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Effect of Green Manuring of Garadi Leaves (*Cleistanthus collinus*) on Soil Physico-Chemical Properties and Yield of Paddy in Eastern Vidarbha Zone

Usha R. Dongarwar[1], V.S. Shinde[2] and C.B. Mendhe[3]

ABSTRACT

A study on effect of garadi leaves (*Cleistanthus collinus*) on physico-chemical properties of soil and yield of paddy was carried out on clay loam soil with available N, P_2O_5 and K_2O 220.0, 28.0, 290.0 kg ha^{-1}, respectively during *Kharif* for consecutive three years from 2000-2003 at Agriculture Research Station, Sakoli (Bhandara) in the Eastern Vidarbha Zone. The experiment comprised of seven treatments (i.e. control, garadi leaves application @ 0.75 t ha^{-1}, garadi leaves application @ 1.0 t ha^{-1}, garadi leaves application @ 1.25 t ha^{-1}, garadi leaves application @ 1.50 t ha^{-1}, spraying of monocrotophos as per recommendation and foliar spray of 10 per cent garadi leaves extract) replicated thrice in randomized block design. The recommended dose of fertilizer 100:50:50 kg NPK ha^{-1} was applied to all the treatments. The pooled results revealed that the application of garadi leaves @ 1.5 t ha^{-1} gave significantly higher paddy grain yield over rest of the treatments except treatment garadi leaves application @ 1.25 t ha^{-1} which was at par with treatment garadi leaves application @ 1.50 t ha^{-1}. The treatment T_5 gave 6.70 per cent, 12.85 per cent and 30.52 per cent more grain yield over T_4, T_6 and control, respectively. The bulk density was found to be decreased by incorporation of garadi leaves indicating the improvement of soil structure, porocity, and maximum water holding capacity. The available NPK kg ha^{-1} was also increased due to application of garadi leaves. Hence, it can be stated that the application of garadi leaves @ 1.5 t ha^{-1} gave higher monetary return.

Organic manures application generally improve the soil physical, chemical and biological properties alongwith conserving and improving the moisture holding capacity of soil and results in enhanced crop productivity.

Green manuring is also a cheap and effective way of improving soil fertility as long as water conditions permit. It proves better and efficient as fertilizer for rice crop. Green manuring in combination with chemical fertilizers improve the soil fertility, yield and also has residual effect on succeeding crop. In paddy, it has been observed that green manuring before transplanting helps to sustain with high yield levels. Agroforestry is an ageold land use that has been practiced by farmers and agrisilviculture is the major class of agroforestry. Garadi (*Cleistanthus collinus*) is one of the most important multipurpose tree which grow very profusely in wasteland, forests and paddy bunds in Eastern Vidarbha Zone of Maharashtra state used as green manure (2.18% N) and for fencing as it contains *Cleistanthus* which is toxic and repellent for insects and pests of paddy crop. Research work is not available on this tree in EVZ. Keeping this in view, the present study was undertaken to study the effect of garadi leaves on growth, yield of paddy and physico-chemical properties of soil.

MATERIAL AND METHODS

Experiment was conducted for consecutive three years during *Kharif* 2000-2001 to 2002-2003 at Agriculture Research Station, Sakoli, District Bhandara. The experiment was laid out in randomized block design with three replications. There were seven treatments viz., control, Incorporation of garadi leaves @ 0.75 t ha^{-1} at transplanting, garadi leaves incorporation @ 1.0 t ha^{-1}, incorporation of garadi leaves @ 1.25 t ha^{-1}, incorporation of garadi leaves @ 1.50 t ha^{-1}, spraying of monocrotophos as per recommendation (0.05%) and

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foliar spray of 10 per cent garadi leaves extract. A common dose of 100:50:50 kg NPK ha^{-1} was applied to all treatments. Rice variety PKV HMT was used. The gross and net plot size was 4.0 x 4.5 m^2 and 3.6 x 4.20 m^2, respectively. The crop was transplanted at 20 x 15 cm spacing during the second week of July during all three years. The initial fertility status was pH 7.1, EC (dSm^{-1}) 0.19. The soil is low in organic carbon, nitrogen and phosphorus and rich in potash (organic carbon 0.35 per cent, total N 739, available N 220 kg ha^{-1}, available P_2O_5 28 kg ha^{-1} and available K_2O 290 kg ha^{-1}). The irrigation was given as per requirement.

RESULTS AND DISCUSSION

I. Grain Yield of Paddy

The data on grain yield of paddy presented in Table 1 indicated that incorporation of garadi leaves @ 1.5 t ha^{-1} recorded significantly higher grain yield as compared to rest of the treatments during 2000-2001 and 2001-2002.

In the pooled result of three years the incorporation of garadi leaves @ 1.5 t ha^{-1} (T_5) gave significantly higher grain yield over all other treatments, however, it was at par with treatment T_4. Incorporation of garadi leaves @ 1.5 t ha^{-1} (T_5) gave 6.70 per cent, 12.85 per cent and 30.52 per cent more grain yield over T_4, T_6 and control, respectively. This is attributed due to higher N content in garadi leaves that becomes available to crop.

II. Physical and Chemical Properties of Soil

The data obtained after the analysis of post harvest soil (Table 2 and 3) indicated that bulk density found to be decreased by incorporation of garadi leaves indicating the improvement of soil structure. The porocity and maximum water holding capacity was increased due to incorporation of 1.5 t ha^{-1} garadi leaves. Available NPK was also increased due to incorporation of garadi leaves. Similar results were reported by Chaphale *et al.* (2000) with glyricidia green manuring and Gangwar *et al.* (2004) with subabul (*Leucaena leucocephala*) green manuring.

Economic Analysis

The data on cost of cultivation, gross and net monetary return and cost benefit ratio as influenced by various treatments (Table 4) indicated that the highest cost benefit ratio was recorded with application of garadi leaves @ 1.5 t ha^{-1} followed by foliar sprays of 10 per cent garadi leaves extract and garadi leaves application @ 1.25 and 1.0 t ha^{-1}.

Table 1. Mean grain yield as influenced by various treatments

Treatments	Grain yield (q ha^{-1})			
	2000-2001	2001-2002	2002-2003	Pooled mean (q ha^{-1})
T_1 - Control	20.14	16.51	51.92	29.52
T_2 - Garadi leaves application @ 0.75 t ha^{-1}	25.02	20.27	56.92	30.07
T_3 - Garadi leaves application @ 1.00 t ha^{-1}	26.77	20.39	57.93	35.03
T_4 - Garadi leaves application @ 1.25 t ha^{-1}	28.52	21.65	58.18	36.11
T_5 - Garadi leaves application @ 1.50 t ha^{-1}	33.52	22.77	59.30	38.53
T_6 - Spraying of Monocrotophos (0.05%)	24.77	21.52	57.53	34.60
T_7 - Foliar spray of (10%) garadi leaves extract	24.02	20.27	58.15	34.14
'F' test	Sig.	Sig.	NS	Sig.
SE (m) ±	0.84	1.11	1.75	0.91
CD at 5%	2.59	3.13	-	2.56
CV %	4.54	9.44	5.33	-

Table 2. Physical properties of soil as influenced by different treatments

Treatments	2000-2001				2001-2002				2002-2003			
	B.D. gm/cm^3	P.D. gm /cm^3	Porocity %	MWHC %	B.D. gm/cm^3	P.D. gm/cm^3	Porocity %	MWHC %	B.D. gm/cm^3	P.D. gm/cm^3	Porocity %	MWHC %
T_1 - Control	1.42	2.26	33.05	35.90	1.41	2.25	33.05	35.90	1.43	2.27	33.05	35.92
T_2 - Garadi leaves application @ 0.75 t ha^{-1}	1.39	2.18	33.20	36.09	1.38	2.19	33.20	36.09	1.40	2.18	33.20	36.10
T_3 - Garadi leaves application @ 1.00 t ha^{-1}	1.37	2.21	30.20	38.68	1.38	2.20	33.70	38.61	1.38	2.21	39.70	38.70
T_4 - Garadi leaves application @ 1.25 t ha^{-1}	1.35	2.20	34.10	41.19	1.36	2.20	34.11	41.19	1.36	2.20	34.10	41.20
T_5 - Garadi leaves application @ 1.50 t ha^{-1}	1.37	2.09	34.95	41.49	1.38	2.09	34.90	41.48	1.38	2.10	34.95	41.52
T_6 - Spraying of Monocrotophos (0.05%)	1.42	2.25	33.05	34.90	1.39	2.25	33.04	24.90	1.43	2.26	33.05	34.95
T_7 - Foliar spray of (10%) Garadi leaves extract	1.42	2.26	33.07	35.18	1.40	2.26	33.07	35.18	1.44	2.26	33.07	35.20

Table 3. Chemical properties of soil as influenced by different treatments

Treatment	2000-2001				2001-2002				2002-2003			
	O.C. %	N Kg ha^{-1}	P_2O_5 Kg ha^{-1}	K_2O Kg ha^{-1}	O.C. %	N Kg ha^{-1}	P_2O_5 Kg ha^{-1}	K_2O Kg ha^{-1}	O.C. %	N Kg ha^{-1}	P_2O_5 Kg ha^{-1}	K_2O Kg ha^{-1}
T_1 - Control	0.35	220	29	284	0.34	222	28	280	0.36	222	30	285
T_2 - Garadi leaves application @ 0.75 t ha^{-1}	0.40	226	31	300	0.40	224	30	291	0.42	227	32	310
T_3 - Garadi leaves application @ 1.00 t ha^{-1}	0.44	228	35	330	0.41	226	34	330	0.46	230	36	340
T_4 - Garadi leaves application @ 1.25 t ha^{-1}	0.50	235	37	341	0.49	237	36	340	0.50	236	37	345
T_5 - Garadi leaves application @ 1.50 t ha^{-1}	0.50	246	41	342	0.50	246	40	342	0.55	247	42	350
T_6 - Spraying of Monocrotophos (0.05%)	0.50	220	30	230	0.50	221	30	241	0.39	223	31	230
T_7 - Foliar spray of (10%) Garadi leaves extract	0.49	220	30	284	0.48	221	30	231	0.34	224	31	285

Table 4. Economic analysis

Treatments	Mean cost of cultivation (Rs.)	Pooled mean of grain yield (q ha^{-1})	Mean straw yield (q ha^{-1})	Gross monetary return (Rs. ha^{-1})	Net monetary return (Rs. ha^{-1})	C:B ratio
T_1 - Control	14750	29.52	33.08	23642	8892	1:1.60
T_2 - Garadi leaves application @ 0.75 t ha^{-1}	14925	30.07	35.99	24630	9705	1:1.65
T_3 - Garadi leaves application @ 1.00 t ha^{-1}	15010	35.03	36.08	25187	10177	1:1.68
T_4 - Garadi leaves application @ 1.25 t ha^{-1}	15075	36.11	37.48	25672	10597	1:1.70
T_5 - Garadi leaves application @ 1.50 t ha^{-1}	15140	38.53	39.41	26598	11458	1:1.76
T_6 - Spraying of Monocrotophos (0.05%)	15862	34.60	36.59	25838	9976	1:1.63
T_7 - Foliar spray of (10%) Garadi leaves extract	15118	34.14	37.15	26151	11033	1:1.73

Garadi leaves : Rs. 250 t^{-1}, Selling rate of PKV HMT : Rs. 750 q^{-1},
Straw : 25 Rs. q^{-1}, Cost of monocrotophos : Rs. 350 L^{-1}

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Response of Groundnut to Land Configuration, Phosphorus and Phosphate Solubilizing Bacteria

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ABSTRACT

A field experiment was conducted during *Kharif* season of 2000-01 to 2002-03 at Agriculture College Farm, Nagpur to study the response of groundnut to land configuration, phosphorus and phosphate solubilizing bacteria. Application of 100 per cent recommended phosphorus dose (50 kg ha $^{-1}$) and 75 per cent recommended phosphorus dose (37.5 kg ha $^{-1}$) + PSB recorded similar dry pod yield of 10.89 and 10.42 q ha^{-1}, respectively indicating that 25 per cent phosphorus dose can be saved by application of PSB. Total uptake of NPK (kg ha^{-1}) was also at par with 100 per cent phosphorus dose and 75 per cent phosphorus dose + PSB. Every year addition of reduced phosphorus dose along with PSB increases availability of phosphorus nearly by 10 per cent over 100 per cent phosphorus dose without PSB. Land configuration treatments did not show any significant differences in dry pod yield, uptake of NPK and availability of phosphorus.

The productivity of groundnut crop in Maharashtra state is low due to several constraints. Unavailability of phosphate and cultivation practices are the major reasons for low productivity of groundnut. As phosphorus is immobile, present in unavailable form, it is necessary to convert it into available form so as the requirement of crop can be fulfilled. The phosphate solubilizing bacteria can solubilize unavailable form of phosphorus into available form. They can solubilize 20 to 22 per cent insoluble phosphate into available form and increase yield attributes, dry pod yield (10 to 20 %) and uptake of phosphate (Ramesh and Sable, 2001). Cultivation practices such as earthing up through land configuration are essential for pod development as well as for conservation of moisture at critical stages of crop. Rasve *et.al.* , (1983) reported ridges and furrows in groundnut crop conserve moisture during critical stages and gave higher dry pod yields than flat bed cultivation.

MATERIAL AND METHODS

A field experiment was conducted during *Kharif* 2000-01 to 2002-03 at Agriculture College Farm, Nagpur to study the response of groundnut to land configuration, phosphorus and phosphate solubilizing bacteria. The soil of the experimental plot was vertisol with pH 7.8, initial available N, P and K were 274.2, 16.11 and 322.0 kg ha^{-1}, respectively. The experiment was conducted in factorial randomized block design with three replications. The treatments were (A) Phosphate fertilizer and PSB i.e. 100 per cent phosphate as per recommended dose (F_1), 75 per cent phosphate fertilizer +PSB (F_2) and 50 per cent phosphate fertilizer + PSB (F_3). In both the treatments F_2 and F_3 PSB @ 3 kg ha^{-1}soil application was made at the time of sowing. (B) Land configuration i.e. Flat bed (T_1), Flat bed and furrow after three rows (T_2) and Flat bed and furrow after six rows (T_3). In treatment T_2 and T_3 furrows were opened after three and six rows, respectively at 25 days from sowing.

The fertilizer dose of nitrogen was applied as per recommendations. Phosphate fertilizer was given as per treatments. Both the fertilizers (Nitrogen and Phosphate) were applied at the time of sowing.

The soil samples were taken to analyze initial status of the soil and after experiment every year to study the effect of land configuration and phosphate fertilizer and PSB on nutrient balancing and uptake by the crop. Observations on pod yield, haulm yield, yield contributing parameters, nutrient uptake and total nutrients added to the soil were taken. Cost: benefit ratio was calculated according to prevailing market rates.

RESULTS AND DISCUSSION

Effect of phosphate fertilizer and PSB

Individual year as well as mean data indicated that application of 100 per cent phosphate dose ha^{-1} and 75 per cent phosphate dose + PSB recorded statistically similar yield levels and were significantly more over 50 per cent dose of phosphate + PSB in respect of dry pod yield. In pooled data, over all increase in dry pod yield

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Table 1. Effect of land configuration, phosphorus and PSB on yield, yield attributes and economics

Treatments	Dry pod yield (q ha^{-1})				No. of pods plant^{-1}	Dry pod yield plant^{-1} (g)	Haulm yield (q ha^{-1})	Gross monetary returns (Rs ha^{-1})	Cost of cultivation Rs ha^{-1})	C: B ratio
	2000-01	2001-02	2002-03	Pooled mean						
(A) Phosphate fertilizer and PSB										
F_1 -100% Phosphate	13.18	10.64	8.86	10.89	10.47	5.29	20.50	22033	10746	2.05
F_2 -75% Phosphate + PSB	12.88	9.75	8.63	10.42	10.17	5.04	19.40	20978	10352	2.03
F_3 – 50% Phosphate + PSB	11.17	8.98	8.05	9.40	9.24	4.52	17.68	19044	10109	1.88
S. E. (m) ±	0.43	0.34	0.09	0.19	-	-	-	374	-	-
C. D. at 5 %	1.23	1.02	0.26	0.51	-	-	-	1121	-	-
(B) Land configuration										
T_1 - Flat bed	11.94	9.49	8.56	10.00	9.74	4.89	18.91	20267	10262	1.97
T_2 - Flat bed + furrow after 3 rows	12.95	9.98	8.37	10.43	10.12	5.03	19.52	20944	10542	1.99
T_3 – Flat bed + furrow after 6 rows	12.34	9.90	8.60	10.28	10.02	4.93	19.14	20844	10402	2.00
S. E (m) ±	0.43	0.34	0.09	0.19	-	-	-	374	-	-
C. D. at 5%	NS	NS	NS	NS	-	-	-	-	-	-
C. V. %	10.54	10.44	13.13	-	-	-	-	-	-	-

Market rate - Groundnut dry pod - Rs 1527 q^{-1}
Groundnut haulm - Rs 260 q^{-1}
Phosphorus - Rs 19.50 kg^{-1}
PSB - Rs 50 kg^{-1}

Table 2. Effect of land configuration, phosphorus and PSB on nutrient uptake and residual nutrient status of soil

Treatments	Nutrient uptake (kg ha^{-1})			Residual nutrient status (kg ha^{-1})		
	N	P	K	N	P	K
(A) Phosphate fertilizer and PSB						
F_1 – 100 % Phosphate	68.41	15.33	36.29	270.50	16.48	328.39
F_2 - 75 % Phosphate + PSB	68.65	15.02	35.96	269.00	18.18	316.86
F_3 - 50 % Phosphate + PSB	61.30	13.40	32.23	262.93	18.09	310.98
S.E (m) ±	1.61	0.31	0.75	-	-	-
C. D. at 5 %	4.84	0.90	2.23	-	-	-
(B) land configuration						
T_1 – Flat bed	67.41	14.27	34.22	266.28	16.71	320.99
T_2 - Flat bed + furrow after 3 rows	67.49	14.86	35.63	265.73	17.07	319.63
T_3 - Flat bed + furrow after 6 rows	66.17	14.63	34.64	267.54	17.73	319.74
S. E. (m) ±	1.61	0.31	0.75	-	-	-
C.D. at 5 %	NS	NS	NS	-	-	-
Initial available soil (kg ha^{-1})	N- 274.23 , P - 16.11 and K - 322					

due to 100 per cent phosphate (F_1) and 75 per cent phosphate + PSB (F_2) was 16 and 11 per cent, respectively over 50 per cent phosphate + PSB (F_3), indicating that 25 per cent of phosphate dose can be saved by application of PSB. Similar results were also reported by Ramesh and Sable (2001).

Effect of land configuration

Land configuration treatments did not show any significant difference in respect of dry pod yield.

Uptake of nutrients and soil nutrient status

Total uptake of NPK ha^{-1} was significantly higher in 100 per cent phosphate dose over 50 per cent phosphate + PSB, however 100 per cent phosphate dose was at par with 75 per cent phosphate dose + PSB. In latter treatment reduced dose of phosphate with PSB could increase NPK uptake and reached to similar level of 100 per cent phosphate dose. Similar observation was noted by Tiwari *et.al.* (1989).

Addition of PSB along with reduced dose of phosphate recorded increase in the availability of phosphate 10.31 per cent (F_2) and 9.76 per cent (F_3) over 100 per cent phosphate dose without PSB (F_1). Tiwari *et.al.*(1983), Manjunathan and Devi (1990) and Ramesh and Sable (2001) also reported increase in availability of phosphorus due to inoculation with PSB. Land configuration slightly increased the phosphate availability over flat bed.

Economics

Both the treatments i.e. application of 100 per cent phosphate dose (50 kg ha^{-1}) and 75 per cent phosphate dose (37.5 kg ha^{-1}) + PSB were at par and significantly superior over 50 per cent phosphate dose (25 kg ha^{-1}) + PSB in respect of gross monetary returns. C: B ratio is more or less similar in 100 per cent phosphate dose and 75 per cent phosphate + PSB. Land configuration treatments also recorded more or less similar C: B ratio.

For getting higher dry pod yield and economic returns from groundnut, application of 75 per cent phosphate (37.5 kg ha^{-1}) along with PSB @ 3 kg ha^{-1} is beneficial.

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Effect of Irrigation, Phosphorus and Sulphur Levels on Quality and Uptake of Nutrients by *Rabi* Sunflower (*Helianthus annuus*)

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ABSTRACT

A field experiment was conducted during *Rabi* season of 2003-2004 at the farm of Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to study the effect of irrigation, phosphorus and sulphur on quality and uptake of nutrients by sunflower variety PKV-SF-9 on clay loam soil. Highest quality parameters and nutrient uptake were recorced with six irrigations applied at 0.9 IW:CPE ratio than 0.3 and 0.6 IW:CPE ratio. Application of 90 kg P_2O_5 ha^{-1} recorded highest values of quality parameters and uptake of nutrients than 30 and 60 kg P_2O_5 ha^{-1}. Application of 50 kg S ha^{-1} recorded highest value of quality parameters and nutrient uptake than zero and 25 kg S ha^{-1}.

Oilseed crops play vital role in Indian agriculture as food for human and animals and also important component of industrial commodities e.g. varnishes, paints, etc. Sunflower contains about 40-45 per cent oil and high amount of quality protein in cake.

The estimated nutrient removal by oilseed during 1998-99 was 3.49 million tonnes (N, P_2O_5, K_2O and S), while the contribution to nutrient uptake by fertilizer was only 13 per cent. This gap in nutrient removal and supply requires balancing for achieving the target of 34 million tonnes of oilseed by 2020 A.D. So, far balance in nutrient supply system and its management plays a key role in the 21st century. Low or no use of plant nutrients is one of the most important factors responsible for low productivity of oilseed. The nutrient requirement of oilseed, in general is high and needs to be supplied in adequate quantities for higher yields (Giri and Rana, 2003).

MATERIAL AND METHODS

A field experiment was conducted during *Rabi* season of 2003-2004 at the farm of Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The soil was clayey in texture and slightly alkaline (pH 7.3). It was low in total nitrogen (0.034%) and phosphorus (22.58 kg ha^{-1}), low in sulphur (8.29 kg ha^{-1}) and moderately high in available potash (302.0 kg ha^{-1}). The experimental design was split plot and treatment consisted of three levels of irrigation (irrigation at 0.3, 0.6 and 0.9 IW:CPE ratio), three phosphorus levels (30, 60 and 90 kg P ha^{-1}) in main plot and three sulphur levels (0, 25 and 50 kg S ha^{-1}) in sub plot with three replications. One common pre-sowing irrigation was given to all the plots to ensure uniform plant population. The sunflower variety PKV-SF-9 was sown at 45 x 30 cm^2 spacing on 21st October, 2003. The crop was harvested on 21st February, 2004.

RESULTS AND DISCUSSION

Data on quality paremeters viz. of oil content (%), protein content (%), oil yield (q ha^{-1}), proetin yield (q ha^{-1}) and nutrient uptake is presented in Table 1 and 2.

Effect irrigation :

Quality parameters and nutrient uptake by sunflower were significantly influenced due to irrigation levels (Table 1 and 2). Quality parameters viz. oil content, protein contein, oil yield and protein yield and sulphur, nitrogen, phosphorus content in seed, straw and their total uptake were significantly increased with increase in irrigation frequencies and were significantly highest with six irrigations applied with increase in irrigation frequencies and were significantly highest with six irrigation applied at 0.9 IW:CPE ratio than four and two irrigations applied at 0.6 and 0.3 IW:CPE ratio. This may be attributed to the influence the concentration and uptake of these nutrients. Similar trends were also reported by Prasad *et. al.*, (1999), Taha *et. al.*, (1999) and Bikas Mandal and Giri (2002).

Effect of phosphorus :

Application of phosphorus had no significant effect on oil and protein content. However, highest oil

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and protein content were observed with application of 60 kg P_2O_5 ha^{-1}. Effect of phosphorus levels on protein yield was found to be significant. Highest protein yield was recorded with 60 kg P_2O_5 ha^{-1}, which was signficantly superior over 30 kg P_2O_5 ha^{-1} but was at par with 90 kg P_2O_5 ha^{-1}. Maximum oil yield was recorded with 60 kg P_2O_5 ha^{-1}. This might be due to abundance of P in seeds, which stimulated the formation of filled compact seeds and increase in seed number. The above results are in line with findings reported by Kene *et. al.*, and Tamak *et. al.*, (1997).

Sulphur and phosphorus content in straw and seed increased significantly with increase in levels of phosphorus from 30 to 60 kg ha^{-1}. 90 kg P_2O_5 ha^{-1} recorded maximum, whereas 30 kg P_2O_5 ha^{-1} recorded lowest value of sulphur and phosphorus instraw and seed. In case of nitrogen maximum value was recorded with 90 kg P_2O_5 ha^{-1} and lowest with 30 kg P_2O_5 ha^{-1}. No signficant differences were observed with 90 kg and 60 kg P_2O_5 ha^{-1} in respect of sulphur, phosphorus and nitrogen content in seed and straw.

Significant highest phosphorus uptake was observed with 90 kg P_2O_5 ha^{-1} but was at a par with 60 kg P_2O_5 ha^{-1}. Effect of phosphorus on total uptake of sulphur and nitrogen was found to be significant. Application of 60 kg P_2O_5 ha^{-1} recorded highest total uptake of sulphur and nitrogen followed by 90 and 30 kg P_2O_5 ha^{-1}.

This might be due to vigorous growth of plant because of efficient utilization of native and applied phosphorus, which has resulted in significant increase in sulphur, phosphorus and nitrogen content in straw and seed. The increase in uptake of these nutrient may be attributed to increased concentration of these nutrients in seed and stover. These findings are in agreement with the findings of Tomar *et. al.*, (1995).

Table 1. Quality parameters of sunflower as influenced by irrigation, phosphorus and sulphur levels

Treatments	Protein content (%)	Protein yield (q ha^{-1})	Oil content (%)	Oil yield (q ha^{-1})
Irrigation level (IW/CPE ratio)				
0.3 (2)	15.08	1.64	39.36	3.34
0.6(4)	18.70	2.44	39.45	5.10
0.9 (6)	19.18	2.96	40.04	6.21
SE (m)±	0.080	0.054	0.169	0.038
CD at 5% level	0.242	0.164	0.505	0.114
Phosphorus levels				
30 kg ha^{-1}	10.36	2.25	39.45	4.70
60 kg ha^{-1}	18.77	2.46	39.82	5.14
90 kg ha^{-1}	18.75	2.33	39.57	7.80
SE (m)±	0.080	0.054	0.169	0.038
CD at 5% level	NS	0.164	NS	0.114
Sulphur levels				
0 kg ha^{-1}	18.51	0.27	38.99	4.32
25 kg ha^{-1}	18.60	2.38	39.84	4.99
50 kg ha^{-1}	18.77	2.59	40.03	5.33
SE (m)±	0.059	0.046	0.197	0.073
CD at 5% level	0.170	0.132	0.564	0.219

Table 2. Concentration of nutrient in straw, seed and their total uptake by sunflower crop as influenced by irrigation, pyhosphours and sulphur levels

Treatments	Nutrient content in straw (%)			Nutrient content in seed (%)			Total uptake of nutrient (kg ha^{-1})		
	S	N	P	S	N	P	S	N	p
Irrigation levels (IW/CPE ratio)									
0.3 (2)	0.163	0.380	0.173	0.233	2.88	0.736	5.34	35.11	9.36
0.6(4)	0.177	0.420	0.184	0.241	2.98	0.843	8.05	50.71	14.56
0.9 (6)	0.191	0.459	0.207	0.265	3.05	1.00	9.73	62.40	19.75
SE (m)±	0.00083	0.0043	0.0012	0.0015	0.011	0.0092	0.21	1.01	0.28
CD at 5% level	0.0025	0.013	0.0035	0.0045	0.032	0.028	0.64	3.03	0.83
Phosphorus levels									
30 kg ha^{-1}	0.173	0.392	0.183	0.241	2.92	0.838	7.26	48.04	13.91
60 kg ha^{-1}	0.179	0.438	0.187	0.250	3.00	0.854	8.10	51.78	14.48
90 kg ha^{-1}	0.179	0.429	0.194	0.248	3.00	0.892	7.76	48.61	15.29
SE (m)±	0.00083	0.0043	0.0012	0.0015	0.011	0.0092	0.21	1.01	0.28
CD at 5% level	0.0025	0.013	0.0035	0.0045	0.032	0.028	0.64	3.03	0.83
Sulphur levels									
0 kg ha^{-1}	0.174	0.382	0.181	0.242	2.97	0.835	7.19	44.51	12.80
25 kg ha^{-1}	0.178	0.421	0.191	0.250	2.98	0.865	7.81	50.36	14.84
50 kg ha^{-1}	0.179	0.442	0.193	0.248	2.99	0.883	8.12	53.56	16.03
SE (m)±	0.00096	0.0020	0.0013	0.0012	0.0064	0.0060	0.25	0.68	0.24
CD at 5% level	0.0027	0.058	0.0044	0.0035	NS	0.017	0.73	1.94	0.72

Effect of sulphur :

Application of sulphur signficiantly influenced the protein and oil content with increase in levels of sulphur from zero to 50 kg S ha^{-1} protein and oil content, which was significantly superior over zero kg S ha^{-1}, but was at par with 25 kg S ha^{-1}. Both protein and oil yield were significantly increased with increase in levels of sulphur from zero to 50 kg S ha^{-1}. Application of 50 kg S ha^{-1} produced more protein and oil yield, which was significantly superior over zero and 25 kg S ha^{-1}, but incase of protein yield 50 kg S ha^{-1} was at par with 25 kg S ha^{-1}. This might be due to the enhanced availability of S, which increased the level of sulphur containing co-enzymes, which involved in the synthesis of fatty acids. These findings are in agreement with the findings of Sagre *et. al.*, (1990) and Hegde and Babu (2004).

Sulphur, nitrogen and phosphorus content in straw and seed were increased significantly with increase in levels of sulphur from zero to 50 kg S ha^{-1}. Application of 50 kg S ha^{-1} recorded maximum value of all the above nutrients in straw and seed, whereas zero kg S ha^{-1} recorded lower value of all the above nutrients in straw and seed.

Total uptake of sulphur, nitrogen and phosphorus by the crop was significantly more with 50 kg S ha^{-1}. The lowest uptake of sulphur, nitrogen and phosphorus by the crop was observed with zero kg S

ha^{-1}. This may be attributed to increased uptake of sulphur, nitrogen and phosphorus by the crop with increase in availability of sulphur, ultimately more utilization of these nutrients, which enhanced their concentration and uptake. These results are in conformity with the findings reported by Bhagat *et. al.*, (2001).

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Correlation and Path Analysis in Okra (*Abelmoschus esculentus* (L.) Moench)

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ABSTRACT

Correlation and path analysis in thirty genotypes of okra were worked out at the field of Chilli and Vegetable Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The variance for all the eight characters studied were significant. Genotypic coefficient of correlations, were greater in magnitude than the corresponding phenotypic in most of the cases indicating that there was an inherent association among various characters and phenotypic expression of correlation was lessened under the influence of environment. The correlation studies revealed the importance of characters *viz*., number of fruits plant^{-1} and number of fruiting nodes on main stem, because of their strong genotypic correlation with fruit yield plant^{-1}. The path analysis further suggested that number of fruits plant^{-1} and weight of marketable fruit were the reliable and effective character to be consider while selection in crop improvement programme when high yield is the main objective.

The low productivity of okra has been attributed to the number of reasons *viz*., poor genetic potential of the existing genotypes, luxuriant vegetative growth and incidence of yellow vein mosaic diseases. Therefore, the prime objective of breeding programme was to evolve varieties having high yield potential with disease resistance and to break the existing plateau of productivity and it requires information on genetic variability and relationship among characters. The main aim of the present study was therefore, to work out correlations and path analysis among the yield and its components, to initiate effective breeding programme.

MATERIAL AND METHODS

Thirty genotypes of okra were raised in a randomized complete block design with three replication at the field of Chilli and Vegetable Research Unit, Dr. PDKV, Akola during *Kharif* season of 2001-02. Observations were recorded on five randomly selected plants from each plot for eight characters *viz*., days to first flowering, plant height(cm), number of fruiting nodes on main stem, number of fruits plant^{-1}, weight of marketable fruit (g), girth of marketable fruit (cm), length of marketable fruit (cm) at four days picking interval and yield plant^{-1} (g). The data obtained was subjected to statistical analysis as per the method suggested by Panse and Sukhatme(1954). The correlations were calculated as per formula given by Johnson *et al.* (1955) and path coefficient calculated as per method suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The mean sum of square of all characters were found to be significant indicating significant variation in the material under study (Table 1). Phenotypic and genotypic correlations are presented in Table 2. Genotypic coefficients of correlation were greater in magnitude than corresponding phenotypic ones in most of the cases indicating that there was an inherent association among various characters and phenotypic expression of correlation was lessened under the influence of environment. The results of correlation coefficients revealed that the positive and significant correlation existed for yield with number of fruits plant^{-1} (r = 0.930) and number of fruiting nodes on main stem (r = 0.604). Similar finding was also reported by Hazare and Basu (2000) for number of fruits palnt^{-1} and Fageria *et al.* (1992) for number of fruiting nodes on main stem. This is an indication of importance of these two characters. The highest genotypic correlation coefficient was

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Table 1: Analysis of variance for various characters in okra

SourceS of variation	Df	Mean sum of squares							
		Days to first flowering	Plant height (cm)	No. of fruiting nodes on main stem	No. of fruits plant^{-1}	Weight of marketable fruit (g)	Length of marketable fruit (cm)	Girth of marketable fruit (cm)	Yield plant^{-1} (g)
		X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
Replications	2	13.2890	38.7812	51.1425**	3.4814	1.4931	0.0893	0.003189	1249.2188
Genotypes	29	91.9265**	107.5134**	17.6369**	9.2007**	3.9318**	1.5398*	0.0249**	1443.5625**
Error	58	4.3847	20.3068	7.9119	3.4642	1.7899	0.7722	0.00597	590.5075

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

Table 2: Genotypic and phenotypic correlation coefficients (r) between yield and yield contributing characters

Characters		Days to first flowering	Plant height (cm)	No. of fruiting nodes on main stem	No. of fruits plant^{-1}	Weight of marketable fruit (g)	Length of marketable fruit (cm)	Girth of marketable fruit (cm)	Yield plant^{-1} (g)
		X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
X_1	G	1.000	0.226	0.653 **	0.002	0.060	-0.166	0.188	0.075
	P	1.000	0.102	0.312	0.002	0.081	-0.019	0.130	0.042
X_2	G		1.000	0.227	0.341	-0.534 **	-0.319	-0.398 *	0.119
	P		1.000	0.519 **	0.508 **	0.037	0.351 *	-0.227	0.483 **
X_3	G			1.000	0.517 **	0.069	0.129	-0.142	0.604 **
	P			1.000	0.485 **	0.026	0.214	-0.237	0.500 **
X_4	G				1.000	-0.223	0.137	-0.485 **	0.930 **
	P				1.000	-0.077	0.340	-0.388 *	0.924 **
X_5	G					1.000	0.317	0.764 **	0.147
	P					1.000	0.619 **	0.609 **	0.288
X_6	G						1.000	-0.364 *	0.236
	P						1.000	-0.006	0.543 **
X_7	G							1.000	-0.176
	P							1.000	0.135
X_8	G								1.000
	P								1.000

G - Genotypic correlation coefficient, P - Phenotypic correlation coefficient * S ignificant at 5 % level, * * Significant at 1 % level

Table 3: Direct and indirect effects of different characters on yield in okra

Characters	Days to first flowering	Plant height (cm)	No. of fruiting nodes on main stem	No. of fruits plant^{-1}	Weight of marketable fruit (g)	Length of marketable fruit (cm)	Girth of marketable fruit (cm)	Genotypic correlation with yield
Days to first flowering	**0.070**	-0.024	0.013	0.001	0.042	0.049	-0.077	0.075
Plant height (cm)	0.016	**-0.018**	0.005	0.325	-0.375	0.003	0.163	0.119
No. of fruiting nodes on main stem	0.046	-0.024	**0.020**	0.493	0.049	-0.038	0.058	0.604
No. of fruits plant^{-1}	0.000	-0.037	0.010	**0.955**	-0.157	-0.040	0.198	0.930
Weight of marketable fruit (g)	0.004	0.057	0.001	-0.213	**0.702**	-0.092	-0.312	0.147
Length of marketable fruit (cm)	-0.012	0.034	0.003	0.131	0.223	**-0.292**	0.149	0.236
Girth of marketable fruit (cm)	0.013	0.043	-0.003	-0.489	0.563	0.106	**-0.409**	-0.176

Residual effect = 0.0008

(Diagonal and bold values indicate direct effect and values above and below the diagonal indicate indirect effect).

recorded for the association between number of fruits plant^{-1} and yield plant^{-1} (r = 0.930), followed by weight of marketable fruit and girth of marketable fruit (r = 0.764) and days to first flowering and number of fruiting nodes on main stem (r = 0.653). Negative association of girth of marketable fruit with yield plant^{-1} both at genotypic and phenotypic level was observed in the present study which is in confirmation with the results of Murthy and Bavaji (1980). The intercorrelation among the yield components is an useful study to find out the individual character which have a strong influence on the yield. Days to first flowering recorded significant positive association with number of fruiting nodes on main stem (r = 0.653). The correlation between number of fruiting nodes on main stem and number of fruits plant^{-1} was positive and significant (r = 0.517). Weight of marketable fruit showed significant and positive correlation with girth of marketable fruit (r = 0.764),where as the correlation of plant height, number of fruits plant^{-1} and length of fruit with girth of marketable fruit was negative and significant (r = -0.398, r = -0.485, r = -0.364 and –0.534, respectively).

The results of path coefficient analysis (Table 3) revealed that the number of fruits plant^{-1} and fruit weight are the direct and positive contributing characters to yield plant^{-1} due to their high direct effects (0.955 and 0.702, respectively). It is an indication of importance of these two characters in improvement programme. The results of similar nature were observed by Murthy and Bavaji (1980). Though the character number of fruiting nodes on main stem exhibited strong positive correlation with yield plant^{-1} but its direct effect on yield was very less suggesting the importance of indirect contribution of number of fruits plant^{-1}. Low value of residual effect (0.0008) indicated the importance of characters taken under study. Thus, the correlation and path analysis studies indicate the importance of characters *viz.*, number of fruiting nodes on main stem, number of fruits plant^{-1} and weight of marketable fruit in okra while selection when high yield is the main objective of crop improvement programme.

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Effect of Polythene Mulch with Different Perforates on Physiomorphological Parameters and Yield of Groundnut (*Arachis hypogaea* L.)

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ABSTRACT

A field experiment was conducted to study of "Effect of polythene mulch with different perforates on physiomorphological parameters and yield of groundnut" during *Kharif* season of 2002-03. Various morphological parameters viz., plant height (cm), flowers plant^{-1}, days to 50 per cent flowering, Pegs plant^{-1}, Pods plant^{-1} and physiological parameters viz. leaf area (cm^2 plant^{-1}), total dry matter (g plant^{-1}), chlorophyll content (mg g^{-1}), transpiration rate (mg dm^{-2} sec^{-1}) were significantly influenced by polythene mulch technology with treatment (T_3) 1.8 cm perforation on polythene followed by treatment (T_2). 2.5 cm and (T_1) 5.0 cm perforation, respectively. Significantly maximum pod yield hectare^{-1} was recorded with treatment (T_3) 1.8 cm performation (38.13 q ha^{-1}) as compared to treatment (T_4) control or non mulched. Treatment (T_3) 1.8 cm perforation on polythene increased yield of groundnut by 52 per cent over non mulched. Incremental cost benefit ratio (ICBR) registered higher in treatment T_3 (3.5) followed by T_2 (3.4) and T_1 (2.6), respectively.

Groundnut (*Arachis hypogaea* L.) is one of the most important oilseed legume crops of India. Groundnut being a legume crop helps to enrich the soil nitrogen and improves the soil fertility. it is an important source of vegetable oil which accounts more than 45 per cent share of total oilseed area and 60 per cent production. Although India ranks first in the world in respect of area and production but ranks 8th in productivity. Polythene mulch production technology will help to improve the productivity of groundnut in India. Besides increasing the yield of groundnut, it plays an important role in reducing the water losses and suppress in weed growth. use of polythene mulch had a positive effect on growth and yield of groundnut (Delhare and Lechat, 1986). Considering these thrust areas, the present investigation was undertaken.

MATERIAL AND METHODS

A field experiment to study the effect of polythene mulch with different perforates on different physiomorphological parameters and yield of groundnut was conducted during *Kharif* season of 2002-03 at Oilseed Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.). The trial was conducted in Ramdomised Block Design (RBD) with four treatments and five replications. The treatments were T_1-5.0 cm perforation on polythene, T_2-2.5 cm perforation of polythene, T_3-1.8 cm peforation on polythene and T_4-Non mulched (Control). The experiment site has medium black soil with moderate fertility and slight alkaline in reaction. The plot size was 0.75 x 5 m^2 having broad bed furrow with spacing of 20 x 10 cm^2. After good tillage, 0.75 m broad bed furrows were prepared having 5 m length. Polythene sheet was prepared by punching holes with the help of iron pipes of different diameters of 1.8 cm, 2.5 cm and 5 cm for treatments T_3, T_2 and T_1, respectively. Polythene film was spread treatmentwise on the bed and border was embedded in the soil. The variety used for experiment was TAG-24 and seeds were dibbled per hole and covered with Soil. The sheet of same spacing covered on control plot and after dibbling it was removed. The observation on various physiomorphological parameters were recorded during the ontogeny of crop.

RESULTS AND DISCUSSION

Morphological parameters :

Morphological parameters of groundnut as influenced by polythene mulch with different perforates (Table 1) indicated that, plant height (cm) recorded significantly maximum in treatment (T_3) 1.8 cm perforation (23.26) over treatment (T_4) non mulched (18.58). However, treatments T_1, T_2 and T_3 were at par with each other. Polythene mulch had great influence to increase plant

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Table 1. Effect of polythene mulch with different perforates on morphological parameters of groundnut

Treatments	Plant height (cm)	Flowers plant^{-1}	Days to 50% flowering	Pegs plant^{-1}	Pods plant^{-1}
T_1 - 5.0 cm perforation	22.36	50.45	26.8	28.23	17.60
T_2 - 2.5 cm perforation	23.20	50.85	26.8	33.12	19.12
T_3 - 1.8 cm perforation	23.26	49.54	26.2	35.22	23.62
T_4 - Non-mulched (control)	18.58	53.68	33.4	27.49	15.26
SE (m)±	0.77	0.55	0.85	1.29	0.53
CD at 5%	2.38	1.70	2.62	3.97	1.63

Table 2. Effect of polythene mulch with different perforates on physiological parameters of groundnut

Treatments	Leaf area at maturity (cm^2 plant^{-1})	TDM plant^{-1} at maturity (g)	Chlorophyll content at maturity (mg g^{-1})	Transpiration plant^{-1} at Peg formation stage mg/dm^2/sec
T_1 - 5.0 cm perforation	961.99	31.00	2.09	130.59
T_2 - 2.5 cm perforation	1007.19	32.52	2.10	134.32
T_3 - 1.8 cm perforation	1031.62	34.17	2.25	139.95
T_4 - Non-mulched (control)	734.92	25.04	1.97	118.90
SE (m)±	1.26	0.90	0.04	0.76
CD at 5%	3.09	2.79	0.14	2.35

Table 3. Effect of polythene mulch with different perforates on pod yield, % increase over control, harvest index and ICBR of groundnut

Treatments	Pod yield (q ha^{-1})	% increase over control	Harvest index (%)	ICBR
T_1 - 5.0 cm perforation	34.66	38.31	23.83	1.26
T_2 - 2.5 cm perforation	37.60	50.04	24.44	1.34
T_3 - 1.8 cm perforation	38.13	52.15	24.78	1.35
T_4 - Non-mulched (control)	25.06		21.59	
SE (m)±	1.53		0.43	
CD at 5%	4.72		1.32	

height (Mahalle *et. al.*, 2002 b). Polythene mulch applied treatments showed decrease in number of flowers plant^{-1} over non mulched. This findings is in agreement with the findings of Subramanian *et. al.*, (2002). It was also observed that polythene mulch technology reduced 7 to 8 days to 50 per cent flowering as compared to non mulched or control treatment. In case of the number of pegs plant^{-1} and number of pods plant^{-1}, treatment T_3 recorded significantly maximum pegs plant^{-1} (35.22) and pods plant^{-1} (23.62) over treatment T_4 (27.49 and 15.26, respectively). The number of pegs plant^{-1} in treatment (T_3) 1.8 cm perforation was increased by 2.8 per cent over control. Similar result was reported by Mahalle *et. al.*, (2002b).

Physiological parameters

The data on physiological parameters (Table 2) revealed that, the effect of polythene mulch with different perforates occured indirectly in increasing the leaf area plant^{-1} (cm^2 plant^{-1}) at maturity. Treatment T_3 recorded significantly greater leaf area (1031.62) as compared to treatment T_4 (961.99). Treatment (T_3) control. Increased leaf area is might be due to increased number of leaves, size of leaves and branches plant^{-1}. Similar findings was also reported by Mahalle (2000). Total dry matter accumulation (g plant^{-1}) at maturity recorded significantly maximum in treatment T_3 (34.17) closely followed by treatment T_2 (32.52) over treatment T_4 (25.04). It is might be due to increased transpiration rate under polythene mulch treatment increases CO_2 uptake which improves photosynthesis. Transparent plastic mulch increases dry weight as compared to non mulched (Golombek and Talwar, 1995). Chlorophyll content (mg g^{-1}) at maturity and transpiration rate (mg/dm^2/sec) at peg formation stage recorded significantly highest in Treatment (T_3) 1.8 cm perforation (2.25 and 139.95, respectively) over treatment (T_4) non mulched (1.97 and 118.9, respectively). In case of chlorophyll content treatment T_2, T_1 and T_4 being at par with each other. Transpiration rate was maximum in treatment T_3 (17.7% more than control) because of increase in soil temp by application of polythene mulch. Increased rate of transpiration also increase the CO_2 uptake which enhance the rate of photosynthesis. These results are in agreement with those of Mahalle *et. al.*, (2002 a).

Pod yield

Pod yield (q ha^{-1}), harvest index (%) and incremental cost benefit ratio (ICBR) of groundnut as influenced by various treatments (Table 3) indicated that, the treatment (T_3) 1.8 cm perforation on polythene recorded significantly maximum pod yield (38.13) and harvest index (24.78) over the treatment (T_4) non mulched (25.06 and 21.59). Per centage increase over control indicated that the per centage contribution remarkably greater values at T_3 (52.15%), followed by T_2 (50.04%) and T_1 (38.31%) over control. The increase in pod yield of groundnut might be due to favourable micro climate developed by polythene mulch that results in better germination and retention of moixture which enhanced the yield attributes of groundnut. The similar results are also reproted by Mahalle (2000) and Ravankar *et. al.*, (2003). As regards ICBR (incremental cost benefit ratio), treatment T_3 recorded higher incremental cost benefit ratio (3.5), followed by T_2 (3.4) and T_1 (2.6), respectively. Treatment T_3 and T_2 obtained nearly equal incremental cost benefit ratio.

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Economics of Various Bt Cotton Hybrids as One of the Component in IPM Under Rainfed Situation

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ABSTRACT

A field experiment was conducted at Cotton Research Unit of Dr. PDKV, Akola during 2004-05 at Akola Maharashtra, India in RBD with 4 replications to work out the economics of various Bt cotton hybrids grown under rainfed situation as one of the component in IPM in comparison with the check hybrids. For this three Bt cotton hybrids i.e. MECH-12 Bt, MECH-162 Bt and MECH-184 Bt were sown under rainfed condition at 90 x 60 cm spacing along with two check hybrids. NHH-44 and PKV-Hy-2. The plant protection packages included in IPM module recommended by Dr. PDKV, Akola were adopted as and when required based on ETL. From the present studies it was observed that the yield differences were non-significant amongst Bt cotton hybrids and check hybrids. Highest gross monetary return and less plant protection cost was recorded in Bt cotton hybrids as compared to check hybrids. However maximum net monetary return and cost benefit ratio was obtained from check hybrids i.e. NHH-44 followed by PKV Hy-2 as compared to Bt cotton hybrids due to high cost of seed of Bt cotton hybrids. Amongst Bt cotton hybrids highest net monetary return and cost benefit ration was obtained from MECH-162 Bt followed by MECH-184 Bt and MECH-12 Bt.

The Indian subcontinent occupies a prominent place among the cotton growing tracts of the world, India ranks first globally area wise but with regards to production it ranks third due to low productivity. Amongst the various reasons for low productivity in the country, a loss due to insect pest is one of them. Area under cotton crop is only 5 per cent of the total cropped area in the country. However 44.5 per cent insecticides are being used on this single crop to control the pests (Pawar *et al.* 2003). This excessive and indiscriminate use of pesticides resulted in development of resistance to pesticides, adverse effect on beneficial insects, residue problems, resurgence of secondary and minor pests and environmental pollution (Kranthi *et al.* 2002).

In such a situation growing of Bt cotton hybrids can reduce the insecticidal sprays required for bollworms and thereby reduction in plant protection cost, taking in to consideration this fact these Bt cotton hybrids can be fitted in IPM programme as one of the component. However 95 per cent area under cotton is rainfed in Maharashtra State. Hence present study was planned and undertaken to see the economics of Bt cotton hybrids as one of the component in IPM under rainfed situation.

MATERIAL AND METHODS

A field experiment was conducted at Cotton Research Unit, of Dr. PDKV, Akola, Maharashtra, India during *Kharif* season of 2004-2005 under rainfed condition. The design of the experiment was randomized block design with four replications. The plot size was 9.00 x 6.00 m^2. The three Bt cotton hybrids viz. MECH-12 Bt, MECH-162 Bt and MECH-184 Bt and two check hybrids viz. PKV-Hy 2 and NHH-44 were sown at 90 x 60 cm in IPM module which is recommended by Dr. PDKV, Akola as one of the component.

The details of plant protection packages to be undertaken under IPM module are -

1) Thiamethoxam 70 WS seed treatment @ 4.28 g kg^{-1} of seed.
2) Spraying of Acetamiprid 20 SP @ 0.003 per cent for sucking pests based on ETL
3) Two releases of *T. chilonis* egg parasitoid @ 1.5 lakh ha^{-1} at 45 – 50 and 55-60 DAG.
4) Spraying of Azadirachtin 300 ppm @ 5 ml. lit^{-1}. of water for bollworms based on ETL

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5) Spraying of Spinosad 45 SC @ 0.01 per cent for bollworms based on ETL

6) Spraying of Beta – cyfluthrin 2.5 EC @ 0.0025 per cent for bollworms based on ETL .

The imposition of treatments were based on economic threshold level of a particular pest. Whereas, seed treatment and parasitoid releases were undertaken at a specific time and interval. Weekly observations were recorded to ascertain the pest load. The observations on yield of seed cotton at each picking were recorded to calculate the economics.

The following ET levels were considered for major pests of cotton for imposition of treatments in various cotton hybrids during this study.

Sucking pests

1) Aphids : 10 nymphs leaf^{-1}
2) Jassids : 2 nymphs leaf^{-1}
3) Thrips : 10 leaf^{-1}
4) Whiteflies : 8-10 adults or 20 nymphs leaf^{-1}

Bollworm complex

Five per cent damage in green fruiting bodies (squares, flowers and green bolls) on plant .

Details of treatments actually undertaken in various cotton hybrids

1] MECH-12 Bt :

i) Seed treatment with Thiamethoxam 70 WS @ 4.28 g kg^{-1} of seed.

ii) Five sprays of Acetamiprid 20 SP @ 0.003 per cent for sucking pests based on ETL

iii) Two releases *T. Chilonis* @ 1.5 lakh ha^{-1} at 49 and 59 DAG.

2] MECH-162 Bt

i) Seed treatment with Thiamethoxam 70 WS @ 4.28 g kg^{-1} of seed.

ii) Three sprays of Acetamiprid 20 SP @ 0.003 per cent for sucking pests based on ETL

iii) Two releases *T. Chilonis* @ 1.5 lakh ha^{-1} at 49 and 59 DAG.

3] MECH-184 Bt

i) Seed treatment with Thiamethoxam 70 WS @ 4.28 g kg^{-1} of seed.

ii) Three sprays of Acetamiprid 20 SP @ 0.003 per cent for sucking pests based on ETL

iii) Two releases *T. Chilonis* @ 1.5 lakh ha^{-1} at 49 and 59 DAG.

4] PKV-Hy-2

i) Seed treatment with Thiamethoxam 70 WS @ 4.28 g kg^{-1} of seed.

ii) Three sprays of Acetamiprid 20 SP @ 0.003 per cent for sucking pests based on ETL

iii) Two releases *T. Chilonis* @ 1.5 lakh ha^{-1} at 49 and 59 DAG.

iv) One spray of Azadirachtin 300 ppm @ 5 ml lit^{-1} for bollworms based on ETL

v) Two sprays of Spinosad 45 SC @ 0.01 per cent for bollworms based on ETL.

5] NHH-44

i) Seed treatment with Thiamethoxam 70 WS @ 4.28 g kg^{-1} of seed.

ii) Three sprays of Acetamiprid 20 SP @ 0.003 per cent for sucking pests based on ETL

iii) Two releases *T. Chilonis* @ 1.5 lakh ha^{-1} at 49 and 59 DAG.

iv) One spray of Azadirachtin 300 ppm @ 5 ml lit^{-1} for bollworms based on ETL

v) Two sprays of Spinosad 45 SC @ 0.01 per cent for bollworms based on ETL.

RESULTS AND DISCUSSION

Cost effectiveness of various cotton hybrids in IPM under rainfed situation :

Yield of seed cotton :

There were non significant differences amongst the various cotton hybrids as regards the yield of seed cotton. However, the highest yield of seed cotton was obtained from MECH-162 Bt (10.71 q ha^{-1}) followed by MECH-184 Bt (10.30 q ha^{-1}.), MECH-12 Bt (9.12 q. ha^{-1}.), NHH-44 (8.98 q ha^{-1}) and PKV-Hy-2 (8.63 q ha^{-1}).

Gross monetary return :

Highest gross monetary return (Rs. 26775 ha^{-1}) was obtained from MECH-162 Bt followed by MECH-184 Bt (Rs. 25750 ha^{-1}), MECH-12 Bt (Rs. 23800 ha^{-1}), NHH-44 (Rs. 22450 ha^{-1}) and PKV-Hy-2 (Rs. 21575 ha^{-1}).

Table 1 : Effect of various cotton hybrids on cost benefit ratio under rainfed situation.

S.N.	Cotton hybrids	Yield (ha^{-1})	Gross monetory returns	Seed cost ($Rs.ha^{-1}$)	No of sprays under taken for the control	Cost of Pl. protection SP + BC	Total cost prot. ($Rs\ ha^{-1}$)	Net monetory returns	C:B ratio	Rank
1	MECH-12 Bt	9.12	23800	12446	5+0	3570	16016	6784	1:0.42	5
2	MECH-162 Bt	10.71	26775	12446	3+0	2275	14721	12054	1:0.82	3
3	MECH-184 Bt	10.30	25750	12446	3+0	2275	14721	11029	1:0.75	4
4	PKV-Hy-2	8.63	21575	1866	3+3	5304	7170	14405	1:2.01	2
5	NHH-44	8.98	22450	1400	3+3	5304	6704	15746	1:2.35	1
	SE (m) ±	0.21								
	CD at 5%	N.S.								
	CV %	13.26								

Cost of seed :

Maximum cost on seed was incurred on Bt cotton hybrids (Rs. 12446 ha^{-1}) followed by PKV-Hy-2 (Rs. 1866 ha^{-1}) and NHH-44 (Rs. 1400 ha^{-1})

Cost on plant protection :

Maximum cost on plant protection was incurred in PKV-Hy-2 and NHH-44 (Rs. 5304 ha^{-1}) followed by MECH-12 Bt (Rs. 3570 ha^{-1}) and MECH-162 Bt and MECH-184 Bt (Rs. 2275 ha^{-1}) each.

Net monetary return :

Maximum net monetary return was obtained from NHH-44 (Rs. 15746 ha^{-1}) followed by PKV-Hy-2 (Rs. 14450 ha^{-1}), MECH-162 Bt (Rs. 12054 ha^{-1}), MECH-184 Bt (Rs. 11029 ha^{-1}) and MECH-12 Bt (Rs. 6784 ha^{-1}).

Cost benefit ratio :

Highest cost benefit ratio (1:2.35) was obtained from NHH-44 followed by PKV-Hy-2 (1:2.01). The cost benefit ratio obtained from Bt cotton hybrids viz. MEH-162 Bt, MECH-184 Bt and MECH-12 Bt was 1:0.82, 1:0.75 and 1:0.42 respectively which was due to high cost of seed of Bt cotton hybrids.

From the present studies (Table 1) it can be concluded that the cost incurred on plant protection was less in Bt cotton hybrids as compare to check hybrids and maximum gross monetary return was obtained from these Bt cotton hybrids. However, the highest net monetary return and maximum cost benefit ratio was obtained from check hybrids i.e. NHH-44 followed by PKV-Hy-2 as compared to Bt cotton hybrids due to high cost of seed of Bt cotton hybrids.

As regards the less cost on plant protection recorded in Bt cotton hybrids in the present study Anonymous (2002a) Anonymous (2002b), Bagade *et al* (2004) and Daware *et al* (2003) also reported that Bt cotton requires less plant protection cost as compare to non Bt and check hybrids. However as regards the maximum cost benefit ratio in check hybrids as compared to Bt cotton hybrids present findings are correlated with the findings of Bagade *et al* (2004) and Nakhat (2004). They also reported low cost benefit ratio in Bt cotton hybrids than non Bt and check hybrids due to high cost of seed of Bt cotton hybrids.

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Management of Sesamum Gallfly *Asphondylia sesami* Felt with Some Botanicals and Synthetic Insecticides

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ABSTRACT

Field trials were conducted on sesamum for three years during 2000-01 to 2002-03 at Oilseed Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to evaluate the efficacy of some botanicals in comparison with synthetic insecticides against sesamum gallfly. Out of eleven botanicals and synthetic insecticides evaluated for the management of sesamum gallfly, treatment viz. fenvalerate 0.01 per cent, followed by endosulfan 0.07 per cent and dimethoate 0.05 per cent were found most effective and economical. The highest ICBR (1:10.60) was recorded in treatment due to fenvalerate 0.01 per cent, followed by endosulfan 0.07 per cent (1:5.07), dimethoate 0.05 per cent (1:4.78) and NSE 5 per cent (1:4.02). Lowest ICBR (1:0.46) was recorded in treatment due to neem oil 3 per cent. Hence fenvalerate 0.01 per cent or endosulfan 0.07 per cent or dimethoate 0.05 per cent are suggested for control of sesamum gallfly.

Ahuja and Bakhetia (1995) and several workers have reported 65 insect species infesting sesame in India at different stages of its plant growth. But only three species viz. Sesamum leaf webber and pod borer *Antigastra catalaunalis* Dup. Sesamum hawk moth, *Acherontia styx* Westw and sesame gallfly *Asphondylia sesami*. Felt are considered as major pests. Among these sesamum gallfly *Asphondylia sesami*. Felt is an important one and is of regular occurrence.

The sesamum gallfly, *A. sesami* is found widely distributed in sesame growing areas of India viz. Maharashtra, Tamil Nadu, Gujrat, Rajasthan, Andhra Pradesh, Madhya Pradesh, Uttar Pradesh, Bihar and Orissa. Sachan(1959) reproted it as a minor pest from Rajasthan. However, severe attack of gallfly was recorded in Pali and Udaipur districts of Rajansthan (Annonymous, 1971). After a lapse of 20 years, its outbreak was again recorded at farmers fields in Pali and Jodhpur district when 100 per cent plants were infested during 1990, the year when highest rainfall (840 mm) of the century was experienced in Rajasthan (Anonymous, 1990).

The infestation of sesamum gallfly starts at the bud initiation and maximum infestation occurs when the crop attains full bloom stage. The maggots feed on buds and cause gall formation in place of normal pods. Flowering, bud and capsules are galled by the maggots as a result no fruits or seeds are produced. When infestation is severe, the crop may be total failure. its damage has been continuously recorded since 1998 to 2004 at Akola and rainfall seems to enhance the damage. Presence of galls clearly indicate the damage of pest. Outbreak of this pest was observed at Akola campus during 2001 and 2003 where 100 per cent plant infestation occurred.

Presently, there is no recommendation for control of this pest in plant protection schedule of State Deptt. of Agriculture, Maharashtra state, hence, present investigation was undertaken to findout the efficacy of some botanicals and synthetic insecticides against sesame gallfly at Oilseed Research Unit, Dr. PDKV, Akola during *Kharif* season of 2000-01 to 2002-03.

MATERIAL AND METHODS

A field experiment was conducted during *Kharif* season of 2000-01, 2001-02 and 2002-03 at Oilseed Research Unit of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The sesamum variety AKT-64 was sown on 11th and 12th July during 2000 and 2001, respectively, however during 2002 it was sown on 29th June. The experiment was conducted in randomized block design with three replications having 12 treatments comprising of 7 botanicals and 4 insecticides of 3 different groups including control (untreated) plot. Each treatment plot was sown at spacing of 30 x 15 cm with gross plot size of 4.5 x 3.0 m^2 and net plot size of 3.9 x 2.7 m^2.

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Table 1. Effect of treatments on average per cent infestation of gallfly at 3, 7 and 14 days after spray (pooled mean for 2000-2003)

S.N.	Treatments	Av. % inf. of gallfly at 3 DAS				Av. % Inf. of gallfly at 7 DAS				Av. % Inf. of gallfly at 14 DAS			
		2000-01	2001-02	2002-03	Pooled mean	2000-01	2001-02	2002-03	Pooled mean	2000-01	2001-02	2002-03	Pooled mean
1.	NSE 5%	2.01	55.06	2.47	19.85	1.91	64.73	3.95	23.53	2.76	72.1	10.01	28.29
		(7.13)	(47.93)	(9.10)	(21.72	(7.92)	(53.55)	(11.39)	(24.29)	(9.63)	(58.12)	(18.44)	(28.73)
2.	Neem oil 3% @ 30 ml lit^{-1}	0.68	56.31	1.91	19.63	1.46	65.30	3.52	23.43	2.32	71.7	12.85	28.96
		(4.73)	(48.62)	(7.92)	(20.42)	(7.04)	(53.91)	(10.78)	(24.75)	(8.72)	(57.86)	(20.96)	(29.18)
3.	Azadirachtin 1500 ppm @ 1.5 ml lit^{-1}	0.28	58.26	2.59	20.38	2.06	62.75	5.48	23.43	6.82	73.4	11.65	30.62
		(3.03)	(49.78)	(9.28)	(20.70)	(8.33)	(52.36)	(13.56)	(24.75)	(15.12)	(58.95)	(19.91)	(31.33)
4.	Azadirachtin 1500 ppm @ 2.0 ml lit^{-1}	0.21	55.91	1.84	19.32	3.60	67.18	4.04	24.94	5.20	65.4	10.80	27.14
		(2.63)	(48.39)	(7.71)	(19.58)	(10.94)	(55.06)	(11.54)	(25.85)	(13.18)	(53.97)	(19.19)	(28.78)
5.	Azadirachtin 1500 ppm @ 3.0 ml lit^{-1}	1.06	58.03	1.74	20.28	0.79	64.87	3.22	22.96	4.25	66.1	9.93	26.76
		(6.02)	(49.60)	(7.49)	(21.04)	(5.10)	(53.67)	(10.31)	(23.03)	(11.83)	(54.39)	(18.34)	(28.19)
6.	Azadirachtin 300 ppm @ 4.0 mllit^{-1}	0.80	49.42	2.29	17.50	1.47	64.05	3.29	22.94	2.94	74.9	12.92	30.25
		(5.13)	(44.66)	(8.72)	(19.50)	(7.04)	(53.13)	(10.47)	(23.55)	(9.81)	(59.93)	(21.05)	(30.26)
7.	Azadirachtin 300 ppm @ 5.0 ml	0.51	59.37	1.22	20.37	1.98	59.53	3.15	21.55	4.05	66.3	9.65	26.67
		(4.09)	(50.42)	(6.29)	(20.27)	(8.13)	(50.48)	(10.14)	(22.92)	(11.54)	(54.51)	(18.05)	(28.03)
8.	Dimethoate 30 EC 0.05%	1.04	55.68	2.25	19.66	2.71	54.97	3.53	20.40	2.28	68.35	8.66	26.43
		(5.74)	(48.27)	(8.53)	(20.85)	(9.46)	(47.87)	(10.78)	(22.70)	(8.72)	(55.73)	(17.16)	(27.20)
9.	Chlorpyriphos 20 EC 0.05%	0.55	55.77	2.42	19.58	2.41	56.64	3.38	20.81	6.62	62.83	8.87	26.11
		(4.25)	(48.33)	(8.91)	(20.50)	(8.91)	(48.79)	(10.63)	(22.78)	(14.89)	(52.42)	(17.36)	(28.22)
10.	Endosulfan 35 EC 0.07%	0.27	52.09	1.20	18.19	1.32	53.23	3.30	19.28	5.23	62.79	7.10	25.04
		(6.55)	(46.20)	(6.29)	(19.68)	(6.55)	(46.83)	(10.47)	(21.28)	(13.18)	(52.42)	(15.45)	(27.02)
11.	Fenvalerate 20 EC 0.01%	0.22	50.91	1.19	17.44	1.62	52.93	2.39	19.98	5.14	46.41	2.64	18.06
		(2.69)	(45.52)	(6.29)	(18.17)	(7.27)	(46.66)	(8.91)	(20.95)	(13.05)	(42.94)	(9.28)	(21.76)
12.	Control	3.1	60.82	2.85	22.26	4.13	65.88	5.69	25.23	8.09	76.47	15.28	33.28
	(Water spray)	(10.14)	(51.24)	(9.63)	(23.67)	(11.68)	(54.27)	(13.81)	(26.59)	(16.54)	(61.00)	(23.03)	33.52
	'F' test	Sig	N.S.	Sig	N.S.	N.S.	Sig	N.S.	Sig	Sig	Sig	Sig	Sig
	SE (m) $\pm$	0.11	4.03	0.14	0.90	0.21	1.92	0.20	1.05	0.22	2.97	0.18	1.75
	CD at 5%	0.32	-	0.42	-	-	5.63	-	3.08	0.64	8.73	0.52	5.12
	C.V.%	16.61	12.50	3.40	7.62	22.98	6.47	18.33	7.72	17.39	9.27	9.87	10.61

N.B. : Figures in parentheses indicates Arcsine transformation.

The observations were recorded on five randomly selected plants in each plot. The pre treatment observations on total buds, flowers, capsules (total number of fruiting bodies) and number of galls formed on plant were undertaken from bud initiation stage onwards at 24 hrs. before spray. Likewise post treatment observations were also recorded at 3, 7 and 14 days after spray. On the basis of above observations, average number of galls formed plant^{-1} and average per cent infestation of gallfly were worked out.

In all two sprays were given, first spray at bud initiation stage i.e. 30-35 days after sowing and subsequent at 15 days interval. Yield plot^{-1} was recorded. The data thus obtained for three years was subjected to pooled analysis and results are presented in Table 1 to 3.

RESULTS AND DISCUSSION

Efficacy of Various Treatments on Gallfly Infestation

Per centage infestation of gallfly as effected due to various treatments during the three years along with the pooled results are presented in Table 1. These revealed non-significant effect of treatments on infestation of gallfly at 3 days after spray.

However, at 7 days after spray the results with respect to different treatments were found statistically significant. Minimum infestation of gallfly (18.98%) was recorded due to fenvalerate 0.01 per cent and it was significantly superior to NSE 5 per cent, neem oil 3 per cent, azadirachtin 1500 ppm @ 1.5 ml lit^{-1}, 2 ml lit^{-1} and untreated control. Treatment of fenvalerate 0.01 per cent was found statistically at par with endosulfan 0.07 per cent, dimethoate 0.05 per cent, chloropyriphos 0.05 per cent, azadirachtin 300 ppm @ 5 ml lit^{-1}, azadirachtin 1500 ppm @ 3 ml lit^{-1} and azadirachtin 300 ppm @ 4 ml lit^{-1}. However, the latter two treatments viz. azadirachtin 300 ppm @ 4 ml lit^{-1} was found at par with NSE 5 per cent, azadirachtin 1500 ppm @ 1.5 ml lit^{-1}, @ 2 ml lit^{-1} and untreated control where in miximum infestation of 23.53, 23.43, 24.94 and 25.23 per cent, respectively was recorded.

Likewise, treatment differences were found significant as regard to pooled per centage infestation of gallfly at 14 days after spray. Treatment due to fenvalerate 0.01 per cent was found significantly superior over remaining treatments in recording minimum infestation of gallfly (18.06%). Second best treatment was endosulfan 0.07 per cent which was recorded comparatively minimum infestation of gallfly (25.04%) and was at par with rest of the treatments except control. Maximum infestation of gallfly (33.28%) was recorded in untreated control and it was found statistically at par with NSE 5 per cent,

Table 2. Effect of treatments on yield on sesamum

S.N.	Treatments	Yield in kg ha^{-1}			
		2000-01	2001-02	2002-03	Pooled mean
1.	NSE 5%	236.263	60.439	1234.431	510.073
2.	Neem oil 3% @ 30 ml lit^{-1}	190.476	43.956	1005.493	413.003
3.	Azadirachtin 1500 ppm @ 1.5 ml lit^{-1}	245.421	44.872	925.823	405.677
4.	Azadirachtin 1500 ppm @ 2.0 ml lit^{-1}	268.315	56.776	989.926	438.644
5.	Azadirachtin 1500 ppm @ 3.0 ml lit^{-1}	308.608	65.018	1156.592	510.073
6.	Azadirachtin 1500 ppm @ 4.0 ml lit^{-1}	332.417	41.209	1012.819	462.453
7.	Azadirachtin 1500 ppm @ 5.0 ml	333.333	43.956	1122.709	500.000
8.	Dimethoate 30 EC 0.05%	257.326	59.524	1299.449	538.461
9.	Chlorpyriphos 20 EC 0.05%	244.505	75.091	1259.156	526.556
10.	Endosulfan 35 EC 0.07%	328.754	114.469	1301.280	581.501
11.	Fenvalerate 20 EC 0.01%	395.604	205.128	1342.489	647.435
12.	Control (Water spray)	185.897	34.798	889.193	369.963
S.E. (m)±		27.339	9.689	87.353	46.477
CD at 5%		80.190	25.418	256.213	136.320
CV%		17.03	23.43	13.41	16.36

Table 3. Effect of treatments on yield of Sesamum and their incremental cost benefit ratio (Pooled mean for 2000-2003)

S.N.	Treatments	Total cost of plant protection (input)				Total cost of produce (output)			I.C.B.R.
		No. of spray req.	Cost of insecticide req. ha^{-1} Rs. ha^{-1}	Cost of labour charges including spray pump Rs. ha^{-1}	Total cost on input Rs. ha^{-1} (4+5)	Yield of sesamum in (kg ha^{-1})	Addl. yield increased over control	Net gain (Rs. ha^{-1})	
1.	2	3	4	5	6	7	8	9	10
1.	NSE 5%	2	300	420	720	510	140	2892.40	1:4.20
2.	Neem oil 3% @ 30 ml lit^{-1}	2	1500	420	1920	413	43	888.38	1:0.46
3.	Azadirachtin 1500 ppm 2 1.5 ml lit^{-1}	2	300	420	720	406	36	743.76	1:1.03
4.	Azadirachtin 1500 ppm @ 2.0 ml lit^{-1}	2	400	420	820	439	69	1425.54	1:1.74
5.	Azadirachtin 1500 ppm @ 3.0 ml lit^{-1}	2	600	420	1020	510	140	2892.40	1:2.84
6.	Azadirachtin 300 ppm @ 4.0 ml lit^{-1}	2	520	420	940	462	92	1900.72	1:2.02
7.	Azadirachtin 300 ppm @ 5.0 ml	2	650	420	1070	500	130	2685.80	1:2.51
8.	Dimethoate 30 EC 0.05%	2	306	420	726	538	168	3470.88	1:4.78
9.	Chlorphriphos 20 EC 0.05%	2	462	420	882	527	157	3243.62	1:3.68
10.	Endosulfan 35 EC 0.07%	2	440	420	860	581	211	4359.26	1:5.07
11.	Fenvalerate 20 EC 0.01%	2	120	420	540	647	277	5722.82	1:10.60
12.	Control (Water spray)	-	-	-	-	370	-	-	-

azadirachtin 1500 ppm @ 2 ml lit^{-1}, neem oil 3 per cent, azadirachtin 300 ppm @ 4 ml lit^{-1} and azadirachtin 1500 ppm @ 1.5 ml lit^{-1}.

Effect of Various Treatments on Yield of Sesamum

Pooled data of sesamum yield as affected due to various treatments are presented in Table 2. The yield data were found statistically significant. Significantly maximum yield was recorded in treatment due to fenvalerate 0.01 per cent (647 kg ha^{-1}) closely, followed by endosulfan 0.07 per cent (581 kg ha^{-1}), dimethoate 0.05 per cent (538 kg ha^{-1}) and chlorpyriphos 0.05 per cent (526 kg ha^{-1}) and these treatments were statistically at par with each other. Treatment due to fenvalerate 0.01 per cent was found significanly superior over azadirachtin 1500 ppm @ 3 ml lit^{-1}, NSE 5 per cent, azadirachtin 300 ppm @ 5 ml lit^{-1}, 4 ml lit^{-1}, azadirachtin 1500 ppm @ 2 ml lit^{-1}, neem oil 3 per cent, azadirachtin 1500 ppm @ 1.5 ml lit^{-1} and untreated control. Lowest yield of sesamum (370 kg ha^{-1}) was recorded in untreated control and it was found statistically at par with azadirachtin 300 ppm @ 5 ml lit^{-1} and 4 ml lit^{-1}, azadirachtin 1500 ppm @ 2 ml lit^{-1} and 1.5 ml lit^{-1} and neem oil 3 per cent.

Incremental Cost Benefit Ratio

Highest pooled cost benefit ratio (1:10:60) was recorded due to fenvalerate 0.01 per cent followed by endosulfan 0.07 per cent (1:5.07), dimethoate 0.05 per cent (1:4.78) and NSE 5 per cent (1:4.02). Lower ICBR (1:0.46) was recorded in treatment due to neem oil 3 per cent (Table 3).

It is concluded from the pooled results that the treatments viz. fenvalerate 0.01 per cent, endosulfan 0.07 per cent and dimethoate 0.05 per cent were most effective and economical. Similarly these treatments recorded maximum ICBR.

The above findings regarding the management of sesamum gallfly are in confirmation with the findings of Ghorpade and Thakur (1995) who reported that seasame crop could be protected from the pyralid, *A. catalaunalis* and Cecidomyiid *A. sesami* with two spray of endosulfan 0.07 per cent at 45 and 60 DAS or alternatively dusting with quinolphos 1.5 D or methyl parathion 2 D, quinolphos 1.5 D @ 20 kg ha^{-1} at 45 DAS. Hubeishan (1991) reported that all the insecticides except dimethoate significantly reduced the infestation of both insects and increased yield, where as the diazinon and fenvalerate gave the most effective control of *Asphondylia sesami* and *Antigastra catalaunalis*, respectively. Sawada (1991) also reported that three sprays of fenitrothion or fenvalerate applied at 15 days interval starting from 10 days after the beginning of flowering or 2 sprays of the same components at an interval of 20 days reduced the damage to 8-15 per cent levels.

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Biology and Population Dynamics of Safflower Aphid *Dactynotus carthami* HRL

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ABSTRACT

"Biology and Population Dynamics" of safflower aphid *Dactynotus carthami* HRL was studied on the potted plants covered with a glass chimney and muslin cloth. Different observations of development stages, longevity and fecundity were recorded. Aphids were small, tiny and black in colour, reproduced parthenogenetically and viviparously. There were four moults and five instars. The duration of first, second, third and fourth instar nymphs were recorded as 2-4, 2-3, 2-3 and 2-3 days, respectively. The fifth instar nymph is regarded as adult. Total nymphal period occupied 8 to 13 days. The longevity of adult was 12 to 17 days and life cycle was completed in 20 to 30 days. Each female produced 17 to 41 aphids during its life at the rate of 5 to 7 nymphs daily. The aphid incidence was observed during 48th meteorological week and attained peak population from 3rd to 7th meteorological week. Maximum aphid population was recorded in 6th meteorological week when temperature was 11.1°C and 31.1°C maximum and minimum, respectively and RH 56 and 23 per cent morning and evening, respectively.

Safflower (*Carthamus tinctorius* L.) is one of the important *Rabi* oilseed crop reported to be originated from Albyssinia and Afghanistan. Seed contains 28 to 32 per cent oil and oil cake 40 to 45 per cent protein.(Weiss, 1983) Main hurdles in boosting up safflower production are the different pests, which hamper the production considerably. The crop is known to be infested by 22 insect pests of which aphids *Dactynotus carthami* HRL are of great importance. During the young and flowering stages of plant growth the central shoot is the most preferred by aphids, followed by the leaves and the head. Other parts of the safflower are too cumbersome or show highly variable density, for aphids. (Bhat, *et al.* 1989).It affects the plant by sucking as a result the plant growth vigour and development are retarded, causing great reduction in yield due to devitalization and plant later dry up. Besides these damages, an aphid secretes a secretion, which acts as a medium for the growth of sooty mould and affects photosynthesis adversely. The fungus *Capnodium* spp. live saprophytically on honey dew secreted by aphids and form black sooty mould development on plants. Knowing the seriousness of aphid infestation on safflower, present study i.e. biology of safflower aphids, it's time of incidence in the field, the observation on the population dynamics of this pest were recorded throughout the crop season, i.e. lowest, marginal and highest aphid population with relation to environmental factors was undertaken.

MATERIAL AND METHODS

The present experiment was conducted to study the Biology and Population dynamics of safflower aphids carried out at the field of Entomology Department, PGI, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during *Rabi* season in 1999-2000. For biological studies of safflower aphid *Dactynotus carthami* HRL following points were considered viz., Fecundity, longevity and speed of development. For that five potted plants were selected for the study. Twenty nymphs about four hours old were transferred on these plants and allowed to breed under caged condition. These plants were also covered with a glass chimney. Majority of the aphids reached the adult stage. Of these, five fully developed females were allowed to produce progeny and rest of the aphids were removed from the plants. The fecundity of the females, speed of development and longevity were recorded in respect of the subsequent generation. Biological studies were carried out from 15th January to 30th March. Studies on population of safflower aphids throughout the crop season was recorded at 8 days intervals starting from 26th November to middle of March. Small piece of land was sown with safflower variety "Bhima" four plots of three square meters were selected and kept under observation. Five plants per plot were randomly selected and tender shoot tagged for recording population development from each plant. Five cm terminal shoot

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length was taken for weekly observations were co-related with meteorological data.

RESULTS AND DISCUSSION

Biology of Safflower aphid

The results on the biology of aphids studies indicated that aphids reproduce parthenogenetically and viviparously, it was found that female normally lowers it's abdomen towards the leaf or stem and the emergent nymph, which burst it's embryonic membrane grip the leaf or stem. After producing one nymph, the female moved her abdomen either to left or right of just born and gave birth to other young nymph. Sometimes the nymphs may die itself at the time of birth. The time required for complete ejection of a nymph varied from 10 to 20 minutes, it may also vary greatly with individuals.

First instar nymph :

After bursting the membrane, freshly emerged nymph was very delicate, oval is shape and dirty white in colour with legs white in colour. Colour changed to dark in 15 minutes. Head was triangular in shape and opisthognathus with slightly developed compound eyes. Three pairs of legs, absence of wing pads, two cornicles on dorsal side and cauda was slightly visible on last terminal segment of abdomen were observed during first instar. First instar nymph lasted for about 2 to 4 days.

Second instar nymph :

It was darker than first instar, legs were still white but antennae became darker as advanced the instars. It remained inactive for 15 to 30 minutes. Eyes were very prominent body was flat and dorsum convex in shape. Wings pads were not observed at this stage also. The abdominal segments were not distinct. A pair of cornicles was present on the dorsum of abdominal segment and cauda on last segment. The second instar lasted for about 2 to 3 days.

Third instar nymph : In third instar only the body was flat and slightly convex longitudinally and the remaining characters were same as in the second instar nymph. The instar instead for about 2 to 3 days.

Fourth instar nymph : It resembled to it's parent, but smaller in size. The nymphs were black in colour with appendages such as legs, initially white in colour and turned darker within 4 to 5 hours and the antennae turned darker. The nymphs were inactive for 2 to 3 hours and then started feeding. Cornicles and cauda on last segment were well developed and the nymph lasted for 2 to 3 days.

Adult :

The fourth and final moult occurred during 2 to 3 days and apterous adult emerged out, which was shining black in colour thereby forming fully developed adult. The colours changed to black after moulting. Legs were long and rather slender and cornicles were observed dorsally. Last abdominal segment had a small elongated cauda.

Fecundity :

Studies indicated that the maximum number of nymphs produced by the female was 41 and minimum was 17 nymphs. Daily 5 to 7 nymphs were deposited by female. Although, pre- reproduction period appeared to be 3 to 4 days and female continued to breed for the period of 6 to 8 days.

Longevity :

It was indicated that the pre-reproduction period was of 3-4 days. Main reproduction period lasted for 6-8 days. Whereas post reproduction period occupied 3-5 days. Thus the longevity of adult aphid was 12 to 17 days and total life cycle was completed within 20 to 30 days. The present findings on biological studies are in accordance with the studies made by Nachane (1971),Lanjewar (1976), Bhumannawar and Thontadarya (1981) and Gokhe (1989) who recorded that, aphids reproduce parthenogenetically and viviparously and have 4 nymphal instars which, are completed in 7.5 to 16 days.

Population of safflower aphids

The populatin dynamics of ahpid presented in Table 1 revealed that the initiation of alate forms was observed on last week of November. Thereafter the population of aphids started to build up. Aphid population reached to peak and remained constant from 3rd to 7th meteorological weeks, when temperatures and relative humidity were in the range of maximum 31.2°C and minimum 11.1°C and relative humidity 67 per cent (morning) and 23 per cent (evening). Maximum aphids population was 96.50 aphids 5 cm^{-1} shoot length observed in 6th meteorological week, when temperature recorded was 11.1°C and 31.0°C, minimum and maximum declined shortly on receipt of rains in 8th MW and thereafter due to rise in temperature and decrease in RH upto 10th MW week, when maximum temperature and RH were 30°C and

Table 1. Population of safflower aphid and Ladybird beetle shoot^{-1}.

S.N.	Date of Observation	M.W.	Avg. aphid population 5 cm^{-1}shoot length	Avg. No. of LBB shoot^{-1}	Meteorological data				
					Temp(°C)		RH(%)		Rainfall
					Max.	Min.	Morn	Even	(mm)
1	26-11-99	48	3.2	0.0	29.3	10.7	64	26	0.0
2	3-12-99	49	16.95	0.0	30.2	10.2	63	27	0.0
3	10-12-99	50	29.55	0.0	29.2	11.2	75	30	0.0
4	17-12-99	51	35.15	0.0	27.6	8.0	73	27	0.0
5	24-12-99	52	43.80	0.2	28.2	8.6	67	24	0.0
6	1-1-2000	1	68.05	0.3	29.6	11.1	73	31	0.0
7	8-1-2000	2	79.50	0.5	28.4	9.0	71	28	0.0
8	15-1-2000	3	90.20	0.9	30.4	11.2	67	27	0.0
9	22-1-2000	4	84.20	1.2	31.2	13.7	65	29	0.0
10	29-1-2000	5	83.20	1.3	30.8	11.9	65	27	0.0
11	5-2-2000	6	96.50	1.9	31.0	11.0	56	23	0.0
12	12-2-2000	7	94.40	2.3	30.0	12.7	56	28	0.0
13	19-2-2000	8	63.80	2.1	30.0	14.0	53	24	0.0
14	26-2-2000	9	21.35	1.4	29.4	13.3	73	39	25.2
15	5-3-2000	10	4.95	0.5	32.9	15.3	56	19	0.0

Note : Meteorological data presented is of preceding weeks data
MW : Meteorological week RH : Relative Humidity

56 per cent and minimum temperature and RH were 12.7°C and 19 per cent respectively. Minimum aphid population was recorded during, 10th meteorological week when the maximum temperature was 32.9°C and minimum 15.3°C with maximum RH 56 per cent and minimum 19 per cent, respectively. The peak infestation of aphid found during 3rd to 7th MW in the present investigation is in close conformity with Upadhyay *et al.* (1980) who reported peak period of infestation between middle of January to middle of February. Also Rathore and Pathak (1983) reported maximum and minimum temperature and RH to be 33°C, 15°C and 44 per cent, respectively during the peak period of infestation.

Adult population of Ladybird beetle:

Regarding adult population of Ladybird beetle was recorded on safflower from 52nd meteorological week to 10th meteorological week. It steadily increased in accordance with aphid population. The population of Ladybird beetle ranged between 0.2 to 2.3 adults shoot^{-1} length on an average. Maximum population of Ladybird beetle was observed in 7th MW, when maximum and minimum temperatures were 30°C and 12.7°C and RH 56 per cent (morning) and 28 per cent (evening) in the preceding week, when the aphid population was also at peak, Ghorpade (1995) who also observed the incidence of Ladybird beetle on safflower aphids.

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Effect of Soil Solarization on Chlorophyll and Wilt in Pigeonpea

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ABSTRACT

Field experiment was conducted in split plot design during *Kharif* 2000-2001 and 2001-2002 to assess the effect of soil solarization by using transparent polyethylene sheet (LDPE, SILTAP, Swiss make) in the month of April and May and its combination with different biological and chemical treatments in wilt sick soil on chlorophyll content of pigeonpea varieties. Three varieties viz. BSMR-736, BDN-2 and ICP-2376 were sown in wilt sick soil. BSMR-736 recorded maximum chlorophyll a, chlorophyll b and total chlorophyll i.e. 1.0507, 0.620 and 2.13 mg g^{-1}, respectively at 45 DAS and 0.975, 0.603 and 2.11 mg g^{-1} at flowering, respectively. Among sub treatments, solarization + seed treatment with *Trichoderma* recorded maximum chlorophyll content i.e. higher chlorophyll a (1.066 mg g^{-1}), chlorophyll b (0.624 mg g^{-1}) and total chlorophyll (2.17 mg g^{-1}). However, this treatment was found at par with solarization alone. Wilting per cent was higher in control (52.37 %) whereas, lowest wilting was recorded in solarization + seed treatment with *Trichoderma* (16.20 %). Added benefit of chlorophyll content was obtained when soil solarization combined with other seed treatments.

Pigeonpea occupies a unique position in Indian agriculture by virtue of its high protein contents. Besides other factor, diseases take a heavy toll of the crop every year resulting in enormous losses. The most important among them is wilt caused by *Fusarium udum* Butler. Disease manifest in the form of epinasty of leaves, followed by loss of chlorophyll, yellowing, loss of turgor and wilting of the plant ultimately reduce in yield. Increases in chlorophyll content also attributed induced resistance and ultimately better growth and reduction in wilt incidence. Soil solarization reduced soil sickness by changing chemical and microbial factors of soil (Chen *et al*, 1991). It increases biomass, plant height and chlorophyll content in three successive crop cycles (Chen *et al*, 1991; Davis, 1991). Soil solarization is a non chemical ecofreindly sustainable method commonly used in hot climates and promotes plant growth by disease independent mechanism termed as increase growth response (IGR) (Katan,1981). Whereas, other soil disinfection technique have been reported to affect soil mineral availability as well as plant elemental composition and growth (Ellis *et al., 1995*).Soil solarization is known to induce changes in soil chemical composition (Ahmad and Baker, 1988). However, physiological response of pigeonpea, growing in fusarial wilt sick soil, especially related to chlorophyll was rarely investigated.

In view of this, present study was carried out to assess the effect of soil solarization and its combination with other treatments on chlorophyll content of the pigeonpea under sick soil conditions and its relation to wilt incidence.

MATERIAL AND METHODS

The field experiment was conducted in split plot design at ARS Badnapur (M.S.) during *kharif* 2000-2001 and 2001-2002 in pigeonpea wilt sick soil condition. Three varieties of pigeonpea resistant (BSMR-736), moderately resistant (BDN-2) and susceptible (ICP-2376) were sown in main plots. The subplot treatments included solarization and its combination with seed treatment of *Trichoderma harzianum, Pseudomonas fluorescens,* Thiram + Benomyl (1:1) and check treatment (control). For soil solarization, the plots were irrigated to the depth of 10 cm before they were covered with transparent polyethylene sheet (90 GSM, LDPE, SILTAP, Swiss make) on 22nd April 2000 and 22nd April 2001 i.e. on the next day following irrigation by spreading the sheet, burring and sealing along the edges with top soil in a 20 cm deep furrow so as to prevent

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Table 1. Effect of different IDM treatments on chlorophyll contents and wilt incidence (2000-2001, 2001-2002)

Treatments	Chlorophyll at 45 days				Chlorophyll at flowering			
	Chloro-phyll a	Chloro-phyll b	Total chloro-phyll	Wilt (%)	Chloro-phyll a	Chloro phyll b	Total chlorophyll	Wilt (%)
BSMR-736 (V_1)	1.0507	0.620	2.13	0.51 (0.98)	0.975	0.603	2.11	5.66 (13.22)
BDN-2 (V_2)	1.0414	0.613	2.11	2.10 (1.57)	0.962	0.574	1.99	38.38 (37.44)
ICP-2376 (V_3)	1.0331	0.610	2.11	13.41 (3.72)	0.828	0.554	1.79	88.56 (74.24)
CD (P=0.05)	NS	NS	NS	0.083	0.051	0.36	0.080	0.041
Solarization (T_1)	1.053	0.618	2.13	2.30 (1.67)	0.930	0.575	1.96	16.62 (23.89)
Solarization + seed treatment with thiram (T_2)	1.058	0.619	2.13	2.09 (1.57)	0.932	0.576	1.99	16.22 (23.26)
Solarization + seed treatment with *Trichoderma* (T_3)	1.066	0.624	2.17	1.62 (1.44)	0.942	0.588	2.07	16.20 (23.21)
Solarization + seed treatment with *Pseudomonas* (T_4)	1.060	0.622	2.14	2.10 (1.60)	0.937	0.618	2.03	16.22 (23.26)
Control (T_5)	0.972	0.589	2.02	8.41 (2.98)	0.867	0.527	1.73	52.37 (50.23)
CD (P=0.05)	0.020	0.0062	0.71	0.28	0.046	0.047	0.12	0.46
Interaction (VxT) CD (P=0.05)	NS	NS	NS	0.45	NS	NS	NS	0.21

Figures in parenthesis are arc sin means

escape of heated air. The plots remained covered for 45 days and soil temperature was recorded daily at 2.30 pm by IMD specified thermometers.

Seed treatment

Fungicides alone or in combination were used as dry seed dressing in the experiment. Formulation of *Pseudomonas fluorescens* prepared by G.B.Pant University of Agricultural and Technology Pantanagar was used @10g kg^{-1} seeds, whereas, *T .harzianum* formulation was used @ 4 g kg^{-1} seed.

Determination of chlorophyll

Chlorophyll content in leaves of pigeonpea was determined at 45 DAS and at flowering as described by Hiscox and Israelstam (1979).The optical density was recorded on Spectronic 20 using 645,652 and 663 nm wavelength. Chlorophyll a, b and total chlorophyll was calculated (Dhopte and Livera, 1989).

Wilt (%)

No. of plants wilted at flowering was recorded and per cent wilt incidence was calculated on the basis of no. of plants wilted in each treatment.

RESULTS AND DISCUSSION

The data (Table 1) in regards to varietal response indicate non significant differences in chlorophyll a, chlorophyll b, and total chlorophyll at 45 DAS. However, significant increase was found during flowering where, BSMR-736 recorded increase in chlorophyll a (0.975 mg g^{-1}), chlorophyll b (0.603 mg g^{-1}) and total chlorophyll (2.11 mg g^{-1}) than other two varieties. The lowest a, b, and total chlorophyll was recorded in ICP-2376 i.e. 0.828, 0.554 and 1.79 mg g^{-1}, respectively. It may be due to cultivation of the vulnerable variety in unprotected condition i.e. without soil solarization and seed treatments. Anver *et.al.* 1997 recorded greatest reduction of chlorophyll due to pathogenic microorganism. Nagaraj *et al.* 2001recorded positive correlation of photosynthetic rate with chlorophyll content. Similar results in respect of main treatments and sub plot treatments were observed during the course of studies.

Subplot treatments showed significant influence on chlorophyll content in pigeonpea varieties at 45 DAS and at flowering during both season. Maximum chlorophyll a (1.066 mg g^{-1}), Chlorophyll b (0.624 mg g^{-1}) and total chlorophyll (2.17 mg g^{-1}) was recorded in solarization + seed treatment with *Trichoderma harzianum* @ 4 g kg^{-1} seed. However, it was at par with all other treatment except control, where, less chlorophyll content was recorded i.e. Chlorophyll a (0.972 mg g^{-1}), b (0.589 mg g^{-1}) and total chlorophyll (2.02 mg g^{-1}). Similarly, solarization + seed treatment with *Trichoderma harzianum* gave higher amount of chlorophyll content at flowering i.e. 0.942 mg g^{-1}, 0.588 mg g^{-1} and 2.07 mg g^{-1} chlorophyll a, chlorophyll b and total chlorophyll, respectively. Similar trends of Chlorophyll content was observed during 2000-2001and 2001-2002. Inbar *et al.*, 1994 reported increase in chlorophyll due to application of *Trichoderma harzianum* in chilli and cucumber seedlings .This clearly indicates that the increase in chlorophyll content was due to solarization with added benefit of different seed treatments. The increase in chlorophyll content attributed to induction of wilt resistance mechanism in pigeonpea varieties. The results are in support with the finding of Subramanian (1963). Gruenzweig *et.al.* (1993) also reported that the third tomato true leaf showed higher level of chlorophyll due to soil solarization (55µg mg^{-1}) as compared to those from control (32 µg mg^{-1}). Per cent wilt incidence1.62 and 16.20 % was found significantly lower in solarization + seed treatment with *Trichoderma* @ 4 g Kg^{-1} seed (1.62%) at 45 DAS and at flowering , respectively as compared to control (52.37%). The increase in chlorophyll might be attributed to increase resistance against wilt in pigeonpea varieties and better yield of the crop. Nagraj *et al.* (2001) recorded positive correlation of photosynthesis with chlorophyll; suggest increase in chlorophyll content ultimately increases photosynthetic reaction might have induced the disease resistance in plants as compared to control. These observations suggest that, in the face of pathogen attack, the plant might rapidly redirecting its resources from growth processes to defense responses; the fact is also established that the wilt causing organism brought down the photosynthetic reaction ultimately lowering down the chlorophyll content. Regular physiological functioning of the plant in absence of wilt causing pathogen may result in increased nutrient availability and acquired resistance in the plant against pathogens.

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Constraints of Bio-gas Owners in Udaipur District of Rajasthan

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ABSTRACT

The study was conducted in Girwa (tribal) and Bhinder (non-tribal) panchayat samiti of district Udaipur of southern Rajasthan to identify constraints encountered by bio-gas owners about different aspects of bio-gas technology. The data collected from 96 randomly selected respondents revealed that majority (70.83 %) had medium level of constraints. Low gas production in winter and rainy season, unawareness about use of water removing device, choking of burners and lack of trained technicians in the village were perceived as most severe constraints by the respondents. While frequent cleaning of digester tank, disposal of slurry is a problem in the rainy season, clogging of inlet and outlet pipe, non-availability of cow-dung and natural flavour of food is affected due to cooking on bio-gas were perceived as less severe constraints by bio-gas owners. The comparison of constraints encountered by bio-gas owners of tribal and non-tribal area revealed that both the categories had similar constraints about different aspects of bio-gas technology.

In view of shrinking oil and coal reserves and rising costs of these commodities, alternatives have to be developed upto a level where their exploitation is feasible technologically and economically. There are alternative resources in India, which can be used successfully to meet future eventualities. One of these alternatives is bio-gas. The Government is providing technical know-how and subsidy on large scale for the installation of bio-gas plants in the villages. Inspite of this the majority of bio-gas plants are not functioning properly due to various constraints. With this point in view, the present study was undertaken with the specific objective: To identify constraints encountered by bio-gas owners about different aspects of bio-gas technology.

MATERIAL AND METHODS

The present study was conducted in Girwa (tribal) and Bhinder (non-tribal) panchayat samities of Udaipur district of Rajasthan where maximum number of bio-gas plants were installed. Thereafter, six villages from each panchayat samiti were selected on the basis of possessing highest number of bio-gas plants and eight bio-gas owners were identified by applying random sampling technique from each selected village. Thus, the total study sample composed of 96 respondents. Data were collected through structured schedule by employing personal interview technique. Thereafter, data were analysed, tabulated and interpreted in the light of objective of the study.

Individual aspect wise constraints of bio-gas owners were worked out. These were categorized into three groups namely, technical constraints, operational constraints and general constraints. The intensity of constraint encountered was measured on three point continuum scale and weights of 3, 2 and 1 were given for most important, important and least important, respectively. Thereafter, mean per cent score (MPS) for each statement was calculated and ranked accordingly. Mean per cent score (MPS) was calculated by the following formula:

$$\text{Mean per cent Score (MPS)} = \frac{\text{Total score obtained}}{\text{Maximum obtainable score}} \times 100$$

Spearman rank order correlation (r_s) was used to find out correlation between ranks accorded to constraints faced by both the categories of the respondents i.e. tribal and non-tribal area bio-gas owners. Further, Z-test was applied to find out the significance of difference between both the categories of respondents with respect to constraints faced by them.

RESULTS AND DISCUSSION

Distribution of respondents according to their level of constraints:

The data presented in Table 1 indicate that majority of the respondents (70.83%) of the total sample

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belonged to medium constraints group. Whereas, 18.76 per cent respondents were reported in high constraints group and remaining 10.41 per cent in the low constraints group respectively.

A close observation of data contained in Table 1 further shows that majority of tribal area respondents (72.91%) and non-tribal area respondents (68.75%) belonged to medium constraints group. A very few bio-gas owners of tribal and non-tribal area were noted in low constraints group. Whereas, the representation of respondents of tribal and non-tribal area in high constraints group was observed to be 12.51 per cent and 25.00 per cent respectively in the study sample.

Comparison of constraints encountered by bio-gas owners of tribal and non-tribal area about bio-gas technology

A persual of data in Table-1 reveals that calculated 'Z' value was less than the tabulated value at 1 per cent level of significance. Based on this, it could be concluded that there was no difference between tribal and non-tribal area bio-gas owners with respect to constraints faced by them.

Technical constraints perceived by bio-gas owners

A persual of data in Table 2 reveals that low gas production in winter and rainy season was expressed as the most important technical constraint by the bio-gas owners of tribal area with MPS 87.50 and was ranked first in the ranking hierarchy. Whereas, in case of non-tribal area, blockage of gas pipe line by water was realized as priority problem by respondents with MPS 73.95 and ranked first. The second emphasis by the bio-gas owners of both the areas was given on unawareness about use of water removing device in bio-gas plant. The MPS of this aspect was 83.33 and 71.87 for tribal and non-tribal area respondents respectively. The third important constraint perceived by tribal area respondents was blockage of gas pipeline by water (82.29 MPS), while in case of non-tribal respondents, it was low gas production in winter and rainy season with MPS 69.79. The constraints relating to poor and irregular gas supply, cracking of digester wall and leakage of gas pipeline were also expressed as major constraints by both the categories of bio-gas owners and ranked fourth, fifth and sixth respectively in the ranking hierarchy. The least important constraints encountered by the respondents of both the areas were disposal of slurry is a problem in the rainy season and frequent cleaning of digester tank. The realization of problem relating to low gas production in winter and rainy season may be due to the fact that methanogenic bacteria are mesophilic in nature and reduction in temperature adversely affects the gas production. The constraint about blockage of gas pipeline by water may be either due to unawareness of adopters about removal of water from pipeline on regular basis or due to not installing the water tap. The leakage of gas pipeline is due to its rupturing.

Operational constraints encountered by bio-gas owners:

The analysed data contained in Table 2 shows that choking of burners (MPS 77.60) was most severe constraint encountered by bio-gas owners of tribal and non-tribal area with mean per cent score 83.33 and 71.87 respectively and was ranked first in the ranking hierarchy. The reason for this constraint may be the accumulation of food or dust in the holes of burners. This was followed by constraints like scarcity of water for efficient running

Table 1 Distribution of respondents according to their level of constraints

S.N.	Level of constraints	Tribal area		Non-tribal area		Total	
		Frequency	Per cent	Frequency	Per cent	Frequency	Per cent
1.	Low (Upto 13)	7	14.58	3	6.25	10	10.41
2.	Medium (14 to 22)	35	72.91	33	68.75	68	70.83
3.	High (Above 22)	6	12.51	12	25.00	18	18.76
	Total	48	100.00	48	100.00	96	100.00

Comparison of constraints encountered by bio-gas owners of tribal and non-tribal area about bio-gas technology

S.N.	Category of respondents	Mean score	S.D.	S.E.	C.V.	Z value
1.	Tribal area	18.04	3.71	0.536	20.565	1.34 NS
2.	Non-tribal area	19.10	4.07	0.588	21.308	

Table 2 : Constraints encountered by bio-gas plant owners

S.N.	Constraints	Tribal area		Non-tribal area		Total	
		MPS	Rank	MPS	Rank	MPS	Rank
A.	**Technical constraints:**						
1.	Blockage of gas pipe line by water	82.29	3	73.95	1	78.12	2
2.	Unawareness about use of water removing device in bio-gas plant	83.33	2	71.87	2	77.60	3
3.	Leakage of gas pipe line	58.33	6	46.87	6	52.60	6
4.	Cracking of digester wall	61.45	5	53.12	5	57.28	5
5.	Frequent cleaning of digester tank	10.00	7.5	9.37	8	7.68	8
6.	Poor and irregular gas supply	65.62	4	57.29	4	61.45	4
7.	Low gas production in winter and rainy season	87.50	1	69.79	3	78.64	1
8.	Disposal of slurry is a problem in the rainy season	10.00	7.5	13.54	7	11.27	7
			$r_s = 0.893^{**}$				
B.	**Operational constraints:**						
1.	Non-availability of cow dung	16.66	6	47.91	5	32.28	6
2.	Scarcity of water for efficient running of plant	59.37	2	64.58	2	61.97	2
3.	Insufficient knowledge about operation of plant	35.41	5	30.20	6	32.80	5
4.	Corrosion of iron gas holders and pipeline	48.95	4	53.12	4	51.03	4
5.	Scum formation in digester tank	58.33	3	59.37	3	58.85	3
6.	Clogging of inlet and outlet pipe	10.00	7	20.00	7	15.00	7
7.	Choking of burners	83.33	1	71.87	1	77.60	1
			$r_s = 0.893^{**}$				
C.	**General constraints:**						
1.	Lack of time for maintenance of bio-gas plant	22.91	5	27.70	5	25.30	5
2.	Maintenance of bio-gas plant is costly	56.40	3	48.95	3	52.67	3
3.	Non-availability of spare parts in the village	72.25	2	62.50	2	67.36	2
4.	Lack of trained technicians in the village	79.16	1	80.20	1	79.68	1
5.	Gobar gas plant is not suitable for large families	33.54	4	31.87	4	32.70	4
6.	Natural flavour of food is affected due to cooking on bio-gas	20.00	6	16.00	6	18.00	6
			$r_s = 0.893^{**}$				

** Significant at 1 per cent level of significance

of plant, scum formation in digester tank and corrosion of iron gas holders and pipeline. These were ranked at second, third and fourth positions in the ranking hierarchy. Scarcity of water for efficient running of the plant was due to severe drought condition for the last 2 to 3 years in the study area. Problem about scum formation in digester tank may be due to infrequent stirring and the presence of undigested material in the slurry. Proper

mixing of the slurry to disperse the floating material and regular agitation may prevent scum formation. The least important constraints encountered by the tribal and non-tribal area bio-gas owners were: insufficient knowledge about operation of plant, non-availability of cattle dung and clogging of inlet and outlet pipe.

General constraints encountered by bio-gas owners:

It is evident from the data contained in Table 2 that lack of trained technicians in the village was expressed as the most important constraint by the respondents of tribal and non-tribal areas with MPS 79.16 and 80.20 respectively. The second emphasis by the tribal and non-tribal area respondents was given on non-availability of spare parts in the village (MPS 67.36). This was followed by problems relating to costly nature of maintenance of bio-gas plant (MPS 52.67) and gobar gas plant is not suitable for large families (MPS 32.70). These constraints got third and fourth ranks in the ranking hierarchy.

Lack of time for maintenance of bio-gas plant (MPS 25.30) and natural flavour of food is affected due to cooking on bio-gas (MPS 18.00) were the least important constraints encountered by the bio-gas owners of both the areas. The realization of constraint relating to lack of trained technicians in the village may be due to the reason that none of the trained technician is available in the village for repairing bio-gas plant. As and when there is a need of trained technicians, bio-gas owners have to call them from outside. Sometimes, trained technicians are not available in time. As a result of this bio-gas plant remained non-functional for longer period of time. Problem about non-availability of spare parts of bio-gas plant in village was due to the reason that bio-gas owners have to purchase spare parts from city which were expensive.

Table 2 further shows that Spearman rank order correlation (r_s) values for technical, operational and general constraints were 0.893, 0.96 and 1.00, respectively and statistically significant at 1 per cent level of significance. Based on this, it could be inferred that there was significant correlation between the ranks assigned to tribal and non-tribal area bio-gas owners. Similar findings were reported by Biswas (1977), Joglekar (1982), Dhakar (1986), Bhatnagar (1995), Jagarwal (1996), Singh (1985) and Mahapatra (1985).

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Measurement for Role Performance of Agriculture Assistants

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ABSTRACT

The effectiveness of One Window Approach of Farm Technology Transfer depends mainly upon the AAs effective performance of duties, functions and roles. A standardize measuring instrument was not available for assessing the role performance of Agriculture Assistants under this system. An instrument to measure the role performance of AAs in One Window Approach of Farm Technology Transfer was therefore, constructed and standardized. The Likert technique of scaling was used for construction and standardization of role performance scale. The reliability coefficients obtained by these methods were 0.75 and 0.64 and were significant at 0.01 level of probability and established the reliability of the constructed role performance scale. The content and construct validity were also judged. The content of the scale were drawn from the job chart / job prescription of AAs. The final format of the role performance scale consisting of 37 statements for measuring the role performance of AAs in One Window Approach of Farm Technology Transfer.

The Department of Soil Conservation, T & V System (Agriculture) and Horticulture were brought under one umbrella of "One Window Approach of Farm Technology Transfer" by the Government of Maharashtra since 1st July, 1998 for effectiveness in transfer of farm technology. The idea behind this was to cater to the agricultural information and technology needs of the farmers at one place/window. The Agricultural Assistant (AA) is the key field level functionary in this approach.

Farmer is considered as the focal point and the organization of the department is done in such a fashion that a single mechanism facilities the farmer for adoption of advanced technology and sustainable use of available resources. A single Agriculture Assistant performs different activities and duties connected with farm technology transfer. The effectiveness of the Agriculture Assistant and the department as a whole depends on the degree of discharge of duties the role performance. Therefore an effort was made to standardize an instrument to measure the role performance of Agriculture Assistants in One Window Approach of Farm Technology Transfer.

Davis (1949) referred to role performance as to how an individual actually performs in a given position, as distinct from he is supposed to perform. The role performance therefore, refers to the activities that are actually carried out by an Agriculture Assistant in One Window Approach of Farm Technology Transfer.

MATERIAL AND METHODS

The method of Summated Rating developed by Likert (1932) was adopted for construction of the measuring instrument. The detail procedure followed for this purpose is described below.

1. Collection of role items

To prepare an exhaustive list of role/job items, the role were identified by referring the job chart prescribed for AAs by the State Department of Agriculture. The experts in the field of extension education and the field extension personnel were also consulted. In all 95 role items were identified and categorized under four role dimensions, namely, technical, extension and training, input supply and quality control and managerial. These 95 role items were carefully edited in light of the criteria suggested by Edwards (1957). The details about areas and items that are formulated initially are given in Table 1.

2. Item relevancy

The degree of relevancy of each role item was determined on the basis of judgement by a panel of experts. A panel of 100 judges consisting of academicians in extension education and experts in extension service was selected and the role item pool was mailed to them. They were requested to check the relevancy of each of the item related with the role performance of Agriculture Assistant in One Window Approach of Farm Technology Transfer. Their responses were elicited on five point

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Table 1. Details about role items developed and finally retained in role performance scale

S.N.	Dimensions	Total number of items identified	Number of items retained retained after relevancy test	Number of items retained after item analysis
1.	Technical	11	6	1
2.	Extension and training	50	37	27
3.	Input supply and quality control	8	4	2
4.	Managerial	26	10	7
	Total	95	57	37

continuum namely, Most Relevant, Relevant, Somewhat Relevant, Not Relevant and Cannot say and were scored as 5,4,3,2 and 1, respectively.

Only 50 judges responded and their responses were utilized for working out the relevancy per centage of each role performance item by adopting the prodecure given by Patil *et. al.* (1996). Considering more than 75 per cent relevancy per centage, as a cutting point for relevancy 57 role items were selected and subjected to item analysis.

3. Item analysis

It was considered essential to delineate the items which accurately differentiate the persons performance of roles attached to his position. An item analysis was resorted to for this purpose. The list of 57 per cent role performance item was administered to 60 AAs from non sampled area. Their responses were secured on five point continuum viz. Strongly Agree, Agree Undecided, Disagree and Strongly disagree and assigned the scores of 5,4,3,2, and 1, respectively.

The total scores obtained by each AA ascertained by summing the scores of all role items. The respondents were arranged in descending order on the basis of total scores earned by them and divided in to four groups. Two groups, namely 25 per cent respondents having highest total score and 25 per cent with lowest total score were then selected. These two groups acted as criterion groups for item analysis. The significance of the difference of means of thse two groups was tested with the help of 't' test, 't' is the measure of the extent to which a given item differentiate between high and low group.

4. Item Selection

The critical ratio, that is 't' values for all the 57 items were computed by using the formula given by Edwards (1957). All the items were arranged in descending order by considering 't' values. The 't' value equal to or greater than 2.04 was found to be significant and indicated that the average response of high and low group differs significantly. From the 57 role items subjected for item analysis, 37 role items with significantly 't' value greater than 2.04 were selected and included in final format of role Performance Scale (Table 2).

5. Testing reliability

The split-half and test-retest technique were used for testing the reliability of the constructed measuring instrument.

i) Split-half reliability

The finally selected 37 role items were sub divided into two halves on the basis of odd and even number of items. They were administered separately to 25 AAs from non sample area. The responses were obtained on five point continuum : Strongly Agree, Agree, Undecided, Disagree and Strongly Disagree and scored as 5,4,3,2 and 1, respectively. The total scores obtained by each respondent on both the sets were worked out independently.

The two sets of scores were then correlated. The value of coefficient of correlation was indicative of consistency. The correlation coefficient (r) was worked to be 0.75 and was found to be significant at 0.01 level of probability. The coefficient of correlation was quite high and significant and indicated the reliability of instrument developed for measurement of role performance of Agriculture Assistants.

ii) Test-retest reliability

The format of the scale containing 37 role performance items was administered twice to 25 non-sampled AAs with an interval of 15 days. The responses were rated on five point continuum, namely, strongly agree, Agree, Undecided, Disagree and Strongly disagree having scores of 5,4,3,2 and 1, respectively. For working out test retest reliability the scores earned by the AAs at two point time on all the items were

Table 2. Final format of role performance scale constructed and standardized for measuring the role performance of AAs in One Window Approach of Farm Technology Transfer

Response continuum : Most Often (4), Often (3), Sometimes (2), Seldom (1) & Never (0)

S.N.	Role Items
1.	Inform farmers about the time and place of agricultural extension activity
2.	Distribution farm literature for use as reference to farmers (leaflets, folders, etc.)
3.	Visit farmares fields on the fixed time as per the schedule
4.	Keep contact with the SMSs for technical advice
5.	Identify himself with the villagers and work with them during emergency
6.	Understand problems and situations of farmers through personal visit
7.	convince the farmers and their leaders to accept new farm ideas
8.	Motivate farmers to participate in agricultural extension activities
9.	Give timely information to the farmers about marketing conditions at local, state and national level.
10.	Keep close contact with the ADO, SDAO and higher officers for guidance
11.	Ensure coordination in the distribution of important inputs according to demand / availability/ supply / quality.
12.	Prepared and use of audio-visual aids for effectives transfer of technology
13.	Giving wide publicity to the various programmes implemented by the Agricultural Department
14.	Provide spot solutions to the identified agricultural problems
15.	Attend meeting at various places/ head quarter in time
16.	Communicate about various biological and non biological systems for increasing production in rainfed farming.
17.	Attend scheduled as well as time to time training programme organized by the Agricultural Department
18.	Submit report of natural calamities to the senior officers immediately
19.	Contact and enlist cooperation of grass root level change agents working in the operational area through meetings and personal visit
20.	Keep regular contact with non-responsive farmers and extent technical guidance to them
21.	Evaluate trial results
22.	Implement of agricultural production problem of farmers
23.	Identify crop production problems of farmers.
24.	Identify responsive farmers and local leaders and secure their participation in agricultural development programme
25.	Attend meeting of village level committees constituted for different schemes
26.	Submit reports of disease and pest occurrence immediately to the senior officers.
27.	Implement programmes given by higher officers from time to time
28.	Coordinate Soil and water conservation work with agriculture production through the preparation of integrated action plan of work
29.	Select farmers for growing different seasonal crops and fruit crops.
30.	Collect information of Horticultural crops and other crops in the operational area
31.	Plan for and conduct demonstrations.
32.	Contact and enlist participation of responsive farmers in agricultural development work.
33.	Arrange for the material and equipments required for carrying out the agricultural extension activity
34.	Submit timely information immediately to the senior office about the black marketing and poor quality of inputs.
35.	Plan for and conduct minikit trials
36.	Help in organization of specialized compaigns like Tur and Gram pod border/ cotton bolloworm
37.	Organize farmers trainings.

summed together separately and were correlated. The value of 'r' was 0.64 and was noted to be significant. The constructed role performance scale was therefore assumed to be reliable and stable.

6. Testing Validity

The validity of role performance instrument developed was tested by applying the criteria of content and construct validity.

i) Content Validity

The content of the measuring instrument were drawn by reviewing the related literature, job chart of AAs, discussion with experts as well as by working out relevancy per centages and hence the scale satisfied the content validity of measure the role performance of Agriculture Assistant and nothing else.

ii) Construct Validity

The item analysis was undertaken by applying 't' test for mean differences of two criteria groups, that is, high group and low group. The items with significant 't' values were then retained and included in the scale. The construct validity of role performance instrument to measure the role performance of Agriculture Assistants was therefore reasonably established.

RESULTS AND DISCUSSION

The final scale is composed of 37 items representing four role dimension was administered to the AAs along with five point response continuum namely, Most frequently, Frequenly, Sometime, Seldomly and Never. The scores of 4,3,2,1 and Zero were then assigned to these responses. The role performance score was calculated by summing up the scores obtained by each AA on all the items and considered as his score. The role performance score on the scale ranged from a minimum of 37 to maximum of 148. The role performance index was then worked out by considering the actually obtained and maximum obtainable score. The Agricultural Assistants were then categorized into three groups with the help of cum. $3\sqrt{f}$ method of formation of classes (Singh, 1964), on the basis of range as poor (Up to 57 index) Mederate (58 to 77 index) and Excellent (Above 77 index) role performance. This standardized scale can be used with the procedure mentioned above for assessing the degree of role performance of Agriculture Assistant.

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Dynamics of Acreages Under Oilseeds in Vidarbha : A Markov Chain Approach

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ABSTRACT

The present study is associated with the diversification of acreage under oilseeds with respect to their competing crops. The specific objectives of the study were to examine the dynamics of acreages under oilseeds in two grouped seasons i.e. *Kharif-Rabi* and *Rabi*-summer. The study was undertaken in Vidarbha for the period from 1990-91 to 1998-99. The study was based on secondary data collected from official source. A Markov Chain Approach was used for the analysis of data. The results of the study indicated that among different oilseeds in Vidarbha, soybean and *Kharif* groundnut were found to be more stable in acreages while the maximum acreages of oil seed crops were shifted towards competing crops like *Tur* and *Kharif Jowar*. This might be due to Government policies, which do not favour farmer to go for oilseed cultivation. Hence, there is a need to adopt policy which is in favour of oilseed as well as other crops.

India is one of the largest producer of oilseeds in the world, even though we have been forced to import large quantities of edible oils. Demand of edible oils is estimated at 13.9 million tonnes in 2004-2005 from the present level of 10.2 million tonnes. This would go up to 19 million tonnes by 2009-2010. To overcome the importing situation of edible oil it is necessary to increase the area and production of edible oil in India. The present study was undertaken to examine the dynamics of oilseeds and their competing crops in Vidarbha region of Maharashtra state for the period 1991-92 to 1998-99.

MATERIAL AND METHODS

A Markov process whereby the outcome of a given trial t (t = 1, 2 ..... T) depends only on the outcome of preceding trial (t -1) and this dependence is the same at all stages in the sequence of trials (Lee *et. al.*)

A stochastic process is one, which can analyse a set of trials or experiements probabilistically.

Let.

S_{it} Reprenent i th state of 'r' possible outcomes; i= 1,2..r.

Wit represent the probability the state Si occurs on trial 't' or the proportion observed in trials 't' alternative outcome state 'i' of a multionmial population based on a sample of size n, i.e. Pr. (S_{it})

P_{ip} represent the transitional probability which denotes the probability that if for any time 't' the process is in state Si, it moves on the next trial to stage Sj, i.e. Pr (S_{jt}, t+1/S_{jt-} = P_{ij})

$P=(P_{ij})$ represent the transitional probability matrix which denotes the transitgional probability for every pair of states (i,j+1,2.....,r) and has the following properties :

$$O \leq P_{ij} \leq 1, \quad \text{.....(1)}$$

AND $\Sigma_j P_{ij} = 1$, for i = 1,2 ...., r .....(2)

Given this set of notations and definitions for first order Markov chain the probability of a particular sequence Si on trial t and S_j on trial t+1 may be represented by

$$\Pr(S_{it}, t\ S_j, t+1) = \Pr(S_{it}) \Pr(S_j, t+1/S_{it}) = W_{it} P_{ij} \quad \text{.....(3)}$$

and the probability of being is state j at trial t+1 may be represented by

$$\Pr(S_j, t+1) = \Sigma_i W_{it} P_{it} \quad \text{or}$$

$$Wj, t+1 = \Sigma_i W_{it} P_{ij} \quad \text{.....(4)}$$

The data for the study are the proportion of area under the oilseed crops i.e. safflower, Sunflower, Groundut, and Soyabean, and their respective competing crops. These proportions change from year to year due to the factors like weather, technology, price and other institutional change. It is reasonable to assume that the combined influence

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Table 1. Transition probability matrix for oilseeds and their competing crops in *Kharif-Rabi* season of Vidarbha region (1990-91 to 1998-99)

Crops	*Kharif* Groundnut	Safflower	Sunflower	Soybean	*Tur*	*Kharif Jowar*	*Rabi Jowar*
Kharif Groundnut	**0.61**	0	0	0	0	0.39	0
Safflower	0	0	0.29	0.28	0.43	0	0
Sunflower	0	0	**0**	0	0	0.71	0.29
Soybean	0	0	0	**1.00**	0	0	0
Tur	0	0.16	0.01	0.08	**0.75**	0	0
Kharif Jowar	0.01	0.03	0.01	0	0.07	**0.83**	0.05
Rabi Jowar	0.08	0	0	0	0	0.36	**0.55**

Table 2. Transition probability matrix for oilseeds and their competing crops in Rabi-summer season of Vidarbha region (1990-91 to 1998-99)

Crops	Safflower	Sunflower	Summer Groundnut	Tur	*Rabi* Jowar	Wheat
Safflower	**0**	0.13	0	0.72	0.07	0.08
Sunflower	0	**0.44**	0.03	0.29	0.18	0.06
Summer Groundnut	0	0	**0**	1.00	0	0
Tur	0.21	0.03	0	**0.75**	0.01	0
Rabi Jowar	0	0	0.08	0.11	**0.81**	0
Wheat	0	0	0	0.17	0	**0.83**

of these individually systematic forces approximate to a stochastic process and the propensity of farmers to move from one crop state to another differs according to the crop state involved. If these assumptions are acceptable, then the process of cropping pattern change may be described in the from of a matrix P of first order transition probabilities. The element of Pij of the matrix indicates that the probability of a farmer in crop state 'i' in one period will more to crop state 'j' during the following period. The diagonal element Pij measures the probability that the proportion share of i^{th} cagtegory of crop will be retained.

Estimation of transition Probability Matrix

Equation (4) can be used as a basis for specifying the statistical model for estimating the transiton probabilities. If errors are incorportated in equation (4) to account for the difference between the actual and estimated occurrence of (Wjt+1), the sample observations may be assumed to be generated by the following Linear statistical Model.

$$W_{jt} = \sum_{j} W_{it}\, W_{i,\, t-1}\, P_{ij} + U_{jt} \quad \ldots\ldots\ldots\ldots (5)$$

Or in Matrix from it can be written as

$$Y_j = X_j P_j + U_j \quad \ldots\ldots\ldots\ldots (6)$$

Where,

Yj is a (tx1) vector of observations reflecting the proportion in cropping pattern j in time t, Xj is a (Txr) matrix of realised values of the proportion in cropping pattern i in time t-1, Pj is a (rx1) vector of unknown

transition parameters to be estimated and Uj is a vector or rondom disturbances.

The acreage date of oilseeds and their competing crops were used in the present study. the analysis was done for two grouped seasons viz., *Kharif-Rabi* and *Rabi*-summer. It was carried out for four regions and state as a whole.

The analysis was carried out for two grouped seasons viz., *Kharif-Rabi* and *Rabi*-summer. The competing corps were selected by finding correlation matrix. The crop for which the 'r' value in matrix was negative, highest and significant was selected as competing crop. The crop, which possessed larger area under cultivation, was also a criteria in selecting competing crop.

RESULTS AND DISCUSSION

The transition probability matrices estimated are presented in Table 1 and Table 2 for *Kharif-Rabi* and *Rabi*- summer season, respectively.

Table 1 shows the dynamics of acreages among oilseeds and their competing crops in *Kharif-Rabi* season. from the table it is observed that the farmers were retaining highest acreage (100 %) under soybean followed by *Kharif* Groundnut (61%). The competing crops like *Kharif* Jowar, *Tur* and *Rabi Jowar* were comparatively retaining substaintial share of acreage in the current year over the previous year. Farmers shifted the maximum share of area under sunflower and safflower to the competing crops kharif Jowar and *Tur,* respectively during the current year over the previous year.

Table 2 exhibits the dynamics of acreages among oilseeds and their competing crops in *Rabi*-summer season. The table shows that the farmers were retaining the acreage only under the oilseeds-sunflower, accounting for 44 per cent over the previous year during the year under reference. The oilseed safflower, sunflower and summer goundnut shifted their area to the most stable competing crops like *Tur, Rabi Jowar* and Wheat.

The study concludes that in general, in acreage under soybean was found stable in Vidarbha region.

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Physical Characteristics of Vertisol as Influenced by Integrated Nutrient Management Systems Under Sweet Orange (*Citrus sinensis* Osbeck)

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ABSTRACT

The effect of different treatments of integrated nutrient management on physical and hydraulic properties of Vertisol were studied for two years under sweet orange orchard. Significant improvement in soil physical properties was observed with the incorporation of different organic manures, green manures and crop residues either alone or in combination with inorganic fertilizers or biofertilizers. The improvement was directly related to the quantity of organic amendments added to the soil. Application of FYM (to supply 100% N) was the best to improve physical properties, while highest improvement in infiltration characteristics was with the application of wheat straw (to supply 50% N) + 50 per cent RDF.

Sweet orange (*Citrus sinensis* Osbeck), an important cultivar of 'Citrus' is the most valued fruit crop which accounts for more than 80 per cent of processing industry. It is commercially grown in about 25000 ha area on black soils of Maharashtra. These soils are characterised by very high clay content, montmorilonitic mineralogy, swelling and shrinkage, low hydraulic conductivity, poor internal drainage, perched water table and low organic carbon content. These properties makes these soils preamptly problematic in their physical characteristics and pose an entirely different management problem. Use of organic manures in these soils hold a great promise due to their ability to improve soil characteristics besides, balanced supply of all the nutrients. But, bulky nature and inadequate availability limits their large scale use on regular basis. Therefore, with this in view and considering the increasing acreage of sweet orange in 'Vidarbha' region, the present investigation was undertaken to study the effect of integrated nutrient management on soil physical properties under sweet orange.

MATERIAL AND METHODS

The field experiment was conducted during 2002-2004 on 9 year old sweet orange cv. Mosambi orchard at Regional Fruit Research Station, Katol, Nagpur. The soils of the experimental field was classified as Udic Haplusterts with more than 150 cm soil depth and clay content more than 70 per cent throughout the soil depth. Some important characteristics of the soil were as follows : pH 7.84, EC 0.30 dS m^{-1}, organic carbon 0.70 per cent, CEC 46.5 cmol (p^+) kg^{-1}, available N, P_2O_5 and K_2O were 199.2, 19.1 and 508.4 kg ha^{-1}, respectively. Initial physical properties of the soil indicated that the soil have high bulk density (1.40 Mg m^{-3}) and COLE (0.242) values, slow hydraulic conductivity (0.385 cm hr^{-1}), moderately slow rate of infiltration (0.710 cm hr^{-1}) and moisture held at field capacity and permanent wilting point was 37.8 and 22.1 kg kg^{-1}, respectively. A total of 13 treatments having 2-tree unit replicated three times were executed in randomised block design. Different treatments involved application of FYM, vermicompost, wheat straw and green manuring with Sunhemp, as singly and in combination with inorganic fertilizers and biofertilizers like *Azotobacter* and Phosphate Solubilizing Bacteria (PSB). The dose of organic manures was applied on nitrogen equivalent basis. The average total N content on oven dry basis in different organic manures used was 0.88, 1.56, 0.44 and 1.86 per cent in FYM, vermicompost, wheat straw and sunhemp, respectively, with corresponding values of total P as 0.04, 0.32, 0.16 and 0.38 per cent and total K as 0.76, 0.75, 1.04 and 1.13 per cent. Soil samples were collected after two years, processed and analysed for different soil physical properties using standard methods (Black, 1965 and Singh, 1989).

RESULTS AND DISCUSSION

The percent water stable aggregates (WSA) greater than 0.25 mm, 0.10 mm and mean weight diameter (MWD) under different treatments varied from 34 to 48 per cent, 64 to 88 per cent and 0.233 to 0.366 mm,

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Table 1. Effect of different treatments on soil physical properties

	Treatments	WSA (>0.25 mm)	WSA (>0.10 mm)	MWD (mm)	Bulk density ($Mg\ m^{-3}$)	Porosity (%)	COLE
T_1	RDF	40.4	74.0	0.286	1.39	47.5	0.242
T_2	FYM (to supply 100% N)	48.4	88.0	0.366	1.29	51.3	0.216
T_3	Vermicompost (to supply 100% N)	44.2	82.2	0.325	1.32	50.9	0.226
T_4	FYM (to supply 50% N) + 50% RDF	44.3	83.1	0.323	1.34	49.4	0.235
T_5	Vermicompost (to supply 50% N) + 50% RDF	43.7	80.2	0.315	1.34	49.4	0.230
T_6	Green manuring with Sunhemp + 50% RDF	45.9	84.9	0.334	1.33	49.8	0.225
T_7	Wheat straw (to supply 50% N) + 50% RDF	47.4	87.6	0.355	1.30	50.2	0.218
T_8	FYM (to supply 25% N) + 50% RDF + *Azotobacter* + PSB	43.6	83.2	0.319	1.36	48.7	0.228
T_9	Vermicompost (to supply 25% N) + 50% RDF + *Azotobacter* + PSB	42.7	80.1	0.311	1.39	47.5	0.224
T_{10}	75% RDF +*Azotobacter* + PSB	38.9	74.1	0.279	1.40	47.2	0.238
T_{11}	FYM (to supply 75% N) + *Azotobacter* + PSB	47.7	87.9	0.362	1.33	49.8	0.224
T_{12}	Vermicompost (to supply 75% N) + 50% RDF + *Azotobacter* + PSB	43.1	82.5	0.317	1.35	49.1	0.226
T_{13}	Control	34.1	64.1	0.233	1.44	45.7	0.240
	CD at 5 %	3.9	6.54	0.018	0.076	2.85	0.011

respectively (Table 1). Overall results revealed that highest aggregation of soil particles were observed with the application of FYM (to supply 100% N) followed by application of wheat straw (to supply 50% N) + 50 per cent RDF and FYM (to supply 75% N) + 50 per cent RDF. However, these treatments were statistically at par with each other and significantly superior over the application inorganic fertilizers and control. The increased soil aggregation was due to the cementing effect of humic substances produced from the organic matter in to the soil which added stability to the aggregates (Chakraborty *et. al.,* 1981).

The bulk density varied from 1.29 to 1.44 $Mg\ m^{-3}$ and decreased with increasing depth. Highest values were observed under control (1.44 $Mg\ m^{-3}$) which decreased significantly and recorded the lowest value of 1.29 $Mg\ m^{-3}$ with the application of FYM (to supply 100% N) followed by application of vermicompost (to supply 100% N) (1.30 $Mg\ m^{-3}$). The treatments involving sole application of inorganic fertilizers were not much effective. The decreasing trend in soil bulk density by amending the soil with organic manures was observed by Bellakki *et al.* (1998) and Babhulkar *et al.* (2000) in Vertisol. Similarly highest percentage of porosity (51%) was observed with the application of FYM (to supply 100% N) which was significantly superior over rest of the treatments.

The coefficient of linear extensibility (COLE) values under different treatments varied from 0.216 to 0.240. Comparatively, the higher COLE values indicated that the experimental soil possessed high shrink-swell property (Shirsath *et al.,* 2000). Most of the treatments where organics were applied either alone or in combination, reduced the COLE values, while inorganic fertilizers treatments produced no significant response. On the contrary the study by Rabindra *et al.* (1985) showed an increase in percent volume expansion of Udic Haplustalfs when treated with FYM.

Hydraulic properties

Significant improvement in hydraulic conductivity and maximum water holding capacity (MWHC) of soil was observed due to different treatments (Table 2). Highest values were observed with the application of FYM (to supply 100% N) followed by application of wheat straw (to supply 50%N) + 50 per cent RDF. Incorporation of higher level of organic materials recorded comparatively higher values than their lower levels Treatments involving application of inorganic

Table 2. Effect of different treatments on soil hydraulic properties

	Treatments	MWHC (%)	Moisture held at 33 kPa (%)	Moisture held at 1500 kPa (%)	AWC (cm m^{-1})	Hydraulic conductivity (cm hr^{-1})	Infiltration rate (cm hr^{-1})	Cumulative infiltration (mm)
T_1	RDF	70.0	39.8	23.4	17.9	0.485	1.27	108
T_2	FYM (to supply 100% N)	77.2	47.0	25.9	20.0	0.725	1.90	178
T_3	Vermicompost (to supply 100% N)	74.4	44.7	24.6	19.3	0.685	1.71	151
T_4	FYM (to supply 50% N) + 50% RDF	75.2	45.8	24.6	18.6	0.680	1.70	157
T_5	Vermicompost (to supply 50% N) + 50% RDF	72.0	43.8	23.6	19.1	0.655	1.65	129
T_6	Green manuring with Sunhemp + 50% RDF	74.9	44.9	24.2	19.8	0.685	1.72	154
T_7	Wheat straw (to supply 50% N) + 50% RDF	77.0	44.9	24.9	19.6	0.715	1.95	170
T_8	FYM (to supply 25% N) + 50% RDF + *Azotobacter* + PSB	72.5	42.5	23.5	19.4	0.640	1.55	132
T_9	Vermicompost (to supply 25% N) + 50% RDF + *Azotobacter* + PSB	71.5	41.2	23.1	19.1	0.625	1.40	122
T_{10}	75% RDF +*Azotobacter* + PSB	69.5	39.0	23.4	17.6	0.470	1.25	97
T_{11}	FYM (to supply 75% N) + *Azotobacter* + PSB	75.9	45.0	24.9	19.7	0.705	1.75	159
T_{12}	Vermicompost (to supply 75% N) + 50% RDF + *Azotobacter* + PSB	72.1	43.6	23.9	19.6	0.660	1.60	131
T_{13}	Control	66.0	38.5	22.5	18.0	0.400	0.80	63
	CD at 5 %	3.26	4.09	1.56	NS	0.039	0.261	33.5

fertilizers were also effective but proportion of increase was of lesser magnitude.

The values for water retention at 33 kPa and 1500 kPa significantly varied from 38.5 to 47.0 per cent and from 22.5 to 25.9 per cent, respectively, while available water capacity (AWC) showed non-significant variation. Water retention characteristics of the soil showed a large variation under treatments of organic manures as compared with those under inorganic fertilizers and control. The difference was more pronounced at lower tension (33 kPa) while at higher tension (1500 kPa), it was narrowed down. The increased organic carbon, improved aggregation and favourable pore geometry of soil helped in improving the water retention of soil at low tension. While water retention at higher tension was by and large dependent on the proportion of clay content (Biswas *et al.*, 1971). Highest increase in water retention at 33 kPa, 1500 kPa and AWC was observed with the application of FYM (to supply 100% N). The other treatments involving application of wheat straw (to supply 50% N) + 50 per cent RDF, FYM (to supply 75% N + *Azotobacter* + PSB, FYM (to supply 50% N) + 50 per cent RDF, green manuring with sunhemp + 50 per cent RDF were equally effective and significantly superior over inorganic fertilizer application and control. Bhriguvanshi (1988) reported a considerable improvement in water retention characteristics of soil with the application of FYM @ 50 Mg + 20kg N ha^{-1} due to improvement in structural condition of soil.

The infiltration rate and cumulative infiltration under different treatments varied significantly from 0.75 to 1.95 cm hr^{-1} and 55 to 178 mm, respectively (Table 2). Application of wheat straw (to supply 50% N) + 50 per cent RDF recorded highest basic infiltration rate (1.95 cm hr^{-1}) followed by FYM (to supply 100% N) (1.90 cm hr^{-1}), FYM to supply 75 per cent N + *Azotobacter* + PSB (1.75 cm hr^{-1}) and green manuring with sunhemp + 50 per cent RDF (1.72 cm hr^{-1}). These treatments (T_7, T_2, T_{11} and T_6) were at par with each other and recorded 144, 138, 119 and 113 per cent increase over control, respectively.

Infiltration characteristic curves showed that infiltration rate was very high initially at 10 minutes, and then decreased as the time elapsed. Such a higher initial infiltration rate persisted for a considerable period under those treatments where FYM/wheat straw/green manure was applied and accompanied with high cumulative infiltration values (139 to 152 mm). This is attributed to high organic carbon content enabling strengthening the stability of the soil structure, thereby, increased porosity of soil. The earlier studies by Pandey *et. al.* (1985) indicated high infiltration rate due to wheat and rice straw application, while four fold increase was recorded with the application of FYM in black soils (Magar *et al.* 1983), on account of increased non-capillary pores and better soil aggregation. In inorganic fertilizer application treatments (T_1 and T_{10}) and control plots, there was sudden decrease in higher initial infiltration rate after 10 minutes and produced significantly lower values of cumulative infiltration (59 - 92 mm).

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Dynamics of Soil Carbon and its Sequestration Under Long-Term Fertilization

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ABSTRACT

In order to evaluate the effect of long-term fertilization and sorghum-wheat crop sequence on organic carbon pools in Vertisols, plot wise samples were collected from experimental site before sowing of the crop during 2003-2004. The sustainability of active pool of carbon along with other pools is higher under long-term use of balanced fertilization with manure. High SMBC, SMBN, SMBP and DHA were observed in the treatment of NPK + FYM followed by other treatments. There are various sources of carbon sequenstration like root, rhizo deposition and annual mineralization. The net total carbon input showed the trend in the order of NPK + FYM > 100 per cent NPK > 100 per cent NP > 100 per cent N> control. Significant carbon sequestration was observed in the treatment of NPK + FYM.

Soil organic carbon dynamics is of paramount importance for sustaining long-term soil fertility and productivity under intensive cropping. It is also a store house of all essential plant nutrients and provides energy material for the soil organisms. Although amount of SOM (Soil Organic Matter) in the soil of India is relatively low (ranging from 0.1 to 1.0%) its influence on soil fertility and physical properties is of great significance (Anonymous, 2001).

Soils have a major carbon pool and are estimated to contain 1220 to 1550 pgC (Present day global carbon) in organic form (SOC). Amongst different soil orders-Histosols contain maximum and Vertisols minimum amount of carbon (Pratap Narain, 2001).

Soil organic carbon exists in the following five carbon pools.

1) Active pool: Consists of SMBC, WSC, WS carbohydrate. C:N ratio about 5 to 15. Provides mineral nutrients and life to soil.

2) Slow pool: Consists of POM (Particulate Organic Matter). Slow decomposable OM. C:N ratio 20:1. Provides binding material to soil particles.

3) Passive pool : Consists of HA, FA, Humin etc. Highly calcitrant. Resistant to decomposition. Provides humus-controls nutrient supply capacity.

4) Metabolic pool : Consists of leaf litter and other OM freshly added to soil. Releases mineral N during decomposition.

5) Structural pool : Consists of straw, wood, stem etc. C:N ratio varies widely 1:50. High in lignin content

Hence, the present investigation was undertaken on the dynamics of carbon pools and their sequestration under long-term fertilization in Vertisols.

MATERIAL AND METHODS

The investigation was superimposed during the year 2003-2004 on the old long-term fertilization experiment started since 1988, at Central Research Station, Dr.PDKV, Akola. There were five treatments and four replications under RBD comprise of NPK levels with and without FYM.

In order to evaluate the effect of long-term fertilization and sorghum-wheat crop sequence on soil organic carbon, plot-wise soil samples (0-15 cm and 15-30 cm depth) were collected from experimental site belonging to vertisols, before sowing of sorghum crop during June 2003. Soil samples were processed and analysed for different organic carbon pools i.e. SMBC (Soil Microbial Biomass Carbon) by chloroform fumigation method (Jenkinson and Powlson, 1976), SMBN (Soil Microbial Biomass Nitrogen) by modified direct extraction method (Jenkinson & Ladd, 1981), SMBP (Soil Microbial Biomass Phosphorus), from microbial biomass (Brookes *et al.*, 1982), WSC (Water soluble carbon) by dichromate method (McGill *et al.*, 1986), WS carbo (Water soluble carbohydrate) by hydrolytic extraction of carbohydrates from soil by H_2SO_4 (Brink *et al.*, 1960) and DHA (Dehydrogenase Activity) by soil treated with TTC (Triphenyltetrozolium chloride) extract and colour determined on spectrophotometer at 485 nm (Casida *et al.*, 1964).

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RESULTS AND DISCUSSION

The active pool of carbon along with other pools sustained under long-term fertilization in nutrient supply to the growing plants.

From Table 1, high SMBC, SMBN, SMBP and DHA contents were observed in the NPK + FYM treated plots followed by NPK, NP, N and control in Vertisols, possibly, due to improvement of water soluble fraction in these treatments. These contents were more prominent in surface layer as compared to sub-surface layer. These results are in consonance with the findings of Singaram and Kamalakumari (1995) who observed that in long-term field experiments activities of six soil enzymes related to carbon, nitrogen, phosphorus cycling and peroxide decomposition were assessed and enzymes activities wee more pronounced with FYM in combination with NPK fertilizers. Continuous application of inorganic fertilizers for over twenty years has not caused detrimental effect on the enzymes of the soil.

Table 1: Long-term effect of fertilization on the content of active pool in Vertisols

Treatments	Depth (cm)	SMBC ($mg\ kg^{-1}$)	SMBN ($mg\ kg^{-1}$)	SMBP ($mg\ kg^{-1}$)	DHA (µg/g/24h)	WSC (ppm)	WS carbo (ppm)
Control	0-15	154	9.32	8.00	35.16	13.20	462.19
	15-30	154	8.29	5.89	36.72	12.10	340.19
100 %N	0-15	185	12.76	8.38	37.50	24.10	590.10
	15-30	140	11.50	8.00	35.78	13.80	520.20
100% NP	0-15	199	13.23	9.37	39.82	36.20	670.10
	15-30	171	12.39	9.10	38.82	20.70	531.56
100% NPK	0-15	210	14.52	12.10	41.29	68.20	725.85
	15-30	196	13.64	11.50	38.16	40.30	610.00
NPK + FYM	0-15	231	16.06	15.10	44.41	83.10	840.20
	15-30	191	14.52	13.10	32.82	48.70	681.91

Table 2: Long-term effect of fertilization on 'C' balance ($Mg\ ha^{-1}$) in Vertisols after 14 years

Source of carbon	Cropping system	Control	100% N	100% NP	100% NPK	NPK + FYM
Root- C ($Mg\ ha^{-1}$)	Sorghum	0.260	1.571	2.110	2.510	3.623
	Wheat	0.040	0.380	0.820	1.270	1.690
	Total	0.300	1.951	2.930	3.780	5.313
Rhizodeposition-C ($Mg\ ha^{-1}$)	Sorghum	0.078	0.471	0.633	0.753	1.087
	Wheat	0.012	0.114	0.246	0.381	0.507
	Total	0.090	0.585	0.879	1.134	1.594
Gross Total- C ($Mg\ ha^{-1}$)	Sorghum	0.338	2.042	2.743	3.263	4.710
	Wheat	0.052	0.494	1.066	1.651	2.197
	Total	0.390	2.536	3.809	4.914	6.907
Annual mineralization of- C ($Mg\ ha^{-1}$)	Sorghum	0.211	1.477	1.983	2.359	3.406
	Wheat	0.032	0.357	0.771	1.194	1.589
	Total	0.243	1.834	2.754	3.553	4.994
Net input (root +Rhizodeposition)	Sorghum	0.127	0.566	0.760	0.904	1.304
($Mg\ ha^{-1}$)	Wheat	0.020	0.137	0.295	0.457	0.608
	Total	0.147	0.702	1.055	1.361	1.913
Net change in Soil Organic C ($Mg\ ha^{-1}$)		9.90	11.66	12.32	12.98	15.40
		(-0.22)	(+1.54)	(+2.20)	(+2.86)	(+5.28)

*At the beginning (1988) the total C was 10.12 $Mg\ ha^{-1}$ in soil,
values in parenthesis indicates the source (-)/sink (+) of C over the period.
** FYM added at the rate of 10 $Mg\ ha^{-1}$ having 33.3 ± 2.3 per cent C content.

A WSC and WS carbohydrate comprises 5 to 10 per cent and 14 to 41 per cent of soil organic carbon, respectively. The content of these two fractions were comparatively higher in Vertisols. These fractions act as a source of energy for soil micro organisms and helps in dynamics of plant nutrients in short time. It was observed that the water soluble carbon in caused by 5 to 24 per cent with the application of NPK + FYM over 100 per cent NPK. This indicates that newly humified organic matter application through FYM every year may have sustained higher amount of water soluble carbon. Long-term continuous use of fertilizer and manures application in Vertisols resulted in build up of WS carbo 462 to 840, 340 to 681 mg kg^{-1} in surface and sub-surface soils.

From the Table 1, results indicate that continuous application of fertilizer N and P either alone or in combination did not improve active pool of nutrients. The active pools are sustained under long-term use of balanced fertilization.

There are various sources of carbon sequestration like root, rhizodeposition and annual mineralization. From Table 2, it is concluded that input of root biomass in 100 per cent NPK treatment was 12.6 times higher than in non-fertilized control. There was significant root biomass carbon addition in treatment receiving FYM along with NPK. Input of carbon from rhizodeposition was maximum (1.594 Mg ha^{-1}) in the NPK + FYM treatment. The net total carbon input showed the trend in the order of NPK + FYM > 100 per cent NPK> 100 per cent NP> 100 per cent N> control. The overall net change in soil organic carbon was negative under control while all other treatments showed positive carbon balance with maximum under NPK + FYM. Therefore, sustainability can only be obtained with application of FYM in combination with NPK fertilizers due to significant positive carbon balance.

Carbon sequestration implies not only increasing the amount of carbon entering in soil but also decreasing the amount of leaving through decomposition and erosion (Pratap Narain, 2001).

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Effect of Foliar Application of Nutrients on Production of Cotton (PKV Rajat)

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ABSTRACT

A field experiment on medium deep soil was conducted to study effect of foliar application of nutrients on production of cotton at Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) during the kharif season of 2000-2001 to 2002-2003. The soil of experimental site was medium deep with low in nitrogen and phosphorus, medium in organic carbon and high in available potassium. The experiment was carried out in Randomized Block Design with eight treatments (Table 1) and replicated thrice. The *hirsutum* cotton variety PKV Rajat was sown by dibbling 2-3 seeds per hill at a spacing of 60 x30 cm with recommended dose of fertilizer i.e. 50:25:0 kg/ha N,P-$_2O_5$ and K_2O. Pooled results showed that three sprays of $MgSO_4$ (1.0 %) + $ZnSO_4$ (0.5 %) followed by 2 per cent urea at flowering and 2 per cent DAP at bolls development stage recorded significantly higher seed cotton yield (25.2 and 20.1 per cent) over control (No spray). However, NMR and BC ratio were higher in the treatment having foliar sprays of 2 per cent urea and DAP at each flowering and boll development stage as compared to other foliar spraying treatments i.e. Rs.14924/- and 2.33, respectively. Hence, it could be concluded that either three sprays of $MgSO_4$ (1.0 %) + $ZnSO_4$ (0.5 %) at square, flowering and boll development stage or two sprays of 2 per cent urea at flowering and 2 per cent DAP at boll development stage are recommended to obtain increased seed cotton yield.

Fertilizer nutrients soluble in water may be applied directly to the aerial portion of plants. The nutrient must penetrate the cuticle of the leaf or the stomata and then enter the cells. This method provides more rapid utilization of nutrients and permits the correction of observed nutrients deficiencies in less time than required by soil application treatments. Foliar spray of nutrients is one of the phenomena which regulates the biochemical changes in the seed cotton and leads to higher productivity by modifying phenotypic growth characters. The foliar application assumes greater importance, as the nutrients are brought in the immediate vicinity of the metabolizing area, i.e. foliage. Information regarding the effect of foliar spraying of macro and micro nutrients on the productivity of cotton is inadequate. Therefore, the present experiment was conducted to find out the effect of foliar application of nutrients on cotton productivity.

MATERIAL AND METHODS

The experiment was conducted during the kharif season of 2000-2001 to 2002-2003 at Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth , Akola (M.S.).The soil of experimental site was medium deep with low in nitrogen (211.13 kg ha^{-1}) and phosphorus (16.26 kg/ha), medium in organic carbon (5.04 g kg^{-1}) and high in available potassium (547 kg ha^{-1}) having pH 7.98.

The experiment was carried out in RBD with eight treatments (T_1- Control, T_2- Boron (0.1%), T_3-$ZnSO_4$ (0.5%), T_4-$MnSO_4$ (1.0%), T_5-$MgSO_4$ (1.0%), T_6-$MgSO_4$ (1.0%) + $ZnSO_4$ (0.5%), T_7-$FeSO_4$ (0.5%), T_8- Urea 2 per cent at flowering and DAP 2 per cent at boll development stage) and replicated thrice. The *hirsutum* cotton variety PKV Rajat was sown by dibbling 2-3 seeds per hill at a spacing of 60 x30 cm with recommended dose of fertilizer i.e. 50:25:0 kg ha^{-1} N,P-$_2O_5$ and K_2O.

Recommended half of nitrogen and full dose of phosphorus (25:25 kg ha^{-1} N and P--$_2$O-$_5$) was applied at the time of sowing and remaining half dose of nitrogen was top dressed at one month after sowing. The three treatments spraying were applied at square, flowering and boll development stage. At the time of first picking randomly selected plants were taken for the observation on the plant growth and yield characters. Seed cotton yield and plant stand were also recorded .The data recorded were analyzed statistically for representing the results.

RESULTS AND DISCUSSION

A. Seed cotton yield: The pooled results indicated that seed cotton yield was significantly increased with the sprayings of various macro and micro nutrient except sprayings of $MnSO_4$ (1.0%) and $FeSO_4$ (0.5%) over control. The later three treatments were on par. The

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Table 1. Seed cotton yield influenced by various treatments.

Treatments	Seed cotton yield (kg ha^{-1})			Pooled	NMR	BC ratio
	2000-01	2001-02	2002-03	Mean	(Rs ha^{-1})	
T_1- Control	1094	907	1259	1086	11149	2.05
T_2- Boron (0.1%)	1197	1058	1601	1285	14394	2.27
T_3-$ZnSO_4$ (0.5%)	1189	1004	1544	1246	12661	2.03
T_4-$MnSO_4$ (1.0%)	1101	895	1313	1103	8443	1.62
T_5-$MgSO_4$ (1.0%)	1143	1042	1658	1281	12647	1.97
T_6-$MgSO_4$ (1.0%) + $ZnSO_4$ (0.5%)	1282	1078	1721	1360	12785	1.88
T_7-$FeSO_4$ (0.5%)	1041	889	1325	1085	9568	1.78
T_8- Urea 2% at flowering and DAP 2% at BDS	1291	1009	1611	1304	14924	2.33
S.E (m) ±	49.6	46.8	71.8	34.7	234.4	
C.D. at 5%	150.6	141.9	218.1	98.2	711.1	
C.V. %	7.37	8.23				

Table 2. Growth and yield parameters as influenced by various treatments (Pooled mean of three years)

Treatments	Number of bolls Plant^{-1}	Yield Plant^{-1}(g)	Plant height (cm)	Sympodia Plant^{-1}	Monopodia Plant^{-1}	Dry matter Plant^{-1}(g)	P.P. ha^{-1} (000')
T_1- Control	9.7	23.6	72.9	13.8	0.41	70.3	49.50
T_2- Boron (0.1%)	10.8	27.8	82.5	14.4	0.48	82.9	49.13
T_3-$ZnSO_4$ (0.5%)	11.1	27.2	73.2	15.5	0.29	83.1	49.54
T_4-$MnSO_4$ (1.0%)	9.3	22.7	73.3	16.4	0.22	81.1	49.98
T_5-$MgSO_4$ (1.0%)	11.0	27.1	70.8	15.3	0.22	87.8	49.66
T_6-$MgSO_4$ (1.0%) + $ZnSO_4$ (0.5%)	11.6	28.8	74.8	15.9	0.33	96.8	49.68
T_7-$FeSO_4$ (0.5%)	8.9	22.6	72.3	15.3	0.33	91.8	49.99
T_8- Urea 2% at flowering and DAP 2% at BDS	11.7	28.3	74.5	16.3	0.22	96.8	49.76
S.E (m) ±	0.49	1.01	3.19	0.57	0.13	6.94	0.29
C.D. at 5%	1.49	3.06	N.S.	N.S.	N.S.	N.S.	N.S.

highest seed cotton yield was recorded by the treatment having 3 sprays of $MgSO_4$ (1.0%) +$ZnSO_4$ (0.5%) followed by spraying of 2 per cent urea at flowering and 2 per cent DAP at boll development stage. These two treatments showed 25.2 and 20.1 per cent increased respectively seed cotton yield over control. Similarly, spraying of $MgSO_4$ (1.0%), Boron (0.1%) and $ZnSO_4$ (0.5%) recorded 17.9, 18.3 and 14.7 per cent higher yield over control (Table 1).The similar results were observed by Padole and Deshmukh (1980), Wankhade *et al* (1994), Katkar *et al* (2002) and Nehra and Kumavat (2003).

b. Yield parameter : The data presented in Table 2 showed that bolls per plants were significantly higher in the treatments having 2 per cent urea at flowering and 2 per cent DAP at boll development stage and spraying of $MgSO_4$ (1.0%) + $ZnSO_4$(0.5%) over control. Other spraying treatments of Boron (0.1 %) $ZnSO_4$ (0.5%) and $MgSO_4$ (1.0%) were also produced more number of bolls per plant over control, but the differences were not significant. All the treatments except $FeSO_4$ (0.5%) and $MnSO_4$ (1.0%) recorded significantly higher seed cotton yield per plant over control. The favorable effects on higher number of bolls per plant and yield per plants are in accordance with the results observed by Mehetre *et al* (1990).

c. Growth parameters: Growth characters viz., plant height, sympodia per plant, monopodia per plant and dry matter per plant did not influenced significantly with the foliar spraying of macro and micro nutrients. Plant population was more or less similar in all the treatments. Similar results were recorded by Katkar *et al* (2002).

d. Net monetary return : Net monetary return was highest in the treatment spray of 2 per cent urea at flowering and 2 per cent DAP at boll development stage (Rs. 14924 ha^{-1}) followed by Boron (0.1%) which were significantly more by Rs. 3775 and 3245 ha^{-1}over control. Spraying of $MgSO_4$ (1.0%) + $ZnSO_4$ (0.5%), $ZnSO_4$ (0.5%) and $MgSO_4$ (1.0%) also exhibited higher NMR over control (Table 1).

e. BC ratio : BC ratio was maximum with the treatment having spraying of 2 per cent urea at flowering and 2 per cent DAP at bolls development stage (2.33) followed by Boron (2.27). BC ratios showed by the other micro nutrient spraying treatments were less than control.

Thus, it could be concluded that on the basis of NMR and BC ratio spraying of 2 per cent urea at flowering and 2 per cent DAP at boll development stage were found more effective in increasing yield of seed cotton variety PKV Rajat.

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Vertical Distribution of Macro and Micronutrients and Productivity of Sorghum as Influenced by Vegetative Hedgerows on Inceptisols

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ABSTRACT

The field experiment on impact of vegetative barriers on vertical distribution of macro and micronutrients and productivity of sorghum was conducted during the year 2002-03 on moderately deep soils (Typic Haplustepts), having land capability class IIIes with 1.6 % slope gradient, well drained and very dark grayish brown (10 YR 3/2) in colour. The four treatments consisted of sowing along the main slope (T_1), contour cultivation along the leucaena hedges (T_2), contour cultivation along the vetiver hedges (T_3), and sowing across the slope (T_4). The results indicate that the soils were neutral to moderately alkaline in nature with pH, EC and calcium carbonate values increasing with depth. The organic carbon content of surface soil was higher as compared to subsurface soil. The N, P and K content of the soils decreased with depth. Due to the adoption of contour cultivation along vetiver and leucaena hedgerows the N, P and K loss through surface runoff were reduced thereby improving the fertility status of soil. The micronutrients Cu, Mn and Fe were sufficient while Zn was found to be deficient in soils. The highest grain yield was observed in contour cultivation along vegetative hedgerows, indicating that the contour cultivation along the vegetative hedgerows is one of the yield contributing factors. The results obtained in present study will help in achieving potential yields on a sustainable basis.

Sorghum is said to be the poor man's crop. But it is indeed a most assured crop of dryland agriculture and a source of food grains and fodder for live stock. It is also one of the most important cereal crop grown under rainfed condition in various parts of India. Most of the kharif sorghum area is concentrated in Vidarbha region. The dual purpose and drought resistant nature of sorghum may keep it as economical, more viable and suitable crop under semi arid region.

It is the third important crop after rice and wheat in India. In Maharashtra, it is grown on 4.77 million hectares, out of which 1.95 and 2.82 million hectares are in *Kharif* and *Rabi*, respectively. The total sorghum grain production in Maharashtra is about 4.48 million tonnes with production of 2.78 and 1.70 million tonnes in *Kharif* and *Rabi*, respectively. The average yield of sorghum in India is about 850 kg ha^{-1} (Anonymous, 2002).

Soil and water are our most precious resources and maintaining the soil in a storage of high productivity on sustainable basis is important for meeting growing food demand of our growing population. But the situation is not encouraging due to urbanization which has resulted decrease in the area of fertile land for crop production. The productivity per unit area is also declining due to low inputs, poor management and unawareness amongst farmers regarding basic soil resources.

Several soil and water conservation practices have been recommended to minimize soil erosion and to maintain organic matter, soil moisture, aeration and microbial activity. In order to have the sustainable agriculture, maintaining soil properties in favourable proportion for a long time is a problem. Further, the pressure on land accelerated soil erosion through degrading the soil which leads to reduced soil fertility. Such a situation demand suitable land use and soil and water conservation practices to overcome this problem.

The vegetative barriers on contour for in-situ soil and moisture conservation has been preferred to conventional mechanical structure alone on arable and non-arable farming. Considering the small land holding size and other limitations of farming community in our country, vegetative hedgerows system is found to have encouraging results (Bharad *et al.*, 1991).

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Soil moisture is a prime constraint in increasing crop production and soil act as a filter for the soil moisture storage. This natural situation needs to be utilized to the maximum extent before we think of storing the water elsewhere. This situation can be created by various structures and structural measures. In India, per capita holding is very low and poor land holder can not afford to go for costly mechanical soil protection work. Contour and graded bunding and bench terracing etc. although reduce the runoff and soil loss considerably, the conservation of moisture by contour farming in watershed area is one of the recent approach. Contour cultivation along various vegetative barriers in a watershed area is useful for increasing available soil moisture storage and moisture use efficiency.

MATERIAL AND METHODS

The field experiment was planned during the year 2002-03 in the Watershed Management Research unit, Agroecology and Environment centre, Dr. PDKV, Akola, in Randomized Block Design using sorghum (CSH –9) as a test crop with four treatments replicated five times (for productivity studies) on Inceptisols. The details of each treatment and other information pertaining to trial is given below.

Treatment Details

T_1 – Sowing along the main slope

T_2 – Contour cultivation along the leucaena hedges at 1 m VI (2 hedges)

T_3 – Contour cultivation along the vetiver hedges at 1 m VI (2 hedges)

T_4 – Sowing across the slope

RESULTS AND DISCUSSION

Fertility Status of Soil

The data pertaining to fertility status in respect of available N, P and K content in soils is presented in Table 1.

N status of soil

Plants require large amount of nitrogen for growth and development, very small fraction of soil total nitrogen is in available form. It is well known that more than 90 per cent of soil total nitrogen is organically bound and is a potential reserve from plant nutrition point of view. Under the normal soil condition, inorganic nitrogen is continuously formed from the organic N by mineralization process and the dynamics of available nitrogen determines the magnitude of N supply to crops. Thus the study of available nitrogen and its vertical distribution becomes important from the point of view of plant nutrition and its translocation in soil.

The result pertaining to distribution of available nitrogen at different depth are presented in Table 1. The available nitrogen in surface (0-15 cm) and subsurface (15-30 cm) soil varied from 134.84 to 150.52 and 128.57 to 137.98 kg ha^{-1} respectively and on the basis of soil test rating the available nitrogen content in most of the soil samples were categorized as low. The data clearly indicate the decrease in available N content with soil depth. Similar trend was also reported by Tyagi and Venkatesh Bhardwaj (1994).

Maximum available N recorded in treatment contour cultivation along the vetiver hedges (T_3) and the minimum available N observed in treatment sowing across the slope.

Table 1. Fertility status of soil

Treatments	Depth (cm)	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
T_1 – Sowing along the main slope	0-15	141.21	13.45	268.8
	15–30	134.84	11.35	257.6
T_2 – Contour cultivation along the leucaena	0-15	144.25	15.45	280.0
hedges at 1 m VI (2 hedges)	15–30	128.57	12.10	252.0
T_3 – Contour cultivation along the vetiver	0-15	150.52	15.65	324.8
hedges at 1 m VI (2 hedges)	15–30	137.98	12.45	302.4
T_4 – Sowing across the slope	0-15	134.84	14.90	224.0
	15–30	131.71	11.40	219.2
Initial Fertility status of soil	15-30	133.25	13.28	221.52

The nitrogen status of soil found to be increased due to contour cultivation along vegetative hedgerows. Results further showed that a maximum increase in N status was observed due to contour cultivation along the vetiver hedges followed by contour cultivation along the leucaena hedges. Vegetative hedgerows act as barrier and reduce surface runoff and soil loss and could conserve the plant nutrients.

P status of soil

Available phosphorus content in soil has a great bearing on the plant growth. Available phosphorus constitutes very small fraction of total P in soil and therefore, the knowledge of phosphorus availability need to be examined.

Data presented in Table 2 indicate the depthwise variation in P status of the soil. The available P in surface and subsurface soil ranged from 13.45 to 15.65 and 11.35 to 12.45 kg ha^{-1}, respectively indicating that these soils are low in available phosphorus content.

Available P status of soil as influenced by various treatments varied in the range of 13.45 to 15.65 kg ha^{-1}. However, lowest P content in soil recorded due to sowing along the main slope (T_1). Results further showed that higher P status recorded in treatment contour cultivation along the vetiver hedges (T_3) followed by contour cultivation along the leucaena hedges. The vegetative hedgerows acts as barrier which resulted in decreasing runoff and soil loss thereby reduction in nutrient loss and enhancement in availability of P.

K status of soil

Potassium compounds in the soil are distributed as water soluble and exchangeable or non-exchangeable or fined potassium bearing minerals in clay or coarse fraction of soil. The amount of K released depends upon the nature of clay minerals in the soil. The readily available form of K in black soil forms a small portion (1 to 4 %) of total K. Major fraction remains in non-exchangeable or unavailable forms. The soils under study possesses high content of available potassium and is generally quite adequate for normal cropping adopted by farmers.

The available K content varied from 224 to 324.8 and 219.2 to 302.4 kg ha^{-1} for surface (0-15 cm) and subsurface (15-30 cm) soil respectively. The data clearly indicate the decrease in available K content with depth. Similar findings were also observed by Mishra and Srivasatava (1991) and Singh and Tripathi (1993). On the basis of soil test rating all the soil samples were categorized as high in available potassium content.

The K status of soil as influenced by various treatments indicated that minimum K content was observed in treatment sowing across the slope (T_4) whereas maximum available K was observed in treatment contour cultivation along vetiver hedges (T_3), followed by contour cultivation along the leucaena hedges (T_2). This can be attributed to reducing the losses of available K through surface runoff due to adoption of vegetative barriers. The build up of NPK status in soil might be due to increase in organic carbon status of soil and reduction in nutrient losses through surface runoff. Gain in residual nutrient status of soil due to vegetative hedgerows over across the slope sowing was also noticed by Sagare *et al.*, (1996).

Micro-nutrients Status

The data pertaining to the DTPA extractable micronutrient status of soil are presented in Table 2.

Zinc (Zn)

The Zn content in surface and subsurface soil ranged from 0.39 to 0.58 and 0.32 to 0.54 ppm. The critical limit for Zn is 0.6 ppm (Katyal, 1985) so the Zn content in studied soil is deficient for the growth of plants. The data clearly indicate that the Zn content decreased with depth. Similar observations were also reported by Jadhav *et al.* (1978), Chavan *et al.* (1980) and Gajbhiye (1995).

Maximum DTPA extractable zinc recorded in treatment contour cultivation along the vetiver hedges (T_3), followed by contour cultivation along leucaena hedges.

Copper (Cu)

The copper content in 0-15 cm and 15-30 cm depth varied from 0.89 to 1.60 and 0.70 to 1.30 ppm respectively. The data clearly indicate that the DTPA extractable Cu decreased with depth. Gajbhiye (1995) and Joshi (1996) also noticed similar decrease in Cu with increase in depth of soil. Higher amount of organic carbon may account for higher values of the available Cu in the surface layer as compared to subsurface soils.

The lowest DTPA extractable Cu content in soil recorded due to sowing across the slope. Results further showed that higher values of DTPA Cu recorded in contour cultivation along the vetiver hedges (T_3),

Table 2. DTPA extractable micronutrients (ppm)

Treatments	Depth (cm)	Zn (ppm)	Cu(ppm)	Mn (ppm)	Fe(ppm)
T_1 – Sowing along the main slope	0-15	0.45	0.90	4.9	5.8
	15-30	0.42	0.80	4.7	5.5
T_2 – Contour cultivation along the leucaena	0-15	0.48	1.50	5.2	6.2
hedges at 1 m VI (2 hedges)	15-30	0.44	1.30	5.0	5.9
T_3 – Contour cultivation along the vetiver	0-15	0.58	1.60	5.3	6.4
hedges at 1 m VI (2 hedges)	15-30	0.54	1.30	5.1	6.1
T_4 – Sowing across the slope	0-15	0.39	0.89	4.8	5.7
	15-30	0.32	0.70	4.6	5.5

followed by contour cultivation along the leucaena hedges (T_2).

Manganese (Mn)

Data presented in Table 2 indicated the depthwise variation in DTPA extractable Mn. The manganese in surface (0-15) and subsurface (15-30 cm) soil varied from 4.8 to 5.3 and 4.6 to 5.1 ppm respectively. The data clearly indicate that the DTPA extractable Mn decreased with depth. Low content of DTPA extractable Mn in subsurface soil as compared to surface layer might be due to higher values of pH of surface soil which may convert Mn^{2+} in to Mn^{3+} (inorganic oxide which is water insoluble). Similar observations were also reported by Chavan *et al.*, (1980) and Gajbhiye (1995).

Minimum DTPA extractable Mn observed in treatment sowing across the slope whereas maximum DTPA extractable Mn observed in treatment contour cultivation along the vetiver hedges, followed by contour cultivation along the leucaena hedges. This can be attributed to reducing the losses of DTPA extractable Mn through surface runoff due to adoption of vegetative barriers.

Iron (Fe)

The DTPA extractable Fe in 0-15 and 15-30 cm soil ranged from 5.7 to 6.4 and 5.5 to 6.1 ppm. The data indicate that the DTPA extractable Fe decreased with depth. Similar observations were reported by Jadhav *et al.* (1978) and Gajbhiye (1995).

Decrease in available Fe in subsurface soil attributed to low organic carbon and higher pH of subsurface soil. Due to high pH, available Fe may get precipitated as hydroxides and becomes unavailable to plants. Maximum DTPA extractable Fe recorded in treatment contour cultivation along the vetiver hedges followed by contour cultivation along leucaena hedges.

Considering 0.6 ppm DTPA extractable Zn (Katyal, 1985), 3.0 ppm DTPA extractable Mn (Shukla and Gupta, 1975), 0.2 ppm DTPA extractable Cu and 4.5 ppm DTPA extractable Fe (Katyal and Randhawa, 1983) as the critical limits, the soils of study area can be rated as sufficient in available micronutrient status except zinc.

Effect of contour cultivation on productivity of sorghum

Data in relation to grain yield of sorghum as influenced by contour cultivation along vegetative hedgerows are tabulated in Table 3.

Results indicate that the highest increase in grain yield was recorded in contour cultivation along vetiver barrier (24.6%), followed by contour cultivation along leucaena barrier (20.2 %) and the minimum grain yield was recorded in treatment sowing along the main slope.

Table 3. Grain yield of sorghum (q ha^{-1}) as influenced by various vegetative barriers

S. N.	Parameters	Treatments			
		T_1	T_2	T_3	T_4
1	Plant height (cm)	178.00	182.00	184.00	179.00
2	Length of cob (cm)	17.50	19.20	19.80	18.10
3	Grain yield $plot^{-1}$ (kg) ($4.5m^2$)	0.600	0.722	0.748	0.687
4	Grain yield (q ha^{-1})	13.24	16.04	16.62	15.27
5	Per cent increase in yield over T_1	—	20.20	24.60	14.50

Thus contour cultivation alongwith vegetative hedgerows are one of the yield contributing factors which may help in uniform distribution of rain water in the soil solum avoiding excess and deficit water situation and leads to uniform recharge of soil moisture in effective rooting depth of crops. Moreover, vegetative hedgerows act as barriers which results in increasing infiltration rate and available soil moisture storage of soil. The beneficial effects due to these combinations might be attributed to reduction in nutrient losses and enhancement in availability of nutrients and productivity of crops.

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Characterization and Classification of Some Typical Acid Lime Growing Soils of Akola District

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ABSTRACT

Fourteen typical villages supporting acid lime in Akola district of Maharashtra state were characterized and assessed fourty eight soil sample for their suitability. The soil being developed from basalt. The texture of soil ranged between clay to clay toam (28.92 to 62.10 per cent clay) with slightly alkaline in nature, pH ranged between 7.30 to 8.35, moderate to high calcareous in nature i.e. $CaCO_3$ ranged between 2.30 per cent to 16.46 per cent, with organic carbon low to high ranged between 3.4 to 52.3 cmol (p^+) kg la^{-1}. Bulk density and porosity of soil ranged between 1.15 to 1.27 Mg m^{-3} and 52.08 per cent to 56.60 per cent, respectively. Available water capacity water holding capacity ranged between 12.20 per cent to 17.35 per cent and 55.60 per cent to 73.58 per cent respectively and hydraulic conductivity of soil ranged between 0.27 to 0.39 ch hr^{-1}.

Citrus is often ragarded as a queen of all fruits and is one of the remunative commercial fruit crop of India after mango and banana occupying on area of 4.82 lakh ha with total production of 42.6 lakh tonnes, there by placed at 6th position on the basis of total production amongst frontline citrus growing countries. Fertilizers inputs account for 30.40 per cent of total cost of citrus production, suggesting the significance of citrus nutrition. Among the important citrus fruit, acid lime is cultivated on a very large scale specially in central and south Indian states. Maharashtra state is leading in acid lime cultivation. Vidarbha region of the Maharashtra state particularly in Akola district have more acid lime growing area (2283 ha).

However, in India the best performance of the crop is confined to specific soils. Deep soils with good tilt and good available moisture are optimum for Acid lime plantation. The incidence of pests and diseases bear a direct relationship with soil condition and when the soil condition are not optimum there would be considerable deterioration of acid lime plantation.

Therefore the present study has been taken to characterize and classify some typical acid lime growing soils of the Akola district of Maharashtra for their suitability assessment and food security of acid lime fruit.

MATERIAL AND METHODS

The study area is located in fourteen villages of Akola district. The area falls in tropical dry subhumid monsoonic type climate with average normal rainfall was 15.49 mm. The actual maximum and minimum temperature are 33.79°C and 20.49°C and the average actual relative humidity was 38.31 per cent in the year 2003.

Forty eight composite representative surface soil sample (0-30 cm) were collected from circular band of 30-40 cm away from stem by means of soil tube auger. All 48 soil samples were collected from 14 villages of Akola district acid lime orchards. Particle size distribution, bulk density, particle density, maximum water holding capacity, available water capacity, hydraulic conductivity of soil was analysed by the standard methods Black (1965) and Richards (1945), respectively. The chemical properties like soil pH, electrical conductivity, cation exchange capacity, free calcium carbonate and organic carbon were determined by appropriate method of analysis (Piper, 1966).

RESULTS AND DISCUSSION

Physical characteristics :

Particle size distribution (Soil texture)

Regarding physical characteristics of soil, data on particle size distribution is presented in Table 1. The soil samples were fractioned into sand, silt and clay. The range of clay content in soil under study ws 28.92 per cent to 62.10 per cent with an average of 43.70 per cent. The silt content of soil range from 13.60 per cent to 32.38 per cent with an average of 23.32 per cent and sand content of soil ranged from 17.50 per cent to 42.88 per cent with an average of 32.80 per cent was observed. From the

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Table 1. Physico-chemical characteristics of acid lime orchards soil

S.N.	Name of village	Sand (%)	Silt (%)	Clay (%)	Textu-ral class	B.D. (Mg^{-3})	Porosity (%)	MWHC (%)	AWC (%)	H.C. ($cm\ hr^{-1}$)	PH	EC (dSm^{-1})	Organic carbon ($g\ kg^{-1}$)	$CaCO_3$ (%)	CEC cmol (p*) $kg\ ha^{-1}$
1.	Maispur	36.39	18.20	45.41	C	1.17	55.80	65.70	16.92	0.39	7.75	0.20	5.3	7.70	42.38
2.	Maispur	40.38	17.35	42.27	C	1.21	54.30	67.50	16.51	0.29	7.90	0.23	6.4	2.50	51.32
3.	Maispur	41.58	15.76	42.66	C	1.16	56.20	66.74	16.80	0.31	7.85	0.21	5.9	2.30	45.16
4.	Maispur	35.90	13.60	50.50	C	1.15	56.60	58.90	16.72	0.30	7.80	0.18	6.9	7.90	46.60
5.	Lakhanwada	41.38	29.60	28.92	CL	1.19	55.10	70.32	14.41	0.32	7.70	0.26	5.2	7.60	49.32
6.	Lakhanwada	38.36	27.39	34.25	CL	1.22	53.90	69.50	15.80	0.34	8.15	0.29	5.8	7.06	51.38
7.	Lakhanwada	40.32	22.38	37.30	CL	1.18	55.40	73.58	14.28	0.29	8.10	0.22	6.2	8.72	52.31
8.	Lakhanwada	35.60	17.50	46.90	C	1.16	56.20	72.39	14.90	0.29	8.00	0.15	5.9	8.33	48.32
9.	Barshitakali	17.50	26.30	56.20	C	1.19	55.10	71.20	12.45	0.28	8.10	0.19	8.8	10.10	46.28
10.	Barshitakali	22.28	25.48	52.24	C	1.21	54.30	69.20	13.38	0.30	8.15	0.17	8.4	8.04	44.44
11.	Kapshi	22.30	17.30	60.40	C	1.19	55.10	62.30	14.52	0.35	7.80	0.22	7.1	9.40	47.25
12.	Kapshi	28.35	23.50	48.15	C	1.17	55.80	63.80	14.70	0.33	7.75	0.34	6.4	8.33	46.76
13.	Chikhalgaon	42.88	21.80	35.32	CL	1.18	55.40	59.57	15.33	0.34	7.90	0.28	8.1	7.60	41.70
14.	Chikhalgaon	26.54	21.38	52.08	C	1.20	54.70	62.38	14.20	0.37	7.65	0.18	7.5	8.62	38.40
15.	Chikhalgaon	37.67	23.50	38.83	CL	1.27	52.08	60.69	14.70	0.39	8.05	0.14	6.9	7.25	34.64
16	Chikhalgaon	20.68	26.60	52.72	C	1.23	53.50	59.37	15.21	0.31	8.15	0.25	7.8	9.80	39.62
17.	Deulgaon	40.70	24.30	35.00	CL	1.21	54.30	58.60	15.20	0.37	8.10	0.31	6.3	10.00	45.50
18.	Deulgaon	40.30	25.50	34.24	CL	1.24	53.20	63.70	14.38	0.32	7.90	0.44	7.9	13.72	46.78
19.	Deulgaon	40.10	23.38	36.52	CL	1.26	52.40	65.50	16.30	0.36	8.25	0.38	6.8	15.40	47.34
20.	Deulgaon	42.38	17.69	39.93	CL	1.19	55.10	62.68	12.38	0.32	8.15	0.28	6.5	11.77	49.54
21.	Wadegaon	41.18	23.50	35.32	CL	1.16	56.20	58.60	17.35	0.34	7.95	0.24	5.5	11.50	64.60
22.	Wadegaon	39.50	25.57	34.83	CL	1.17	55.80	58.45	17.05	0.33	8.00	0.26	6.8	12.54	41.36
23	Wadegaon	38.33	22.40	39.27	CL	1.22	53.90	57.38	17.10	0.28	7.90	0.25	7.3	16.46	44.31
24.	Wadegaon	40.35	19.50	40.15	C	1.18	55.40	59.70	16.93	0.28	8.00	0.22	8.0	14.11	47.28

S.N.	Name of village	Sand (%)	Silt (%)	Clay (%)	Textu-ral class	B.D. (Mg^{-3})	Porosity (%)	MWHC (%)	AWC (%)	H.C. ($cm\ hr^{-1}$)	PH	EC (dSm^{-1})	Organic carbon ($g\ kg^{-1}$)	$CaCO_3$ (%)	CEC cmol (p*) $kg\ ha^{-1}$
25.	Patur	28.48	27.50	44.02	C	1.17	55.80	62.70	12.08	0.93	7.35	0.17	4.8	5.59	49.32
26.	Patur	25.30	19.38	55.32	C	1.20	54.70	55.60	13.90	0.32	7.50	0.15	6.7	6.27	43.32
27.	Patur	34.38	32.38	33.24	CL	1.16	65.20	59.64	12.20	0.35	7.90	0.21	5.9	6.17	40.38
28.	Patur	27.50	20.38	52.12	C	1.15	56.60	59.39	14.21	0.33	8.10	0.19	3.4	5.78	42.50
29.	Babhulgaon	28.38	26.30	45.32	C	1.16	56.20	59.30	13.38	0.28	7.65	0.27	5.3	15.19	46.37
30.	Babhulgaon	35.39	21.42	34.19	C	1.19	55.10	61.48	12.58	0.27	7.70	0.21	5.7	14.90	45.50
31.	Babhulgaon	33.50	28.30	34.20	CL	1.20	54.70	63.59	14.21	0.31	7.85	0.25	3.7	14.21	46.75
32.	Babhulgaon	39.48	22.45	38.07	CL	1.18	55.40	59.35	14.28	0.35	7.95	0.27	4.8	15.09	49.38
33.	Borgaon (Manju)	22.37	25.30	52.32	C	1.19	55.10	65.31	16.88	0.35	8.30	0.31	6.4	10.20	46.53
34.	Borgaon(Manju)	24.48	29.42	46.10	C	1.15	56.60	68.59	17.35	0.27	8.25	0.35	6.9	8.62	49.57
35.	Dongargaon	15.42	22.40	62.10	C	1.21	54.30	66.68	14.20	0.29	7.45	0.18	5.4	8.90	47.68
36.	Dongargaon	19.40	25.30	55.30	C	1.16	56.20	67.49	13.80	0.35	7.60	0.15	4.6	7.94	51.33
37.	Dongargaon	23.42	25.68	50.90	C	1.22	53.90	59.42	12.50	0.36	7.65	0.19	3.9	8.13	34.31
38.	Dongargaon	29.70	27.38	42.92	C	1.15	56.60	59.79	13.58	0.32	7.90	0.21	6.1	8.23	49.80
39.	Wyala	35.20	22.40	42.40	C	1.16	56.20	57.50	13.60	0.34	7.55	0.18	7.0	15.09	42.32
40.	Wyala	28.45	21.20	50.35	C	1.19	55.10	62.34	13.42	0.31	7.30	0.31	6.5	13.60	41.90
41.	Wyala	26.34	19.45	54.21	C	1.17	55.80	63.45	12.80	0.27	7.60	0.28	7.6	12.94	42.28
42.	Wyala	31.12	24.78	44.10	C	1.20	54.70	63.40	14.72	0.29	7.35	0.35	8.2	14.80	40.08
43.	Kanheri	40.37	22.45	37.18	C	1.22	53.90	68.72	13.80	0.39	8.10	0.26	6.9	11.20	45.80
44.	Kanheri	36.56	23.20	40.24	CL	1.25	52.80	59.90	17.40	0.30	8.20	0.28	5.8	9.60	45.95
45.	Kanheri	35.60	21.38	43.02	CL	1.21	54.30	64.79	16.20	0.32	8.05	0.26	7.2	8.33	46.70
46.	Kanheri	35.34	25.30	39.30	CL	1.19	55.10	65.43	14.12	0.31	7.95	0.25	6.1	10.58	45.20
47.	Shadad	31.10	27.47	41.43	CL	1.20	54.70	65.96	14.31	0.33	8.00	0.31	6.9	5.60	44.12
48.	Shadad	31.80	28.60	39.60	CL	1.25	52.80	68.70	13.40	0.36	7.80	0.28	6.3	7.25	44.29
	Mean	32.79	23.32	43.70		1.19	54.97	63.47	14.72	0.32	7.88	0.25	6.4	9.81	45.08

data the soil texture was found varied from clay to clay loam with the predominance of clay texture. Similar findings were reproted by Barade (2000).

Bulk density and porosity :

The bulk density between 1.15 Mg m^{-3} to 1.27 Mg m^{-3} with an average of 1.19 Mg ,m^{-3}. Similar findings were also reported by Bharambe *et. al.*, (1990). Bulk density indicates the degree of soil compactness. Ease a root penetration depends on soil compactness. Porosity ranges between 52.08 per cent to 56.60 per cent with an average of 54.97 per cent. Similar observations were reported by Bharambhe and Ghonsikar (1985). As the pore spaces increase in soil, movement of water and air increase in soil.

Maximum water holding capacity and available water capacity :

Maximum water holding capacity ranged between 55.60 per cent to 73.58 per cent with an average of 63.47 per cent and available water capacity renged between 12.20 per cent to 17.35 per cent with an average of 14.72 per cent. Similar observation was recorded by Ramteke (1996).

Hydraulic conductivity : The hydraulic conductivitity ranged between 0.27 ch hr^{-1} to 0.30 $chhr^{-1}$ with an average of 0.32 $chhr^{-1}$. Similar observation was reported by Bharambe and Ghonsikar (1985). The saturated hydraulic condictuvity depends upon clay content and pore size distribution of soil.

Chamical characteristics :

The data regarding chemical characteristics of soil are presented in Table 1.

pH and electrical conductivity : It was seen from the result that pH of soil varied from 7.30 to 8.25 with an average of 7.88, indicating that the soil acid lime orchards under study were observed to be in safe limit. Similar observations were reported by Ingole *et. al.*, (1993). The electrical conductivity range from 0.14 dS m^{-1} to 0.35 dS m^{-1} with the mean value of 0.25 dS m^{-1} which is the safe range for growing citurs crop. Similar observations were reported by Borade (2000).

Organic carbon : Organic carbon is the index for nitrogen content in soil in acid lime soil under study orchard area. It ranged from 3.4 g kg^{-1} to 8.8 g kg^{-1} with the mean value of 6.4 kg^{-1}. It means majority of orchards belonging to the category of low to moderately high for content of organic carbon. Similar observations were reported by Ingole *et. al.*, (1993).

Calcium carbonate and cation exchange capacity: Free calcium carbonate in soil varied from 2.30 per cent to 16.46 per cent with the mean value of 9.81 per cent. In general, 40 per cent orchards soil content more than 10 per cent calcium carbonate indicating their calcareous nature. Similar observations were also reported by Ingole *et. al.*, (1993). Cation exchange capacity of soil varied from 34.31 cmol (+) kg ha^{-1} to 52.31 Mol (+) kg ha^{-1} with the mean value of 45.08 cmol (+) kg ha^{-1} . Similar observations were reported by Jagdish Prasad *et. al.*, (2001)

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Application of Fertility Capability Classification System in Soils of Belura Watershed in Rainfed Agro-ecosystem of Vidarbha

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ABSTRACT

The fertility capability classification (FCC) system has been used to group soils with same kind of limitations from the point of view of fertility management in Belura watershed of semi-arid environment in rainfed agro-ecosystem in Akola district of Maharashtra. The information on fourteen soil profiles identified during detailed soil survey have been analyzed into six FCC units. Among the fourteen soil profiles, two are sandy clay loam and remaining twelve are clayey type. Swell shrink properties, calcariousness, redder hue, moisture regime and gravelliness are the condition modifiers used. By computing FCC units, an attempt has been made to highlight the fertility constraints and measures to revert the situation for sustainable production in rainfed agro-ecosystem.

Soil survey report although provides information on the relative suitability of soils for alternative uses, however, its utility can be enhanced if the taxonomic units are grouped into management units which can easily indicate the potential and constraints of an area in terms of its fertility. The fertility capability classification (FCC) system is a technical soil classification system that focuses quantitatively on the physical and chemical properties of the soil that are important to soil fertility management (Sanchez *et al.*, 1982). It lays maximum emphasis on the component of soil fertility within 50 cm layer from the surface, however, soil taxonomy puts more emphasis on sub-surface soil properties because of their more permanent nature. Bhattacharya (1995) made an attempt to bridge the natural classification of soils based on reconnaissance soil survey in part of western Maharashtra and FCC unit. In this study, attempt has been made to convert the soil taxonomy (classification) of Belura Watershed in Akola district of Maharashtra into FCC units.

MATERIAL AND METHODS

Belura watershed is situated at 20° 32' 14" to 20 °33' 54" N latitude and 76° 53' to 76° 55' E longitude, about 35 km south-west to Akola. The total area of watershed is 577 ha and an elevation ranging from 300 to 343 m above MSL. The area is characterized by undulating relief (1 to 4 per cent slope) and dentritic drainage. The climate of the area is semi-arid tropical with average normal rainfall of about 824.7 mm.

The area is mostly under dryland farming with traditional management. A small area is irrigated. The common rainy season crops include sorghum, cotton, pigeonpea and wheat and horticultural crops like orange, lime and banana are grown under irrigation. Based on detailed soil survey, fourteen soil profiles belonging to Entisols, Inceptisols and Vertisols have been identified and mapped as phases of soil series (Fig.1). The relevant morphological, physical and chemical characteristics of the soils are given in Table 2 and the morphological characteristics and physico-chemical properties of four dominant soils are presented in Table 3 and 4 , respectively.

FCC units were determined following the procedure outlined by Sanchez *et al.* (1982). The FCC units list the 'type' (texture of plough layer or surface 20 cm) at the highest category of the system, refers to the texture of the sub soil that occurs within 50 cm from the surface and was used only when there was any marked textural change from the surface or if a hard root restricting layer was encountered within 50 cm. 'Condition modifiers' which is the lowest category of the FCC system was determined after assessing the physical and chemical properties of the surface and subsurface soils. The modifiers used are d (ustic moisture regime), i (soil matrix

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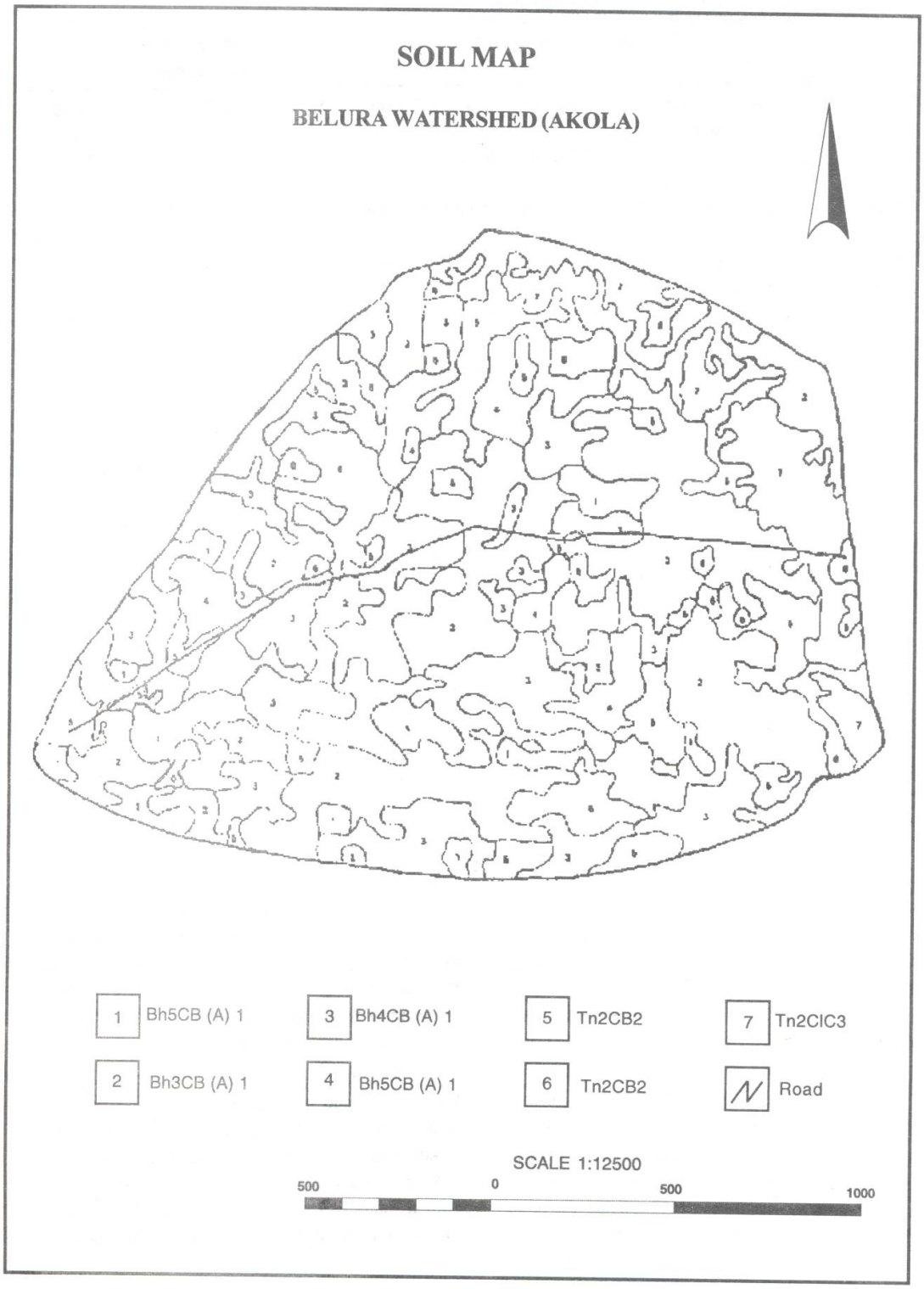
SOIL MAP
BELURA WATERSHED (AKOLA)
1 Bh5CB (A) 1
2 Bh3CB (A) 1
3 Bh4CB (A) 1
4 Bh5CB (A) 1
5 Tn2CB2
6 Tn2CB2
7 Tn2ClC3
Road
SCALE 1:12500
500
0
500
1000

Table 1.Area and distribution of various mapping units

Mapping symbol	Mapping unit descriptions	Land capability classification	Area (ha)
Bk5CB(A)1	Clay soils, deep, moderately well drained with 1-3% slope and non to slightly eroded	IIe	35.63
Bb3CB(A)1	Clay soils, shallow, well drained with 1-3% slope and moderately eroded	III e	219.49
Bh4CB(A)1	Clay soils, moderately deep, well drained with 1-3% slope and moderately eroded	II e	120.46
Tn2SclB2	Sandy clay loam soils, shallow, well drained, 1-3% slope and moderately eroded	VI es	19.32
Bh5CB(A)1	Clay soils, moderately deep, well drained with 1-3% slope and moderately eroded	II e	51.57
Tn2CB2	Clay soils, shallow, well drained with 2-3 % slope and moderately eroded	VI es	82.02
Tn2SclC3	Sandy clay loam soils, shallow, well drained, 3-4% slope and severely eroded	VI es	48.51
	Total area		577.00

colour in hue 7.5 YR or redder), v(shrink-swell phenomenon), b (free calcium carbonate, ' (gravels 15-35 %), " (gravels >35 %). The various mapping units description along with their respective land capability classes and area in hectares are presented in Table 1.

RESULTS AND DISCUSSION

The fertility capability classification is designed to group soils that have same kind of limitation from the point of view of fertility management. Thus, the soils are grouped only by characteristics that make them similar for fertility. The soil coding of fourteen profiles are presented in Table 5, which facilitates the systematic placement of the soils into 6 FCC units (Table 6) and it clearly indicates that soil individuals in one FCC class belong to different taxonomic class. Two soil series had sandy clay loam type (L) and are underlined by weathered basalt (R) which constitute substrata type with the exception of Tn2SclC3 soils associated with sandy clay loam type but gravelly. The loamy type soils generally associated with shallow solum are very much prone to moisture stress during dry season and even in rainy season under intermittent dry spells (Hajare *et al.*, 1992).

Three soils mapping units namely Belura (Bk)1, Belura (Bk) 8 and Bhandaraj 12 (moderately deep) have clayey type, Tandali 13 and Tandali 14 soils are also prone to erosion, high clay content with such expansible clay minerals cause tillage problem when these soils are too dry or too moist.

Belura(Bk)1, Bhandaraj-4, Bhandaraj-7, Bhandaraj-9,Belura (Bb)10 and Bhandaraj 12 (deep) soils had clayey subsurface type (high clay content) with swell-shrink properties presence of free $CaCO_3$. Similar observations were also recorded by Nipunje *et al.*, 1996).

The soils belonging to Belura(Bk)1, Belura(Bb)3,Bhandaraj(Bh)-9, Belura(Bb)10, Belura(Bb)11 and Bhandaraj(Bh)-12 with different taxonomic classification are grouped in one FCC unit viz, CRdvb characterized by clayey type, shrink-swell properties and free $CaCO_3$ with high productivity. The particular properties of these soils caused by alternate drying and wetting pose difficulty in seedbed preparation and also in other agricultural operations. Absence of p bearing minerals and presence of free $CaCO_3$ further aggravate the problem of p deficiency in these soils and hence response of applied p is frequently observed (Sathone and Babhulkar ,1991 ; Hajare *et al.*, 1994) .

Moderately deep soils should be tilled in *Kharif* for sorghum and pigeonpea under proper soil water conservation practices. Deep and very deep soils are to be kept under kharif cotton and sorghum, wheat in *Rabi* and horticultural crops like orange, lime and banana. The graded bunding , contour ditching and broad based channel and terraced may be recommended for proper

Table 2. Relevant properties of soils of Belura watershed, Distt. Akola

Soil mapping units	Taxonomic classification	Depth (cm)	Texture	Clay (%)	$CaCO_3$ (%)	pH (1:2.5)	CEC (cmol (p+) kg^{-1})	Drainage	Colour (moist)
Belura -(Bk)1	Very fine montmorillonitic Typic Haplusterts	130	c	70.09	13.87	7.71	55.91	MW	10YR 3/2
Tandali -2	Fine, montmorillonitic Typic Ustorthents	15	Scl	34.40	23.12	7.30	51.16	W	10YR 4/2
Belura -(Bb)3	Very fine, montmorillonitic Typic Ustochrepts	34	c	60.11	18.70	7.75	54.06	W	10YR 3/2
Bhandaraj- 4	Very fine, montmorillonitic Vertic Ustochrepts	76	c	66.07	13.83	7.66	56.40	W	10YR 3/2
Tandali -5	Fine, montmorillonitic Typic Ustorthents	19	c	54.40	5.50	7.28	53.41	W	10YR 3/2
Tandali -6	Fine, montmorillonitic Typic Ustorthents	20	c	48.00	4.50	7.15	51.17	W	2.5YR 3/4
Bhandaraj -7	Very fine, montmorillonitic Vertic Ustochrepts	81	c	67.82	9.54	7.59	56.21	W	10YR 3/2
Belura -(Bk)8	Very fine, montmorillonitic Typic Haplusterts	118	c	66.52	10.63	7.92	60.64	MW	10 YR 3/2
Bhandaraj- 9	Very fine, montmorillonitic Vertic Ustochrepts	80	c	61.49	11.54	7.63	58.64	W	10YR 3/2
Belura- (Bb)10	Very fine, montmorillonitic Typic Ustochrepts	48	c	62.96	6.22	7.47	57.61	W	10YR 3/2
Belura-(Bb) 11	Very fine, montmorillonitic Typic Ustochrepts	30	c	64.18	6.03	7.39	56.90	W	10YR 3/2
Bhandaraj-12	Very fine, montmorillonitic Vertic Ustochrepts	112	c	70.32	13.37	8.29	59.05	MW	10 YR 3/2
Tandali -13	Fine, montmorillonitic Typic Ustorthents	10	c	51.60	4.12	7.38	52.13	W	10YR 3/2
Tanadali -14	Fine, montmorillonitic Typic Ustorthents	15	Scl	40.80	5.87	7.28	51.47	W	10YR 3/6

W- Well drained, MW- Moderately well drained.

Table 3. Morphological characteristics of four dominant soils

Horizon	Depth(cm)	Colour moist	Texture	Structure	Consistence D M W	Nodules	Efferve scence	Other features
Belura (Bk)series: very fine, montmorillonitic, hyperthermic, Typic Haplusterts								
Ap	0-18	10YR 3/2	c	m2sbk	sh fr sp	ff	e	Slickensides in IVth
A1	18-33	10YR 3/2	c	m2sbk	sh fi sp	ff	es	and Vth horizon.
A2	33-55	10YR 3/2	c	m2sbk	sh fi sp	fc	es	
B_{ss1}	55-80	10YR 3/2	c	m2abk	sh fi sp	ff	es	
B_{ss2}	80-130	10YR 3/1	c	m2abk	sh fi sp	fc	ev	
Tandali 2 series: fine, montmorillonitic, hyperthermic, Typic Ustorthents								
A	0-15	10 YR 4/2	Scl	m2sbk	sh fr ssps	fc	ev	
Belura (Bb) 3 series: very fine, montmorillonitic, hyperthermic, Typic Ustochrepts								
Ap	0-20	10 YR 3/2	c	m2sbk	sh fr ssps	-	e	
AC	20-34	10 YR 3/2	c	m2sbk	sh fr ssps	-	es	
Bhandaraj-4 series: very fine, montmorillonitic, hyperthermic, Typic Ustochrepts								
Ap	0-16	10 YR 3/2	c	m2sbk	sh fr ssps	-	e	Cracks 1-2 cm wide upto 25 cm,
A	16-32	10 YR 3/2	c	m2sbk	sh fr ssps	-	e	pressure faces in IIIrd and IVth
B_{w1}	32-55	10 YR 3/1	c	m2abk	sh fr sp	-	e	horizon
B_{w2}	55-76	10 YR 3/1	c	m2abk	sh fr sp	-	es	

Abbreviations used are according to Soil Survey Manual (Soil Survey Staff,1995)

Table 4. Physico-chemical properties of four dominant soils

Horizon	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	pH (1:2.5)	Organic C (%)	$CaCO_3$ (%)	CEC (cmol (P^+) kg^{-1})	BS(%)
Belura (Bk)series: very fine, montmorillonitic, hyperthermic, Typic Haplusterts									
Ap	0-18	5.0	34.4	64.6	7.57	0.67	10.37	53.12	95.18
A1	18-33	7.2	25.6	67.2	7.80	0.61	10.87	56.27	94.61
A2	33-55	5.2	26.8	68.0	7.75	0.53	12.00	54.24	97.65
B_{SS1}	55-80	3.0	26.0	71.0	7.75	0.40	15.87	56.40	95.01
B_{SS2}	80-130	1.8	24.8	73.4	7.71	0.37	16.75	57.32	96.80
Tandali 2 series: fine, montmorillonitic, hyperthermic, Typic Ustorthents									
A	0-15	42.0	23.6	34.4	7.30	0.39	23.12	51.16	95.87
Belura (Bb) 3 series: very fine, montmorillonitic, hyperthermic, Typic Ustochrepts									
Ap	0-20	10.8	27.6	61.6	7.71	0.68	18.50	54.06	95.34
AC	20-34	16.2	25.8	58.0	7.82	0.32	19.00	54.18	95.85
Bhandaraj-4 series: very fine, montmorillonitic, hyperthermic, Typic Ustochrepts									
Ap	0-16	4.8	33.6	61.6	7.67	0.70	12.25	55.30	92.76
A	16-32	3.0	32.6	64.4	7.62	0.67	12.62	55.28	95.04
B_{W1}	32-55	1.2	30.2	68.6	7.66	0.66	14.25	57.34	90.95
B_{W2}	55-76	4.8	27.2	68.0	7.71	0.41	15.50	57.10	91.24

Table 5. Checklist showing type, substrata type and modifiers

Profile No.	Soil mapping unit	Type	Substrata type	Modifiers						Aggregate
				d	i	v	b	'	"	
1.	Bk5CB(A)1	C	R	✔	—	✔	✔	—	—	CRdvb
2.	Tn2 Scl B2	L	—	✔	—	—	✔	✔	—	L'db
3.	Bb3CB(A)1	C	R	✔	—	✔	✔	—	—	CRdvb
4.	Bh4CB(A)1	C	R	✔	—	✔	✔	—	—	CRdvb
5.	Tn2CB2	C	R	✔	—	—	✔	—	—	CRdb
6.	Tn2CB2	C	—	✔	—	—	✔	—	—	Cdb
7.	Bh4CB(A)1	C	R	✔	—	✔	✔	—	—	CRdb
8.	Bk5CB(A)1	C	R	✔	—	✔	✔	—	—	CRdvb
9.	Bh4CB(A)1	C	R	✔	—	✔	✔	—	—	CRdvb
10.	Bb3CB(A)1	C	R	✔	—	✔	✔	—	—	CRdvb
11.	Bb3CB(A)1	C	R	✔	—	✔	✔	—	—	CRdb
12.	Bh5CB(A)1	C	R	✔	—	✔	✔	—	—	CRdvb
13.	Tn2CB2	C	R	✔	—	—	✔	✔	—	C'Rdvb
14.	Tn2 Scl C3	L	—	✔	—	—	✔	—	✔	L"db

L - Loamy, C-clayey (by USDA definition) R- Proposed for weathered basalt, d- Ustic moisture regime, i- Soil matrix colour in hue 7.5 YR or redder, v-Shrink swell phenomenon, b- free calcium carbonate, ' -15-35 per cent gravels, " - >35 per cent gravels.

Table 6. Soil mapping units correlated into FCC units and their explanation

Fertility Capability unit	Explanation
CRdvb	Clayey soils, weathered rock, ustic moisture regime with free calcium carbonate
L"db	Sandy clay loam soils, (>35% gravels, ustic moisture regime, with free calcium carbonate
CRdb	Clay soil, weathered rock, ustic moisture regime and free calcium carbonate
Cdb	Clayey soils, ustic moisture regime free calcium carbonate
C' Rdvb	Clayey soils (15-35% gravels) weathered rock, ustic moisture regime, swell shrink properties with free calcium carbonate
L'db	Sandy clay loam soils (15-35% gravels), ustic moisture regime with free calcium carbonate.

tapping of soil moisture. However under irrigated conditions climatically adopted crops can be grown but unjudicious use of irrigation water may lead to development of sodicity in these soils (Jagdish Prasad *et al.*, 1996).

These soils are poor in organic carbon/N. The practice of green manuring, introduction of pulses in cropping system, FYM application and interrelation of seeds/ seedlings with biofertilizer (Rhizobium, Azatobactor) are the ways to supplement N to soil. Residue management may be advantageous, problem of poor status of total p and low availability of p due to soil factors can be improved by adding a phosphatic fertilizers rich in sulphur, inoculation with Phosphorus solubilizing bacteria/fungi (Jagdish Prasad *et al.* , 1998).

This evaluation showed that the FCC system is a meaningful tool for relating fertility limitation to crop yield response in the taxonomically varied soils. It's applications provides basic clue for fertility and fertilizer management for optimum production.

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Effect of Long Term Integrated Nutrient Management on Yield of Soybean and N-Fractions in Vertisols

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ABSTRACT

The present investigation entitled, "Effect of long term integrated nutrient management on yield of soybean and N-fractions in vertisols" was undertaken at Central Research Station, Dr. PDKV, Akola in the year 1997 a view to study the long term changes in soil fertility. The twelve treatments replicated four times in Randomised Block Design comprised of NPK levels with and without FYM /wheat straw/Leucaena loppings + Sulphur + Zinc and flyash. The soil was slightly alkaline in reaction, low in total nitrogen and available phosphorus and high in available potash. The status of N fractions were improved with the application of nitrogen in combination with organics, zinc and sulphur. All the fractions of N evaluated showed an appreciable build up under 150 per cent RD NPK + S + Zn followed by leucaena loppings treatment. The relative abundance of N fractions in soil followed the order of soluble humin- N > Hydrolyzed NH_4^+ - N + amino sugar – N > amino acid – N> acid soluble humin N > fixed NH_4^+ - N > NO_3^- - N > exchangeable NH_4^+ - N which contributed 21.81 – 27.87 per cent > 15.49 – 20.84 per cent - 18.05 per cent > 9.73 – 12.13 per cent > 9.62 – 11.03 per cent > 8.11 – 10.72 per cent > 8.63 – 10.66 per cent to total N, respectively. Organic and inorganic forms of N, total N and available N were found significantly correlated with yield and fertility status.

Amongst major plant nutrients, nitrogen is one of the key nutrient found in almost all living tissues of both plants and animals. Nitrogen is an essential constituent of protein and chlorophyll and is present in many other compounds of great physiological significance in plant metabolism such as nucleotides, phosphatides, alkaloids, enzymes, harmones, vitamins etc. Thus, it is very basic consistuent of life. But, the Indian soils are reported to be poor in the nitrogen and hence, in order to achieve higher crop yields, nitrogen management in different cropping systems assumes a greater significance. Continuous application of manures and fertilizers are bound to influence the various fractions of soil N, besides influencing other soil properties. Results from long-term experiments in India have clearly demonstrated that addition of organic manures and inorganic fertilizers for over a long period had favourable effect in increasing the N fractions in soil.

Studies on N dynamics by Lin *et al.* (1973) revealed that the average contribution of non-hydrolysable N, total hydrolysable N, amino acids, hydrolysable NH_4^+ - N and unidentified NH_4^+ - N were 24.4, 75.6, 35.7, 25.0 and 10.8 per cent, respectively.

Soybean (*Glycine* max.) has become the miracle crop of twentieth century and is also called as "Golden bean". Soybean helps in maintaining soil fertility by fixing atmospheric nitrogen symbiotically. It contains about 40 – 44 per cent protein, 20 per cent oil and vit. A, B, C, D and K with all essential aminoacids. It is therefore, necessary to boost up productivity with the use of manures.

MATERIAL AND METHODS

The field experiment to study the impact of long term fertilization to soybean on N-fractions in Vertisols was laid in Randomised Block Design with 12 treatments replicated four times. The soil of experimental site was Vertisols particularly montmorillonitic type, hyperthermic, family of Typic Haplusterts. The treatment details viz., T_1- Control (No manures, no fertilizer) T_2 – Recommended dose of NPK (S free, urea, DAP, MOP), T_3 – RD of NPK + S (Through gypsum) + Zinc sulphate, T_4 – RD of NPK + Zinc sulphate, T_5 – RD of NPK + S (Through gypsum), T_6 – RD of NPK + S + Zinc sulphate (50 % N through fertilizer, 50 % N through Leucaena loppings), T_7 – RD of NPK + S + Zinc sulphate (50% N through FYM, 50 % N through fertilizer), T_8 – RD of NPK = S + Zinc sulphate (N to be

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added through wheat straw produced in plant + Rest of N through fertilizer), T_9– RD of NPK + S + Zinc sulphate (50 % N through leucaena loppings + 25 % N through FYM + 25 % N through wheat straw), T_{10} – 150 per cent Recommended dose of NPK + S + Zinc sulphuate, T_{11}- RD of NPK through urea, SSP, MOP, T_{12} – RD of NPK (S-free) + Flyash 10 t ha^{-1}. Initial soil samples (0-30 cm) were collected from each plot after layout of the experiment and plant samples were collected from five randomly selected plants from each treatment at harvest of crop.

Nitrogen fractions were determined by inorganic forms of N and organic forms of N. Inorganic forms of N viz., exchangeable NH_4^+ - N, NO_3^- - N, fixed NH_4^+ - N as well as organic forms of N viz., hydrolysed NH_4^+ - N + amino sugar – N, soluble N i.e., amino acid – N acid soluble humin – N, insoluble humin – N, were determined as per the procedure suggested by Cheng and Kurtz (1963).

Table 1. Yield of soybean (q ha^{-1}) as influenced by various treatments (2003 – 04)

Treatments	Yield of soybean (q ha^{-1})	
	Grain	Stover
T_1 - Control	1.51	2.30
T_2 - RD NPK (S-free)	6.94	10.42
T_3 - RD NPK + S + Zn	8.21	12.32
T_4 - RD NPK + Zn	7.74	11.60
T_5 - RD NPK + S	8.12	12.19
T_6 - RD NPK + S + Zn (50 % N LL)	9.14	13.70
T_7 - RD NPK +S + Zn (50 % N FYM)	9.00	13.50
T_8 - RD NPK + S + Zn (N WS in plot)	7.75	11.62
T_9 - RD NPK + S + Zn (N 50:25:25 LL + FYM + WS)	8.47	12.71
T_{10} - 15 0 % RD NPK + S + Zn	9.23	15.11
T_{11} - RD NPK (with S)	7.72	11.57
T_{12} - T_2 + Flyash	7.57	11.33
SE (m) ±	0.56	0.44
CD at 5 %	1.56	1.22

LL – Leucaena lopping

WS – Wheat straw

RESULTS AND DISCUSSION

Yield of soybean

The data regarding grain and straw yield of soybean are presented in Table 1. The data revealed that application of nutrients in organic, inorganic forms and their combination increased the grain yield of soybean significantly over control. The highest yield was obtained with the application of 150 per cent. Recommended NPK along with sulphur and zinc (T_{10}) treatment followed by RD NPK + S + Zn with 50 per cent N through leucaena loppings (T_6) which were significantly superior over RD NPK treatment. Whereas lowest was obtained in control plot. Application of fly ash with RD NPK (T_{12}), significantly increased the yield of soybean over NPK (S free) (T_2) treatment.

Fractions of soil nitrogen

Various N fractions content in soil before sowing of soybean (Table 2) revealed that, amongst various fractions of N, insoluble humin – N constituted a major portion of soil total N, followed by hydrolyzed NH_4^+ - N + amino sugar N. The amino acid – N was distinctly higher than exchangeable NH_4^+ - N , NO_3^- - N and fixed NH_4^+ - N. The relative status of N fractions in soil were in the order of insoluble humin N > hydrolyzed NH_4^+ - N + amino sugar – N > amino acid – N > acid solube humin – N > fixed NH_4^+ - N > NO_3^- - N > exchangeable NH_4^+ - N content. Build up in all the forms of N was higher with 100 per cent NPK recommended dose along with sulphur and zinc followed by application of NPK + S + Zn (50 % N L.L. + 25 % N FYM + 25 % N W.S.). It was observed that soil under study contained nearly 73 – 75 per cent of total N in organic forms which on mineralization may serve as an important pool for available soil N. Duran and Blasco (1972) reported 84 – 90 per cent of total N as organic N. Similar trend was noticed in Vertisols by Puranik *et al.* (1978) and Santhy *et. al.* (1998).

The data presented in Table 3 in respect to forms of N in soil after harvest of soybean revealed that the relative status of N fractions were in the order of insoluble humin – N > hydrolysed NH_4^+ - N + amino sugar – N > amino acid – N > acid soluble humin – N > fixed NH_4^+ - N

Table 2 : Distribution of N fractions (mg N 100 g^{-1} soil) under treatments before sowing of soybean (2003 – 04)

Treatments	Exch. NH_4^+ - N	NO_3^- - N	Fixed NH_4^+ - N	Hydro NH_4^+ - N + amino sugar N	Amino acid – N	Acid insoluble humin N	Insoluble humin – N	Total Nitrogen
T_1 - Control	3.91	3.38	3.78	5.94	5.78	3.65	10.22	36.67
T_2 - RD NPK (S-free)	3.22	3.47	3.83	6.00	6.22	4.24	10.32	37.33
T_3 - RD NPK + S + Zn	3.63	4.29	3.98	6.20	6.78	4.46	10.67	40.03
T_4 - RD NPK + Zn	4.21	4.08	4.14	8.25	7.00	4.24	11.10	43.05
T_5 - RD NPK + S	4.40	3.75	4.66	9.00	7.72	4.96	11.72	46.22
T_6 - RD NPK + S + Zn (50 % N LL)	4.42	3.69	4.88	8.30	7.51	5.08	11.32	45.45
T_7 - RD NPK +S + Zn (50 % N FYM)	4.18	3.19	4.77	8.23	6.86	5.03	11.01	43.26
T_8 - RD NPK + S + Zn (N WS in plot)	4.20	3.44	4.74	8.00	7.02	5.34	11.22	43.99
T_9 - RD NPK + S + Zn (N 50:25:25 LL + FYM + WS)	4.26	3.96	4.90	9.12	8.22	4.51	11.29	46.27
T_{10} - 150 % RD NPK + S + Zn	4.89	4.98	5.53	10.92	8.27	6.01	11.43	52.40
T_{11} - RD NPK (with S)	4.30	3.64	4.92	9.00	7.23	5.39	11.31	45.98
T_{12} - T_2 + Flyash	3.97	3.71	4.17	7.92	7.63	4.11	10.72	42.26
SE (m) ±	0.13	0.15	0.20	0.37	0.37	0.32	0.23	2.62
CD at 5 %	0.38	0.44	0.56	1.04	1.03	0.90	0.66	7.82
Mean	4.13	3.80	4.52	8.07	7.22	4.75	11.02	43.52
% Contribution to total N	9.48	8.71	10.38	18.51	16.57	10.90	25.30	-

Table 3 : Distribution of N fractions (mg N 100 g^{-1} soil) under various treatments after harvest of soybean (2003 – 04)

Treatments	Exch. NH_4^+ - N	NO_3^- - N	Fixed NH_4^+ - N	Hydro NH_4^+ - N + amino sugar N	Amino acid – N	Acid insoluble humin N	Insoluble humin – N	Total Nitrogen
T_1 - Control	3.48	3.81	3.78	7.01	5.75	5.08	8.81	37.72
T_2 - RD NPK (S-free)	3.38	3.65	3.84	7.23	5.86	5.34	10.10	39.40
T_3 - RD NPK + S + Zn	3.56	3.98	4.19	8.05	6.12	6.14	11.02	43.07
T_4 - RD NPK + Zn	4.03	3.83	5.46	9.42	6.26	7.09	10.28	46.25
T_5 - RD NPK + S	4.08	4.28	4.01	9.72	6.85	7.26	11.12	47.32
T_6 - RD NPK + S + Zn (50 % N LL)	4.09	4.23	5.12	8.54	6.54	6.24	10.76	45.52
T_7 - RD NPK +S + Zn (50 % N FYM)	4.25	4.02	5.27	8.72	5.91	6.37	10.77	45.31
T_8 - RD NPK + S + Zn (N WS in plot)	4.49	4.23	5.30	9.11	6.26	6.73	11.16	47.28
T_9 - RD NPK + S + Zn (N 50:25:25 LL + FYM + WS)	4.93	4.11	5.42	9.36	6.32	7.12	11.12	48.38
T_{10} - 150 % RD NPK + S + Zn	4.97	4.71	5.49	9.96	7.56	7.38	11.54	51.61
T_{11} - RD NPK (with S)	4.73	4.07	4.42	9.01	6.89	6.28	9.99	45.39
T_{12} - T_2 + Flyash	3.59	3.88	3.92	7.14	6.11	5.6	9.84	40.07
SE (m) $\pm$	0.33	0.16	0.29	0.51	0.27	0.36	0.34	2.48
CD at 5 %	0.99	0.45	0.82	1.53	0.74	1.01	0.96	7.45
Mean	4.13	4.06	4.69	8.60	6.36	6.39	10.54	44.77
% Contribution to total N	9.25	9.08	10.46	19.31	14.22	14.26	23.54	-

> NO_3^- - N > exchangeable NH_4^+ - N and contributed 22 – 25.63 per cent, 17.82 – 20.54 per cent, 13.04 – 15.25 per cent, 13.47 – 15.34 per cent, 8.47 – 11.80 per cent, 8.28 – 10.10 per cent and 8.27–10.42 per cent of total N, respectively. Significantly highest content of all forms of N were recorded with the application of 150 per cent RD NPK plus sulphur and zinc followed by NPK + S + Zn where 50 per cent N Leucanea loppings + 25 per cent N FYM + 25 per cent N through wheat straw were added. The highest content of total nitrogen was under 150 per cent NPK + S + Zn followed by NPK + S + Zn (50 % N L.L. + 25 % N FYM + 25 % N W.S.).

Cheng and Kurtz (1963) observed that 90 per cent added N in soil was in hydrolytic products of soil organic matter as amino acid – N, amino sugar – N and other soluble N.

An increase in the rate of applied N was found to be associated with an increase in the build up of total N, available – N and the organic matter content in soil. Similar observation were also reported by Ravankar *et al.* (1998) and Santhy *et al.* (2002).

Hence, it can be concluded that application of NPK (30:75:0 kg ha^{-1}) and S (20 kg ha^{-1}) along with the organics (50% N – Leucaena loppings) was found to be beneficial for soybean yield and also build of soil N and their forms, which are easily available to plants for sustainable crop production and maintenance of soil fertility.

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Effect of Integrated Nutrient Management in Cotton Grown on Shallow Soil on Growth, Seed Cotton Yield and Physico-Chemical Properties

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ABSTRACT

The field experiment was conducted at Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the season of 2000-2001 to 2002-2003. The soil of experimental site was shallow (soil depth 18.5 cm) with low in available nitrogen, phosphorus and low in organic carbon, high in available potassium with pH 7.35. The bulk density of soil was 1.58 Mg m^{-3} . The experiment was carried out in Factorial Randomised Block Design with six treatments combinations (i.e. Organic manure M_0- No FYM and M_1-FYM 5 t ha^{-1} and Fertilizer levels F_1-25: 12.5 , F_2- 50:25.0 and F_3- 75:37.5 N and P_2O_5 kg ha^{-1}) and replicated four times . The short duration *hirsutum* cotton variety AKH-081 was sown by dibbling 2-3 seeds per hill at a spacing of 60 x 15 cm. The seedlings were thinned to one plant per hill. The FYM @ 5 t ha^{-1} was applied before sowing as per the treatments. The half of nitrogen and full dose of phosphorus applied as per treatments at the time of sowing and remaining half dose of nitrogen was top dressed one month after emergence as per treatments. Pooled results indicated that cotton grown on shallow soil produced higher seed cotton yield with the application of 5 t ha^{-1} FYM and 50:25 kg ha^{-1} N and P_2O_5 But NMR and BC ratio was maximum in the lowest fertilizer level of 25:12.5 kg ha^{-1} N and P_2O_5. The soil pH, electrical conductivity, bulk density decreased slightly and soil organic carbon content was increased significantly at the end of the experiment with application of FYM @ 5 t ha^{-1} (M_1). The available NPK were increased significantly with the application of FYM @ 5 t ha^{-1} (M_1) and only NP were increased significantly with the application of fertilizers levels. Hence, on the basis of monetary returns the application of FYM 5 t ha^{-1} along with low fertilizer level of 25:12.5 kg ha^{-1} N and P_2O_5 was recommended for the cultivation of early duration cotton variety AKH-081 on shallow soil.

Cotton holds a very important position amongst the Indian crops and as a cash crop it plays a vital role in Indian economy. It is popularly known as "White Gold". India stands first in area which is about 8.78 millions hectare and present productivity is about 298 lint kg ha^{-1}. Maharashtra is one of the major cotton growing state having 2.78 million hectare which occupy one third of country area and production is 3.4 million tons. Productivity of cotton in Maharashtra is 194 kg lint per hectare. As cotton crop is a cash crop it is well recognized fact that agricultural economy of Vidharbha is dependant on the cotton production. The productivity of Vidharbha is very low (104 kg ha^{-1} Lint).

About 30 per cent land in Vidharbha is having soil depth below 25 cm. Farmers are made aware through various extension activities not to grow cotton on shallow soil. But small and marginal land holders many times grow cotton on shallow soils, because they do not have choice of suitable land selection and this is one of the major constraints in less productivity of seed cotton. A short duration variety AKH-081 was recommended for shallow soil in Vidharbha region .However, fertilizer management study was lacking. To keep these points in view the present experiment was conducted to find out the suitable fertilizer requirement to grow the cotton successfully, finalize package of practices, and to see the effect of integrated management response of organic and inorganic fertilizer application on cotton productivity and soil fertility status in respect to shallow soil (less than 25 cm depth).

MATERIAL AND METHODS

The experiment was conducted during the kharif season of 2000-2001 to 2002-2003 at Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.). The soil of experimental site was shallow (soil depth 18.5 cm) with very low in available nitrogen phosphorus and low in organic carbon and high in available potassium with pH 7.35 having bulk density 1.58 Mg m^{-3}.

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The experiment was carried out in FRBD with six treatment combination (i.e. Organic manure M_0- No FYM and M_1-FYM 5 t ha^{-1} and Fertilizer levels N and P_2O_5 kg ha^{-1} F_1-25: 12.5 , F_2- 50:25.0 and F_3- 75:37.5) and replicated four times . The hirsutum cotton variety AKH-081 by dibbling 2-3 seeds per hill at a spacing of 60 x 15 cm. The seedlings were thinned to one plant per hill.

FYM @ 5 t ha^{-1} was applied before sowing as per the treatments. The half of nitrogen and full dose of phosphorus applied as per treatments at the time of sowing and remaining half dose of nitrogen was top dressed at one month after emergence. At the time of first picking randomly selected plants were taken for the observation of plant growth, plant stand, yield characters and seed cotton yield. The data collected were analyzed statistically for representing the results .The initial composite soil sample was collected before start of experiment and analyzed for physico - chemical properties. Treatment wise soil and plant samples were collected and analyzed for residual effect on soil properties and uptake study.

RESULTS AND DISCUSSION

A. Seed cotton yield

a. Manure: The pooled results (Table 1) indicated that a treatment having 5t ha^{-1} FYM gave 23. 3 per cent increased seed cotton yield over (449 kg ha^{-1}) control (No FYM).

b. Fertilizer levels : Seed cotton yield was progressively increased with increase in the fertilizer levels from 25:12.5 to 75: 37. 5 kg ha^{-1} N and P_20_5, however, the differences were significant only up to 50 : 25 kg ha^{-1} N and P_2O_5. On an average the fertilizer doses of 75: 37. 5 (426 kg ha^{-1}) and 50: 25 (411 kg ha^{-1}) kg ha^{-1} N and P_20_5 showed 11.8 and 7. 87 per cent increase in seed cotton yield over 25: 12.5 kg ha^{-1} N and P_20_5, respectively (Table 1). Interaction effect of organic manure x fertilizer levels was not significant in pooled data. Similar findings were reported by Khumova *et. al.*, (1983), Pagaria *et. al.* (1995) and Malewar *et. al.* (1999).

B. GMR: GMR was significantly increased by 23.5 per cent with application of 5 t ha^{-1} FYM (Rs. 8084 ha^{-1}) as compared to no FYM (Rs. 6546 ha^{-1}). However, GMR was not changed significantly with the various levels of fertilizers (Table 1). Interaction was not significant.

C. NMR: Application of 5 t ha^{-1} FYM showed significantly more net monetary returns (Rs.1008ha^{-1}) over no FYM (Rs. 519 ha^{-1}) treatments (Table 1). In respect to fertilizer levels a lower dose of fertilizer i.e. 25:12.5 kg ha^{-1} N and P_2O_5 recorded significantly higher NMR values as compared to the higher doses of fertilizer i.e. 50 : 25 and 75 : 37.5 kg ha^{-1} N and P_2O_5. Highest fertilizer level 75 : 37.5 kg ha^{-1} N and P_2O_5 showed lowest NMR value. The results are in conformity with Katkar *et al.*(2002).

Interaction: Interaction effect of organic manure x fertilizer levels was significant. The data reported in Table 1 showed that maximum monetary returns (Rs.1266 ha^{-1}) was recorded with the application of FYM 5 t ha^{-1} along with 25:12.5 kg ha^{-1} N and P_2O_5.

D. BC ratio: BC ratio was highest in low fertilizer level (i.e. 25 : 12.5 kg ha^{-1} N and P_2O_5) followed by the treatment having 5 t ha^{-1} FYM. It was observed that BC ratio was decreased with increase in fertilizer levels and attained lowest BC ratio at highest fertilizer level of 75:37.5 kg ha^{-1} N and P_2O_5 (Table 1). Similar findings were reported by Katkar *et al.*(2002).

E. Yield parameters: Number of bolls per plant and seed cotton yield per plant was significantly more in 5 t ha^{-1} FYM treatment over no FYM. Similarly these yield attributes were at increasing trend with increase in fertilizer levels from 25:12.5 to 75:37.5 kg ha^{-1} N and P_20_5 but the differences in higher two fertilizer levels were not significant (Table 2).

F. Growth parameters : An application of 5 t ha^{-1} FYM recorded more plant height and it was found similar with application of 75:37.5 kg ha^{-1} N and P_20_5 and sympodia per plant and as compared to no FYM treatment but monopodial branches were similar in both these organic manure treatments. Plant height was significantly increased with increase in fertilizer doses and showed maximum plant height at 75:37. 5 kg ha^{-1} N and P_20_5.

G. pH, electrical conductivity, bulk density and organic carbon : Data reported in Table 3 indicated that pH, EC and bulk density was slightly decreased with application of FYM (5 t ha^{-1}) as compared to no FYM treatment. Organic carbon was significantly increased by 0.10 g kg^{-1} with application of FYM and it was decreased by 0.277 g kg^{-1} in the treatment having no FYM as compared to initial values at the start of the experiment. Similar results are reported by Choudhary *et al.* (1981) and Sharma and Sharma (1993).

Table 1. Seed cotton yield, GMR, NMR and BC ratio as influenced by various treatments

Treatments	Seed cotton yield (kg ha^{-1})						BC ratio
	2000-01	2001-02	2002-03	Pooled mean	GMR (Rs.ha^{-1})	NMR (Rs. ha^{-1})	
a. Organic manure							
M_0-No FYM	352	319	420	364	6546	519	1.26
M_1-FYM 5 t ha^{-1}	483	361	502	449	8084	1008	1.42
S.E (m)±	6.4	12.2	16.0	18.3	440.9	25.6	
C.D. at 5%	19.4	36.7	48.4	54.7	1389.5	80.7	
b. Fertilizer levels (N & P_2O_5 kg ha^{-1})							
F_1-25:12.5	386	309	448	381	6861	951	1.45
F_2-50:25.0	417	351	466	411	7407	790	1.35
F_3-75:37.5	450	359	469	426	7677	549	1.22
S.E (m)±	7.9	15.0	19.6	8.5	535.5	31.3	
C.D. at 5%	25.8	N.S.	N.S.	25.3	N.S.	98.8	
C.V.%	5.34	12.5	12.12				
c. Interaction effect							
M_0F_1	325	279	417	341	6132	635	1.34
M_0F_2	361	333	419	371	6678	635	1.31
M_0F_3	370	344	424	379	6828	286	1.13
M_1F_1	446	340	479	422	7590	1266	1.57
M_1F_2	474	367	514	452	8136	946	1.39
M_1F_3	530	375	515	473	8526	811	1.31
S.E. (m)±	11.0	21.2	27.8	24.3	763.8	44.4	
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	139.7	

Table 2. Ancillary information (pooled mean of three years)

Treatments	No. of bolls plant^{-1}	Yield plant^{-1}	Plant height (cm)	Sympodia plant^{-1}	Monopodia plant^{-1}	Dry matter plant^{-1} (g)	Plant population ha^{-1} (000')
a. Organic manure							
M_0-No FYM	2.2	4.6	35.2	9.5	0.17	21.1	99.81
M_1-FYM 5 t ha^{-1}	2.5	5.3	36.8	9.8	0.16	28.1	99.66
S.E (m)±	0.05	0.09	0.18	0.04	0.02	1.84	0.14
C.D. at 5%	0.16	0.30	0.56	0.15	N.S.	5.79	N.S.
b. Fertilizer levels (N and P_2O_5 kg ha^{-1})							
F_1-25:12.5	2.18	4.6	35.1	9.6	0.16	22.3	99.78
F_2-50:25.0	2.35	5.0	36.1	9.7	0.17	26.6	99.64
F_3-75:37.5	2.52	5.1	36.8	9.7	0.16	24.9	99.78
S.E (m) ±	0.06	0.11	0.22	0.05	0.02	2.25	0.17
C.D. at 5%	0.20	0.36	0.71	N.S.	N.S.	N.S.	N.S.

Table 3. Soil pH, EC, bulk density and organic carbon as influenced by various treatments (3rd year at harvest)

Treatments	pH (1:2.0)		EC dSm^{-1}		B.D. ($Mg\ m^{-3}$)		OC ($g\ kg^{-1}$)	
	3 rd yr. at harvest	Inc. /dec.	3 rd yr. at harvest	Inc./dec.	3 rd yr. t at harvest	Inc./dec.	3 rd yr. at harvest	Inc./dec.
a. Organic manure								
M_0	7.35	-	0.225	0.008	1.58	-	2.687	-0.277
M_1	7.33	-0.02	0.212	-0.005	1.56	-0.02	3.068	0.104
S.Em.±	0.062		0.009		0.031		0.044	
C.D. at 5%	N.S.		N.S.		N.S.		0.140	
b. Fertilizer levels (N and P_2O_5 $kg\ ha^{-1}$)								
F_1	7.33	-0.02	0.209	-0.008	1.57	-0.01	2.866	-0.098
F_2	7.34	-0.01	0.221	0.004	1.58	-	2.880	-0.084
F_3	7.35	-	0.225	0.008	1.58	-	2.885	-0.079
S.E (m)±	0.076		0.011		0.038		0.054	
C.D. at 5%	N.S.		N.S.		N.S.		N.S.	
Initial value		7.35		0.217		1.58		2.964

Table 4: Available N, P and K in soil as influenced by various treatments (3rd year at harvest)

Treatments	Available N $kg\ ha^{-1}$		Available P_2O_5 $kg\ ha^{-1}$		Available K_2O $kg\ ha^{-1}$	
	3 rd yr. at harvest	Inc. /dec.	3 rd yr. at harvest	Inc./dec.	3 rd yr. t at harvest	Inc./dec.
a. Organic manure						
M_0	142.4	1.7	9.38	0.92	322.4	-5.6
M_1	148.0	7.3	10.43	1.97	330.8	2.8
S.Em.±	0.42		0.11		0.79	
C.D. at 5%		0.91		0.33		2.41
b. Fertilizer levels (N and P_2O_5 $kgha^{-1}$)						
F_1	142.7	2.0	9.15	0.69	324.7	-3.3
F_2	145.2	4.5	9.90	1.53	326.2	-1.8
F_3	147.7	7.0	10.58	1.64	328.9	0.9
S.E (m)±	0.52		0.04		1.41	
C.D. at 5%	1.57		0.12		N.S.	
Initial value		140.7		8.46		328

Table 5. Dry matter accumulation and uptake of nutrient as influenced by various treatments (Pooled mean of three years)

Treatments	Dry matter accumulation ($kg\ ha^{-1}$)	Uptake of nutrients ($kg\ ha^{-1}$)		
		N	P	K
a. Organic manures				
M_0-No FYM	1992	24.22	8.22	23.89
M_1-FYM 5 t ha^{-1}	2482	29.73	9.92	29.23
S.Em±	273.0	2.93	0.07	3.00
C.D. at 5%	N.S.	N.S.	0.22	N.S.
b. Fertilizer levels (N & P_2O_5 $kg\ ha^{-1}$)				
F_1-25:12.5	2024	24.76	8.32	24.46
F_2-50:25.0	2222	26.86	9.05	26.15
F_3-75:37.5	2465	29.30	9.82	29.01
S.E (m)±	67.8	0.82	0.09	0.90
C.D. at 5%	195.1	2.36	0.25	2.59

After third year of the experimentation it was observed that soil pH, EC, bulk density and organic carbon did not differ significantly with the levels of fertilizer.

Interaction effect of manure x fertilizer was not significant.

H Available nutrients: The data reported in the Table 4 indicated that the available NPK in the soil was significantly increased with application of FYM 5 t ha^{-1} as compared to no FYM level. Available N in soil was significantly increased with increase in fertilizers levels. Available P_2O_5 was increased significantly up to 50:25 N and P_2O_5 kg ha^{-1} level only and K_2O content was statistically similar in all the fertilizer levels. These results are in conformity with Chahal *et al.* (1982).

Interaction effect in respect to NPK in soil was not significant.

I Dry matter accumulation and nutrient uptake: Dry matter accumulation and nutrient uptake (kg ha^{-1}) was higher in the treatment having 5 t ha^{-1} FYM over no FYM level, but the differences were significant in respect to uptake of P only (Table 5).

Dry matter accumulation per hectare was significantly increased with increase in fertilizer levels and recorded maximum dry matter per hectare at highest fertilizer level of 75: 37.5 N and P_2O_5 kg ha^{-1}.Similarly, NPK uptake was also higher in the higher level than lower levels The similar findings are reported by Kubde and Lakhdive (1993) and Datey *et al.*(1994).

Interactions effects were found to be non significant.

From the three years of experimentation it could be concluded that cotton variety AKH 081 sown in shallow soil (less than 25 cm soil depth) produced more seed cotton yield with the application of FYM 5 t ha^{-1} and a fertilizer level of 50: 25 kg ha^{-1} N and P_2O_5. However, application of FYM 5 t ha^{-1} along with low fertilizer level of 25:12.5 kg ha^{-1} N and P_2O_5 showed maximum NMR and BC ratio. Hence on the basis of monetary returns the application of FYM 5 t ha^{-1} along with low fertilizer level of 25:12.5 kg ha^{-1} N and P_2O_5 is recommended for the cultivation of AKH-081 on shallow soil.

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Soil Properties and Nutrient Availability as Influenced by Long-Term Fertilization to Sorghum-Wheat Sequence in Vertisols

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ABSTRACT

Long-term fertilization registered significant increasing organic carbon content in soil. The pH of the soil ranged between 7.6 to 8.1 and EC varied from 0.27 to 0.32 dSm^{-1} but the differences were non significant. Amongst the various treatments the treatment of 100% NPK + 10 t FYM ha-1 recorded a build up in OC, available and total N, P and S content in soil after 14 cycle. The next superior treatment is 150 per cent NPK, hence the fertilizer dose along with FYM proved superior in built up of organic carbon content and nutrient availability in the soil. The ratio of C:N, C:P and C:S showed wide variation. Application of organic manures with inorganic fertilizers recorded higher C:N, C:P and C:S ratio.

Land is one of the most important natural resource for agricultural production. Sustainable productivity is possible only when best nutrient management practices are adopted. Judicious application of inorganic along with organic sources of nutrients to crop and particularly to sorghum is one of the judicious management practices.

N, P and S are present in soil organic matter in organically bound forms. Thus, inter-relationship between N and C, N, and P, N and S, S and P ratios plays a significant role in soil fertility and humus complex formation. During mineralization under optimum environmental conditions, C:N ratio tends to decrease with time because carbon is lost in gaseous form while nitrogen remains in organic combination as long as the C:N ratio is wide. Hence, the present investigation was undertaken with an object particularly changes in soil properties as well as nutrient availability under long term fertilization.

MATERIAL AND METHODS

The field experiment for monitoring long-term changes in soil properties and nutrient availability under cropping system were carried out at Central Research Station, Dr.PDKV, Akola since 1988. The present study was undertaken during 2003-2004 after 15th complete cycle of crop sequence. There were seven treatment and four replication framed under RBD comprised of NPK levels with and without FYM. Plot wise soil sample were collected from experimental soil before sowing of sorghum crop during June 2003-2004. The soil of the experimental site was vertisols particularly mont morillonitic type, hyperthermic, family of Typic Haplusterts. The soil samples were processed and analysed by using standard analytical method for pH, EC, Organic Carbon (Piper, 1966), total N, P, S, available P and S (Jackson, 1967) and available N (Subbiah and Asija, 1956). Similarly, C:N, C:P and C:S ratios were computed on the basis of result obtained.

RESULTS AND DISCUSSION

Physico-Chemical properties of soil at the start of experiment:

In this study, some important changes are noticed in physico-chemical properties of soil due to continuous fertilization during the last fifteen years.

Data on soil pH and EC presented in Table 1 did not show any significant change within the various treatment. The pH value ranged from 7.6 to 8.1, the minimum value 7.6 was recorded in 100 per cent NP and slightly increased due to various treatments and maximum 8.1 was recorded in the treatment 100 per cent NPK + 10 t FYM ha^{-1}. These results are in conformity with the findings of Subramanian and Kumarswamy (1989). Application of FYM or its integrated use showed slight reduction in EC of soil as compared to control and initial value electrical conductivity after thirteen years of experimentation does not cause any effect by the continuous application of fertilizer and FYM in different combinations at various levels as reported by Chaudhary *et al.* (1981).

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The beneficial and significant effect of fertilization was noticed in increasing the organic carbon content in soil after the harvest of the crop. These results are in conformity with the findings of Rabindra and Honne (1986) who observed the effect of FYM and judicious combination of organic and inorganic enhanced the organic carbon content from 0.46 to 0.81 per cent.

The treatment 100 per cent NPK + 10 t ha^{-1} FYM showed significantly higher organic matter than rest of the treatments as well as control. These results are in consonance with the findings of vasanthi and Kumarswamy (2000) according to them organic carbon content was higher in the treatments which had received manures at 10 t ha-1 + 100 per cent NPK than in the 100 per cent NPK treatment.

Available and total nutrient content in soil:

The data (Table 2) revealed that the available nitrogen content in soil increased significantly with increasing fertilizer doses in all the treatments as compared to control. The total nitrogen content in soil showed similar trend as that of available nitrogen. The significant superiority was also observed in 150 per cent NPK and NPK + FYM treatments to both available and total nitrogen. The long-term application of 100 per cent NPK dose with 10 t FYM enhanced spectacularly the amount of total and available nitrogen content in vertisols under sorghum-wheat sequence was reported by Ravankar *et al.* (1998).

The build up in available phosphorus was much higher in the treatment receiving regular application of recommended dose of P (100%) in combination either with N or NK. Highest value of available P content was recorded in NPK + FYM treatment followed by 150 per centNPK, 100 per cent and 100 per cent NP considering the total P content it was significantly higher in NPK + FYM, followed by 150 per cent NPK, 100 per cent NPK, 100 per cent NP and 100 per cent N. The possible reason for this enrichment of soil in respect to available P content may be the phosphorus present in organic farm in FYM which had added to the soil an due to mineralization of

Table 1: Physico-chemical properties of soil before sowing of sorghum as influenced by various treatments

Treatments	pH	EC dSm^{-1}	O.C. (%)	O.M. (%)
T_1 – Control	7.8	0.30	0.36	0.81
T_2 – 100% N	8.0	0.29	0.42	0.97
T_3 – 100% NP	7.6	0.27	0.49	1.12
T_4 – 100% NPK	8.0	0.32	0.52	1.17
T_5 – 150 % NPK	7.9	0.30	0.59	1.32
T_6 – 100%NPK + 10 t FYM	8.1	0.28	0.63	1.41
T_7 – FYM 10 t ha^{-1}	7.8	0.27	0.56	1.26
SE (m)±	0.16	0.023	0.037	0.086
CD at 5%	NS	NS	0.103	0.242
Initial value	8.0	0.30	0.46	

Table 2: Available and total nutrients in soil before sowing of sorghum as influenced by various treatments

Treatments	Available nutrients			Total nutrients (%)		
	N (kg ha^{-1})	P (kg ha^{-1})	S ppm	N	P	S
T_1 – Control	197	13.57	10.3	0.032	0.039	0.010
T_2 – 100% N	243	24.79	15.8	0.040	0.050	0.015
T_3 – 100% NP	245	29.79	20.6	0.042	0.054	0.016
T_4 – 100% NPK	256	30.09	24.1	0.046	0.055	0.019
T_5 – 150 % NPK	277	30.83	24.2	0.049	0.065	0.020
T_6 – 100%NPK + 10 t FYM	311	36.58	30.1	0.053	0.068	0.021
T_7 – FYM 10 t ha^{-1}	251	25.37	14.3	0.048	0.044	0.017
SE (m)±	6.58	1.01	2.5	0.0028	0.0017	0.0023
CD at 5%	18.48	2.85	7.1	0.0080	0.0047	0.0065
Initial value	120	8.4	4.8	0.04		

organic matter, it get converted into inorganic available form. The more FYM added, the more is the amount of phosphorus liberated due to mineralization. Similar results were also reported by Choudhary *et al.* (1981).

The similar trend was also observed (Table 2) in the availability of soil sulphur. The significant superiority was observed in respect to available sulphur in treatment NPK + FYM, followed by 150 per cent NPK and 100 per cent NPK which were at par with each other. A slight change was also observed in respect to total sulphur in fertilizer and manure treatments and these were significantly superior over control. In the long-term fertility experiments, FYM application maintained adequate sulphur status to guard against its deficiency (Nambiar and Abrol, 1989).

Ratios of different nutrient content:

The ratios between C:N, C:P and C:S are indices of characterization of organic matter and also magnitude of decay stabilization hence, they were worked out and presented in Table 3.

Table 3: Ratio of C with N, P and S nutrient content

Treatments	C:N	C:P	C:S
T_1 – Control	10.49	9.07	27.88
T_2 – 100% N	11.29	8.38	30.90
T_3 – 100% NP	11.95	9.25	33.36
T_4 – 100% NPK	11.38	9.47	31.46
T_5 – 150% NPK	11.95	9.28	30.62
T_6 – 100% NPK+ 10t FYM ha^{-1}	12.16	12.79	37.08
T_7 – FYM 10 t ha^{-1}	11.59	9.24	28.12
SE(m)±	0.33	0.69	1.93
CD at 5%	0.92	1.95	5.43

Significant variation in these ratios were observed with addition of 100 per cent NPK + 10 t FYM. Goswami (1998) reported that organic residues addition (FM, FYM) has beneficial role, particularly in nutrient supply and improvement of soil aggregation, the degree would depends on their ease and rate of decomposition and soil conditions primarily soil water content, temperature, nature and amount of inorganic soil colloids,, C:N, C:P and C:S ratio.

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Defluoridation of Water Using Alum Treated Flyash - A Low Cost Adsorbent

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ABSTRACT

A study was conducted to investigate the possibility of removing fluoride in water using Alum Treated Flyash, a low cost adsorbent. Alum Treated Flyash (ATF) is better adsorbent with good adsorption capacity and higher adsorption potential. Near equilibrium is attended at 330 minutes at optimum conditions. Maximum defluoridation occurs immediately at the start of experiment. This technique is going to be simple low cost for rural and urban population and also of great relief to those water supply systems where fluoride ion concentration is reported to be very high.

Water is a prime natural resource and physiological necessity to mankind. Safe potable water is no longer a 'God given gift' in a modern industrialised world. The rural water supply in our country suffers from inadequacies in terms of quantity as well as the quality. India is among the 23 nations of the world, which confront with the problem of fluorosis due to intake of high fluoride contaminated water. In the country 20 states are affected with dental, skeletal & non-skeletal fluorosis (Susheela, 2001). In Maharashtra 14 districts out of 35 districts are affected with the fluoride as the concentration in the ground water is above 1.5 mgl^{-1} (Thakare *et. al.* 2003). It is a devastating report from recent survey conducted by water technology mission of ministry of rural development, Government of India that over 30 million people living in 8700 villages are affected by fluorosis of which 6 millions are children below the age of 14 years and therefore is a cause of concern in most of the developed & developing countries. There is no permanent cure available till today for this ailment & hence preventive measures should be contemplated. In India the extent of fluoride contamination in ground water varies from 1.0 to 15 mgl^{-1}. Fluoride enters in to the body through a variety of sources viz; water, food, air, medicaments & cosmetics. Fluoride is a salt of an element called fluorine. In India fluoride commonly occurs in earth's crust as Fluospar (Sedimentary rocks), apatite and rock phosphate and phosphorites and cryolite in igneous rocks. Fluoride present in the rock & soil when comes in contact with water of high alkalinity, will release fluoride into ground water. Fluoride contain in mineral soil is shown in Table 1 (Peng *et al.*, 1996).

Table 1. Concentration of fluoride ion in mineral soil

Minerals	Fluoride (ppm)
Meteorites	28.30
Dunite	12.00
Basalt	100
High calcium	520
Alkali rocks	1200 – 8500
Shale	740
Sand Stone	270
Deep sea clays	1300
Granite	- -

Tea has the highest fluoride content of 112 $mgkg^{-1}$ among the various food items (Azbar *et. al.*, 2000). Consumption of water having fluoride content more than 1.5 mgl^{-1} may have multi dimensional health manifestations most common being dental, skeletal & soft tissue fluorosis. Fluoride & fluorosis mitigation is possible through the provision of safe drinking water, with fluoride as low as possible, not to exceed 1.5 mgl^{-1}. To overcome the above situation, it is very essential to adopt any appropriate deep fluoridation technique considering the local conditions, economic status and viability of the treatment method, literacy of the community, easy availability of media and reuse of exhausted media for treatment purpose. The object of present study is to evaluate the feasibility of fluoride removal using alum treated flyash i.e. ATF.

MATERIAL AND METHODS

The flyash was obtained from Thermal Power Plant at Paras, district Akola (Maharashtra). It was first soaked in 1 percent NaOH, washed with distilled water and then dried it at 115 ± 5 °C in an Oven for half an hour.

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The dried matter was mixed with 2 percent $Al_2 (SO_4)_3$ solution and allowed to stand for half an hour. The white precipitate of $Al (OH)_3$ so appeared was dissolved by adding 1:1 HCl till a clear solution was obtained. The solution left over night. The flyash then separated, washed until free from Al^{3+} and dried at 115 ± 5 °C for six hours. This is referred here as Alum Treated Flyash (ATF).

Table 2. Physical and Chemical Characteristics of Flyash

Physical characteristics		Chemical characteristics	
Bulk Density kg/m³	= 925.6	SiO_2 (%)	= 61.25
Moisture (%)	= 11.40	Al_2O_3 (%)	= 23.45
Ash Content (%)	= 6.68	CaO (%)	= 2.10
Porosity (%)	= 0.39	Fe_2O_3 (%)	= 4.00
Surface area (m²/gm)	= 485	MgO (%)	= 1.30
Loss on Drying (%)	= 13.64		
pH_{zpc}	= 2.40		

Experimental Techniques

Reaction mixture for all batch sorption studies consisted of 100 ml. Synthetic fluoride samples were prepared by spiking distilled water with NaF. Batch sorption tests were carried out in stopper reagent bottles and rotated at 150 rpm in a rotatory shaker. At the end of the desired contact time, bottles were removed and allowed to settle for 5 minutes. The samples were filtered using gravimetric filter paper (Whatman 42 filter) and fluoride concentration was determined using SPADNS method as per standard procedure. The initial fluoride concentration chosen for study was 15 mg l^{-1}, as ground water fluoride concentration in fluorosis endemic areas of India, rarely exceeded this limit.

RESULTS AND DISCUSSION

Effect of pH

The pH value of the aqueous solution is an important controlling factor in the adsorption process thus the role of hydrogen ion concentration was examined for different pH values. The extent of removal was investigated at solution ion concentration of 15 mg l^{-1} fluoride and is shown in Figure 1.

In case of ATF, the plot revealed that, the percent removal falls as pH decreases below 4 & rises above 8. The optimum pH for fluoride removal was found to be 6.5 where removal was 54.80 per cent. Thus the aquo groups (-M-OH_2-) and hydro groups (-M-OH)⁷ on the surface of sorbent may be responsible for adsorption of fluoride. Al_2O_3 is the major constituent of flyash. As the pH decreased below 4, Al_2O_3 will be dissolved as Al^{3+} and subsequently positively charged strong Aluminum complexes such as AlF^{2+} & AlF^{3+} are formed. The surface of Al_2O_3 will be further positively charged with decrease in pH. Therefore a decrease in adsorption at low pH is probably a result of the formation of positively charged aluminum complexes and positively charged surface. Conversely as the pH increases above 8 the hydro group (-M-OH)⁷ will gradually disappear forming increasingly negatively charged surface. In addition, OH will also compete for the available sites left on the surface. These findings are in conformation with the observations of Mehrotra, R. *et. al.* (1999).

Effect of Contact Time

From the plot of percentage adsorption versus contact time as shown in Figure 2, it is found that the rate of removal of fluoride ions increases with increase in agitation time to some extent. Further increase in contact time dose not increase the uptake due to deposition of fluoride ions on the available adsorption sites on adsorbent material. The rate of uptake of fluoride ions by ATF at the optimum pH value indicates that the process is quite rapid. This initial rapid adsorption subsequently gives way to a very slow approach to equilibrium and saturation. The ultimate adsorption of 54.80 percent occurs within the first hour of the agitation with an initial concentration of 15 mgl^{-1}. This initial rapid rate of adsorption is subsequently followed by slow rate of adsorption. Equilibrium & saturation is reached in 330 min and max. removal of fluoride is 69.40 per cent.

Effect of Adsorbent Dose

Fluoride uptake by ATF as a function of sorbent dose is shown in Figure 3. it is obvious from the plot that if sorbent dose increased, percentage fluoride removal also increased. There is substantial increase in the adsorption when the dose of adsorbent was increased from 200 mgl^{-1} to 30000 mgl^{-1} and an additional amount of adsorbent did not influence the further removal of fluoride ions. The maximum removal in case of fluoride was found to be 85 percent with an adsorbent dose of 20000 mgl^{-1}. These observations were in conformity with the earlier report of Singh, *et. al.* (2000).

The plot of unit adsorption versus dose reveals that unit adsorption was high at low dosages than at high dosages. As the sorbent dose was increased, there was

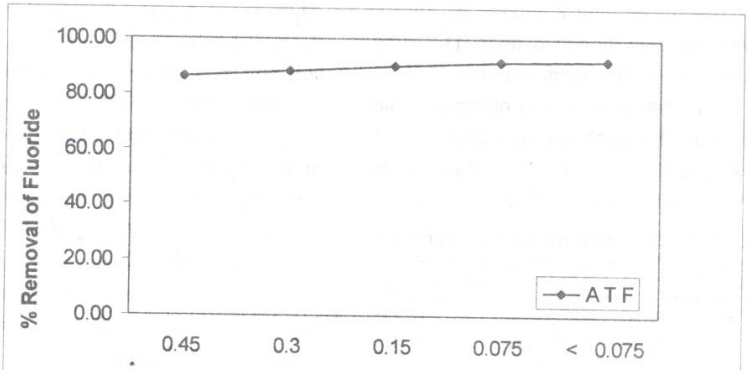

Figure 5 : Effect of Adsorbent Particle Size on the Removal of Fluoride

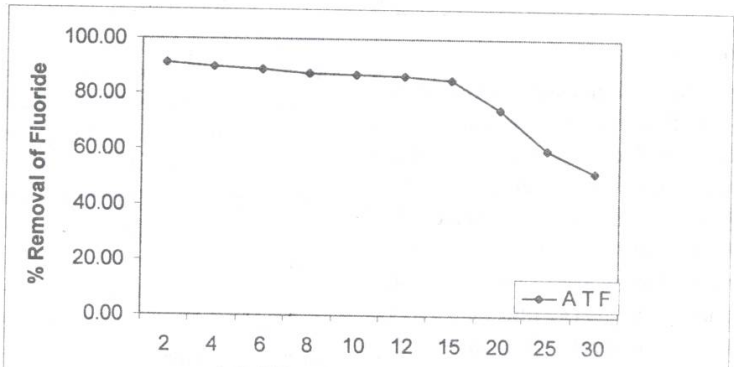

Figure 4 : Effect of Initial Fluoride Concentration on the Sorption

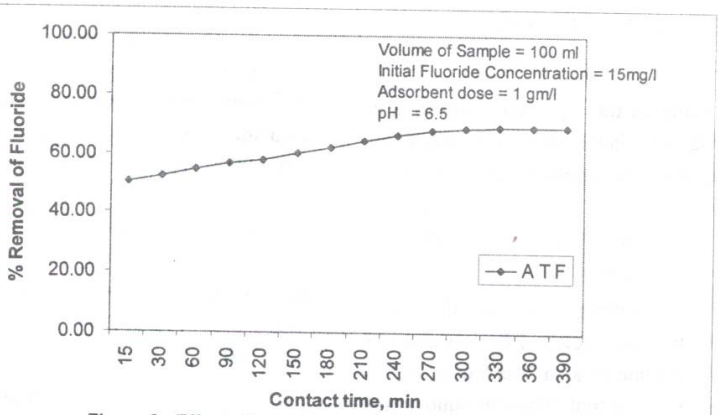

Figure 2 : Effect of contact time on the Removal of Fluoride

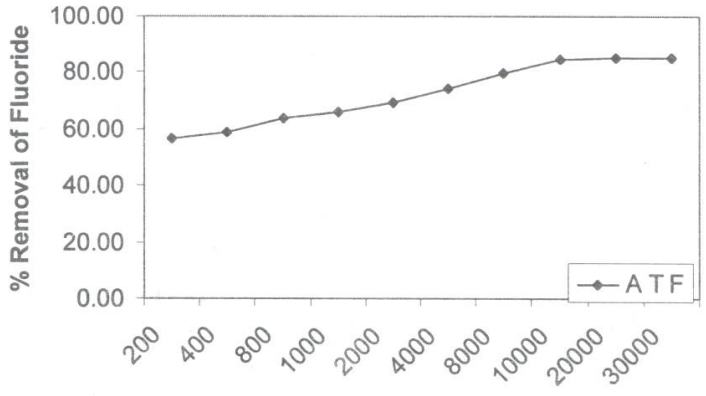

Figure 3 : Effect of Adsorbent dose on the Removal of Fluoride

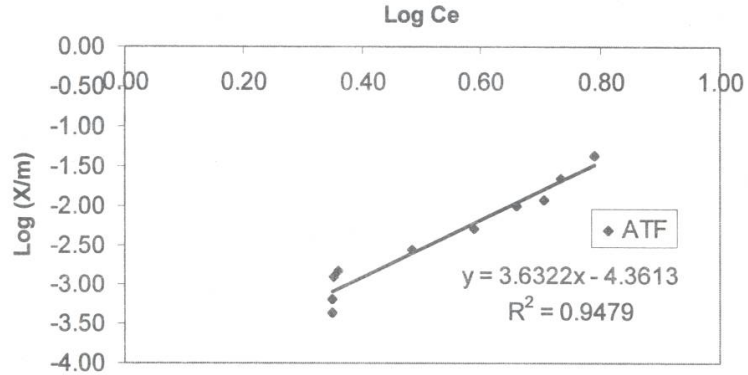

Figure 6 : Freundlich Isotherm for the Removal of Fluoride

less commensurate increase in adsorption resulting from lower adsorptive capacity utilization of sorbent. Unit adsorption decreases significantly with decreasing mass of sorbent per unit volume. This effect has been termed as "Solid concentration effect" meaning overcrowding of particles.

Effect of Initial Fluoride Concentration

The effect of initial fluoride ion concentration on the adsorption efficiency by ATF has been systematically investigated by varying the initial concentration between 2 – 30 mgl^{-1}. and a plot of percentage adsorption versus initial fluoride concentration is shown in Figure 4. It is a well-known fact that the rate of exchange adsorption is controlled by diffusion through a hydrostatic boundary layer called film diffusion control or through the pores of the resin matrix called particle diffusion control. The rate of exchange adsorption is mainly controlled by film diffusion under the conditions of small resin particle, dilute solution and mild stirring and vice versa in case of pore or particle diffusion. More practically, both processes control it.

As the initial concentration of fluoride increases, percentage removal decreased. By using ATF the maximum removal for initial concentration of 15 mgl^{-1} is 85 percent, which is 2.25 mgl^{-1}. In India the permissible limit for the fluoride ion in the drinking water is 1.5 mg l^{-1} thus if the initial concentration of fluoride in the water is about 10mg/l^{-1} then with the optimum conditions the ATF will remove the fluoride up to 87 percent and the concentration of fluoride remained will be 1.3 mgl^{-1}. which is well below the prescribe limit of 1.5 mgl^{-1}. Thus for the further studies the initial fluoride concentration is considered to be 10 mgl^{-1}.

Effect of Adsorbent Particle Size

The effect of sorbent particle sizes having geometrical mean diameter of 0.45mm to <0.075 mm on the removal of fluoride and concentration was investigated for an initial fluoride concentration of 10 mgl^{-1}. and are shown in Figure 5. It was observed that the adsorbent particle size has significant influence on the kinetics of absorption due to change in number of adsorption sites. The removal of fluoride ions at different particle sizes showed that the uptake of fluoride ion increases with decreasing particle diameter. The presence of larger number of smaller particles for a given weight provides, the sorption system with a grater surface area available for fluoride ion removal and it also reduces the external mass transfer resistance. The maximum removal of fluoride ion is at particle size < 0.075 mm i.e. 92.10 percent and the reduction in the percentage removal is with the particle size 0.45 mm that is 86.30 per cent.

Adsorption Isotherms

The freundlich equations has the general from

$$X/M = K_1 C_e^{1/n}$$

Where X/M = amount of fluoride adsorbed / unit weight of sorbent

C_e = Concentration of fluoride remaining in solution at equilibrium

K_1 and 1/n = freundlich parameters and represent adsorption capacity and intensity.

Data are usually fitted into logarithmic form of the equation.

$$\ln X/M = \ln K_1 + 1/n \ln C_e$$

The regression co-efficient (r^2) values presented in Table 3, indicate that the adsorption data of fluoride ion is a better fit for freundlich isotherm. The values of freundlich constants are reported in Table 3 for the removal of fluoride ion.

Table 3. Freundlich constants for the removal of fluoride ion using ATF as adsorbent.

Freundlich constants		
K_1	1/n	r^2
0.1374	3.6322	0.9479

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Stochastic Modelling of Pan Evaporation Under Climatic Conditions of Akola

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ABSTRACT

A stochastic model for weekly pan evaporation series has been developed using 16 years of pan evaporation data under climatic conditions of Akola. The statistical properties of the generated series were compared with observed pan evaporation series. The developed model was validated by predicting two years ahead and compared with the observed pan evaporation series. The test results indicated the high degree of model fitness.

A mathematical model representing the stochastic process is called stochastic model. Forecasting of pan evaporation particularly in water resources project planning, design and operation is of paramount importance. It is importantly recognized that time series analysis is of considerable practical use in dealing with forecasting of hydrological variables (Hippel and McLeod, 1978, Salas *et.al,* 1980). A time series is composed of trend, periodic and stochastic component. However, pan evaporation series is periodic- stochastic in nature. The periodic component can be modelled using the harmonic analysis and stochastic component is modelled using autocorrelation model. These models are suitable for generating the monthly or daily data.

A mathematical model for weekly evaporation series under climatic conditions of Akola was developed.

MATERIAL AND METHODS

The weekly pan evaporation data for 18 years (1985-2002) was obtained from meteorological observatory of Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, (Maharashtra) situated at 20° 42 N latitude and 77° 04 E longitude and 369.0 m above sea level.

Time series model development:

The time series of pan evaporation was decomposed into a deterministic component in the form of periodic parameter and a stochastic (random) component consisting of chance and chance-dependent effects. The additive form provides a reasonable model in most cases and is expressed as:

$$X_t = T_t + P_t + S_t \qquad .....(1)$$

in which, T_t is the trend component; P_t is the periodic component; and S_t is stochastic component having dependent and independent parts, at time t. Since the model is applied to stochastic component, which is treated as random variable, the trend and periodic components were first removed from the time series. To obtain representative stochastic model of the time series, identification and detection of each component is necessary. Each of the model components is, therefore, have been analyzed and determined by following stepwise procedure.

Trend component, T_t:

Steady and regular movements in a time series through which the values are on average either increasing or decreasing is termed a trend (Kottegoda, 1980). In order to model Ep time series, a null hypothesis of no trend in the series was adopted. For detecting the trend in the time series following two statistical tests were performed:

1. Turning point test
2. Kendall's rank correlation test

In these analyses, annual Ep data have been used for detecting the trend. The annual series has been assumed to give better results for the trend component and suppresses the effect of periodic components in the series (Kottegoda, 1980).

Periodic component, P_t:

The periodic component in a time series is deterministic in nature having the property to repeat itself at regular intervals. In a time series periodicity can be

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represented as a function of sine and cosine terms. The procedure used to estimate is termed as harmonic analysis. The existence of P_t was first identified by the serial correlogram, i.e., a graph of autocorrelation coefficients, r_k against lag k. The tolerance limits for the correlogram of an independent series was computed as given by Anderson (1941).

Estimation of significant harmonics: The periodic component was removed using the harmonic constants after identifying the presence of periodicity and the number of harmonics in the series through Fourier series.

Following two tests were then carried out for determination and selection of the significant harmonic coefficients, A_k and B_k.

1. Analysis of variance
2. Fourier decomposition of mean square

Stochastic component, S_t:

A stochastic model of the form of autoregressive model (AR), was used for the presentation of the time series. An autoregressive model of order p, AR(p) can mathematically be expressed as:

$$S(t) = \phi_{p,1} S_{(t-1)} + \phi_{p,2} S_{(t-2)} + \ldots + \phi_{p,p} S_{(t-p)} + a(t) \quad \ldots\ldots(2)$$

$$\sum_{k=1}^{p} \phi_{p,k} S_{(t-k)} + a(t) \quad \ldots\ldots(3)$$

where,

$\phi_{p,k}$ = autoregressive model parameters, k = 1, 2, . . . , p

a(t) = independent random number

The fitting procedure of the AR(p) model involved three steps, viz. model identification, parameter estimation and model diagnostic checking

Model identification:

For selecting the best model and thereby to estimate the parameters of the model structure, residual variance criteria method was used.

Parameter estimation:

The autoregression parameters of different orders were estimated before the proper order for AR terms has been identified. These parameters were estimated by the procedure described by Yule-walker equations.

$$\phi_{p,p} = \left[\frac{r_p - \sum_{k=1}^{p-1} (\phi_{p-1,k})(r_{p-k})}{1 - \sum_{k=1}^{p-1} (\phi_{p-1,k})(r_{p-k})} \right] \quad \text{---- 4}$$

and

$$\phi_{p,k} = \phi_{p-1,k} - \phi_{p,p}\, \phi_{p-1,p-k} \text{ for } k = 1, 2 \ldots . p-1 \quad \ldots\ldots(5)$$

for k = 1, 2, …, p-1 …(5)

In the estimated parameters, ($\phi_{p,k}$), suffix p and k indicate the order and the number of parameters of AR (p) model.

The sum of the periodic and stochastic component forms the generated value of the observed data. The difference was termed as residual, which was tested to check the adequacy of the formulated model. The residuals of the AR(p) model may be computed from:

$$a(t) = S(t) - \sum_{k=1}^{p} \phi_{p,k}\ S_{(t-k)} \quad \ldots(6)$$

Model diagnostic checking:

Once the proper order for AR terms has been identified, the selected model was validated for its suitability through the diagnostic checking. Serial correlation analysis was used as a tool for diagnostic checking.

Serial correlation analysis: After fitting the model to stochastic component the residuals, a(t), were obtained. The serial correlation coefficient of the residuals was estimated for lag k and the correlogram with the 95 % upper and lower confidence limits were drawn. The serial correlation coefficients falling well within the tolerance limits indicate the suitability of the model for the Ep series and the residuals were assumed to be white noise (random).

Validation of stochastic model:

The major application of modelling time series is to generate or forecast future values or data. Generating the Ep time series for the entire sampling period of 1985 to 2000 was first checked using the weekly developed Ep models. Forecasting was made for two years ahead from 2001 to 2002. The generated/forecasted values from the model were compared to the observed data. The variation of the generated/forecasted and observed series was presented graphically with respect to time. Correlation coefficient of mean generated series and mean observed series was determined. Other statistical parameters of

generated and observed series were also computed for validation of the model.

RESULTS AND DISCUSSION

Trend Component:

The estimated values of the test statistic (Z) for turning point test and Kendall's rank correlation test were found to be –2.1 and –1.71 respectively and hence, both the tests were within the acceptable range at 0.01 level of significance. Hence, the hypothesis of no trend was not rejected, indicating that the pan evaporation series was trend free.

Periodic component:

The presence of periodic component in series is detected through the construction of autocorrelogram or correlogram, which is a graph showing the relationship between the autocorrelation function on the ordinate and lag k on the abscissa. For the proper identification and interpretation of the autocorrelogram, the estimates of autocorrelation function for weekly evaporation series were made.

Autocorrelation analysis: The autocorrelation functions (ACF) for the weekly time series up to lag 104 were determined and have been used to identify the periodic component in the time series. Autocorrelograms for the weekly series along with the tolerance limit estimated by Anderson's equation for an independent series is shown in Figure 1.

The resulting oscillating shape of the correlogram shows the presence of periodicity in the time series. The weekly serial correlogram have peak at about 52 and 104, and trough at about 26 and 78. It is also seen that some of the autocorrelogram of the time series fall out of the confidence limits, indicating the presence of time dependant series, i.e., X(t+1) is dependent on X(t), and X(t+2) is dependant on X(t+1) and so on.

Selection of significant harmonics: Once the presence of periodic component in the series is detected, the estimation and removal from the time series is done through harmonic analysis. The periodic time series usually is not stationary. It is expanded in to a Fourier series representation. To estimate the coefficients of harmonics to be fitted in the periodic component, the numbers of harmonics that significantly contribute to periodicities were identified through the following two different test approaches.

Analysis of variance: To determine the number of significant harmonics to be fitted in the periodic series, estimates of α and β parameters were computed for half the base period of periodicity. For a discrete series, the number of possible harmonics is finite which, together with the amplitude and phase differences, can be estimated from an observed sequence (Kottegoda, 1980). Therefore, only few harmonics significantly contribute to periodicity and the rest of harmonics were treated as white noise. Table 1 shows the estimates of the parameters along with amplitude and explained variance for weekly time series.

The numbers of significant harmonics have been then detected from the analysis of variance. The analysis of variance is given in Table 2.

In this analysis, the parameters α and β were evaluated for all harmonics considered in weekly series to obtain the F-values. The harmonics, for which F-ratios

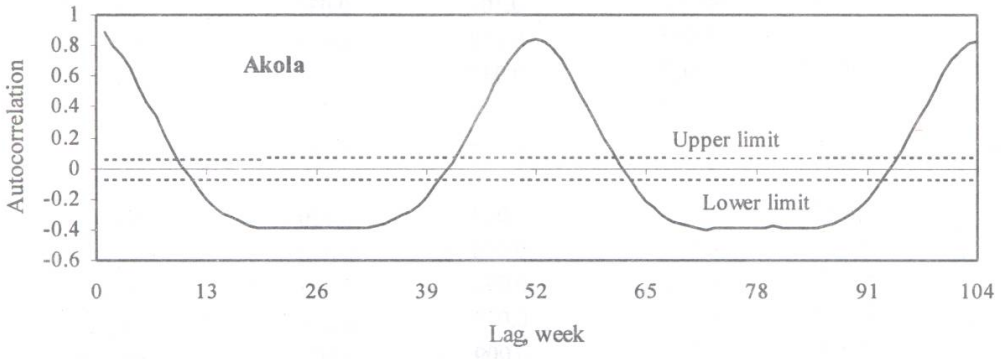

Fig.1. Correlogram of weekly observed pan evaporation at Akola

were greater than the table value of F at 0.05 level of significance, have been considered as significant harmonics. The analysis of variance revealed that four harmonics were found to be significant for Akola.

Fourier decomposition of mean square: The numbers of significant harmonics that represent the periodic component were obtained by evaluating the Fourier series coefficients A_k and B_k. The Fourier series coefficients A_k and B_k were computed. The contribution of the individual harmonics towards the mean square has been shown under the explained variance and those harmonics, which dominantly contribute to mean square are selected as the significant harmonics. The results are shown in Table 3.

At Akola, the first four harmonics have contributed 83 per cent of the total variation caused by the periodic component, while rest of the harmonics have contributed about 1 per cent respectively.

Stochastic component:

The stochastic component that was obtained by the removal of periodic component from the observed series is treated as a random variable. Autoregressive stochastic model of order p, AR(p), was applied to the stochastic component of pan evaporation series to generate a synthetic data sequence of the weekly series. In autoregressive model, the current value of a variable was equated to the weighted sum of a preassigned

Table 1. Fourier series coefficients for mean weekly pan evaporation at Akola

Order	Alpha	Beta	Amplitude	Explained variance	Cumulative explained variance
1	3.600	-2.539	4.405	66.591	66.591
2	-2.512	-0.967	2.692	24.871	91.463
3	0.927	0.530	1.068	3.911	95.374
4	-0.265	-0.545	0.606	1.260	96.633
5	-0.028	0.365	0.366	0.459	97.092
6	0.127	-0.197	0.234	0.188	97.28
7	-0.137	0.141	0.197	0.133	97.413
8	0.102	-0.102	0.144	0.072	97.484
9	-0.273	-0.004	0.273	0.255	97.74
10	0.221	0.054	0.227	0.177	97.917
11	-0.160	-0.105	0.192	0.126	98.043
12	0.035	-0.011	0.036	0.005	98.048
13	-0.010	0.040	0.042	0.006	98.053
14	0.086	0.068	0.110	0.041	98.095
15	-0.062	-0.087	0.107	0.039	98.134
16	-0.002	0.018	0.018	0.001	98.135
17	-0.003	0.029	0.030	0.003	98.138
18	-0.009	-0.002	0.009	0.000	98.138
19	0.014	-0.063	0.065	0.014	98.152
20	-0.073	-0.021	0.076	0.020	98.172
21	0.054	0.055	0.077	0.020	98.192
22	0.048	-0.008	0.048	0.008	98.200
23	-0.083	-0.040	0.092	0.029	98.229
24	0.050	0.053	0.073	0.018	98.247
25	-0.008	-0.004	0.009	0.000	98.248
26	0.000	0.072	0.072	0.018	98.266

Table 2. Analysis of variance of weekly pan evaporation series at Akola

S.N.	Harmonics	Degree of freedom	Sum of squares	Mean squares	F_{cal}	F_{tab} 0.01	0.05
1	5,6,—,26	43	198.17	4.61	0.26	1.57	1.38
2	Residual	788	13849.87	17.58			
3	4	3	152.78	50.93	3.03	3.78	2.60
4	Residual	828	13895.27	16.78			
1	4,5,—,26	45	350.95	7.80	0.45	1.56	1.37
2	Residual	786	13697.10	17.43			
3	3	2	474.34	237.17	14.48	4.61	3.00
4	Residual	829	13573.71	16.37			
1	3,4,—,26	47	825.29	17.56	1.04	1.55	1.37
2	Residual	784	13222.76	16.87			
3	2	2	3014.02	1507.01	113.22	4.61	3.00
4	Residual	829	11034.03	13.31			
1	2,3,—,26	49	3839.30	78.35	6.00	1.54	1.36
2	Residual	782	10208.74	13.05			
3	1	2	8073.11	4036.56	560.06	4.61	3.00
4	Residual	829	5974.93	7.21			

Table 3. Fourier decomposition of periodic components in weekly evaporation series for Akola

Order	A_k	B_k	Amplitude	Theta	Explained variance	Cumulative Explained variance
1	-2.453	3.660	4.41	-0.980	57.430	57.43
2	-1.083	-2.466	2.693	1.157	21.457	78.89
3	0.590	0.891	1.069	0.986	3.378	82.27
4	-0.567	-0.214	0.606	0.360	1.086	83.35
5	0.366	-0.074	0.374	-0.200	0.413	83.77
6	-0.191	0.149	0.242	-0.662	0.173	83.94
7	0.127	-0.145	0.193	-0.851	0.111	84.05
8	-0.083	0.109	0.138	-0.919	0.056	84.11
9	-0.066	-0.273	0.281	1.335	0.233	84.34
10	0.109	0.203	0.231	1.077	0.158	84.50
11	-0.148	-0.109	0.184	0.636	0.100	84.60
12	-0.006	0.021	0.021	-1.290	0.001	84.60
13	0.051	-0.002	0.051	-0.035	0.008	84.61
14	0.071	0.031	0.077	0.413	0.018	84.62
15	-0.090	-0.011	0.090	0.126	0.024	84.65
16	0.015	-0.026	0.030	-1.060	0.003	84.65
17	0.022	0.007	0.023	0.309	0.002	84.65
18	-0.001	-0.023	0.023	1.521	0.002	84.65
19	-0.051	0.042	0.066	-0.690	0.013	84.67
20	-0.049	-0.055	0.074	0.841	0.016	84.68
21	0.070	0.020	0.073	0.282	0.016	84.70
22	0.015	0.040	0.043	1.210	0.005	84.70
23	-0.064	-0.033	0.072	0.473	0.015	84.72
24	0.058	-0.007	0.058	-0.124	0.010	84.73
25	0.002	0.001	0.002	0.496	0.000	84.73
26	0.028	0.000	0.028	0.000	0.002	84.73

Table 4. Model order and autoregressive parameters of weekly pan evaporation series

Region	Model order	$\phi_{(p,k)}$	Value
Akola	AR(3)	$\phi_{(3,1)}$	0.9
		$\phi_{(3,2)}$	-0.062
		$\phi_{(3,3)}$	0.066

number of past values and a variate that is completely random.

Model parameter estimation:

Selection and estimation of autoregressive parameters is based upon the determined values of autocorrelation function of different lags. To obtain the estimates of the parameters for different model order, Equations (4) and (5) were solved recursively.

Model identification:

The serial autocorrelation of each residual series for first, second and third order model were compared and the residual series that gave well within minimum range of values has been selected to represent the stochastic component of autoregressive model.

According to the comparison made, for Akola the third order autoregressive model has been selected.

The stochastic component was estimated by fitting the autoregressive parameters in the Equation (2) for the selected model order. Following are the final form of expression for estimating the stochastic component in weekly evaporation series for the different regions.

Stochastic component for weekly pan evaporation series of Akola is

$$S_t = 0.9S_{t-1} - 0.062S_{t-2} + 0.066S_{t-3} + a_t \quad \ldots(7)$$

Residual series:

The S_t series of stochastic component, which was obtained after the removal of the deterministic components from the time series, consists of two components. These are the dependent part represented by an autoregressive model and the independent or residual part that is completely random also called as a white noise. The residual series, a_t, is obtained by deducting the generated series, which is the sum of periodic and stochastic component, from the observed time series.

Model structure:

The model structure of the time series constitutes the sum of trend, periodic and stochastic component. Since the observed series is trend free, the sub-models of periodic and stochastic component are added together to form the newly developed model structure of the pan evaporation series. The mathematical structure of the additive model as described by Equation (1) can now be presented for weekly pan evaporation series as given in equation 8. The formulated model structure has been used to generate similar sequenced series of weekly pan evaporation.

$$\begin{aligned} Ep = {} & 7.02 - 2.453\cos(2\pi t/p) + 3.66\sin(2\pi t/p) - \\ & 1.083\cos(4\pi t/p) - 2.466\sin(4\pi t/p) + \\ & 0.59\cos(6\pi t/p) + 0.891\sin(6\pi t/p) - \\ & 0.567\cos(8\pi t/p) - 0.214\sin(8\pi t/p) + 0.9S_{t-1} \\ & - 0.062S_{t-2} + 0.066S_{t-3} + a_t \quad \ldots\ldots(8) \end{aligned}$$

Autocorrelation analysis:

The autocorrelation function of residual series was estimated for lag k. The value of autocorrelation function was plotted against the lag to obtain a correlogram. The resulting correlograms of evaporation series is shown in Figure 2 along with the confidence limit at 0.05 level of significance. The results show that for all lags the autocorrelation function falls fairly within the confidence limits. So we can use this model and generate values of weekly pan evaporation and compare the statistical characteristics of observed and generated series.

Validation of Stochastic Model:

Comparison was made between the generated and observed pan evaporation series to validate the model. Figure 3 depict the variation of observed and generated pan evaporation series of sixteen years (1985-2000) for all the stations. Figure 3 indicate that there is a close agreement between generated and observed pan evaporation series.

The basic statistical characteristics for the modeling period (1985-2000) are shown in Table 4. The values of mean, standard deviation, coefficient of skewness, kurtosis and variance show that for observed and generated series, statistical characteristics are not significantly different. Also very low integral square

Table 5. Statistical characteristics of observed, generated and residual weekly pan evaporation series (1985 – 2000) at Akola

Series	Mean mm day^{-1}	S.D.mm day^{-1}	Skewness	Kurtosis	Variance	ISE
Akola						
Observed	7.02	4.11	1.23	0.58	16.19	0.032
Generated	7.02	4.04	1.21	0.44	16.29	
Residual	0.0	0.23	0.11	3.00	0.05	

Table 6. Statistical characteristics of observed, generated and residual weekly pan evaporation series (2001 – 2002) at Akola

Series	Meanmm/day	S.D.mm/day	Skewness	Kurtosis	Variance	ISE
Akola						
Observed	7.21	4.09	1.27	0.93	16.74	0.030
Generated	7.21	4.02	1.25	0.77	16.18	
Residual	0.0	0.22	-0.54	3.10	0.05	

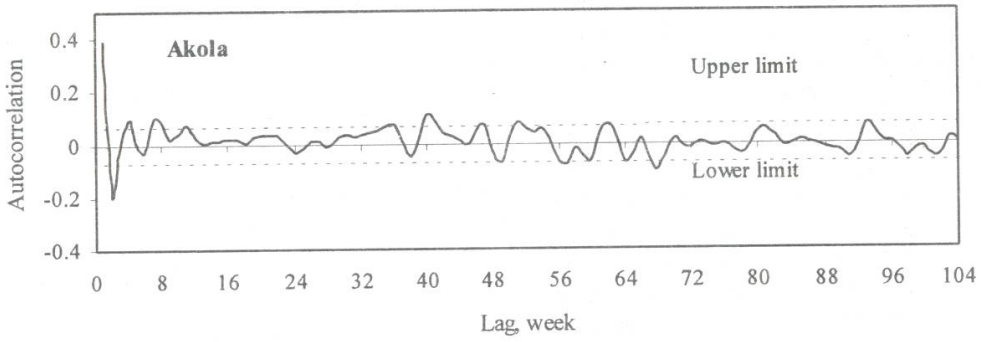

Fig. 2. Correlogram of the residual series of weekly evaporation for Akola

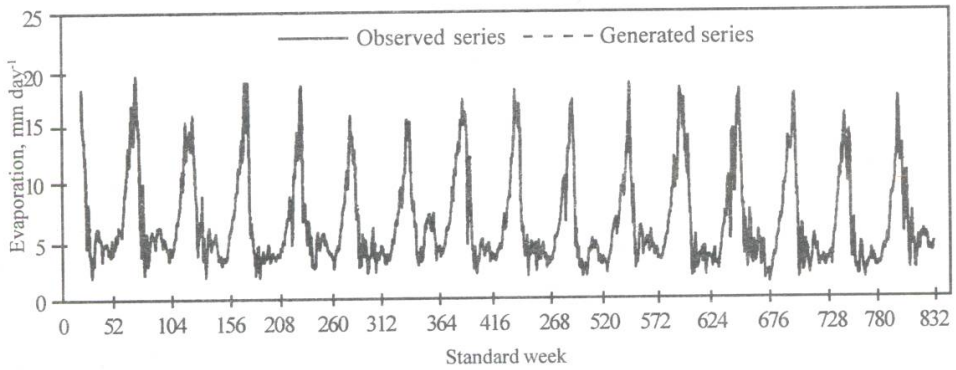

Fig. 3. Variation of weekly observed pan evaporation and generated evaporation series for sixteen years (1985-2000) for Akola

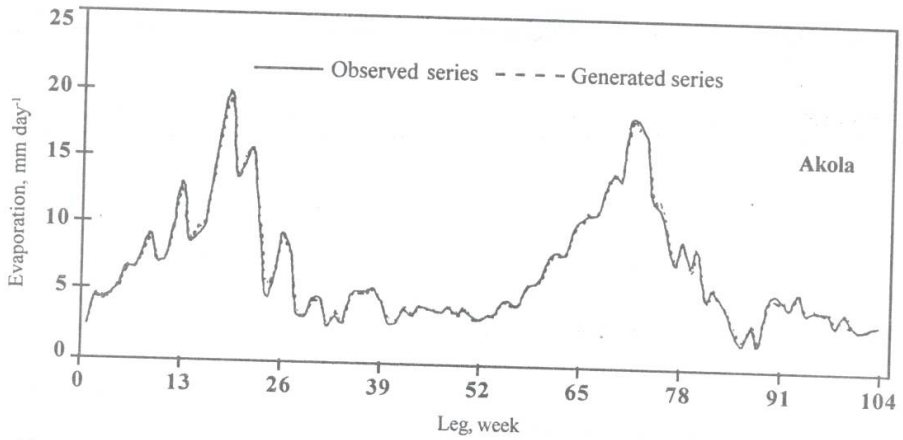

Fig. 4. Variation of weekly observed pan evaporation and generated evaporation series for two years (2001-2002) for Akola

errors (ISE) show that the formulated model was sufficiently adequate for generating evaporation (Reddy and Kumar, 1999). The values of correlation coefficient, (r) between observed and generated weekly series were found to be 0.9986. The mean weekly observed pan evaporation series of sixteen years were also compared with their respective generated series.

Therefore the model structure formulated can be used for the long term prediction of weekly pan evaporation for Akola. Prediction of pan evaporation for weekly series of two years ahead (2001 and 2002) was made. The results are presented in Figure 4. The basic statistical characteristics of the observed and predicted series such as mean, standard deviation, coefficient of skewness, kurtosis and variance were also estimated for comparison as shown in Table 6. Values of correlation coefficient and statistical characteristics for observed and generated series confirm the reliability of weekly pan evaporation model for generation of data.

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Adoption of Dairy Management Practices by Members of Dairy Co-operative Society

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ABSTRACT

The study conducted on adoption of dairy management practices such as, feeding and breeding adopted by 200 randomly selected dairy co-operative society's members of Akola district. Adoption of recommended feeding practices indicated that feeding dry, green and concentrate was 92, 48 and 54 per cent, respectively for cows and for buffaloes it was 89, 58 and 66 per centage, respectively. DM, DCP and TDN intake in cow and buffaloes was 79 and 94, 58 and 72 and 93 and 79.96 per cent, respectively. Practices like maintaining lactation length, dry period and complete miling - were observed in the range of 94 to 96, 88 to 86 and 86 to 90 per cent. Extra allowance to pregnant animals was fed by 40 to 44 per cent members, whereas cleaning and offering warm drinking water, cooked feed after calving and after parturition were followed by 41.66 to 48 and 51.66 to 64 per cent members, respectively. Soaking concentrates and supply of minerals and vitamin was followed by 50 to 52 and 32 to 41.66 per cent farmers, respectively. Grazing more than 6 hours was adopted by 48 to 55 per cent members and 25 per cent female members were involved in milking. Majority of members used knuckling, a wrong method of milking.

Management has long been recognized as a factor of production both in industry and agriculture. However, a few studies have been made on the management in milk production (Sharma and Patel, 1988). Management indices could serve as guidelines for future management improvement programme because the management would lie within the control of producers (Raut, 1982).

The word management includes number of practices related to breeding, feeding and disease control of animals. Besides the adoption of scientific management conditions the output i.e. milk is the function of application of different practices properly so as to create good management environment. Some of the practices are qualitative in nature and others are of quantitative type.

MATERIAL AND METHODS

Theinformation was collected from randomly selected 200 dairy co-operative society's members of Akola district (M.S.). These members were selected from three tahsils of Akola district namely Akola, Barshitakli and Akot on the basis of working of dairy co-operative societies and milk production.

Twenty eight items covering breeding, feeding and management practices likely to have their influence on daily milk yield of cows and buffaloes were considered as indicators to evaluate management stutus of dairy cooperative society's members. The data used in assessment of adoption of dairy management.

Practices were further utilized to calculate the management index as per the method suggested by Narain, *et. al.*, (1996). Where the value composite index is non-negative and it lies between 0 to 1. The value closer to zero indicates the higher management status while closer to 1 indicates the lower level of management. For qualitative interpretation of index it was considered as good, medium, poor and every poor status of management when the score values were 0-40, 41-80, 81-100 and above 100, respectively.

RESULTS AND DISCUSSION

The results on adoption of recommended feeding practices presented in Table 1 indicated that feed dry, green and concentrate was 92, 48 and 54 per cent, respectively for cows and for baffaloes it was 88.83, 58 and 66 per cent, respectivley. Per cent-wise DM, DCP and TDN intake in cows and buffaloes was 79 and 94, 58 and 72 and 93 and 79.96 for cows and buffaloes, respectively. Practices like lactation length, dry period and complete milking were observed in the range of 94 to

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Table 1. Extent of adoption of recommended practices followed by selected members

S.N.	Management practices	Extent of adoption (%)	
		Cow	Buffalo
1.	Animal procurement		
	a. Home breed	38.33	35
	b. Purchase from market	61.67	65
2.	Knowledge about signs of hear	41.66	46.66
3.	Breeding of animals with AI technique	25.00	21.33
4.	Provide extra feeding during pregnancy	40	44
5.	Cleaning and giving warm drinking water after calving	41.66	48.00
6.	Cooked feed after parturition	51.66	64.00
7.	Feeding strategy		
	a. Dry alone + grazing	10	9
	b. Dry + green grasses + concentrate	39	51
	c. Dry + concentrate	51	40
8.	Soaking of concentrate		
	a. 1 - 3 hrs	19	18
	b. 3 - 6 hrs	31	28
	c. Above 6 hrs	50	54
9.	Supplying vitamins and minerals	41.66	32
10.	Grazing site		
	a. Field boundary	55	48
	b. Byaran village pasture	45	52
11.	Grazing hour		
	a. 0	30	72
	b. 5-6	70	58
12	Labour sex for milking		
	a. Male	75	76
	b. Female	25	24
13.	Method of milking		
	a. Stripping	10	12
	b. Knuckling	84	82
	c. Full hand	6	6
14.	Isolation of sick animal	13	16
15.	Wallowing of buffalo	-	44
16.	Quantity of feed dry (kg)	92.00	88.83
17.	Quantity of feed green (kg)	48.00	58.00
18.	Quantity of feed concentrate (kg)	54.00	66.00
19.	Supply of nutrients DM	79.00	94.00
20.	Supply of nutrients DCP	58.92	72.00
21.	Supply of nutrients TDN	93.00	79.96
22.	Lactational yield (lit)	85.91	90.00
23.	Milk yield daily (lit)	86.00	90.00
24.	Lactation length (days)	94.66	96.20
25.	Dry period (days)	88.14	86.47
26.	Calving interval (days)	75.62	96.22
27.	Fat (%)	100.00	100.00
28.	SNF (%)	96.00	95.00

Table 2. Distribution of farmers on the basis of management

S.N.	Management index	No. of members	
		Cow	Buffalo
1.	100 and above (very poor)	3	3
		(4.05)	(2.57)
2.	81 - 100 (Poor)	8	15
		(10.81)	(12.82)
3.	41-80 (medium)	35	37
		(47.30)	(31.62)
4.	0-40 (good)	28	62
		(37.84)	(52.94)

Figures in parentheses indicates the per centage to total

96, 88 to 86 and 86 to 90 per cent, respectively. It was further seen that 41 to 47 per cent members had knowledge of heat deduction and 25 to 21.33 per cent members followed AI technique. Extra allowances was fed by 40 to 44 per cent members, cleaning and offering warm drinking water and cooked fed after parturition were followed by 41.66 to 48.00 and 51.66 to 64 per cent members, respectively. Dry fodder and concentrates together without green were fed to extent of 51 to 40 per cent. Soaking concentrate and supply of minerals and vitamins was followed by 50 to 54 and 31.66 to 32 per cent farmers, respectively. Fifty per cent grazing more than 6 hours and 25 per cent female member were involved in milking.

From the perusal of Table 2, the trend indicated that the rearing status of cows was medium and the index was in the range from 41-80 per cent for majority of members (47.30%). However, substantial members (37.84 per cent) were possessing good management status, the index being 0-40 per cent. In contrast, more than (52.94 %) buffalo rearing members had good management status, followed by 31.62 per cent members with medium status (41-80 per cent index). This means in both the species a sizeable number of members could improve their management status by adopting the scientific practices and could obtain higher daily milk yield from cows and buffaloes. Moreover, about 14 to 15 per cent members had the management status between por, to very poor. It is observed that this section of members failed to adopt 17 practices out of 28 practices studies for management index. The results of Sharma and Patel (1988) tend support to present trend who observed the composite index amongst milk producers had a significant and positive influence on milk production.

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Comparative Efficacy of Different Sorghum Varieties in Broiler Diet

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ABSTRACT

An experiment was conducted to study the comparative efficacy of different sorghum varieties in broiler diets. Two hundred and ten broiler chicks were randomly divided into seven treatments with three replications in each and reared up to six weeks on standard managemental practices. The dietary treatments comprised of T_1 control diet with 60 per cent maize, T_2 60 per cent CSH-9, T_3 30 per cent maize and 30 per cent CSH-9, T_4 60 per cent CSH-5, T_5 30 per cent maize and 30 per cent CSH-5, T_6 60 per cent CSH-16, T_7 30 per cent maize and 30 per cent CSH-16. The feed efficiency between different treatments varied significantly ($P<0.05$), however body weights did not reveal any significant variation. It was concluded that the different varieties of sorghum containing low tannin like CSH-5, CSH-9 and CSH-16 can replace maize at 100 per cent without affecting the performance of broilers.

Amongst the cereals, sorghum is extensively grown in the state of Maharashtra including Vidarbha region. In Maharashtra about 6 lakh hectors area is under sorghum cultivation in both *Kharif* and *Rabi* season. The cultivation of sorghum in Maharashtra state has increased tremendously during last three decades. The production of sorghum is 4.88 million tonnes in Maharashtra (Anand Kumar, 2000). The production of sorghum increased tremendously because of evolution of different sorghum hybrid varieties. Sorghum is reported to have higher level of crude protein (10-13%), lysine, methionine, phosphorus and almost twice the calcium as compared to other cereal grains (Gaultieri and Rapaccipi, 1990). The ME content of sorghum ranges from 2617 to 3886 Kcal kg^{-1} (Lucbard and Casting, 1986 and Douglas *et al.*, 1990). Sorghum varieties like CSH-9, CSH-5 and CSH-16 are mainly cultivated in Vidarbha. Hence the present study was intended to find out replacement of maize by suitable sorghum variety for economical diet formulation.

MATERIAL AND METHODS

An experiment was carried out on two hundred and ten broiler chicks randomly divided into seven treatments with three replications in each and reared up to six weeks on standard managemental practices. The composition of dietary treatments is given in table 2. which comprised of T_1 control diet with 60 per cent maize, T_2 diet with 60 per cent CSH-9, T_3 diet with 30 per cent maize and 30 per cent CSH-9, T_4 diet with 60 per cent CSH-5, T_5 diet with 30 per cent maize and 30 per cent CSH-5, T_6 diet with 60 per cent CSH-16, T_7 diet with 30 per cent maize and 30 per cent CSH-16. The parameters like body weights, feed consumption was recorded and feed efficiency was calculated. The data were analyzed as per Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

The tannin content of CSH-5, CSH-9 and CSH-16 was 0.19, 0.21 and 0.16 per cent, respectively. The overall body weights were higher for T_7 group, however the differences were non significant, which are in agreement with Thakur *et al.* (1984), who replaced 50 per cent of maize by sorghum grain. Khandare (1992) also observed

Table 1 Chemical composition of different sorghum varieties (DM basis)

Composition	CSH-5	CSH-9	CSH-16
Moisture (%)	11.00	11.00	11.00
Crude protein (%)	11.40	11.30	11.00
Crude fibre (%)	1.80	1.80	1.70
Ether extract (%)	3.80	3.90	3.00
Total ash (%)	3.20	2.30	3.10
Nitrogen free extract (%)	79.80	80.70	81.20
ME (K.cal kg^{-1})	3000	3000	3000
Tannin (%)	0.19	0.21	0.16

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Table 2. Per cent composition of broiler ration

Ingredients	Dietary treatments						
	T_1	T_2	T_3	T_4	T_5	T_6	T_7
Maize	60	-	30	-	30	-	30
CSH-9	-	60	30	-	-	-	-
CSH-5	-	-	-	60	30	-	-
CSH-16	-	-	-	-	-	60	30
Deoiled soybean cake	12	12	12	12	12	12	12
Ground nut cake	15	15	15	15	15	15	15
Fish Meal	10	10	10	10	10	10	10
Mineral mixture	03	03	03	03	03	03	03
CP (%)	21.93	23.31	22.62	23.37	22.65	23.13	22.53
*ME (K.cal. kg^{-1})	2903	2733	2813	2733	2813	2733	2813

(* ME calculated)

Table 3. Performance of broiler on different varieties of sorghum

Parameters	Dietary treatments						
	T_1	T_2	T_3	T_4	T_5	T_6	T_7
Initial body wts. (g)	42.30	42.60	42.16	42.31	42.40	42.51	42.36
	±0.19	±0.17	±0.30	±0.16	±0.22	±0.22	±0.40
Final body wts. (g)	1532.00	1515.09	1505.74	1498.04	1506.75	1533.78	1558.78
	±14.96	±6.07	±17.21	±4.70	±12.20	±8.42	±13.40
Weekly wt. gain (g)	247.54	248.28	247.36	241.87	249.83	243.99	248.44
	±6.50	±7.03	±10.03	±7.84	±6.66	±10.03	±12.43
Weekly feed consumption (g)	592.05	585.16	584.94	589.50	584.27	584.72	578.11
	±109.11	±103.02	±105.17	±104.30	±102.11	±104.10	±103.09
Weekly feed efficiency	2.21	2.17	2.18	2.26	2.18	2.16	2.08
	±0.01	±0.04	±0.04	±0.04	±0.07	±0.03	±0.04

non significant difference for body weight on sorghum diets. Further Kank *et al.* (1993) and Sawant *et al.* (1994) observed best performance with 50 and 100 per cent replacement of maize with sorghum. The findings of the present study showed non significant results at 50 and 100 per cent replacement of maize by different varieties of sorghum. The feed consumption between treatments did not show any variation due to different varieties of sorghum, the results corroborating with Rajini *et al.* (1986), however Nagra *et al.* (1990) and Nychoti *et al.* (1996), reported significant differences in feed consumption on sorghum based diet in broilers. The feed efficiency did not vary significantly, however the better feed efficiency was noticed 2.08 ± 0.04 for 30 per cent inclusion of CSH-16 in diet.

The different varieties of sorghum containing low tannin like CSH-5, CSH-9 and CSH-16 can replace maize at 100 per cent level without affecting the

performance of broiler. The sorghum variety CSH-16 shown equal performance to maize diet and hence use of this sorghum variety in broiler diet may be increased for economical feeding of broilers.

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RESEARCH NOTE

Effect of *In-situ* Soil Moisture Conservation Techniques on Growth, Yield Attributes and Yield of Rainfed Maize

Rainfed farming has a distinct place in Indian agriculture, which occupies 67 per cent of the total cultivated area and contributes to 44 per cent of the total food grain production (Nanjappa, 2004). Maize (*Zea mays* L.) is the fourth important food grain crop in India, which is grown mainly under rainfed condition (81.2%). The productivity of rainfed maize (1765 kg ha^{-1}) is comparatively much lesser than irrigated maize (2874 kg ha^{-1}). This yield gap between the two, is mainly attributed to unassured water availability in rainfed farming. The loss of water in rainfed farming is the cause of more runoff and high evaporation. The runoff water can be conserved and utilized to increase the yield of rainfed crop through adopting *in-situ* soil moisture conservation practices (Anonymous, 1982). Therefore the study was carried to sort out the best *in-situ* soil moisture conservation technique in maize under rainfed condition.

A field experiment was conducted at the farm of Agronomy Department, Dr. PDKV, Akola in *Kharif* (monsoon) season of 2003-04. The experiment was laid out in a Randomized Block Design (RBD) with eight treatments and four replications. The treatments were T_1-Normal sowing, T_2-Forming ridges and furrows at 15 DAS, T_3-Opening of dead furrow at 15 DAS, T_4-Compartmental bunding, T_5-Paired row system and opening furrow in between wide rows at 15 DAS, T_6-Mulching with wheat straw @ 5t ha^{-1}, T_7-Intercropping with mungbean, T_8-Sowing across the slope. The site selected has medium black soil with moderate fertility and slight alkaline in reaction. The variety used for experiment was Pro-agro hybrid maize – 4640. Seed rate used was 20 kg ha^{-1} and sowing was done by dibbling the seeds in rows marked with marker at the spacing of 60 x 20 cm^2.

Growth contributing characters viz., plant height, no. of leaves per plant, leaf area $plant^{-1}$ and dry matter accumulation $plant^{-1}$, were significantly influenced by different *in-situ* soil moisture conservation techniques (Table 1). Forming ridges and furrows at 15 DAS (T_2) registered significantly higher plant height (206.73 cm), number of functional leaves (5.20), leaf area (19.80 dm^2) and drymatter accumulation per plant (28.35 g) over normal sowing. However, it was closely followed by sowing across the slope and opening of dead furrow with respect to above traits. These results are in conformity with those of Tumbare and Bhoite (2000).

Yield attributing characters viz., volume of cob $plant^{-1}$ and number of grains cob^{-1} were found to be significantly higher due to opening of ridges and furrows over other practices. The per cent increase with ridges and furrows were 17.56 per cent and 30.86 per cent, respectively over control. Test weight was significantly increased with opening of dead furrow and followed by

Table 1. Growth attributes of maize as affected by different *in-situ* soil moisture conservation treatments

Treatments	Plant height (cm)	No. of functional leaves $plant^{-1}$	Leaf area $plant^{-1}$ (dm^2)	Dry matter (g $plant^{-1}$)
T_1	192.38	4.20	12.66	22.38
T_2	206.73	5.20	19.80	28.35
T_3	203.58	4.60	16.43	25.00
T_4	187.33	5.00	14.40	25.08
T_5	193.25	5.20	14.13	21.75
T_6	197.18	4.75	13.00	21.50
T_7	192.23	4.28	17.39	19.50
T_8	197.50	4.38	16.75	21.50
SE(m)±	4.00	0.10	1.25	1.39
CD at 5 %	11.77	0.30	3.66	4.09

Table 2. Yield attributes and yield of maize as affected by different treatments

Treatments	Volume of cob plant^{-1} (cm^3)	No. of grains cob^{-1}	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1	158.12	222.80	321.45	42.64	82.25
T_2	185.88	291.55	339.30	60.67	96.92
T_3	162.97	248.95	344.10	55.91	86.25
T_4	170.07	247.15	328.10	49.43	88.55
T_5	159.17	254.80	328.30	49.79	90.04
T_6	169.23	254.10	334.30	47.02	83.15
T_7	156.33	247.35	313.10	54.88	85.95
T_8	160.32	255.90	323.40	55.25	87.05
SE (m)±	4.73	11.17	5.03	2.57	2.69
CD at 5 %	13.91	32.84	14.80	7.56	7.90

forming ridges and furrows. Similar results were also reported by Patil *et. al.* (2000) and Sakthivel *et. al.* (2003).

Soil moisture conservation technique of ridges and furrows recorded significantly maximum grain yield over other practices and recorded 42.28 per cent increase over normal sowing, however, it was at par with treatments of opening of dead furrow and sowing across the slope. The increase in grain yield was attributed to superior crop growth and yield components as a result of maximum soil moisture availability due to *in-situ* moisture conservation techniques. Straw yield of maize was maximum with ridges and furrows and it was closely followed by paired row system. The per cent increase was 7.84 and 9.47, respectively over normal sowing. These results are in agreement with those of Sakthivel *et al.* (2003).

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Performance of Scented Rice (*Oryza sativa* L.) Varieties Under Different Transplanting Dates in Eastern Vidarbha Zone

Basmati rice (*Oryza sativa* L.) occupies a special significance in rice cultivation and occupies 0.70 m.ha. with 0.6 m.t. production (0.85%) of total rice production in India. It's excellent eating and cooking qualities are well known throughout the world.. Basmati rice cultivation has been found remunerative because it fetches 2-3 times more price than that of paddy and it has a great potential.

Rice is grown in different agro-ecological environment highly specific to each location. Under natural conditions environmental factors are the most difficult to control and exert pronounced effect on production. Time of transplanting enormously influences the growth and yield of rice (Chopra *et al.*, 2003).

Eastern Vidarbha region of Maharashtra , though a nontraditional area for aromatic rice till date, may have a great potentially to produce a sizeable quantity of scented rice during the rainy season. Hence identification of suitable aromatic rice genotype(s) and grain yield under timely and delayed transplanting for this particular agroclimatic region is major concern of the study.

The experiment was conducted during the rainy season of 2003 at Agriculture Research Station, Sakoli, (M.S.). The soil was clay loam, having pH 7.2, and available N, P_2O_5 and K_2O 220, 28 and 290 kg ha^{-1}, respectively. Seven aromatic rice cultivars viz., IET-16775 (V_1), IET-16549 (V_2), IET-15833 (V_3), IET-15392 (V_4), IET-15391 (V_5), Pusa Basmati-1 (V_6) and CSR-30 (V_7) were arranged as main plots and three transplanting dates (15th July, 30th July and 15th August) as subplot in factorial randomized block design with three replications. Nursery of all scented cultivars was raised in staggered manner. Seedlings of 30 days age were transplanted in puddled soil having uniform spacing of 20 x 15 cm in all treatments in a plot size of 3.60 x 3.75 m^2. A uniform dose of 5 t FYM, 80 kg N, 40 kg P_2O_5 and 40 kg K_2O was given to each treatment where the entire quantity of FYM, phosphorus and potash were applied at the last puddling operation. Nitrogen was supplied through Urea in 3 splits (half at transplanting, one fourth at active tillering and rest one fourth at panicle initiation stage). The other agronomic practices were followed as per standard recommendations for aromatic rice cultivation.

Out of seven cultivars tested, analysis of variance shows significant differences for all the characters among the cultivars except number of filled grains The maximum and minimum panicle length were recorded with IET-16549 (Mugdhsugandha) 26.37 cm and IET-15833 (23.44 cm) respectively. Number of productive tillers $hill^{-1}$ varied widely among the cultivars ranging between 6.56 (Pusa Basmati^{-1}) and 8.11 (IET-15833). Data presented in Table 1 revealed that all genotypes produced < 100 filled grains $panicle^{-1}$. Number of filled grains $panicle^{-1}$ were recorded between 70.22 to 81.11 $panicle^{-1}$ however, the number of chaffy spikelets varied within a range between 6.22 and 21.67. The test weight ranges between 21.94 to 23.90 g .

Among the seven Basmati genotypes tested, IET-16775 (V_1) out yielded the other five genotypes producing 42.11 q ha^{-1} grain but was at par with IET-15392 (38.84 q ha^{-1}). Pusa Basmati-1 and Yamini resulted in least grain yield of 17.00 and 18.41 q ha^{-1} respectively. Variety IET-15833 (V_3), IET-16549 (V_2) and IET-15392 (V_4) were at par in respect of grain yield. Genotype (Mugdhsugandha IET-16549) and IET-15392 (V_4) were significantly superior over Pusa Basmati^{-1}. Similar trend was also recorded in respect of straw yield. (Table 1)

The time of transplanting significantly influenced the growth and grain yield of rice. Early transplanting (15th July and 30th July) resulted in significantly higher yield 31.29 and 32.61 q ha^{-1} respectively than late planting (15th August) (28.40 q ha^{-1}). The better performance under earlier planting may be owing to longer duration of growing period, availability of appropriate climatic conditions for crop growth and less infestation of pest and diseases. This can also be seen from better yield parameters. The present results are also in agreement with the findings of Dhiman *et al.* (1997). Highest grain (32.61 q ha^{-1}) and straw yield (40.75 q ha^{-1}) was recorded with 30th July planting but it was at par with 15th July planting (31.29 and 39.11 q ha^{-1}) and there was significant reduction in grain and straw yield on 15th August planting (12.91%). Interaction effect between date of planting of rice and tested Basmati genotypes (Table 1) was found significant in yield attributing characters, grain and straw yield.

Table 1. Yield and yield attributes of Basmati rice as influenced by genotypes and dates of planting

Treatments	Grain Yield ($q\ ha^{-1}$)	Straw yield ($q\ ha^{-1}$)	Length of panicle (cm)	Productive tillers/hill	Filled grains /panicle	Chaffs / panicle	Grain wt. / panicle (g)	Test weight (g)	Grain yield g/hill
Basmati Cultivars									
V_1-IET-16775	42.11	52.64	24.53	7.78	81.11	21.0	2.08	22.97	11.42
V_2-IET-16549 (Mugdhsugandha)	37.28	46.60	26.37	8.0	76.56	21.67	1.82	23.90	11.99
V_3-IET-15833	36.78	45.97	23.44	8.11	77.44	16.00	1.78	22.43	10.43
V_4-IET-15392	38.84	48.55	25.27	7.33	71.89	14.89	1.74	23.90	11.77
V_5-IET-15391 (Vasumati)	24.90	31.13	23.64	7.78	80.78	14.22	1.43	21.94	8.08
V_6-Pusa Basmati-1	17.00	21.25	24.1	6.56	70.22	13.44	1.73	22.35	8.75
V_7-CSR-30 (Yamini)	18.41	23.01	24.11	7.22	70.33	6.22	1.64	22.65	7.06
SE (m)±	1.34	1.68	0.43	0.31	5.21	0.87	0.11	0.32	0.611
CD (0.05%)	3.84	4.81	1.23	0.90	14.90	2.51	0.33	0.924	1.74
Dates of planting									
T_1-15th July	31.29	39.11	24.50	7.71	68.10	12.05	1.66	22.76	9.87
T_2-30th July	32.61	40.75	24.49	7.67	82.76	15.48	1.78	23.13	9.92
T_3-15th August	28.40	35.49	24.50	7.23	75.57	18.52	1.80	22.74	9.99
SE (m)±	0.88	1.10	0.28	0.20	3.41	0.57	0.077	0.21	0.40
CD (0.05%)	2.52	3.15	0.81	0.59	9.76	1.64	0.22	0.60	1.14
Interaction									
SE (m)±	2.33	2.91	0.75	0.55	9.03	1.52	0.20	0.56	1.05
CD (0.05%)	6.66	8.34	2.14	1.57	25.82	4.34	0.58	1.60	3.02

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Evaluation of Inbreds Derived from Interspecific Crosses in Sunflower (*Helianthus annuus* L.)

Cultivation of sunflower in diverse agro-ecological regions has necessitated the development of more productive hybrids of diverse duration. Concentrated breeding efforts are needed to meet this demand. Success in plant breeding is primarily depends upon the nature and magnitude of variation present in the breeding material. Genetic variability is basic to rational plant breeding (Simmonds, 1983). The variability present in sunflower is reported to vary from considerable to marked for various quantitative characters.

In any crop plant, knowledge about nature and extent of genetic variability present in the germplasm collection is important in planning for successful breeding programme. Estimation of heritable and non-heritable variation is of great value of choice to the plant breeders. Heritability in conjuction with genetic advance has a greater role to play in the determining the effectiveness of selection of a character. Hence, in a present study 81 sunflower inbred lines (Table 1) was evaluated for the presence of variability, heritability and expected genetic advance for different quantitative traits.

The 81 diverse sunflower inbred lines (Table 1) along with the checks surya, morden, PKV SF–9 and SS–56 were grown during kharif 2002-03 in 9 x 9 triple lattice design, with three replications. Each inbred line was grown in three rows of three meters with spacing of 45 cm between rows and 30 cm between plants within the row.

Table 1. Inter-specific crosses

S.N.	Crosses	No. of inbred lines derived
1	*H. argophyllus* x sunflower	19
2	*H. petiolaris* x sunflower	13
3	Wild *H. annuus* x sunflower	10
4	H. argophyllus x wild *H. annuus* x sunflower	20
5	Sunflower x *H. debilis*	15

The data for days to 50 per cent flowering, days to maturity, plant height (cm), total number of leaves, head diameter (cm), 100 seed weight (g), number of filled seeds, seed filling per centage, hull content, oil content, volume weight (g 100 ml^{-1}) and yield $plant^{-1}$ (g) were recorded on five randomly selected plants for all inbreds in each replication. Oil content expressed, as per cent was determined directly from Nuclear Magnetic Resonance (NMR). Standard statistical procedures were followed for analysis of variance and estimation of genetic parameters.

Significant variance due to genotypes and a wide variability for all the characters were observed among the inbreds studied (Table 2). The phenotypic and genotypic coefficient of variations were higher for yield $plant^{-1}$, 100 seed weight and number of filled seeds indicating greater variability in relation to population mean among the entries suggesting ample scope for improvement in these traits through selection. Moderate GCV and PCV were recorded for head diameter and plant height. However GCV and PCV were low for days to 50 per cent flowering, days to maturity, total number of leaves, seed filling per cent, hull content, volume weight and oil content indicating low variability in relation to the mean and a need to generate more variability. This is in conformity with the earlier reports of Singh and Yadava (1986). Mogali and Virupakshappa (1994) and Lakshmanaiah (1979).

Table 2 : Estimation of genetic parameters GCV, PCV, h^2 and expected genetic advance

S. N.	Characters	Range	Mean	PCV	GCV	h^2	Expected genetic advance over mean
1	Days to 50% flowering	40.33 – 71.00	55.03	11.02	10.66	93.81	21.28
2	Days to maturity	74.33 – 103.33	89.02	06.45	06.10	89.99	11.95
3	Plant height (cm)	60.54 – 164.99	102.83	22.91	22.78	98.85	46.66
4	Total Number of leaves	14.2 – 31.00	20.55	16.57	13.21	63.34	21.64
5	Head diameter (cm)	5.34 – 15.53	10.18	24.23	20.96	74.87	37.37
6	100 seed weight (g)	1.22 – 6.07	03.03	34.15	31.48	84.99	13.68
7	Number of filled seeds	81.00 – 600.83	307.51	51.91	20.58	15.71	16.80
8	Seed filling per cent	62.45 – 98.41	09.29	03.90	01.90	24.61	1.96
9	Hull content per cent	31.20 – 53.00	41.04	13.88	13.07	88.66	25.35
10	Volume weight (g/100 ml)	17.36 – 45.13	32.51	16.28	15.93	95.75	32.11
11	Oil content per cent	33.94 – 40.36	36.53	04.90	3.20	43.90	4.48
12	Yield per plant (g)	3.02 – 22.9	8.34	70.63	40.09	32.86	47.87

High heritability and high expected genetic advance was recorded for plant height (98.85 cm, 46.66 cm), volume weight (95.75 cm, 32.11 cm), head diameter (74.87 cm, 37.37 cm) and hull content (88.66 %, 25.35 %). This suggests a definite scope for improvement in these characters through direct selection. Saravanan *et al.* (1996) and Singh and Yadav (1986) have reported similar results.

High heritability and moderate to low genetic advance was recorded for days to 50 per cent flowering (93.81, 21.28), days to maturity (89.99, 11.95), hundred seed weight (84.99 g, 13.68 g). Similar result has been recorded by Saravanan *et al.* (1996). Moderate heritability and moderate to low genetic advance was recorded for total number of leaves (63.34, 21.64), oil content (43.90 %, 4.48 %). Similar, results were also recorded by Gangappa *et al.* (1992) and Saravanan *et al.* (1996). Seed yield recorded moderate heritability and high-expected genetic advance. Moderate GCV, low heritability and low genetic advance were recorded for number of filled seeds. Mogali and Virupakshappa (1994) had reported similar results. Low GCV, h^2 and EGA were found for seed filling per cent, indicating greater influence of environment on the expression of these characters and can not be improved effectively by selection. Similar results has been obtained to Patil *et al.* (1996).

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Leaf Variants in Pigeonpea

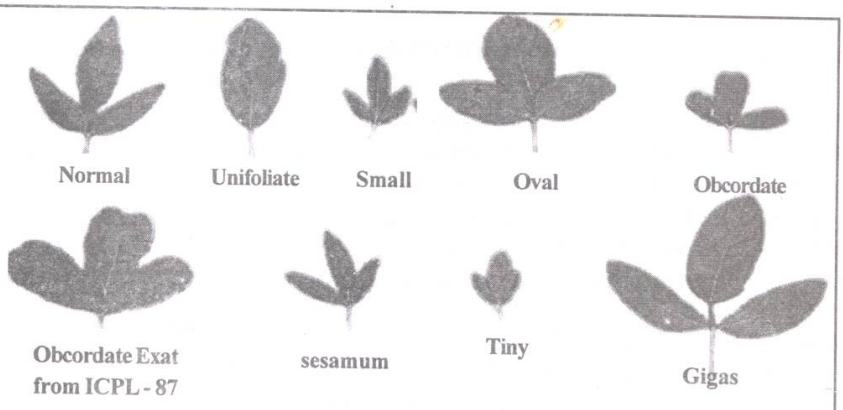
Normally leaves of cultivated pigeonpea (*Cajanus cajan* (L) Millips.) are trifoliate type with lanceolate shape of the leaflets. Number of variants for size and shape of leaflets were reported earlier in pigeonpea by various workers. It includes obcordifoliate (Singh *et. al.* 1942), borad elliptical leaflets (Murthi *et. al.*, 1970), multifoliate (Sengupta and Sen, 1993). The leaflet sizes and shape of eight variants for leaflet characters isolated in pigeonpea were studied at Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) during *Kharif* 2004 and discussed as under.

On the basis of the shape other variants are termed as oval, small, obcordate, tiny, gigas and sesamum (Fig. 1 a to i) leaflet type. Besides them variant was typically with unifoliate leaf type, unlike trifoliate in normal . The sizes of leaflets lamina area (cm^2) varied in the variants which was compared with a standard check variety AKT-8811 (Table 1). On the basis of area the leaflets were grouped into three categories viz., larger than normal,more or less of normal size and smaller than normal leaflets. Gigas and unifoilate leaf variants lies in the first category of larger leaflets. The gigas variant possessed extra larger leaflets with the area of central leaflet of 25.46 cm^2 and side leaflet were 16.79 cm^2 against 16.03 cm^2 area of central leaflet and 11.59 cm^2 of side leaflets in normal check variety AKT-8811. The unifoliate variant had a single terminal leaflet and side leaflets were reduced to scales. The area of single well developed leaflet of unifoliate variant was 23.11 cm^2, which is more than the central leaflet of normal check (16.79cm^2).

The leaflets of oval leaf variant and one of the obcordate leaf (No. 87) were very close to normal check in respet of the area of the leaflets. The oval leaf variants possessed central leaflet area of 18.48 cm^2 and side leaflet were of 12.75 cm^2 size. The obcordate leaf No. 87 had the central and side leaflets of average size of 13.83 and 11.16 cm^2, which were more or less nearer to the normal cultivated type. However the obcordate leaf variant No. 1 had very small leaflets measuring 5.78 cm^2 and 4.34cm^2

Table 1. Range, mean and area (cm^2) of central and side leaflet of different leaf variants in pigeonpea (*Cajanus cajan* (L) Millsp)

Line no.	Variant		Central lealflet			Side leaflets		
			Length (mm)	Breadth (mm)	Area (cm^2)	Length (mm)	Breadth (mm)	Area (cm^2)
1.	Unifoliate leaf	Range	65-75	30-36	19.43-23.70	-	-	-
		Mean ± SE	68.66 ± 3.22	33.66 ± 1.86	23.11 ± 1.98			
2.	Gigas	Range	58-82	25-40	14.40-31.98	30-74	24-34	7.10-21.78
		Mean ± SE	74.0 ± 4.41	34.4 ± 2.61	25.46 ± 3.08	57.0 ± 7.77	29.4 ± 1.93	16.79 ± 2.96
3.	Oval leaf	Range	42.63	25-40	10.60-24.80	34-52	20-35	6.15-18.10
		Mean ± SE	53.33 ± 6.13	34.66 ± 4.38	18.48 ± 3.61	45.0 ± 5.57	28.33 ± 4.41	12.75 ± 3.04
4.	Obcordate	Range	45-55	23-34	10.18-18.50	42-54	21-32	8.12-16.80
	No. 87	Mean ± SE	50.0 ± 2.89	27.66 ± 3.29	13.83 ± 2.46	44.66 ± 4.81	25.0 ± 3.52	11.16 ± 2.83
5.	Obcordate	Range	38-38	12-21	3.48-7.90	22-33	12-19	3.00-6.15
	leaf no. 1	Mean ± SE	34.4 ± 1.60	16.8 ± 1.46	5.78 ± 0.70	28.2 ± 2.39	15.4 ± 1.64	4.34 ± 0.55
6.	Small leaf	Range	40-49	12-15	4.71-6.86	35-42	11-14	3.36-5.10
		Mean ± SE	44.33 ± 2.61	13.66 ± 0.88	6.05 ± 0.66	37.66 ± 2.19	12.66 ± 0.88	4.76 ± 0.52
7.	Tiny leaf	Range	23-32	12-14	3.36-4.48	22-25	9-11	2.07-2.42
		Mean ± SE	28.75 ± 2.14	13.25 ± 0.48	3.81 ± 0.38	23.75 ± 0.75	9.75 ± 0.55	2.32 ± 0.10
8.	Sesamum	Range	40-45	12-15	8.62-9.90	26-40	8-13	2.08-5.00
		Mean ± SE	43.3 ± 1.03	21.0 ± 0.60	9.11 ± 1.32	33.8 ± 2.37	10.6 ± 1.03	3.58 ± 0.54
9	Normal -	Range	60-70	24-26	14.38-18.15	52-58	19-22	10.35-14.96
	AKT -8811 (Cultivated check)	Mean ± SE	63.5 ± 2.36	25.25 ± 0.48	16.03 ± 0.85	57.25 ± 3.64	20.25 ± 0.63	11.59 ± 1.12



Fir. 1. Leaf variants in pigeonpea a) Normal AKT-8811 (Cultivated check), b) Unifoliate c) Small d) Oval e) Obcordate no. 1 f) Obcordate No. 87 g) sesamum h) Tiny and i) Gigas leaf.

area of central and side leaflets, respectively. The obcorted leaves were in inverted heart shaped (Fig. 1).

The central leaflets of small leaf variant exhibited 6.05 cm^2 and side leaflet -4.76 cm^2. In respect of the tiny leaf variant, the area of central leaflet was 3.81 cm^2 and that of side leaflet was 2.32 cm^2, which was the smallest among all the variants and check under study. The sesamum leaf variant possessed the leaflet with the shape of sesamum leaves with waxy appearance on their surface on both sides. Its central and side leaflets measured 9.11 cm^2 and 3.58 cm^2, which were comparatively larger than tiny leaf, obcordate leaf and small leaf variants. The leaflets of sesamum leaf type were however, more elongated and narrow as compared to other variants as well as control.

These variants may be useful as morphological markers as distinguishing characters of the genotypes. It would be more desirable for identification of parents and F_1 hybrid genotypes under hybrid breeding. Inheritance of the variant traits needs to be studied with reference to hybrid breeding (Patil *et. al.*, 1998).

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Evaluation of Thiamethoxam (Cruiser 35 FS) as Seed Dresser for Phytotoxicity on Sorghum and its Effects on the Population of Natural Enemies of Insect Pests

A field experiment was conducted at the farm of Sorghum Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeets, Akola (M.S.) during *kharif* season of 2003, in a randomized block design with four replication, having. Plot size of 3.00 x 1.35 m. with the sorghum hybrid CSH-14 at the spacing of 45 x 15th cm, to know the phytotoxicity of thiamethoxam 35 FS as seed dresser and its effects on natural enemies of sorghum pests. The insecticide thiamethoxam 35 FS was treated to sorghum seed @ 2 ml a.i., 3ml a.i. and 12, ml. a.i. kg^{-1} of seed and evaluated alongwith untreated control. The seed treatment was applied by preparing slurry by mixing the required quantity of thiamethoxam 35 FS with 10-20ml of water for each kg of seed. This slurry was added to the seed and rotated in plastic bag until the seed were evenly covered.

The observations on phytotoxicity (Table 1) as leaf injury, wilting, vein clearing, Necrosis, Epinasty and Hyponasty was recorded on 1,5,7,10,15 and 30 days after germination and the population of natural enemies was counted on 30th and 45th days after germination in each treatment. The results indicated that none of the treatment of the test product Cruiser 35 FS (Thiamethoxam) showed any type of phytotoxic symptoms on sorghum leaves or seedlings at different concentration used in the experiment.

The data in Table 2, regarding the natural enemies i.e. lady bird beetle, the results were statistically significant at 30th days observations. All the doses of thiamethoxam 35 FS were significantly superior to untreated control. The treatment of thiamethoxam (Cruiser 35 FS) @ 12 ml. a.i. kg^{-1} seed recorded the highest 27.50 LBB $plot^{-1}$ and found significantly superior to rest of the treatments. Rest of the doses of thiemethoxam (Cruiser 35 FS) treatments were at par with each other.

The highest 24.75 LBB $plot^{-1}$ was noticed on 45th day after crop emergence in the treatment of thiamethoxam (Cruiser 35 FS) 12 ml. a.i. kg^{-1} seed and found significantly superior to rest of the treatments. Treatment (Cruiser 35 FS) @ 6 ml a.i. kg^{-1} seed (19.25 LBB $plot^{-1}$) was found significantly superior to thiamethoxam (cruiser 35 FS) 3 ml a.i. kg^{-1} seed (14.25 LBB $polt^{-1}$), thiamethoxam @ 2 ml a.i. kg^{-1} seed (12.75 LBB $plot^{-1}$) and untreated control.

The above results could not be compared for want of literature on the above aspects. However, Kandalkar and Kadam (2001) reported the phytotoxicity of various insecticides of liquid formulation on sorghum crop.

Table 2. Effect of various doses of thiamethoxam on the population LBB

S. N.	Treatments	Av. LBB population on	
		30th day	45th day
1	Thiamethoxam (Cruiser) 35 FS @ 2 ml a.i. kg^{-1} seed (5.71 ml)	12.75	12.75
2	Thiamethoxam (Cruiser) 35 FS @ 3 ml a.i. kg^{-1} seed (8.60 ml)	11.75	14.25
3	Thiamethoxam (Cruiser) 35 FS @ 6 ml a.i. kg^{-1} seed (17.14 ml)	17.50	19.25
4	Thiamethoxam (Cruiser) 35 FS @ 12 ml a.i. kg^{-1} seed (34.28 ml)	27.50	24.75
5	Untreated control	2.75	4.75
	'F' test	Sig.	Sig.
	SE (m) ±	1.96	1.67
	CD at 5%	5.50	4.70
	CV%	27.13	22.12

Table 1. Effect of Thiamethoxam 35 FS (Cruiser) seed treatments on phytotoxicity to hybrid sorghum *Kharif* 2003.

Days of observation after germination	Treatments	Phytotoxicity Symptoms (0-10 score)				
		Leaf tips and surface injury	Wilting	Vein clearing	Necrosis	Epnasty and Hyponasty
1st day	Thiamethoxam Cruiser 35 FS @ 2 ml a.i. kg^{-1} seed (5.71 ml)	0	0	0	0	0
	Thiamethoxam Cruiser 35 FS @ 3 ml a.i. kg^{-1}seed (8.60 ml)	0	0	0	0	0
	Thiamethoxam Cruiser 35 FS @ 6 ml a.i. kg^{-1}seed (17.14 ml)	0	0	0	0	0
	Thiamethoxam Cruiser 35 FS @ 12 ml a.i. kg^{-1}seed (34.28 ml)	0	0	0	0	0
	Untreated control	0	0	0	0	0
5th day	Thiamethoxam Cruiser 35 FS @ 2 ml a.i. kg^{-1} seed (5.71 ml)	0	0	0	0	0
	Thiamethoxam Cruiser 35 FS @ 3 ml a.i. kg^{-1} seed (8.60 ml)	0	0	0	0	0
	Thiamethoxam Cruiser 35 FS @ 6 ml a.i. kg^{-1}seed (17.14 ml)	0	0	0	0	0
	Thiamethoxam Cruiser 35 FS @ 12 ml a.i. kg^{-1}seed (34.28 ml)	0	0	0	0	0
	Untreated control	0	0	0	0	0
7th day	Thiamethoxam Cruiser 35 FS @ 2 ml a.i. kg^{-1} seed (5.71 ml)	0	0	0	0	0
	Thiamethoxam Cruiser 35 FS @ 3 ml a.i. kg^{-1} seed (8.60 ml)	0	0	0	0	0
	Thiamethoxam Cruiser 35 FS @ 6 ml a.i. kg^{-1} seed (17.14 ml)	0	0	0	0	0
	Thiamethoxam Cruiser 35 FS @ 12 ml a.i. kg^{-1} seed (34.28 ml)	0	0	0	0	0
	Untreated control	0	0	0	0	0
10th day	Thiamethoxam Cruiser 35 FS @ 2 ml a.i. kg^{-1} seed (5.71 ml)	0	0	0	0	0
	Thiamethoxam Cruiser 35 FS @ 3 ml a.i. kg^{-1} seed (8.60 ml)	0	0	0	0	0
	Thiamethoxam Cruiser 35 FS @ 6 ml a.i. kg^{-1} seed (17.14 ml)	0	0	0	0	0
	Thiamethoxam Cruiser 35 FS @ 12 ml a.i. kg^{-1}seed (34.28 ml)	0	0	0	0	0
	Untreated control	0	0	0	0	0
15th day	Thiamethoxam Cruiser 35 FS @ 2 ml a.i. kg^{-1} seed (5.71 ml)	0	0	0	0	0
	Thiamethoxam Cruiser 35 FS @ 3 ml a.i. kg^{-1} seed (8.60 ml)	0	0	0	0	0
	Thiamethoxam Cruiser 35 FS @ 6 ml a.i. kg^{-1} seed (17.14 ml)	0	0	0	0	0
	Thiamethoxam Cruiser 35 FS @ 12 ml a.i. kg^{-1} seed (34.28 ml)	0	0	0	0	0
	Untreated control	0	0	0	0	0
30th day	Thiamethoxam Cruiser 35 FS @ 2 ml a.i. kg^{-1} seed (5.71 ml)	0	0	0	0	0
	Thiamethoxam Cruiser 35 FS @ 3 ml a.i. kg^{-1}seed (8.60 ml)	0	0	0	0	0
	Thiamethoxam Cruiser 35 FS @ 6 ml a.i. kg^{-1}seed (17.14 ml)	0	0	0	0	0
	Thiamethoxam Cruiser 35 FS @ 12 ml a.i. kg^{-1} seed (34.28 ml)	0	0	0	0	0
	Untreated control	0	0	0	0	0

Score : 0 = No adverse effect (No Phytotoxicity
10 = Complete adverse effect (100% Phytoxocity)

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Efficacy of Helicide TM Against *Helicoverpa armigera* on Tomato

Tomato (*Lycopersicon esculentum* Miller) is one of the most popular and widely grown vegetable fruit crop in India cultivated in almost all the states occupying 0.50 million hectare with annual productionof 8.5 million tonnes (Anonymous 2002a). In Maharashtra this crop is grown on an area of 30, 620 hectares producing 4.87 lakh tonnes (Anonymous, 2002 b). This crop is attacked by an array of various pests. The major one is *Helicoverpa armigera* (Hub). Causing losses to the fruits at various stages.

The experiment was carried out Chilli and Vegetable Research Unit, Central Research Station, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) during *Kharif* 2003. The trial was laid out in Randomized Block Design with four replications. Thirty five days old seedlings of Pusa rubi variety were raised on seed bed and as recommended by the University and transplanting. Interculture operations were carried out as per recommendation of university for this crop. Five plants were selected randomly and labeled from each plot and observations on fruit borer damage was recorded.

Table 1. Average per cent larval reduction of tomato fruit borer after 5 and 7 DAS

S.N.	Treatments	Larval reduction after	
		5 DAS	7 DAS
1.	Helicide 250 ml ha^{-1}	27.35	50.83
		(31.39)	(45.47)
2.	Helicide 375 ml ha^{-1}	37.77	65.03
		(37.83)	(53.64)
3.	Helicide 500 ml ha^{-1}	43.47	79.99
		(41.22)	(63.89)
4.	Endosulfan 35 EC 2 ml L^{-1}	49.54	61.97
		(44.60)	(51.96)
5.	Untreated control	14.49	21.60
		(21.60)	(26.70)
	'F' Test	Sig	Sig
	SE (m)±	2.423	2.336
	CD at 5%	6.805	6.560
	CV%	13.715	9.668

Figures in parentheses are arcsin values

In all three sprayings were under taken with an interval of 10 days. First spray was given as soon as incidence of borer was observed on fruits. Pretreatment observations on larval population of *Helicoverpa* were recorded one day before spraying and post treatment at 5 and 7 days after application of treatments.

Per cent larval reduction

For reducing the fruit borer indicence on 5th and 7th day of spraying all the treatments were significantly superior over untreated control on fifth day of treatment, endosulfan 35 EC @ 2 ml^{-1} highest larval reduction of 49.54 per cent was recorded. however, it was at par with the treatment Helicide 500 ml ha^{-1} (43.47%) and 375 ml ha^{-1} (37.77%). In lower dose of Helicide significantly more larval reduction over untreated control (14.49 %) was recorded on 7th DAS treatment. Helicide 500 ml ha^{-1} was found significantly superior over all the treatments contributing the highest per cent larval reduction (79.99%). Treatment Helicide 375 ml ha^{-1} and endosulfan 35 EC 2 ml l^{-1} registered larval reduction of 65.03 and 61.97 per cent, respectively and both are equally effective. Lower dose of Helicide 250 ml ha^{-1} though registered less per cent larval reduction (50.83) it was significantly superior to control treatment.

Infestation of fruit borer

All the treatments were significantly superior over untreated control in reducing the infestation of tomato fruit borer (Table 1). The treatment of HaNPV (Helicide) at higher dose of 500 ml ha^{-1} was more effective against fruit borer infestation recording least fruit dmage on number basis (4.92%) and weight basis (7.17%). Application of Helicide at 375 ml ha^{-1} was the next superior treatment (7.74%) and was at par with the insecticide endosulfan 35 EC @ 2 ml l^{-1} (8.28%) and the lower dose of Helicide @ 250 ml ha^{-1} (8.75%). The similar trend was observed for infestation on weight basis.

Highest yield of tomato fruits (16.97 q ha^{-1}) was obtained in Helicide application at 500 ml ha^{-1}, followed by 375 ml ha^{-1} (15.09 q ha^{-1}) and both the treatments were at par with each another. Helicide application at 250 ml ha^{-1} (13.87 q ha^{-1}) was at par with insecticidal treatment endosulfan @ 2 ml l^{-1} in which (11.58 q ha^{-1}) fruits were harvested.

Table 2. Effect of treatment on infestation of tomato fruit borer at 7 DAS and yield of tomato fruits

S.N.	Treatments	Larval reduction after		Yield q ha^{-1}
		Number basis	Weight basis	
1.	Helicide 250 ml ha^{-1}	8.75	12.58	13.87
		(17.16)	(20.76)	
2.	Helicide 375 ml ha^{-1}	7.74	10.71	15.09
		(16.11)	(19.11)	
3.	Helicide 500 ml ha^{-1}	4.92	7.17	16.97
		(12.67)	(15.52)	
4.	Endosulfan 35 EC 2 ml L^{-1}	8.28	12.01	11.58
		(16.67)	(20.27)	
5.	Untreated control	36.63	37.68	4.76
		(37.24)	(37.86)	
	'F' Test	Sig	Sig	Sig
	SE (m) ±	0.438	0.433	1.082
	CD at 5%	1.232	1.217	3.032
	CV%	4.401	3.818	16.254

Figures in parentheses are arcsin values

The results obtained during the present investigation as regard to the impact of HaNPV and endosulfan against fruit borer of tomato are in conformity with results reported by mehetre and Solunke (1998), who observed 22.8 and 7.2 per cent damaged fruits in the treatment of HaNPV and endosulfan, respectively as against 43.9 per cent infested fruits in an untreated control. While Gajendra *et. al.*, (1999) observed that the minimum damage to the fruits due to *Helicoverpa* in the treatment of endosulfan 0.05 (2.71%) and HaNPV @ 250 LE ha^{-1} (3.33%). Pokharkar *et. al.*, (1999) found that HaNPV @ 500 LE ha^{-1} dose was as effective as when it was used in higher dose i.e. 700 LE ha^{-1} which gave better protection to tomato crop from *H. armigera* to 98.25-100.00 per cent reduction in larval population, 6.89 per cent mean fruit damage and 53.64 kg plot^{-1} (4 m x 5 m) mean marketable fruit yield.

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Viability of *Fusarium udum* and Inoculum Potential Required for Pigeonpea Wilt in Sick Soil

Pigeonpea wilt is widely prevalent in India and causes severe losses especially in Maharashtra, Madhya Pradesh, Uttar Pradesh and Bihar during *Kharif* season *Fusarium udum* is a heterogenous and cosmopolitan organism and survive in the form of spore, chlamydospore and mycelial bits for more than three years in the absence of pigeonpea. The pathogen is capable of causing infection to the plant at any stage of its growth but symptoms are more pronounced when crop is at the flowering and podding stage i.e. from October-November onwards. The wilting may be complete or partial depending on the infection of root and plant can tolerate certain population of pathogen. Looking to the earlier potential and data of wilt sick plot affecting more than 90per cent plants, studies were initiated to know the role of soil moisture, temperature and depth in the survival of the pathogen and to ascertain the inoculum load for maximum wilt in pigeonpea.

The experiment was conducted at Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. Estimation of propagules of *Fusarium udum*, soil temperature, and moisture at different depth 0, 10, 20 and 40 cm was recorded periodically from June, 2003 to January, 2004. The prescribed methodology was adopted for assessing inoculum density of *Fusarium udum* in sick soil.

Effect of inoculum density

The field soil was autoclaved 30 minutes for two successive days. Mass culture multiplied on sorghum grain and was mixed with the soil in different proportion and incubated for seven days. Seeds of highly susceptible pigeonpea cultivar TAT-10 were sown in 30 cm diameter earthen pots. Total 30 plants were under study in each treatment. Initial inoculum proportion were 5, 10, 25, 50, 75 and 100 g ka^{-1} grown on sorghum grain for seven days and mixed in sterilized soil. The presence of inoculum was assessed before sowing and 90 and 105 days after sowing. The wilting symptoms and mortality was observed periodically and the rate of multiplication was also assessed.

Soil moisture per cent and soil temperature at different depths plays an important role on existence of *Fusarium udum*. Soil moisture (W/W) was ranged between 3.13-29.29 per cent (Table 1). Average soil moisture i.e. 28.30 followed by 27.04 per cent was recorded during September and October with maximum propagules i.e. 3.66 and 3.1X 10^4 cfu^{-1} g soil, respectively. The

Table 1. Influence of moisture (%) monthly at different depth on *Fusarium udum* population

Month	Moisture				Mean	Cfu x 10^{4-1}g				Mean
	0cm	10 cm	20 cm	40cm		0cm	10cm	20cm	40cm	
June, 03	3.30	3.41	3.13	3.77	3.40	0.66	1.33	1.33	-	0.83
July	27.16	27.88	24.03	20.65	24.93	4.00	4.00	2.66	1.33	2.99
August	26.74	28.20	27.55	25.18	26.91	2.00	3.33	3.33	3.33	2.99
Sept.	26.90	29.23	29.19	27.87	28.30	3.33	4.66	4.00	2.66	3.66
October	23.45	29.17	29.29	26.26	27.04	2.00	4.00	4.00	2.66	3.16
November	17.92	21.45	22.15	20.25	20.44	-	3.33	3.33	-	1.66
December	10.79	12.10	13.89	13.45	12.56	1.33	5.66	2.66	-	1.66
January, 04	14.18	12.11	11.60	11.51	12.35	1.33	2.66	2.66	1.33	1.99
February	8.03	10.20	11.16	11.60	10.25	1.33	1.33	2.00	0.66	1.33
					Mean	1.77	3.03	2.88	1.33	

Table 2. Effect of soil temperture at different depth on population of *F. udum*

Month	Moisture				Mean	Cfu x 10^{4-1}g				Mean
	0cm	10 cm	20 cm	40cm		0cm	10cm	20cm	40cm	
June, 03	37.10	35.50	32.70	31.80	34.27	0.66	1.33	1.33	-	0.83
July	33.10	31.20	30.90	32.90	32.02	4.00	4.00	2.66	1.33	2.99
August	31.10	27.70	28.20	26.90	28.47	2.00	3.33	3.33	3.33	2.99
Sept.	31.30	28.30	28.40	27.00	28.75	3.33	4.66	4.00	2.66	3.66
October	31.90	29.00	27.40	27.80	29.02	2.00	4.00	4.00	2.66	3.16
November	30.90	28.20	28.40	26.80	28.57	-	3.33	3.33	-	1.66
December	17.20	18.20	20.10	21.10	19.15	1.33	5.66	2.66	-	1.66
January, 04	16.20	17.40	19.30	20.00	18.22	1.33	1.33	2.00	1.33	1.99
February	17.70	19.30	21.30	21.90	20.05	1.33	1.33	2.00	0.66	1.33
					Mean	1.77	3.03	2.88	1.33	-

minimum population was estimated on surface soil as the soil moistue was low during June. Retention of more numbers of *Fusariyum* colonies was recorded in the soil regimes of 10 to 20 cm depth i.e. 3.03 and 2.88 x 10^4 $cfu^{-1}g$ soil. Naik *et. al.*, (1997) reported the existence of higher population at 10 and 20 cm and declined at 0 to 40 cm depth. The findings of Chaudhary *et. al.*, (2001) confirms the present investigation that 15 cm stratum invariably had highest while lower at 30-45 cm Attitalla *et. al.*, (1998) also recorded highest tomato wilt at 30 per cent moisture.

Soil temperature prevailed during September and October i.e. 28.75 and 29.02°C (Table 2) had shown profound effect on existence of average 3.66 and 3.16 x 10^4 $cfu^{-1}g$ of *Fusarium undum*. Minimum population was noticed at surface soil during June and it was declined from November to February i.e. 0.83-1.99 x 10^4 $cfu^{-1}g$ Chuang and Su (1988), Dasgupta and Gupta (1993) reported that 25-31°C as an optimum for growth of *Fusarium udum*.

Inoculum load and its virulence to cause the wilt is an important factor (Table 3) results indicated that initial population after seven days of incorporation of inoculum was between the range of 2 to 22 x 10^4 $cfu^{-1}g$ soil in different tested proportion in order to know the

Table 3. Survival of *F. udum* under different inoculum load (cfu x 10^4 g^{-1})

S.N.	Treatments (Proportion of inoculum) *F. udum*	Initial population	90 days after incorporation	Rate of multiplication (0-90 days)	105 days incorporation	Rate of multiplication 90 days	Days for iniation of wilting	% wilt
1.	5 g kg^{-1} soil	2 x 10^4	36 x 10^4	18.00	40 x 10^4	1.11	62	46.66
2.	10 g kg^{-1} soil	3.33 x 10^4	40.66 x 10^4	12.21	42 x 10^4	1.03	56	50.00
3.	25 g kg^{-1} soil	4.66 x 10^4	43.33 x 10^4	9.29	48.66 x 10^4	1.12	45	63.33
4.	50 g kg^{-1} soil	12.66 x 10^4	28.00 x 10^4	2.21	35.33 x 10^4	1.26	42	63.33
5.	75 g kg^{-1} soil	17.33 x 10^4	32.66 x 10^4	1.88	38.66 x 10^4	1.18	17	100.0
6.	100 g kg^{-1} soil	22 x 10^4	37.33 x 10^4	1.70	40.66 x 10^4	1.09	17	100.0
7.	Sterilized soil	-	-	-	-	-	-	0.00

Table 4. Correlation co-efficient (r) values of moisture per cent and temperature with cfu x 10^4 of *F. udum* at different depth (June-February).

	Cfu x 10^4 of *Fusrium udum*			
	0 cm	10 cm	20 cm	40 cm
Soil moisture	0.703*	0.922**	0.911**	0.767*
Soil temperature	0.218*	0.241	0.064	0.129

* Significant at 5% ** Significant at 10%

rate of multiplication. The multiplication ratio was estimated after 90 and 105 days. After 90 days maximum (18.00) rate was noted in 5 g while minimum (`1.700 in 100 g kg^{-1} soil, reduction might be due to competition. The findings reported by Zote *et. al.*, (1996), Naik *et. al.*, (1997) confirms the present studies. it is revealed that propagules of *Fusarium udum* between the range of 32.66-37.33 x 10^4 $cfu^{-1}g$ after 90 days with initial 17.33-22 x 10^4 $cuf^{-1}g$ soil could result into 100 per cent mortality. Inoculum @ 75 and 100 g^{-1} kg yielded 32.66 and 37.33 x 10^4 $cfu^{-1}g$ resulted in 100 per cent wilting and initiation of wilting also recorded after seventeen days while at lower doses wilting initiated 42 days after sowing.

Correlation analysis (Table 4) revealed the significance with the *Fusarium udum* population though contributory effect of soil moisture and temperature exhibited positive correlation but soil moisture exhibited significant while non significant with temperature for retaining the viability.

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Reaction of Some Groundnut Genotypes Against Powdery Mildew Disease

Powdery mildew (*Oidium arachidis* Chorin) has been reported in many countries like Mauritius, Israel, Portugal, Tanganyika and India on groundnut. The first incidence of powdery mildew on groundnut in India was reported on Spanish varieties during *Kharif*,1986 at NRCG, Junagadh by Ghewande & Reddy (1987). But so for this disease was not reported in Maharashtra state. During the *Rabi* season of 1999-2000,this disease was noticed on F_3 generation of cross ICGV-86031 X TAG-24 at Oilseeds Research Station , Jalgaon. The first record of this disease was noticed in February, 2000, when the *Rabi* sown crop was at pod maturity stage Subsequently, this disease was reported in the month of February of 2002, 2003 and 2004 in research fields at Jalgaon as well as in farmers' fields.(Anno.2000& Anno. 2004). The incidence of powdery mildew was moderate to severe in various *Rabi*/ Summer season. The development of the disease in groundnut are as white floury patches on upper surface of leaflet. These patches were found to originate as dull minute discolored speck from which a powdery mass radiated on all side. The centre of the spot later become brown and necrotic. (Smith,1984 , Subrahmanyam *et al.*1992) . There were no reports of screening of groundnut varieties/ cultivars/ genotypes for their relative resistance and susceptible for powdery mildew under natural field condition. An attempt was made to screen water use efficient genotypes of groundnut for reaction to powdery mildew disease under natural epiphytic conditions during *Rabi* 2002-03 at Oilseeds Research Station , Jalgaon.

The experiment was conducted during *Rabi* 2002-2003 at Oilseeds Research Station, MPKV, Jalgaon. Twenty one entries including three varieties of Spanish bunch and fifteen entries including two varieties of Virginia type were sown on 7th Oct. 2002 in RBD with three replications .Each genotype was sown in two rows of 4 m length at 30X 10 cm spacing. The crop management practices were applied as per recommended schedule. The first incidence of powdery mildew was observed at 40 days after sowing (DAS). The data on per cent disease intensity of powdery mildew on five randomly selected plants were recorded as per Mayee & Datar (1989). The final observations were recorded at pod maturity stage of the crop(110 DAS). Dry pod yield of each genotypes was recorded. The meteorological data during growth period of the crop (October 02 to Jan. 03) was reported . The data was analyzed to test the statistical significance of the disease intensity and dry pod yield of various genotypes.

Powdery mildew is a very minor and not a regular disease of groundnut However, this disease have been regularly observed since 2000 in *Rabi* sown crop in Jalgaon district. The data on per cent intensity of Powdery mildew on Spanish bunch and Virginia bunch type are presented in Table 1. During *Rabi* 2002-2003, incidence of powdery mildew was moderate to severe on some genotypes tested under WUE experiment. The Powdery mildew intensity was comparatively lower in Virginia types than Spanish bunch. The per cent disease intensity (PDI) in Spanish bunch was in the range of 0.1 to 40.0 per cent. Meager to low intensity was noticed on JALW-46,JALW-43, JL-501,TAG-24,JALW-48,JALW-23 and JALW-20 (0.1 to 10.0%). Severe incidence was seen on JALW-10, JALW-12, JALW-38, JALW-41 & JALW-42.In Virginia types , the entries exhibited low infection ranging from 0.1 to 10.0 per cent. From the Table1 it was revealed that the dry pod yield differences among the Spanish bunch and Virginia bunch genotypes were significant . The genotype JL-501 & JALW-47of Spanish bunch and JALW-30,JALW-06,JALW-15 and JALW-05 of Virginia bunch recorded significantly higher yield than checks (Table 1) is the effect of pod yield potential of due to different genotypes.

An overview of these findings and discussion, it is clear that although this disease is of minor importance in Maharashtra state today, it may cause epidemic in future in *Rabi* / summer sown groundnut crop. The highly resistant genotypes could be used as donors in breeding programme for developing Powdery mildew resistant varieties of groundnut.

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Table-1: Highest per cent intensity of powdery mildew & dry pod yield of groundnut in kg ha^{-1}

	Spanish type				Virginia type		
S. N.	Genotypes	%intensity of powdery mildew	Dry pod yield kg ha^{-1}	S. N.	Genotypes	%intensity of powdery mildew	Dry pod yield kgha^{-1}
1	JALW-07	20.0(3.73*)	1594	1	JALW-05	2.0(1.39)	3362**
2	JALW-08	20.0(3.73)	1605	2	JALW-06	5.0(1.62)	3392**
3	JALW-09	20.0(3.44)	2105	3	JALW-13	0.1(1.04)	2749
4	JALW-10	30.0(4.71)	2208	4	JALW-15	5.0(1.86)	3362**
5	JALW-11	5.0(2.20)	1944	5	JALW-17	2.0(1.62)	2690
6	JALW-12	30.0(5.23)	2119	6	JALW-18	2.0(1.73)	3158
7	JALW-20	10.0(3.02)	1638	7	JALW-26	1.0(1.16)	3275
8	JALW-21	20.0(3.96)	1725	8	JALW-27	0.1(1.04)	2383
9	JALW-23	5.0(2.20)	1813	9	JALW-29	0.1(1.04)	2090
10	JALW-38	30.0(4.90)	1798	10	JALW-30	1.0(1.41)	3801**
11	JALW-39	20.0(3.44)	1433	11	JALW-32	0.1(1.04)	2617
12	JALW-41	40.0(5.84)	2265	12	JALW-33	1.0(1.16)	2193
13	JALW-42	30.0(5.40)	1623	13	JALW-35	5.0(1.75)	2909
14	JALW-43	1.0(1.16)	1462	14	ICGS-76	2.0(1.62)	2397
15	JALW-44	10.0(2.15)	2047	15	ICGV-86325	10.0(2.73)	2456
16	JALW-46	0.1(1.04)	2076				
17	JALW-47	5.0(1.75)	2485**				
18	JALW-48	2.0(1.51)	1564				
19	JL-501	1.0(1.28)	2866**				
20	TAG-24	1.0(1.28)	1974				
21	SBXI	20.0(3.44)	1754				
	CD=p=0.05	0.85	344.9	CD=p=0.05		0.99	526.3

*Square root value of per cent mean intensity ** Significant at 5 %

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Economics of Different Farming Technologies in Amravati District

Now a day only crop production does not fulfill the requirements of the farmer. So, the concept of combination of different farming system come forward which completely secure the farmer from different calamities. Farming system represents an appropriate combination of different farm enterprises viz. cropping systems, livestock, horticulture, forestry, poultry, piggery, fisheries and goat rearing etc. and the means available to the farmer to raise their profitability. All components of farming system are interrelated to each other. This combination of different farming system gives permanent earning and employment opportunities to the farmers and improves the standard of living. Therefore, the economists are attracted towards this concept. In the present investigation, an attempt was made to study the economics of different farming technologies in Amravati district. The specific objectives of the present study were

i) To study the comparative economics of different farming system.

ii) To find out the contribution of each subsidiary enterprise in total farm income.

Five villages were purposively selected from Amravati and Bhatkuli Tahsils of Amravati district and from these villages, 120 cultivators were selected ramdomly who followed the different farming system viz. crop farming, crops + dairy, crops + poultry, crops + oranges cultivation. The relevant data from the selected cultivators were collected through individual contact method. The data pertains to the year 2002-2003. Simple tabular analysis was carried out to accomplish the ojbectives of the study.

Land Utilization Pattern : It is indicated that the area available for cultivation, gross cropped area and intensity of cropping. On an average per farm land holding was found to be 7.35 hectares. The total land holding varied from 4.56 hectares in case of poultry farmers to 10.85 hectares in case of crop growing farmers only. The net sown area per farm ranges from 4.40 to 10.64 hectares and area sown more than once was 1.00 to 3.73 hectares.

The area under irrigation in crop, dairy, orange,dairy + orange, poultry + orange and dairy + poultry + orange group was 0.94, 0.07, 1.93, 1.85, 1.80 and 1.87 hectares, respectively. In case of poultry and goat group, there was no irrigated land. The average intensity of cropping was recorded as 127.19 per cent. In case of crop group, the cropping intensity was highest i.e. 135.05 per cent. The overall average cropping intensity in study area was too small because of inadequate irrigation facilities.

Cropping pattern under different farming system (2002-03)

The area under *Kharif* crop ranges from 4.40 to 10.64 hectares, respectively. Among the *Kharif* season cotton, mung and soybean were major crops of the area as they occupied 32.86 per cent, 15.73 per cent and 17.68 per cent of the total area, respectively. In *Rabi* season, wheat and gram were dominating crops and they occupied 2.49 per cent and 19.20 per cent of the total area, respectively.

In case of crop + orange, crop + dairy + orange, crop + poultry + orange and crop + diary + poultry + orange groups, the area under orange was 1.93 hectares (19.71%), 1.80 hectares (16.52%), 1.73 hectares (20.94%) and 1.87 hectares (16.80%) of the total area, respectively.

Livestock position in different farming systems :

Livestock provides draft power for various farm operations and also provides family income by way of milk production and supply of manures etc. The average number of bullock per farm were 2.66 on crop + diary + orange farm, 2.13 on the crop + orange farm and lowest i.e. 1.60 on the crop + poultry farm. The average number of buffaloes per farm were 4.13 on the crop + dairy farm, 4.13 on the crop + diary + orange farm and lowest 3.40 on the crop + diary + poultry + orange farm.

The average investiment of livestock per farm on the crop + diary + orange farm were Rs. 64,440.58 which was highest and followed by Rs. 63,278.37 on the crop + dairy + poultry + orange farm. Rs. 61,375.96 on the crop + diary farm Rs. 19,817 on the crop farm and lowest of Rs. 10,557.60 on the crop + goat farms.

Per hectares net income from different farming system:

The study on different farming systems in the selected area of Amravati district revealed that the highest ha^{-1} net returns were obtained from crop + diary + poultry +

orange farming system which were estimated to Rs. 24,076,.26 and of which the contribution of crop to the total net income was 36.42 per cent. The contribution of subsidiary enterprises to the total net income was estimated to 63.58 per cent.

The second highest income generating farming system was crop + poultry + orange giving net return of Rs. 23,850.43. Per hectares net income from crop + poultry was Rs. 20,426.73, crop + diary + orange was Rs. 19,878.27, crop + poultry + orange was Rs. 19,793.53, crop + goat was Rs. 18,956.34, crop + diary was Rs. 13,663.67 and the lowest income generating farming system was crop farming i.e. Rs. 10,674.94.

Output-Input ratio under different farming system : The study of output-input ratio revealed that the highest output-input ratio was found in crop + orange (1:1.82) followed by crop + goat (1:1.64), crop + diary (1:1.52), crop + diary + orange (1:1.48), crop + poultry + orange (1:1.44), crop + diary + poultry + orange (1:1.41), crop + poultry (1:1.29) and the lowest cost estimated in crop farming (1:1.21). So this study clearly indicates that the output-input ratio was greater than unity in all farming systems. Cultivation of crops and subsidiary enterprises i.e. diary, poultry, orange and goat together were more profitable than cultivatng crops only.

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Effect of Long Term Integrated Nutrient Management on N-Fractions in Vertisols

Sorghum (*Sorghum vulgure*) is the most important cereal food grain crop of India. In order to exploit full potential of high yielding varieties, application of proper doses of fertilizers in proper way at a proper time is necessary. Particularly nitrogenous fertilizers are subjected to leaching and volatilization losses.

The present investigation was undertaken during the year 2003-2004 on the long term fertilization experiment started since 1988. Seven treatments replicated four times in a randomized block design comprised of NPK levels with and without FYM as given in Table 1.

The soil of the experimental site was characterized as Vertisols. The soil was slightly alkaline in reaction, medium in organic carbon, low in available nitrogen and phosphorus and high in available potassium. Nitrogen fractions were determined by inorganic forms of N and organic forms of N were determined as per the procedure suggested by Cheng and Kurtz (1963).

The data presented in Table 1 in respect of N in soil revealed that before sowing of sorghum the relative abundance of N fractions in soil were in the order of insoluble humin-N > Hydrolyzed NH_4^+- N + amino sugar – N > amino acid soluble humin-N > fixed NH_4^+ - N > NO_3^- - N > exchangeable NH_4^+ - N and contributed 21.8 – 28.19 per cent, 16.98 –18.99 per cent, 12.29-15.97 per cent, 11.93-15.31per cent, 8.6-10.11per cent, 8.26-9.79 per cent and 8.2-9.48 per cent of total N,

Table 1: Fractions of nitrogen (mg 100 g^{-1} soil) before sowing of sorghum as influenced by long term fertilization

Treatments	Exch. NH_4^+-N	NO_3^- - N	Fixed NH_4^+ - N	Hydro. $NH_4^+N^+$ Amino sugar-N	Amino acid –N	Acid soluble humin –N	Insoluble humin-N	Total nitrogen
T_1 – Control	3.14	3.47	3.45	6.39	5.39	4.31	10.18	36.10
	(8.49)	(9.61)	(9.55)	(17.70)	(14.93)	(11.93)	(28.19)	
T_2 – 100% RD N	3.50	3.63	3.63	7.55	6.03	6.01	10.56	42.18
	(8.29)	(8.60)	(8.60)	(17.89)	(14.29)	(14.24)	(25.03)	
T_3 – 100% RD NP	3.75	3.76	4.14	8.24	6.57	6.31	10.79	43.56
	(8.60)	(8.63)	(9.50)	(18.91)	(15.08)	(14.48)	(24.77)	
T_4 – 100% RD NPK	4.30	4.35	4.38	8.58	7.69	7.02	11.40	50.53
	(8.50)	(8.60)	(8.66)	(16.98)	(15.21)	(13.89)	(26.17)	
T_5 – 150% RD NPK	4.93	4.65	4.94	9.45	8.30	7.96	11.65	51.98
	(9.48)	(8.94)	(9.50)	(18.18)	(15.96)	(15.31)	(22.41)	
T_6 – 100% RD NPK + 10 t FYM ha^{-1}	5.37	5.68	5.11	11.01	9.26	8.33	12.22	57.96
	(9.26)	(9.79)	(8.81)	(18.99)	(15.97)	(14.37)	(21.08)	
T_7 – 10 t FYM ha^{-1}	3.51	3.53	4.32	8.04	6.42	6.24	10.36	42.71
	(8.21)	(8.26)	(10.11)	(18.82)	(15.03)	(14.61)	(24.25)	
SE(m)±	0.11	0.10	0.18	0.13	0.20	0.06	0.08	1.21
CD at 5%	0.31	0.29	0.51	0.38	0.57	0.16	0.24	3.40
Mean	4.07	4.15	4.28	8.46	7.09	7.44	11.02	46.43
% contribution to total N	8.76	8.94	9.22	18.23	15.27	16.02	23.73	

(Figures in parentheses indicate the % contribution of N fraction to total nitrogen)

respectively. Significantly all forms of N were recorded with the application of 100per cent RD, NPK along 10 t FYM ha^{-1}. The highest content of forms of N viz., exch. NH_4^+ - N, NO_3^- - N, fixed NH_4^+ - N, hydrolysable NH_4^+ - N, amino acid – N and acid soluble humin – N was observed with the treatment of 100 per cent RD NPK + FYM while the least content of these fractions were in the control. As increase in the rate of applied N was found to be associated with an increase in the build up of total N and available N and also the organic matter content in soil (Santhy *et al.*, 2001). Similar trend was noticed by Ravankar *et al.* (1998).

The data in respect of forms of N in soil after harvested of sorghum are presented in Table 2. The relative abundance in soil were in the order of insoluble humin-N > hydrolyzed NH_4^+ - N amino sugar – N > amino acid – N > acid soluble humin – N > fixed NH_4^+ - N > NO_3^--N > Exch. NH_4^+ - N. Significantly highest forms of N were recorded with the application of 100 per cent RD NPK along with 10 t FYM which was followed by 150 per cent RDF NPK and lowest forms of N were observed in control plot. The highest content of the forms of N viz. Exch. NH_4^+ - N, amino acid – N hydrolysable – N soluble humin –N and insoluble humin N was observed in the treatment 100per cent RD NPK with FYM while least concentration of these fraction were in control plot.

It was observed that the soil under study contained nearly 73.75 per cent of total N in organic forms which on mineralization may serve as an important pool for soil available nitrogen. Duran and Blasco (1972) reported 84.90 per cent of total N as organic N. Similar trend was noticed in Vertisols by Puranik *et al.* (1978).

Table 2. Fractions of soil nitrogen (mg 100 g^{-1} soil) after harvest of sorghum as influenced by long term fertilization

Treatments	Exch. NH_4^+-N	NO_3^- - N	Fixed NH_4^+ - N	Hydro. $NH_4^+N^+$ Amino sugar-N	Amino acid –N	Acid soluble humin –N	Insoluble humin-N	Total nitrogen
T_1 - Control	3.25	5.59	3.60	6.45	5.44	4.34	10.21	36.88
	(8.85)	(9.73)	(9.76)	(17.48)	(14.75)	(11.76)	(27.68)	
T_2 - 100% RD N	3.60	3.66	3.74	7.64	6.16	6.13	10.57	41.52
	(8.67)	(8.81)	(5.00)	(18.42)	(14.83)	(14.76)	(25.45)	
T_3 - 100% RD NP	3.76	3.78	4.26	8.32	6.61	6.41	10.81	43.97
	(8.55)	(8.59)	(9.68)	(18.92)	(15.03)	(14.57)	(24.58)	
T_4 - 100 RD NPK	4.77	4.52	4.78	8.63	7.71	7.11	11.46	46.61
	(10.11)	(9.69)	(10.25)	(18.51)	(16.54)	(11.25)	(24.58)	
T_5 - 150% RD NPK	5.32	4.86	5.12	9.48	8.35	6.10	11.69	47.83
	(11.11)	(10.15)	(10.70)	(19.81)	(17.45)	(12.74)	(24.43)	
T_6 - 100% RD NPK + 10 t FYM ha^{-1}	5.42	5.73	5.42	11.21	9.29	8.36	12.26	57.71
	(9.19)	(9.92)	(9.39)	(19.42)	(16.09)	(14.48)	(21.24)	
T_7 - 10 t FYM ha^{-1}	3.56	3.72	4.42	8.21	6.47	6.29	10.40	43.08
	(8.26)	(8.63)	(10.25)	(19.05)	(15.01)	(14.60)	(24.14)	
SE(m)±	0.10	0.16	0.14	0.08	0.31	0.17	0.11	1.31
CD at 5%	0.28	0.46	0.51	0.25	0.90	0.51	0.35	3.69
Mean	4.24	4.55	4.47	8.56	7.14	6.89	11.05	45.36
% contribution to total N	9.34	10.03	9.85	18.57	15.74	14.08	24.36	

(Figures in parentheses indicate the % contribution of N fraction to total nitrogen)

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Studies on Evaluation of Sugarcane Planters

Sugarcane planting is one of the labour intensive operations in sugarcane culture. Planting of sugarcane is tedious, time consuming and expensive operation. it involved opening of furrows, proper placement of sugarcane setts and fertilizer, covering of sugarcane setts and fertilizer with soil (Shukla and Tandon, 1984). There is an urgent need to mechanize these operations fully or partially in order to cut down man-h to reduce operational cost. Timely operation and drudgery involved have forced sugarcane growers to think of the use of machines for planting sugarcane.

All the operations involved in sugarcane planting viz. openint of furrows, dropping of setts, placement of fertilizer and covering of setts with soil are accomplished in single pass by sugarcane planter and covering the setts with oil are accomplished in single pass by sugarcane planter (Sharma and Kishan Singh, 1990). The present study was undertaken on farmers fields to assess the performance of the sugarcane planters.

The performance of tractor drawn semiautomatic drum type sugarcane planter and automatic whole stick cutter, planter was evaluated for its feasibility.

Similarly, the test results obtained from these two planters were also compared with conventional planting method.

The two-row drum type sugarcane planter is a semiautomatic type planter. It consists of on sturdy frame accommodating two revolving drums, fertilizer box, seed box, furrow openers, ground wheel and covering devices. In this planter, pre-cut sugarcane setts of desired length (35-40 cm) are fed to the machine.

The two-row whole stick cutter type planter is automatic type planter which consists of one sturdy frame accommodating furrow opening unit, seed metering mechanism with setts cutting unit, fertilizer box and insecticide tank. One pair of chute is also attached to main frame for dropping the setts. The whole sugarcanes are fed to the machine.

The results obtained are summarised as below

1) The effective field capacity was observed to be 0.15 ha h^{-1} and 0.18 ha h^{-1} for semiautomatic drum type and automatic whole stick cutter planter, respectively.
2) The total time required to plant 1 ha area by semiautomatic drum type planter, and automatic cutter planter were 6.30 h and 5.15 h, respectively.
3) Man-h requirement for planting 1 ha sugarcane area with semiautomatic planter, automatic planter and conventional method were 52, 21 and 264, respectively.
4) Cost of planting ha^{-1} comes out to be Rs. 1653.73, Rs. 1382.85 and Rs. 1720 for semiautomatic planter, autmatic planter and conventional method, respectively.
5) Tractor operated planters can be successfully used for planting sugarcane crop.
6) Whole stick cutter planter was more appreciated by the farmers in comparison with drum type planter.

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Effect of Levamisole Treatment on Haematological Parameters in Induced Immunosuppression in Broiler Birds

Decreased immunity in poultry birds causes many losses including exposure to the infections diseases. Imbalance in haemopoeitic system leading to decrease in red blood cells and white blood cells resulting directly to the decrease in defense mechanism of the birds. Decreased immunity appears by many ways that are air pollution, water pollution and feed pollution due to pesticides which are very difficult to control. The internal parasites also helps in decreasing the blood cells and affect the defense mechanism of the body. Present study deals with the effect of levamisole, which is a drug known for anthelmenthic (Hogarth, *et. al.*, 1998) and immunomodulatory properties (Brunner and Charles, 1980 and Shrinivasa Rao *et. al.*, 1996).

Sixty broiler birds of 3 week age were divided equally and randomly intro three groups. These birds were maintained at standard in identical managemental Conditions at PGIVAS, Poultry Research Center, Akola.

First group was kept as normal control (T_1) i.e. without immunosuppresson and treatment. Second group was immunosupressed with cyclophosphamide @ 150 mg kg^{-1} body weight I/V once at 3 week of age and kept as untreated control i.e. immunosupressed but without treatment and last group of birds was immunosupressed and then treated with levamisole @ 2.5 mg kg^{-1} body wt. in feed from 28 to 42 days (5^{th} to 6^{th}) of age.

Collection of blood samples were done at the age of 4^{th} week (after immunosuppression) and 6th week (after treatment) for the estimation of TLC, lymphocytes, heterophils, basophils, monocytes, eosinophils, Hb and PCV. The estimation were made by the method described by Schalm (1975) and Natt and herrick (1954). Data collected was analyzed by standard statistical design as described by Snedecor Cochran (1994).

Table 1 indicating the effect of immuno suppression induced by cyclophosphamide producing significant decrease in total leucocytic count, eosinophils, Hb and PCV. Corrier *et. al.*, (1979) correlated the effect of cyclophosphamide on circulating leucocytes, lymphocytes, neutrophils and platelets with decrease in humoral and cellular immune responses indicating that the immune responses and circulating cells are positively correlated.

Administration of levamisole shows the positive effect on circulatory blood cells by significant increased in haemoglobin and packed cell volume at 6^{th} week of age. These changes occures in the broiler birds might be due to the effect of levamisole as an anthelmenthic action that ceases the blood sucking by internal parasites. Increase in TLC in present observation might be the result of restoration of normal functionof effector cells of cell mediated immunity that involves the induction of increased cyclic gunasonine monophosphate concentration in the cell in the required quantity, enhances the production of leucocytic cells (henessey *et. al.*, 1987). There was significant increase in lymphocytes at 6^{th} week of age in the birds treated with levamisole. As the drug levamisole is having a action of immunomodulation, enhancing the production of B-lymphocyte and T-lymphocyte evidence by increase in HI antibody titre (Sulochana *et. al.*, 1984 and Palanskii *et. al.*, 1990). In present investigation monocytes was significantly increased due to the effect of levamisole.

Overall result indicated that the drug levamisole is very effective for inducing the circulating cells in the body of broiler birds evidenced by significant increase in TLC, lymphocytes, monocytes, Hb and PCV.

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Table 1. Haematological changes in normal control (T_1) untreated control (T_2) and Levamisole treated (T_3) in broiler birds

Haematological	TLC (x 103 cm^{-1} m)		Lymphocyte (%)		Heterophil (%)		Monocyte (%)		Basophils (%)		Eosinophils (%)		Hb (gm %)		PCV (%)	
	4th wk	6th wk	4th wk	6th wk	4th wk	6th wk	4th wk	6th wk	4th wk	6th wk	4th wk	6th wk	4th wk	6th wk	4th wk	6th wk
(T_1) Normal	$35.9^a \pm$	$41.4^b \pm$	$58.16^a \pm$	$59^a \pm$	$31.50^a \pm$	$31.83^a \pm$	$6.60 \pm$	$6.83 \pm$	$0.50 \pm$	$0.33 \pm$	$2.66^b \pm$	$2.00^a \pm$	$9.26^b \pm$	$10.31^b \pm$	$22.5^a \pm$	$23.85^a \pm$
control	3.38	2.15	1.01	0.77	0.95	0.60	0.49	0.83	0.34	0.21	0.49	0.57	0.41	0.43	1.47	0.83
(T_2) Untreated	$30.33^a \pm$	$34.83^a \pm$	$60.33^a \pm$	$58.83^a \pm$	$31.50^a \pm$	$32.50^a \pm$	$6.66 \pm$	$6.50 \pm$	$0.83 \pm$	$0.66 \pm$	$1.00 \pm$	$1.16^a \pm$	$7.63^a \pm$	$7.90^a \pm$	$19.33^a \pm$	$20.5^a \pm$
control	4.72	4.10	1.76	1.16	1.17	0.99	1.02	0.99	0.30	0.21	0.36	0.47	0.24	0.44	1.02	1.58
(T_3) Levamisole	$33.83^a \pm$	$53.16^a \pm$	$55.83^a \pm$	$60.15^b \pm$	$31.66^b \pm$	$29.33^a \pm$	$6.33 \pm$	$7.50 \pm$	$1.16 \pm$	$0.83 \pm$	$1.83^b \pm$	$1.16^a \pm$	$8.35^a \pm$	$10.05^b \pm$	$20.66^a \pm$	$27.5^b \pm$
treated	4.72	4.10	3.01	1.74	1.87	1.05	0.91	0.61	0.40	0.54	0.65	0.47	0.28	1.05	1.05	0.95

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