	Member subscriber	Rs. 150/– per annum
(3)	Institution	Rs. 800/– per annum
(4)	*Single Copy :*	
	(a) Individual	Rs. 60/–
	(b) Institution	Rs. 250/–
(5)	*Life Member :*	
	(a) Individual	Rs. 1,500/–*
	(b) Institution	Rs. 3,000/–
(6)	Patron	Rs. 8,000/–
(7)	Sustaining Associate	Rs. 15,000/–
(8)	*Foreign Countries :*	
	(a) Individual	$ 60/–
	(b) Institution	$ 120/–
(9)	*Foreign Countries (Single copy) :*	
	(a) Individual	$ 30/–
	(b) Institution	$ 50/–

(*can also be paid in 3 instalments in a year)

A company dealing in Fertilizers, Agricultural Equipments, Pesticides, Insecticides, Fungicides, etc. and paying an amount of Rs. 15,000/- and above can become a Sustaining Associate of the Journal. The Sustaining Associates will be allowed to publish free of cost a full page advertisement once in a year. The Life Members, Patrons and Sustaining Associates will be supplied free of cost a copy of each number of a volume.

Registered with the Registrar of Newspaper for India under R.No. 27971/76

PREPARATION OF MANUSCRIPT

Authors are urged to have one or more colleagues, read the manuscript critically prior to submission. Submission implies non-submission elsewhere and if accepted, no future publication without the consent of the Editorial Board.

Submit with a covering letter one original and one copy of the manuscript typewritten on one side, on bond paper (22x28 cm) and double space including title, abstract, text, literature cited, tables, headings and figure legends. One copy should be without author's name, address and acknowledgement. Footnotes should be avoided. Liberal margins should be left for Editorial marking. Number the pages of title, text, literature cited, tables and figures in that order. Tables and captions of figures should be separate and every sheet of manuscript should be numbered. A serial number, assigned to each new manuscript accompanies its acknowledgement to the author who submitted it. Refer to that number in all subsequent correspondence.

MODE OF SUBMISSION - Authors should submit the review / research article / note alongwith prescribed "Article Certificate" directly to the Journal with a copy of it to the Director of Research / Dean / Head of the Institution and, after its publication, a copy of reprint of the paper for his record.

TITLE - The title should be unique and concise description of the paper. It should not exceed 10 to 15 words. Names of the authors should be centered directly below the title. The name and location of the senior author/institution (The institution where most of the research work is conducted) is centered below the author's name. The designations and addresses of the author/s are foot noted.

ABSTRACT - The abstract is placed on the next line after Institution's name on page 1. It should be a concise summation of the findings and should include names of organisms, effects of major treatments and major conclusions. It should not exeed 5 per cent of the length of the paper.

KEY WORDS - A list of additional Key words may be included below the abstract.

HEADINGS - Centre and capitalize letters of main headings of the paper i.e. ABSTRACT, MATERIALS AND METHODS, RESULTS AND DISCUSSION and LITERATURE CITED. Do not centre secondary headings. Place the secondary headings with the first letter of the word capitalized at the beginning of the paragraph.

STYLE - Manuscripts must conform to current standards of English style and usage. The first person pronoun is accepted and often preferred for clarity. Main clauses should usually be stated first. The introduction without a heading should state clearly why the research was conducted with reference to earlier work. Give enough information on methods to indicate how the research was conducted so that the reader will have confidence in the validity of the result. Omit details unless it is method paper. Present results succinctly with emphasis on main effects. Use tables and figures to illustrate the text, interprete the results in discussion. Brief conclusion can terminate the discussion. Complex conclusions should form a separate section. Underline the botanical/scientific names.

LITERATURE CITED - List citations alphabetically by names of authors and type them after the text. The form should be in the order of names of the authors, year, subject title, name of publication (in Roman), Vol. and inclusive page numbers.

EXAMPLES :

Dorsey, M.J. and J.W. Bushnall. 1920. The hardiness problem. Proc. Amer. Soc. Hort. Sci. 17:210-224.

Snedecor, G.W. 1956. Statistical Methods. 5th Edn. Iowa State Univ. Press, Ames, Iowa, pp.534.

Whiteside, W.F. 1973. A study of light as influenced by time and planting date on growth of onion (*Allium cepa* L.) in the glasshouse and the field. Ph.D. Thesis, Univ. of Illinois at Urbana-Champaign, pp.53.

TABLES - Type tables in double-space on separate pages, each one referred to in the text and numbered with Arabic numerals (e.g. Table 1). The title of each table should identify its contents so that reference to the text is not necessary. Title and column heading should be brief. Unnecessary descriptive matter should be avoided. Column and row heading with footnotes should be self explanatory. Capitalize only the first letter of the first word of each column and row heading. Use lower case letter from the end of alphabet (x,y,z) to identify tabular footnotes. Use lower case letters from the beginning of alphabet (a,b,c) or asterisks with explanatory footnotes at 5% level, capitals for significance at 1% level.

(Continued on inside back cover)

Edited and Published by Dr. P. N. Harer at College of Agriculture, Pune 411 005.
Typeset Processed and Printed by : Flamingo Business System, 19, Laxminagar Comm. Complex-1, Pune-411 009. Tel. : 24214636

Date of Issue : September, 2009

Date of Publication : September 1, 2009