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Effect of *In-Situ* Moisture Conservation Practices and Organic Manures on Yield and Quality of Cotton (*G. herbaceum* L.) Grown on Vertisols

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ABSTRACT

A field experiment was conducted on vertisols to study the effect of *In-situ* moisture conservation practices [MCP] and organic manures [OM] on cotton at Agricultural Research Station, Annigeri (Karnataka) during 1998-99 and 1999-2000. Study indicated the beneficial effect of *In-situ* MCP and OM on seed cotton yield. Compartment bunding, broad furrow and ridge and tied ridges and furrows gave 11.7, 11.0 and 9.5 per cent higher yield over flat bed (902 kg ha^{-1}). Among the OM farmyard manure and poultry manure each @ 5 t ha^{-1} recorded 9.1 and 8.3 per cent higher seed cotton yield as compared to cotton stalks @ 5 t ha^{-1} (909 kg ha^{-1}). All the quality parameters except micronaire value was not influenced by *In-situ* moisture conservation practices and organic manures.

The problems of dry lands in India are more diverse and intricate than elsewhere. Extreme variability of rainfall between seasons and within season imposes severe restrictions on crop production. *In-situ* MCP reduce the runoff and thereby store more soil moisture (Radder *et al*, 1991). The long term use of chemical fertilizers has resulted in deterioration of soil health and productivity. The long term experiments so far carried out in the country and elsewhere have clearly indicated that there is need to integrate organic manures and inorganic fertilizer for sustainable crop production, maintenance of soil fertility and conservation of natural resources (Nambiar and Abrol, 1989). Cotton is an important commercial fibre crop of Karnataka and it is cultivated over an area of 4.45 lakh ha with production of 9 lakh bales and productivity is 344 kg ha^{-1}. The efficient management of soil fertility and rainwater is the need of hour. Quality besides being genetic is also determined largely by environmental factors and cultural practices such as use of organic manures known to influence the quality parameters of cotton [Venkanna, *et al.* 1998 and Padole, *et al.* 1998]. The meager information is available on these aspects hence, the field trial was carried out to study the effect of *In-situ* moisture conservation practices and different organic manures on yield and quality of *herbaceum* cotton.

MATERIAL AND METHODS

A field experiment was conducted at Agricultural Research station, Annigeri (Karnataka) during 1998-99 and 1999-2000 under rainfed conditions to study the response of *herbaceum* cotton to *In-situ* MCP and OM. The soil of the experimental field was clayey in texture with a pH of 8.4, having available N 222 kg, P 24 kg and K 425 kg ha^{-1}. The treatments comprised five *in-situ* MCP [Flat bed (FB), tied ridges and furrows (TRF), broad furrow and ridge (BFR), compartment bunding (CB) and contour cultivation (CC)] and three OM [(Farmyard manure @ 5 t ha^{-1} (FYM), poultry manure @ 5 t ha^{-1} (PM) and cotton stalks @ 5 t ha^{-1} (CS)]. The experiment was laid out in spilt plot design with three replications and the net plot size was 4.8 m x 4.8 m. Total rainfall of 656.9 and 451.0 mm received, respectively during 98-99 and 99-2000 as against the normal of 670.9 mm (average of 25 years). The *In-situ* MCP were laid out during first week of July. The CB of 3.0 m x 3.6 m, the BFR at 1.2 m apart and TRF at 60 cm apart and furrows were tied at 1.2 m apart were formed and maintained through out the cropping season. A uniform dose of 30:15:15 kg N, P_2O_5 and K_2O ha^{-1} was given as basal dose at the time of sowing and OM were applied three weeks before sowing as per treatment. The sowing was done during

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last week of September in both the years at spacing of 60 cm x 30 cm. Uniform cultural practices were followed and need based plant protection measures were taken. Fibre quality parameters were analyzed as per the standard procedure out lined by Sundaram (1979). Ginning out turn and lint index was computed as per the procedure outlined by Chabra *et. al.* (1996) and oil estimation was done with the help of NMR instrument.

RESULTS AND DISCUSSION

Moisture Content

The pooled and 1998-99 and 1999-2000 data revealed the significant differences among different *In-situ* moisture conservation practices in moisture storage in the 90 cm soil profile throughout the crop growth period (Table 1). At 120 DAS significantly higher soil moisture content was recorded in CB (28.11 cm), BFR (28.09 cm) TRF (28.03 cm) as compared to FB (25.74 cm) and CC (25.93 cm). The higher soil moisture buildup in CB, BFR and TRF was the consequences of less runoff and more time available for infiltration (Surakod and Itnal 1997 and Radder *et al.* 1991).

Growth and yield

The higher soil moisture storage due to *In-situ* MCP was reflected in the productivity of cotton in the present study in pooled data and individual years (Table 1). The seed cotton yield was significantly higher with CB (1022 kg), BFR (1014 kg) and TRF (997 kg ha^{-1}) compared to FB (902 kg) and CC (897 kg ha^{-1}). The yield differences due to *In-situ* MCP were caused due to the better expressions of growth and yield components. Similar results were reported by Pendke *et al.* (2000).

The seed cotton yield was significantly influenced by OM in pooled as well as individual years (Table 1). Pooled data indicated that application of FYM (1000 kg) and PM (991 kg ha^{-1}) @ 5 t ha^{-1} recorded significantly higher seed cotton yield over cotton stalks incorporation @ 5 t ha^{-1} (909 kg ha^{-1}). Increase in seed cotton yield due to FYM or PM was mainly through increase in the growth and yield components. The low yield with cotton stalks incorporation was due to temporary immobilization of nutrients by the microorganisms during initial years of cotton crop residue application (Babalad, 1999).

The interaction effects were significant in pooled as well as individual years data (Table 1). BFR + FYM (1071 kg) and CB + FYM (1068 kg ha^{-1}) recorded significantly higher seed cotton yield compared to FB or CC with organic manures. Similar trend was followed in growth and yield components.

Net Returns

The pooled data indicated that significantly higher net returns (Table 1) with CB (Rs.11130), BFR (Rs.10980) and TRF (Rs.10510 ha^{-1}) than in FB (Rs.9397) and CC (Rs.9328 ha^{-1}). Increase in the net returns with CB, BFR and TRF was the result of higher yield than in FB and CC. However, organic manures did not influence the net returns both in pooled and individual years data. This might be due to the fact that whatever the yield advantages we got was nullified by higher cost of cultivation in case of FYM and PM. The interaction effects of BFR + FYM (Rs.11590 ha^{-1}) and CB + FYM (Rs.11550 ha^{-1}) recorded higher net returns compared to FB or CC with organic manures. The higher net returns were due to higher seed cotton yield recorded in the above treatments.

Benefit : cost ratio

Significantly higher B:C ratio (Table 1) was observed with CB than FB and CC. This might be due to higher yield that was responsible for increased gross returns. Among the organic manures CS recorded significantly higher B:C ratio than FYM or PM. This was due to low cost of cultivation.

Quality Parameters

Analysis of fibre quality parameters (Table 2 and 3) revealed that CB recorded significantly higher micronaire value as compared to TRF. The other quality parameters were not influenced by *In-situ* MCP. All the quality parameters except ginning out turn and lint index were not influenced by OM. These results conform the findings of Venkanna *et al.* (1998) and Padole *et al.* (1998).

Table 1 Soil moisture at 120 DAS cm/ 90 cm soil depth, Seed cotton yield, net returns and benefit : cost ratio of cotton cultivation as influenced by in situ moisture conservation practices and organic manures variety jayadhar

Treatments	Soil moisture at 120 DAS cm/90 CM depth			Seed cotton yield [kg/ha]			Net Returns [Rs/ha]			Benefit:Cost Ratio		
Moisture Conservation Practices	1998-99	99-2000	Pooled	1998-99	99-2000	Pooled	1998-99	99-2000	Pooled	1998-99	99-2000	Pooled
1. Flat bed [FB]	28.56 b	22.92 b	25.74 b	1120 b*	683 b	902 b	12460 a*	6329 b	9397 b	2.75 ab	2.13 bc	2.44 c
2. Tied ridges & Furrows [TRF]	30.05 a	26.02 a	28.03 a	1166 ab	827 a	997 a	12810 a	8205 a	10510 a	2.69 b	2.31 ab	2.50 bc
3. Broad furrow & ridge [BFR]	29.77 a	26.40 a	28.09 a	1212 ab	815 a	1014 a	13720 a	8239 a	10980 a	2.84 ab	2.36 a	2.60 ab
4. Compartment bunding [CB]	29.69 a	26.54 a	28.11 a	1225 a	821 a	1022 a	13930 a	8325 a	11130 a	2.86 b	2.37 a	2.62 a
5. Contour cultivation [CC]	28.69 b	23.18 b	25.93 b	1151 ab	644 b	897 b	12950 a	5706 b	9328 b	2.80 ab	2.03 c	2.42 c
S.E	0.15	0.17	0.11	27.5	25.04	18.7	437	400	296	0.05	0.06	0.04
rganic Manures												
1. Farm yard manure [FYM] @ 5t ha^{-1}	29.19 a	25.11 ab	27.15 a	1224 a	775 a	1000 a	13660 a	7371 a	10520 a	2.77 a	2.18 b	2.47 b
2. Cotton stalks [CS] @ 5t ha^{-1}	29.41 a	24.70 b	27.06 a	1096 b	722 b	909 b	12470 a	7324 a	9899 a	2.86 a	2.37 a	2.62 a
3. Poultry manure [PM] @ 5t ha^{-1}	29.45 a	25.22 a	27.33 a	1205 a	777 a	991 a	13390 a	7387 a	10390 a	2.73 a	2.18 b	2.46 b
S.E.	0.15	0.14	0.11	30.5	13.7	16.7	480	215	263	0.05	0.03	0.03
Interactions [MCP x OM]												
1. FB + FYM @ 5t ha^{-1}	28.59 c	23.23 bc	25.91 b	1166 ab	651 d	909 c-e	12920 a	5553 e	9236 cd	2.73 a	1.95 de	2.34 d
2. FB + CS @ 5t ha^{-1}	28.52 c	22.54 c	25.53 b	1044 b	670 d	857 e	11810 a	6651 c-e	9230 cd	2.82 a	2.31 a-c	2.56 a-c
3. FB + PM @ 5t ha^{-1}	28.56 c	22.98 bc	25.77 b	1150 ab	729 cd	940 b-e	12670 a	6783 c-e	9725 a-d	2.70 a	2.13 cd	2.42 b-d
4. TRF + FYM @ 5t ha^{-1}	29.95 ab	25.85 a	27.90 a	1224 ab	836 ab	1030 a-c	13450 a	8111 a-c	10780 a-d	2.69 a	2.23 bc	2.46 b-d
5. TRF + CS @ 5t ha^{-1}	30.28 a	25.72 a	28.00 a	1078 ab	811 a-c	945 b-e	11950 a	8488 ab	10220 a-d	2.73 a	2.49 a	2.61 ab
6. TRF + PM @ 5t ha^{-1}	29.91 ab	26.49 a	28.20 a	1198 ab	832 ab	1015 a-d	13040 a	8015 a-c	10530 a-d	2.64 a	2.22 bc	2.43 b-d
7. BFR + FYM @ 5t ha^{-1}	30.02 ab	26.26 a	28.14 a	1256 ab	887 a	1071 a	14090 a	9093 a	11590 a	2.81 a	2.41 ab	2.61 ab
8. BFR + CS @ 5t ha^{-1}	29.78 ab	26.19 a	27.98 a	1107 ab	717 cd	912 c-e	12630 a	7234 b-d	9930 a-d	2.87 a	2.36 a-c	2.61 ab
9. BFR + PM @ 5t ha^{-1}	29.50 a-c	26.76 a	28.13 a	1273 ab	842 ab	1058 ab	14440 a	8391 ab	11410 ab	2.83 a	2.32 a-c	2.58 a-c
10. CB + FYM @ 5t ha^{-1}	29.89 bc	26.51 a	27.70 a	1294 a	842 ab	1068 a	14710 a	8391 ab	11550 a	2.87 a	2.32 a-c	2.59 ab
11. CB + CS @ 5t ha^{-1}	29.91 ab	26.44 a	28.17 a	1142 ab	771 bc	956 a-e	13170 a	8077 a-c	10620 a-d	2.94 a	2.49 a	2.71 a
12. CB + PM @ 5t ha^{-1}	30.27 a	26.67 a	28.47 a	1239 ab	849 ab	1044 ab	13890 a	8507 ab	11200 a-c	2.78 a	2.31 a-c	2.56 a-c
13. CC + FYM @ 5t ha^{-1}	28.52 c	23.70 b	26.11 b	1180 ab	661 d	921 c-e	13140 a	5709 de	9426 cd	2.75 a	1.97 de	2.36 cd
14. CC + CS @ 5t ha^{-1}	28.59 c	22.64 c	25.61 b	1108 ab	639 d	874 e	12810 a	6169 de	9490 b-d	2.95 a	2.23 bc	2.59 ab
15. CC + PM @ 5t ha^{-1}	28.98 bc	23.19 bc	26.09 b	1164 ab	631 d	898 de	12900 a	5239 e	9067 d	2.72 a	1.90 e	2.31 d
S.E	0.34	0.32	0.24	68.2	30.6	37.4	1074	481	588	0.11	0.07	0.07

* Means followed by same letters do not differ significantly .

Table 2 Effect of *in situ* moisture conservation practices and organic manures on fibre quality parameters of cotton [*G. herbaceum*] variety jayadhar

Treatments	Mean fibre lenth[mm]			Fibre strength [g tex^{-1}]			Micronaire value			Maturity coefficent		
Moisture Conservation Practices	1998-99	1999-00	Pooled	1998-99	1999-00	Pooled	1998-99	99-00	Pooled	1998-99	99-2000	Pooled
1. Flat bed [FB]	18.45 a*	17.70 a	18.08 a	19.03 ab	18.69 a	18.86 a	4.15 a	4.01 ab	4.08 ab	0.746 d	0.725 b	0.736 a
2. Tied ridges & Furrows [TRF]	17.80 c	17.88 a	17.84 a	19.14 a	18.71 a	18.93 a	4.17 a	3.98 b	4.07 b	0.751 b	0.725 b	0.738 a
3. Broad furrow & ridge [BFR]	18.21 ab	17.84 a	18.02 a	18.93 b	18.70 a	18.82 a	4.18 a	3.99 ab	4.08 ab	0.749 c	0.724 d	0.737 a
4. Compartment bunding [CB]	18.18 b	17.53 a	17.85 a	19.05 ab	18.57 a	18.81 a	4.17 a	4.08 a	4.12 a	0.753 a	0.726 a	0.740 a
5. Contour cultivation [CC]	18.34 ab	17.60 a	17.97 a	19.12 ab	18.55 a	18.84 a	4.16 a	4.07 ab	4.12 a	0.749 c	0.725 b	0.737 a
S.E.	0.080	0.190	0.010	0.060	0.110	0.060	0.011	0.028	0.015	0.000	0.001	0.002
Organic Manures												
1. Farm yard manure [FYM] @ 5t ha^{-1}	18.28 a	17.71 a	17.99 a	19.08 a	18.60 a	18.84 a	4.17 a	4.02 a	4.10 a	0.751 a	0.725 a	0.738 a
2. Cotton stalks [CS] @ 5t ha^{-1}	18.03 b	17.66 a	17.85 a	18.97 a	18.66 a	18.82 a	4.16 b	4.03 a	4.10 a	0.750 a	0.725 a	0.738 a
3. Poultry manure [PM] @ 5t ha^{-1}	18.28 a	17.77 a	18.02 a	19.11 a	18.67 a	18.89 a	4.17 a	4.02 a	4.10 a	0.748 a	0.725 a	0.737 a
S.E.	0.080	0.150	0.080	0.060	0.050	0.040	0.001	0.018	0.008	0.004	0.001	0.001
Interactions [MCP x OM]												
1. FB + FYM @ 5t ha^{-1}	18.79 a	17.60 a-c	18.20 ab	19.22 a	18.55 ab	18.88 a-c	4.15 b	4.02 ab	4.08 a-c	0.740 a	0.722 h	0.731 d
2. FB + CS @ 5t ha^{-1}	17.90 de	17.63 a-c	17.76 bc	18.64 b	18.64 ab	18.64 c	4.15 b	4.07 ab	4.11 a-c	0.752 a	0.726 e	0.739 ab
3. FB + PM @ 5t ha^{-1}	18.68 ab	17.87 a-c	18.27 ab	19.23 a	18.89 a	19.06 a	4.15 b	3.95 b	4.05 c	0.748 a	0.729 b	0.739 ab
4. TRF + FYM @ 5t ha^{-1}	18.25 a-e	18.34 a	18.30 ab	19.10 a	18.75 ab	18.92 a-c	4.18 a	3.97 ab	4.07 a-c	0.752 a	0.726 ef	0.739 ab
5. TRF + CS @ 5t ha^{-1}	17.29 f	17.61 a-c	17.45 c	19.13 a	18.65 ab	18.89 a-c	4.15 b	4.00 ab	4.08 a-c	0.749 a	0.729 b	0.739 ab
6. TRF + PM @ 5t ha^{-1}	17.86 de	17.70 a-c	17.78 bc	19.21 a	18.73 ab	18.97 ab	4.18 a	3.97 ab	4.07 a-c	0.752 a	0.721 i	0.737 bc
7. BFR + FYM @ 5t ha^{-1}	17.75 ef	17.31 a-c	17.53 c	18.99 ab	18.76 ab	18.88 a-c	4.18 a	3.95 b	4.06 bc	0.755 a	0.722 h	0.739 ab
8. BFR + CS @ 5t ha^{-1}	18.07 c-e	17.75 a-c	17.91 bc	18.92 ab	18.79 ab	18.85 a-c	4.18 a	3.97 ab	4.07 a-c	0.741 a	0.725 f	0.733 cd
9. BFR + PM @ 5t ha^{-1}	18.80 a	18.46 a	18.63 a	18.89 ab	18.56 ab	18.72 bc	4.18 a	4.05 ab	4.11 ab	0.752 a	0.725 f	0.739 ab
10. CB + FYM @ 5t ha^{-1}	18.29 a-e	18.13 ab	18.21 ab	19.16 a	18.53 ab	18.84 a-c	4.15 b	4.10 a	4.13 ab	0.755 a	0.730 a	0.743 a
11. CB + CS @ 5t ha^{-1}	18.36 a-d	17.51 a-c	17.93 bc	19.04 ab	18.63 ab	18.83 a-c	4.18 a	4.07 ab	4.12 ab	0.758 a	0.722 h	0.740 ab
12. CB + PM @ 5t ha^{-1}	17.89 de	16.96 c	17.42 c	18.95 ab	18.55 ab	18.75 bc	4.18 a	4.07 ab	4.12 ab	0.746 a	0.728 c	0.737 bc
13. CC + FYM @ 5t ha^{-1}	18.31 a-e	17.15 bc	17.73 bc	18.95 ab	18.42 ab	18.69 bc	4.18 a	4.08 ab	4.13 a	0.752 a	0.727 d	0.740 ab
14. CC + CS @ 5t ha^{-1}	18.56 a-c	17.79 a-c	18.17 ab	19.13 a	18.60 ab	18.87 a-c	4.15 b	4.05 ab	4.10 a-c	0.751 a	0.727 d	0.740 ab
15. CC + PM @ 5t ha^{-1}	18.16 a-e	17.75 a-c	18.00 bc	19.29 a	18.63 ab	18.96 ab	4.15 b	4.08 ab	4.12 ab	0.743 a	0.723 g	0.733 cd
S.E	0.170	0.340	0.190	0.130	0.110	0.090	0.003	0.041	0.018	0.010	0.001	0.001

* Means followed by same letters do not differ significantly .

Table 3 Effect of *in situ* moisture conservation practices and organic manures on quality parameters of cotton [*G. herbaceum*] variety jayadhar

Treatments	Lint index [g]			Oil [%]			Ginning [%]		
Moisture Conservation Practices	1998-99	1999-2000	Pooled	1998-99	1999-2000	Pooled	1998-99	99-2000	Pooled
1. Flat bed [FB]	2.87 a*	2.42 b	2.64 a	18.46 a	12.40 a	15.43 a	30.65 a	30.50 a	30.58 a
2. Tied ridges & Furrows [TRF]	2.92 a	2.63 a	2.77 a	17.98 a	12.61 a	15.30 a	30.44 a	31.32 a	30.88 a
3. Broad furrow & ridge [BFR]	2.73 a	2.57 ab	2.65 a	18.43 a	13.12 a	15.78 a	30.38 a	30.95 a	30.66 a
4. Compartment bunding [CB]	2.86 a	2.48 ab	2.67 a	18.68 a	12.50 a	15.59 a	30.35 a	30.43 a	30.39 a
5. Contour cultivation [CC]	2.81 a	2.56 ab	2.69 a	18.71 a	12.67 a	15.69 a	30.72 a	30.92 a	30.82 a
S.E.	0.06	0.05	0.04	0.31	0.28	0.21	0.37	0.28	0.23
Organic Manures									
1. Farm yard manure [FYM] @ 5t ha^{-1}	2.90 a	2.57 a	2.74 a	18.44 a	12.72 a	15.58 a	30.61 ab	30.87 a	30.74 ab
2. Cotton stalks [CS] @ 5t ha^{-1}	2.75 a	2.49 a	2.62 b	18.42 a	12.70 a	15.64 a	30.18 b	30.53 a	30.36 b
3. Poultry manure [PM] @ 5t ha^{-1}	2.87 a	2.54 a	2.70 ab	18.50 a	12.56 a	15.53 a	30.74 a	31.07 a	30.90 a
S.E.	0.52	0.05	0.03	0.16	0.15	0.11	0.18	0.26	0.16
Interactions [MCP x OM]									
1. FB + FYM @ 5t ha^{-1}	2.92 ab	2.49 a	2.71 ab	17.89 a	12.00 b	14.94 c	30.57 ab	30.58 ab	30.58 ab
2. FB + CS @ 5t ha^{-1}	2.82 ab	2.35 a	2.59 b	18.73 a	12.85 b	15.79 ab	30.24 ab	30.83 b	30.03 b
3. FB + PM @ 5t ha^{-1}	2.85 ab	2.43 a	2.64 b	18.77 a	12.37 b	15.57 a-c	31.14 ab	31.10 ab	31.13 ab
4. TRF + FYM @ 5t ha^{-1}	3.18 a	2.63 a	2.91 a	18.10 a	12.13 b	15.12 bc	31.05 ab	32.05 a	31.55 a
5. TRF + CS @ 5t ha^{-1}	2.79 ab	2.70 a	2.75 ab	17.78 a	12.99 b	15.39 bc	30.38 ab	30.98 ab	30.68 ab
6. TRF + PM @ 5t ha^{-1}	2.79 ab	2.55 a	2.67 ab	18.06 a	12.71 b	15.39 bc	29.90 b	30.94 ab	30.42 ab
7. BFR + FYM @ 5t ha^{-1}	2.69 b	2.69 a	2.69 ab	18.42 a	14.12 a	16.27 a	29.81 b	31.40 ab	30.60 ab
8. BFR + CS @ 5t ha^{-1}	2.67 b	2.45 a	2.56 b	18.29 a	12.79 b	15.54 a-c	30.00 ab	30.54 ab	30.27 b
9. BFR + PM @ 5t ha^{-1}	2.83 ab	2.57 a	2.70 ab	18.59 a	12.46 b	15.52 a-c	31.33 a	30.90 ab	31.12 ab
10. CB + FYM @ 5t ha^{-1}	2.87 ab	2.40 a	2.64 b	18.95 a	12.36 b	15.66 a-c	30.48 ab	29.46 b	29.97 b
11. CB + CS @ 5t ha^{-1}	2.75 b	2.44 a	2.60 b	18.43 a	12.46 b	15.55 a-c	30.19 ab	30.35 ab	30.27 b
12. CB + PM @ 5t ha^{-1}	2.97 ab	2.59 a	2.78 ab	18.66 a	12.49 b	15.58 a-c	30.38 ab	31.49 ab	30.94 ab
13. CC + FYM @ 5t ha^{-1}	2.74 ab	2.65 a	2.74 ab	18.81 a	13.00 b	15.91 ab	31.14 ab	30.88 ab	31.01 ab
14. CC + CS @ 5t ha^{-1}	2.70 b	2.51 a	2.61 b	18.89 a	12.23 b	15.56 a-c	30.10 ab	30.97 ab	30.53 ab
15. CC + PM @ 5t ha^{-1}	2.79 ab	2.54 a	2.71 ab	18.44 a	12.79 b	15.62 a-c	30.93 ab	30.90 ab	30.92 ab
S.E	0.12	0.10	0.08	0.37	0.33	0.25	0.40	0.59	0.36

* Means followed by same letters do not differ significantly .

Higher lint index and ginning out turn were recorded with FYM and PM than cotton stalks incorporation.

It was concluded that *In-situ* MCP such as CB, TRF and BFR with FYM and PM @ 5.0 t ha^{-1} was found beneficial for getting higher seed cotton yield as well as net returns under rainfed cotton cultivation in black soils of semi arid tropics.

LITERATURE CITED

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PKV Res. J. Vol. 30 (2), 2006

Effect of Biofertilizers with and without Nitrogen Fertilizer on Yield and Economics of *Rabi* Sunflower

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ABSTRACT

An experiment was conducted at Oilseed Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) during *Rabi* season of 2002-2005 to study the effect of biofertilizers with and without N fertilizer on yield and economics of *Rabi* sunflower. Experiment results revealed that the application of 40 kg N ha^{-1} recorded highest seed yield of sunflower (1235 kg ha^{-1}) and which was at par with application of 20 kg N ha^{-1} with *Azotobacter* and *Azospirillum* seed inoculation (1162 kg ha^{-1}) i.e. 50 per cent less than recommended doses of nitrogen. The per cent contribution of biofertilizers viz., *Azotobacter*, *Azospirillum* and *Azotobacter* + *Azospirillum* was 10.05, 10.72 and 13.27 per cent, respectively over control. Application of 40 kg N ha^{-1} registered maximum B:C ratio (2.34), followed by 20 kg N ha^{-1} with seed inoculation of *Azotobacter* and *Azospirillum* (2.28).

Oilseeds play an important role in rainfed agro ecosystem of Maharashtra. Sunflower is an important oilseed crop of Vidarbha under rainfed situation particularly in vertisols. The productivity of sunflower is very low 616 kg ha^{-1} (FAO,2005). Of the many reasons of low productivity nutrient management is one of the key factors in enhancing the productivity of rainfed sunflower crops. In view of the escalating prices and high demand supply gap of chemical fertilizers, there is strong need to adopt integrated nutrient supply system by judicious combination of inorganic with organic ones, more particularly biofertilizers of microbial origin to improve the soil health and productivity. Favourable response of *Azotobacter* and *Azospirillum* bacteria in N economy by saving near about 50 per cent N have been reported by Chauhan *et al.* (1996).

Biofertilizers play a very significant role in improving soil fertility by fixing atmospheric free nitrogen, both in association with plant roots and without it and also mobilize or dissolve certain nutrients like carbon, sulphur and phosphorus, respectively.

Hence, the present study was undertaken to know the response of *Azotobacter* and *Azospirillum* alone and in combination with nitrogen fertilizer on yield and economics of sunflower.

MATERIAL AND METHODS

A field experiment to study the effect of biofertilizers with and without N fertilizers on yield and economics of *Rabi* sunflower was conducted at Oilseed Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) during the year 2002-03 to 2004-05. The All India Coordinated Research Project trial on sunflower was conducted in Randomised Block Design with nine treatments and three replications. The treatment consisted of N levels 0, 20 and 40 kg ha^{-1} with and without *Azotobacter* and *Azospirillum* seed treatment along with control. The experimental site was medium black soil with moderate fertility and slight alkaline (pH-7.2) in reaction having available nitrogen (197 kg ha^{-1}), available phosphorus (30 kg ha^{-1}) and available potassium (296 kg ha^{-1}). The gross and net plot size was 5.4 m x 4.8 m and 4.5 m x 4.2 m, respectively. Sunflower variety Morden with a seed rate of 12 kg ha^{-1} was sown with a spacing 45 cm x 30 cm on 1st July, 2002. Recommended dose of 40 kg P and 40 kg K was uniformly applied as basal dose to each plot by calculating the quantity required for each plot at the time of sowing. Nitrogen applied as per treatments. Seed treatment with *Azotobacter* and *Azospirillum* was done as per treatments by using small quantities of jaggery solution. Five plants were randomly selected by moving diagonally in the centre of net plots. Growth and yield attributing observations and yields net^{-1} plot were recorded at harvest and economics was worked out (Table 2) for pooled data. Market rate of inputs viz., sunflower Rs. 15 kg^{-1}, Urea Rs. 246 50kg^{-1}, *Azotobacter* and *Azospirillum* culture Rs. 60 kg^{-1} each.

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RESULTS AND DISCUSSION

Seed yield (kg ha^{-1}) and B:C ratio:

Different levels of N were applied along with seed treatment with biofertilizer to find out their N economy (Table 1 & 2). During the year 2002 under study 100 per cent inorganic N application gave highest sunflower yield (1040 kg ha^{-1}) which was on par with the use of 50 per cent N alone or in conjunction with use of either *Azospirillum* or *Azotobacter* or both seed treatment. Recommended N application recorded highest monetary returns in terms of gross returns, net returns and benefit cost ratio.

During the year 2003 it is observed that recommended N application resulted in highest seed yield (1226 kg ha^{-1}). However, same was on par with the use of 50 per cent N in conjunction with use of either *Azotobacter* or *Azospirillum* seed treatment, while B:C ratio was

Table 1 : Response of sunflower to biofertilizers application with and without N application during 2002-03 to 2004-05

Treatments	Seed yield (kg ha^{-1})				% yield
	2002-03	2003-04	2004-05	Pooled mean	increase over control
T_1: Control	696	741	801	746	-
T_2: 20 kg N ha^{-1}	881	961	1238	1027	37.66
T_3: 40 kg N ha^{-1}	1040	1226	1439	1235	65.54
T_4: *Azotobacter* (ST)	725	869	868	821	10.05
T_5: *Azospirillum* (ST)	705	899	874	826	10.72
T_6: *Azospirillum* + *Azotobacter*	776	872	888	845	13.27
T_7: 20 kg N ha^{-1} + *Azotobacter*	926	1032	1391	1116	49.59
T_8: 20 kg N ha^{-1} + *Azospirillum*	899	1067	1399	1122	50.40
T_9: 20 kg N ha^{-1} + *Azospirillum* + *Azotobacter*	864	1194	1428	1162	55.76
SE (m) ±	70	56	46	59	
CD at 5%	210	169	131	166	
CV (%)	14.5	9.9	7.5	10.3	

ST : Seed treatment

Table 2 : Effect of various treatments on economics (Rs ha^{-1}) in *Rabi* sunflower (2004-05)

Treatments	Gross returns (Rs ha^{-1})	Net Returns (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	B/C ratio
T_1: Control	11190	3718	7472	1.50
T_2: 20 kg N ha^{-1}	15405	7713	7692	1.87
T_3: 40 kg N ha^{-1}	18525	10613	7912	2.34
T_4: *Azotobacter* (ST)	12315	4818	7497	1.64
T_5: *Azospirillum* (ST)	12390	4893	7497	1.65
T_6: *Azospirillum* + *Azotobacter*	12675	5153	7522	1.68
T_7: 20 kg N ha^{-1} + *Azotobacter*	16740	9073	7667	2.18
T_8: 20 kg N ha^{-1} + *Azospirillum*	16830	9163	7667	2.19
T_9: 20 kg N ha^{-1} + *Azospirillum* + *Azotobacter*	17430	9788	7642	2.28
G.M.	14833.33	7214.66	7618.66	1.92

ST : Seed treatment

Inputs used : Sunflower seed: Rs. 15 kg^{-1}, Urea : 246 50 kg^{-1}, *Azotobacter* and *Azospirillum* culture : Rs. 60 kg^{-1} each.

highest in 50per cent N with use of *Azotobacter* or *Azospirillum*.

During the year 2004 the treatment 100 per cent N recorded highest seed yield (1439 kg ha^{-1}) followed by T_9, T_8, T_7 and all these treatments were found significantly superior to control treatment except T_2 i.e. 50 per cent N.

The pooled results indicated that there were significant differences within the treatments. The treatment T_3 i.e. application of 40 kg N ha^{-1} recorded the highest seed yield (i.e. 1235 kg ha^{-1}), which was at par with T_9, T_8 and T_7. Similarly highest B:C ratio was obtained in T_3 (1:2.34), followed by T_9 (1:2.28). Thus, with combined use of *Azotobacter* and *Azospirillum* a clear 50 per cent saving of inorganic N is possible. The amount of nitrogenous fertilizer can be reduced by using biofertilizers like *Azotobactor or Azospirillum* culture inoculation was recorded by Reddy *et al.* (2003) in case of sunflower. These results are inconformity with those of Chauhan *et al.* (1996) in mustard and Reddy *et. al.*, (1994) and Bhongle *et. al.*, (2003) in case of Safflower. The per cent contribution of biofertilizers viz., *Azotobacter*, *Azosprillum* and *Azotobacter* + *Azosprillum* was 10.05, 10.72 and 13.27 per cent, respectively over control (Table 1). Thus, this indicates that higher yield with biofertilizers was due to better growth of crop as reflected by increased in all the growth and yield attributes and biofertilizers provided favourable environment for plant growth by fixing free nitrogen and by dissolving and mobilizing some nutrients like carbon, phosphorus and sulphur.

It can be concluded from this experiment that seed inoculation with *Azotobacter* or *Azospirillum* in combination with 50 per cent nitrogen was found ideal to achieve seed yield of *Rabi* sunflower.

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PKV Res. J. Vol. 30 (2), 2006

Intercropping of Legumes in Extra Early Hirsutum Cotton

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ABSTRACT

In the study, the experiment comprising 8 treatment combinations of two planting pattern and four inter cropping levels were arranged in FRBD with four replications. The results indicated that the intercropping viz, cotton + blackgram and cotton + greengram were observed to be more efficient and remunerative for early cotton genotypes. Number of bolls plant^{-1}, seed cotton yield, stalk yield ha^{-1}, Lint yield was higher in sole cotton than inter cropping treatments and among inter cropping treatments, cotton + blackgram recorded the highest gross monetary returns.

In past, intercropping has been taken up mainly as a risk covering practice in tradition bound agriculture of dry lands. Growing of two or more intercrops, differing in growth, duration and nutrient requirements in such a way that there is no reduction in productivity of major component vis -a-vis its productivity as a sole crop and they can be grown with least competetion, utilize environmental and manpower resources in a more efficient manner than they do individually and enhance total returns, similarly, utilize inter row space during slow growth rate period of cotton. Many scientists including Tomar and Kushwaha (1991) reported higher monetary returns when cotton was intercropped with legumes.

Past research efforts recommended suitable intercropping system in respect of long and medium duration cotton varieties. The present attempt was made to see the feasibility of adopting intercropping system in extra early genotype of cotton to achieve maximum benefit under rainfed condition.

MATERIAL AND METHODS

The experiment consisting two planting patterns viz, 60 x 15 cm^2 (P_1) and 90 x 10 cm^2 (P_2) and four intercropping systems viz, sole Cotton (I_0), Cotton + greengram (I_1) , Cotton + black gram (I_2) and cotton + soybean (I_3) were tested in factorial randomised block design with four replications. Sowing of cotton and intercrops was done on 5th July, 2000. The harvested plot size was 3.60 x 4.80 m^2. Soil of experimental plot was deep and moderately well drained and taxonomically belonged to fine, montmorillonitic, hyperthermic family of Typic Haplusterts. Soil sample analyses of the site indicated the electrical conductivity 0.37 dsm^{-1}, organic carbon 0.49 per cent, available nitrogen 241.47 kg ha^{-1}, available phosphorus 28.4 kg ha^{-1} and available potash 291.2 kg ha^{-1}. Rainfall received during crop period was 539 mm. The varieties of green gram, blackgram and soybean were AKM - 8803, TAU - 2 and PKV-25, respectively. Cotton was fertilized with 50 kg N and 25 kg P_2O_5 ha^{-1} through Urea and Single super phosphate, respectively.

RESULTS AND DISCUSSION

Various planting patterns did not influence bolls plant^{-1}, seed cotton yield, lint yield and ginning percentage. However, the seed cotton equivalent yield and gross monetary returns were quite higher under closer spacing of 60 x 15 cm^2 than 90 x 10 cm^2 due to higher yield of intercrops. These results are in confirmation with Wankhade *et al.* (2000).

The highest bolls plant^{-1}, seed cotton yield, stalk yield and lint yield were recorded from sole cotton which out yielded all intercropped treatments. Seed cotton yield was maximum in sole cotton and it was significantly reduced by 15.5 per cent and 32.80 per cent when cotton was intercropped with greengram and soybean, respectively. Seed cotton yield was also reduced in cotton blackgram intercropping system but the difference did not reach to level of significance. The earlier observations of Wankhade *et. al.* (2000) were also in conformity with present observations. Cotton associated with black gram recorded highest seed cotton equivalent yield, followed by cotton with greengram (Ranganavaki & Subramanian, 1994).

Gross monetary returns were found to be influenced by different intercropping treatments (Table 2). Blackgram intercropped in between rows of cotton recorded higher gross economic return (Rs. 23,647ha^{-1}) over rest of tratments. This was closely followed by cotton + greengram (Rs. 22,954 ha^{-1}) as compared to sole cotton. This might be due to additional yield of intercrops. Similar findings were also reported by Padhi *et.at.* (1993). Ginning percentage was not

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significantly influenced by intercropping of cotton. These results are in inconformity with the findings of Kubde and Lakhdive, 1993 and Sharma and Tomar, 1995. It could be inferred that the intercropping of cotton + blackgram and cotton + greengram were observed to be more efficient and remunerative in early cotton genotypes.

Table 1 . Mean number of bolls plant^{-1}, seed cotton yield, stalk yield and seed cotton equivalent yield as influenced by various treatments

Treatments	Bolls plant^{-1}	Seed cotton yield (q ha^{-1})	Stalk yield (q ha^{-1})	Seed cotton equivalent yield (q ha^{-1})
Planting Pattern				
P_1	3.38	6.30	21.77	8.51
P_2	3.46	6.46	21.58	7.83
S.E. (m) ±	0.12	0.13	0.27	0.11
C.D. at 5%	-	-	-	0.34
Intercropping				
I_0	3.89	7.41	24.08	7.42
I_1	3.20	6.26	20.30	9.17
I_2	3.67	6.87	21.32	9.59
I_3	2.92	4.98	21.01	6.52
S.E. (m) ±	0.16	0.19	0.38	0.16
C. D at 5%	0.49	0.56	1.13	0.48

Table 2 - Gross monetary returns, Lint yield (qha^{-1}) and ginning percentage, as influenced by various treatments.

Treatments	Gross monetary returns (Rs ha^{-1})	Lint yield (q ha-1)	Ginning percentage
Planting pattern			
P_1	20949	2.22	35.25
P_2	20118	2.28	35.30
S.E.±	265.49	0.12	0.42
C.D. at 5%	780.95	-	-
Intercropping			
I_0	18070	2.66	35.88
I_1	22954	2.21	35.30
I_2	23647	2.42	35.25
I_3	17464	1.73	34.68
S.E. (m) ±	375.46	0.06	0.60
C. D at 5%	1104.44	0.18	-

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PKV Res. J. Vol. 30 (2), 2006

Effect of Integrated Nutrient Management Practices on Yield and Nutrient Uptake by Cotton (*G. herbaceum* L.)

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ABSTRACT

Effect of integrated nutrient management practices on yield and nutrient uptake by herbaceum cotton has been studied in a field experiment conducted at Agricultural Research Station, Annigeri (Karnataka) on vertisols under rainfed conditions during 1998-1999 and 1999-2000. Seed cotton yield, nitrogen, phosphorus and potassium uptake improved with increased fertilizer levels. Among the organic manures, farmyard manure or poultry manure singly or in combination had beneficial effect on yield and nutrient uptake. The soil nutrient status was improved slightly with higher level of fertilizers whereas, organic manures did not influence the phosphorus and potassium status of the soil.

Cotton is a widely grown major cash crop in Karnataka and it is cultivated over an area of 4.45 lakh ha with production of 9 lakh bales and productivity of 344 kg ha^{-1} which is slightly more than national average. The soil productivity is very complex and dynamic property in agriculture. It is influenced by various natural and artificial factors. Elimination of chemical fertilizers from a conventional farming system may cause a significant reduction in crop yields and result in loss of net farm income. In order to avoid such problem, stabilizing soil productivity through a harmonious blend of organics and inorganic fertilizers is essential. The present investigation was directed to develop sustainable and ecologically sound farming practices in rainfed *herbaceum* cotton cultivation. Nitrogen, phosphorus and potassium are the major nutrient required for cotton and it absorbs them in a ratio of 2.5: 0.8: 2.5 (Quereshi, 1962).

MATERIAL AND METHODS

The field experiment was carried out for two years 1998-99 and 1999-2000 in fixed site at Agricultural Research Station, Annigeri (Karnataka) under rainfed conditions. The soil was clayey in texture with pH 8.4 having low in available nitrogen (222 kg ha^{-1}), medium in available phosphorus (24 kg ha^{-1}) and high in available potassium (425 kg ha^{-1}). The trial was laid out in split plot design with three replications. There were eighteen treatment combinations, consisted of three fertilizer levels (F_0= 0 % RDF, F_1= 50 % RDF and F_2= 100 % (30:15:15 kg N : P_2O_5 : K_2O ha^{-1}) RDF) and six organic manures (Farmyard manure (FYM) @ 5.0 t ha^{-1}, poultry manure (PM) @ 5.0 t ha^{-1}, cotton stalks (CS) @ 5.0 t ha^{-1}, FYM+CS each @ 2.5 t ha^{-1}, PM+CS each @ 2.5 t ha^{-1} and FYM+PM each @ 2.5 t ha^{-1}). At the time of sowing all the inorganic fertilizers were applied as per treatments, whereas organic manures applied three weeks before sowing as per treatments. The total rainfall received during 1998-99 and 1999-2000 was 656.9 mm and 451.0 mm, respectively as against the normal of 670.9 mm (average of 25 years).

Plant samples (stem, leaves and reproductive parts) were collected separately at 60, 120 and 180 days after sowing (DAS) and analyzed for nutrient content by standard methods described by Jackson (1973). Based on dry matter, uptake of NPK was computed. Observation on seed cotton yield was recorded on net plot basis and then yield kg ha^{-1} was computed.

RESULTS AND DISCUSSION

Seed cotton yield

The pooled data of two years (Table 1) indicated that application of 100 per cent RDF recorded significantly higher seed cotton yield (1052 kg ha^{-1}) as compared to 0 (890 kg ha^{-1}) and 50 per cent RDF (985 kg ha^{-1}). The variation in seed cotton yield between fertilizer levels was mainly attributed higher growth and yield components. The native available soil nitrogen was low (222 kg ha^{-1}) and hence the application of higher nitrogen

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Table 1 Effect of Integrated nutrient management practices on yield and yield components of cotton [G. herbaceum] variety Jayadhar

Treatments	No. of bolls at 180 DAS			Mean boll weight [g/plant]			Seed cotton yield [g plant $^{-1}$]			Seed cotton yield [kg ha^{-1}]		
Fertiliser levels [F]	1998-99	1999-2000	Pooled	1998-99	1999-00	Pooled	1998-99	99-2000	Pooled	1998-99	99-2000	Pooled
1. No Fertilizer [F_0]	15.31 b*	10.58 b	12.94 c	1.48 c	1.33 c	1.40 c	23.29 c	13.71 b	18.50 c	1037 c	742 b	890 c
2.15:7.5:7.5N,P_2O_5andK_2Okgha^{-1}[F_1]	17.88 a	12.53 a	15.21 b	1.70 b	1.48 b	1.59 b	26.04 b	15.40 b	20.72 b	1143 b	827 a	985 b
2.30:15:15N,P_2O_5andK_2O kg ha^{-1}[F_2]	18.54 a	12.98 a	15.76 a	1.89 a	1.56 a	1.73 a	27.39 a	17.81 a	22.60 a	1244 a	859 a	1052a
S.E.	0.20	0.23	0.15	0.04	0.01	0.02	0.31	0.61	0.34	26	18	16
Organic manures [OM]												
1. FYM @ 5 t ha^{-1}	17.44 a	12.02 a	14.73 a	1.68 ab	1.46 a	1.57 a	26.29 a	16.40 a	21.34 a	1172 a	824 ab	998 a
2. PM @ 5 t ha^{-1}	17.51 a	12.76 a	15.13 a	1.74 a	1.50 a	1.62 a	25.78 a	15.18 a	20.48 a	1153 ab	813 ab	983 a
3. CS @ 5 t ha^{-1}	16.31 a	11.47 a	13.89 a	1.67 ab	1.41 a	1.54 a	24.93 a	15.62 a	20.28 a	1056 b	763 b	910 b
4. FYM@2.5t ha^{-1}+CS@2.5 t ha^{-1}	17.40 a	12.09 a	14.74 a	1.59 b	1.45 a	1.52 a	24.51 a	14.67 a	19.59 a	1133 ab	818 ab	976 a
5. PM @2.5t ha^{-1} +CS@2.5 t ha^{-1}	17.20 a	11.51 a	14.36 a	1.68 ab	1.48 a	1.58 a	25.29 a	16.16 a	20.72 a	1128 ab	812 ab	970 a
6. FYM@2.5t/ha+PM@2.5 t ha^{-1}	17.60 a	12.33 a	14.97 a	1.77 a	1.44 a	1.61 a	26.64 a	15.82 a	21.23 a	1206 a	829 a	1017a
S.E.	0.58	0.57	0.41	0.05	0.05	0.03	0.93	0.78	0.61	33	55	19
Interactions [F x OM]												
1. [F_0] +FYM@ 5 t ha^{-1}	15.53 b-e	10.07 b	12.80 de	1.53 c-e	1.36 a-c	1.45 d-g	24.87 a-c	14.60 b-e	19.73 b-f	1056 c-e	764 b-d	910 de
2. [F_0] +PM @ 5 t ha^{-1}	15.80 b-e	11.07 ab	13.43 b-e	1.55 c-e	1.35 a-c	1.45 d-g	24.13 a-c	14.07 b-e	19.10 c-f	1042 de	741 cd	891 de
3. [F_0] +CS @ 5 t ha^{-1}	14.47 e	10.20 b	12.33 e	1.43 e	1.22 c	1.33 g	21.27 c	13.67 c-e	17.47 f	984 e	670 d	827 e
4. [F_0] +FYM@2.5t ha^{-1} +CS@2.5 t ha^{-1}	15.27 c-e	11.00 ab	13.13 c-e	1.40 e	1.33 bc	1.37 fg	22.73 bc	12.93 de	17.83 f	1027 de	760 b-d	894 de
5. [F_0] +PM @2.5t ha^{-1} +CS@2.5 t ha^{-1}	15.07 de	10.47 ab	12.77 de	1.42 e	1.35 a-c	1.38 e-g	23.47 a-c	14.27 b-e	18.87 d-e	1027 de	757 b-d	892 de
6. [F_0] +FYM@2.5t ha^{-1} +PM@2.5 t ha^{-1}	15.73 de	10.67 ab	13.20 c-e	1.53 de	1.36 a-c	1.45 d-g	23.27 a-c	12.73 e	18.00 ef	1085 b-e	764 b-d	924 c-e
7. [F_1] +FYM@ 5 t ha^{-1}	18.07 a-d	13.40 ab	15.73 ab	1.60 b-e	1.53 ab	1.56 b-e	25.73 a-c	17.20 a-e	21.47 a-e	1186 a-d	868 ab	1027a-c
8. [F_1]+PM @ 5 t ha^{-1}	17.33 a-e	13.47 ab	15.40 a-c	1.73 a-d	1.51 a-c	1.62 a-d	25.40 a-c	14.73 a-e	20.07 a-f	1143 a-e	852 a-c	998 a-d
9. [F_1]+CS @ 5 t ha^{-1}	16.87 a-e	11.67 ab	14.27 a-e	1.73 a-d	1.47 a-c	1.60 a-d	26.00 a-c	15.87 a-e	20.93 a-f	1071 c-e	781 a-c	926 c-e
10.[F_1]+FYM@2.5t ha^{-1} +CS@2.5 t ha^{-1}	18.07 a-d	11.60 ab	14.83 a-d	1.59 b-e	1.48 a-c	1.54 c-f	24.60 a-c	13.47 c-e	19.03 c-f	1128 a-e	810 a-c	969 b-d
11.[F_1]+PM @2.5t ha^{-1} +CS@2.5 t ha^{-1}	18.53 a-c	12.13 ab	15.33 a-c	1.72 a-d	1.53 ab	1.63 a-d	26.13 a-c	14.93 a-e	20.53 a-f	1114 b-e	819 a-c	967 b-d
12.[F_1]+FYM@2.5t ha^{-1} +PM@2.5 t ha^{-1}	18.40 a-d	12.93 ab	15.67 ab	1.81 a-c	1.39 a-c	1.60 a-d	28.40 a	16.20 a-e	22.30 a-d	1215 a-d	833 a-c	1024a-c
13.[F_2] +FYM@ 5 t ha^{-1}	18.73 ab	12.60 ab	15.67 ab	1.90 a	1.50 a-c	1.70 a-c	28.27 ab	17.40 a-d	22.83 ab	1273 ab	839 a-c	1056ab
14.[F_2] +PM @ 5 t ha^{-1}	19.40 a	13.73 a	16.57 a	1.96 a	1.64 a	1.80 a	27.80 ab	16.73 a-e	22.27 a-d	1273 ab	845 a-c	1059ab
15.[F_2]+CS @ 5 t ha^{-1}	17.60 a-e	12.53 ab	15.07 a-d	1.84 ab	1.56 ab	1.70 a-c	27.53 ab	17.33 a-e	22.43 a-c	1114 b-e	839 a-c	977 b-d
16.[F_2]+FYM@2.5t ha^{-1} +CS@2.5 t ha^{-1}	18.87 ab	13.67 a	16.27 a	1.78 a-d	1.54 ab	1.66 a-c	26.20 a-c	17.60 a-c	21.90 a-d	1244 a-c	884 a	1064ab
17.[F_2]+PM @2.5t ha^{-1} +CS@2.5 t ha^{-1}	18.00 a-d	11.93 ab	14.97 a-d	1.91 a	1.57 ab	1.74 ab	26.27 a-c	19.27 a	22.77 ab	1244 a-c	861 ab	1052ab
18.[F_2]+FYM@2.5t ha^{-1} +PM@2.5 t ha^{-1}	18.67 a-c	13.40 ab	16.03 a	1.87 a	1.57 ab	1.77 a	28.27 ab	18.53 ab	23.40 a	1317 a	890 a	1103a
S.E. 1.01	0.99	0.71	0.08	0.09	0.06	1.61		1.35	1.05	57	33	33

* Means followed by same letters do not differ significantly. F0 = 0 % RDF, F1 = 50 % RDF and F2 = 100 % RDF

resulted in higher nutrient availability. This might have favoured better growth and yield components in turn seed cotton yield (Table 1). Similar observations were reported by Koraddi *et al.* (1992). The results recorded during 1998-99 were similar to pooled data. Whereas, during 1999-2000, 50 and 100 per cent RDF recorded on par seed cotton yield and both were superior to control. This might be due to low moisture availability (the rainfall received during the year was nearly 30 per cent less than the normal) which resulted in poor growth of plant and did not utilize the higher applied fertilizer. Within the organic manures FYM+PM each @ 2.5 t ha^{-1} recorded significantly higher yield (1017 kg ha^{-1}) than cotton stalks incorporation @ 5.0 t ha^{-1} (910 kg ha^{-1}), the other organic manurial treatments were on par with earlier treatment (Table 1). The low seed cotton yield with cotton stalks incorporation was mainly due to temporary immobilization of nutrients by the microorganisms during initial years of cotton crop residue application (Babalad, 1999). This might have resulted in poor yield components in turn seed cotton yield. Similar results were observed during individual years of experimentation.

Application of 100 per cent RDF with FYM+PM each @ 2.5 t ha^{-1} in vertisols of semi arid tropics of Karnataka under rainfed conditions found beneficial for getting higher seed cotton yield. The results are in conformity of the findings of Matte *et al.* (1992), Mathur (1997) and Malewar *et al.* (1999).

Uptake of Nutrients

Nitrogen uptake

The nitrogen uptake was influenced by fertilizer levels at 60, 120 and 180 DAS (Table 2). The application of 30 kg N ha^{-1} recorded higher nitrogen uptake at all the three stages of observation as compared to 0 and 15 kg N ha^{-1}. Thus, increased application of nitrogen increased the nitrogen uptake. Krishnan and Lourduraj (1997) and Kawale and Prasad (2001) also reported similar results. The increased uptake of nitrogen was due to increased absorption of the nutrients by the cotton crop. Application of higher levels of phosphorus and potassium increased nitrogen uptake. The nitrogen, phosphorus and potassium interaction was synergetic at all the stages of the crop growth period. The combination of N_{30}, P_{15} and K_{15} recorded the higher nitrogen uptake through out the crop growth period indicating complimentary effect of phosphorus and potassium for better nitrogen uptake. Within the organic manures, combination FYM+CS, PM+CS or FYM+PM each @ 2.5 t ha^{-1} recorded higher nitrogen uptake at all stages of crop growth than their individual application @ 5.0 t ha^{-1}. This might be due to synergetic effect of organic manures. Padole *et al.* (1998) observed similar findings.

Phosphorus Uptake

The uptake of phosphorus was influenced by phosphorus levels throughout the crop growth period (Table 2). Application of 15 kg phosphorus ha^{-1} resulted in consistent increased uptake of phosphorus at all the stages. The total phosphorus uptake at 15 kg ha^{-1} was 2.966, 8.929 and 9.057 kg ha^{-1} at 60, 120 and 180 DAS respectively. The increased total uptake of phosphorus might be due to increased dry matter production that in turn influenced by higher levels of nitrogen and potassium uptake. Mayilsami and Iruthayaraj (1980) reported that the phosphorus uptake was significantly influenced by nitrogen levels. Among the different organic manures FYM+PM each @ 2.5 t ha^{-1} recorded significantly higher phosphorus uptake (2.721 kg ha^{-1}) at 60, (8.122 kg ha^{-1}) 120 and (8.451kg ha^{-1}) 180 DAS as compared to other organic manurial treatments. This might be due to better availability of phosphorus that in turn influenced the higher dry matter production.

Potassium Uptake

The different levels of potassium influenced the potassium uptake at all the stages of observation (Table 2). Application of 15 kg K ha^{-1} recorded higher potassium uptake at (11.99 kg ha^{-1})60, (45.33 kg ha^{-1}) 120 and (57.06 kg ha^{-1}) 180 DAS as compared to other potassium levels. External addition of potassium probably increased the quantity of immediately available potassium to plant, thus resulting in higher uptake of potassium. Within the organic manures FYM+PM each @ 2.5 t ha^{-1} recorded significantly higher potassium uptake at (10.0 kg ha^{-1}) 60, (40.69 kg ha^{-1}) 120 and (51.11kg ha^{-1}) 180 DAS than other organic manurial treatments. This might be due to better availability of potassium that in turn was responsible for

Table 2. Effect of Integrated nutrient management practices on nitrogen, phosphorus and potassium uptake by cotton [*G. herbaceum*] variety Jayadhar at 60, 120 and 180 days after sowing [DAS] [pooled data of two years]

Treatments	Nitrogen uptake			Phosphorus uptake			Potassium uptake		
Fertiliser levels [F]	60DAS	120DAS	180DAS	60DAS	120DAS	180DAS	60DAS	120DAS	180DAS
1. No Fertilizer [F_0]	8.82 c	30.29 c	30.99 c	2.160 c	6.486 c	6.760 c	6.30 c	27.45 c	35.79 c
2.15:7.5:7.5N,P_2O_5andK_2Okgha^{-1}[F_1]	12.05 b	41.43 b	40.35 b	2.563 b	7.917 b	8.168 b	9.27 b	37.15 b	50.04 b
2.30:15:15N,P_2O_5andK_2O kg ha^{-1}[F_2]	14.71 a	49.18 a	48.36 a	2.966 a	8.929 a	9.057 a	11.99 a	45.33 a	57.06 a
S.E.	0.16	0.73	0.66	0.047	0.109	0.048	0.16	1.00	0.69
Organic manures [OM]									
1. FYM @ 5 t ha^{-1}	10.85 b	38.89 b	38.38 b	2.488 bc	7.810 b	8.034 ab	8.85 b	36.39 b	47.64 a-c
2. PM @ 5 t ha^{-1}	11.40 b	39.11 b	39.16 b	2.562 bc	7.923 ab	7.826 b	8.90 b	37.07 b	47.69 a-c
3. CS @ 5 t ha^{-1}	11.24 b	38.08 b	38.51 b	2.437 c	7.248 c	7.742 b	8.90 b	33.51 c	44.63 c
4. FYM@2.5t ha^{-1} +CS@2.5 t ha^{-1}	12.18 a	41.77 a	40.08 ab	2.565 bc	7.726 b	7.787 b	9.01 ab	35.57 bc	45.89 bc
5. PM @2.5t ha^{-1} +CS@2.5 t ha^{-1}	12.73 a	41.64 a	40.18 ab	2.605 ab	7.836 ab	8.129 ab	9.46 ab	36.64 b	48.80 ab
6. FYM@2.5t ha^{-1} +PM@2.5 t ha^{-1}	12.78 a	42.31 a	43.07 a	2.721 a	8.122 a	8.451 a	10.00 a	40.69 a	51.11 a
S.E.	0.26	0.69	1.01	0.048	0.099	0.166	0.34	0.75	1.29
Interactions [F x OM]									
1. [F_0] +FYM@ 5 t ha^{-1}	8.16 j	28.57 hi	30.74 j	2.140 e	6.540 gh	6.935 gh	6.11 f	27.42 i	35.99 fg
2. [F_0] +PM @ 5 t ha^{-1}	8.19 j	26.80 i	29.42 j	2.128 e	6.565 gh	6.280 h	6.40 f	27.16 i	33.67 g
3. [F_0] +CS @ 5 t ha^{-1}	8.46 j	29.02 g-i	30.03 j	1.995 e	6.003 i	6.363 h	5.92 f	23.93 i	32.30 g
4. [F_0] +FYM@2.5t ha^{-1} +CS@2.5 t ha^{-1}	8.95 ij	32.52 g	29.85 j	2.107 e	6.230 hi	6.500 h	5.76 f	25.66 i	34.55 g
5. [F_0] +PM @2.5t ha^{-1}+CS@2.5 t ha^{-1}	9.07 ij	32.11 gh	31.81 ij	2.158 e	6.568 gh	7.045 f-h	6.41 f	27.81 i	36.44 fg
6. [F_0] +FYM@2.5t ha^{-1}+PM@2.5 t ha^{-1}	10.11 hi	32.72 g	34.08 h-j	2.430 d	7.012 fg	7.438 e-g	7.19 ef	32.74 h	41.76 ef
7. [F_1] +FYM@ 5 t ha^{-1}	10.31 g-i	38.20 f	37.07 g-i	2.485 cd	7.765 de	7.805 d-g	8.46 de	34.55 gh	46.99 de
8. [F_1]+PM @ 5 t ha^{-1}	11.60 e-g	40.89 ef	38.31 f-h	2.510 cd	8.045 d	8.050 c-e	9.05 d	38.73 ef	50.44 cd
9. [F_1]+CS @ 5 t ha^{-1}	11.39 f-h	39.48 ef	39.85 fg	2.465 cd	7.457 ef	8.212 b-e	8.56 de	33.83 gh	47.37 de
10. [F_1]+FYM@2.5t ha^{-1} +CS@2.5 t ha^{-1}	12.43 d-f	42.61 de	41.35 e-g	2.515 cd	8.023 d	7.878 d-f	9.23 d	36.90 fg	50.71 cd
11. [F_1]+PM @2.5t ha^{-1} +CS@2.5 t ha^{-1}	13.62 cd	45.13 cd	41.83 d-g	2.710 bc	8.235 cd	8.455 a-d	10.05 cd	39.00 ef	53.63 a-d
12. [F_1]+FYM@2.5t ha^{-1} +PM@2.5 t ha^{-1}	12.97 c-e	42.26 de	43.67 c-f	2.695 b-d	7.977 de	8.605 a-d	10.28 b-d	39.92 d-f	51.10 cd
13. [F_2] +FYM@ 5 t ha^{-1}	14.08 a-c	49.91 ab	47.34 a-d	2.840 ab	9.125 ab	9.363 a	11.98 ab	47.21 ab	59.94 a
14. [F_2] +PM @ 5 t ha^{-1}	14.40 a-c	49.63 ab	49.75 ab	3.047 a	9.160 ab	9.148 ab	11.24 a-c	45.32 bc	58.96 ab
15. [F_2]+CS @ 5 t ha^{-1}	13.86 b-d	45.75 cd	45.64 b-e	2.850 ab	8.285 cd	8.650 a-d	12.21 a	42.78 c-e	54.22 a-d
16. [F_2]+FYM@2.5t ha^{-1} +CS@2.5 t ha^{-1}	15.15 ab	50.16 ab	49.03 a-c	3.072 a	8.925 ab	8.985 a-c	12.04 ab	44.15 bc	52.42 b-d
17. [F_2]+PM @2.5t ha^{-1} +CS@2.5 t ha^{-1}	15.50 a	47.69 bc	46.91 a-e	2.947 ab	8.705 bc	8.887 a-c	11.93 ab	43.10 cd	56.33 a-c
18. [F_2]+FYM@2.5t ha^{-1} +PM@2.5 t ha^{-1}	15.27 ab	51.96 a	51.47 a	3.037 a	9.375 a	9.310 a	12.53 a	49.40 a	60.47 a
S.E.	0.45	1.19	1.76	0.084	0.172	0.287	0.59	1.29	2.24

production of higher dry matter thereby increased the potassium uptake.

It may, therefore, be concluded that application of 30 kg N, 15 kg P_2O_5 and 15 K_2O kg ha^{-1} with FYM or poultry manure each @ 5.0 t ha^{-1} or FYM+PM each @ 2.5 t ha^{-1} enhanced the productivity of cotton as well as uptake of nitrogen, phosphorus and potassium.

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Evaluation of Wheat Straw for its *In-situ* Decomposition and Effect on Crop Growth and Yield in Maize-Wheat Cropping System

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ABSTRACT

An investigation was conducted during 1997-98 to 2001-02, to evaluate *in situ* decomposition of wheat straw (ws) and its subsequent effect on growth and yield of crop under maize-wheat sequential cropping system. Results indicated significant increase in grain/fodder and grain/straw yield of maize and wheat crop by 200 kg FYM (starter) + 100 per cent NPK (recommended dose) + 3 t ws ha^{-1} to maize and 100 per cent NPK (recommended dose) to wheat under maize-wheat sequential cropping system. The addition of *in situ* ws showed improvement in microbial flora and available major nutrient content of soil.

Maintenance of soil fertility through cycling of organic matter is an important object of Agro-ecology. The ws can either be used as feed or as a source of organic manure. As organic matter of the soil forms the substrate for microbial nitrification as well as for humus formation, which ultimately improves soil physio-chemical properties and effects in the improvement of fertility level. Use of organic materials viz., FYM, green manure, wheat straw and other crop residues is now advocated for partial substitution of fertilizers due their to heavy cost and beneficial effects of organic manure on soil fertility (Deshmukh and Kharche, 1994).Since last three decade, use of chemical fertilizers has been tremendously increased to boost-up the crop production. The organic matter, eventhough plays an important role in maintaining physio-chemical properties of soil, has been ignored under the present agro-eco system.

Therefore, present investigations were conducted to study the feasibility of using ws as a source of organic matter with and without chemical fertilizers on wheat under maize-wheat cropping system, with the object of utilization of ws, a crop waste, as a source of organic matter for improving soil properties and subsequently the crop yield.

MATERIAL AND METHODS

A long term experiment on *In-situ* decomposition of ws and its subsequent effect on succeeding wheat crop under maize-wheat sequential cropping system was conducted at Wheat Research Unit, Dr. PDKV, Akola from 1997-98 to 2001-02. The experiment was laid out with eight treatments combination of fertilizers, FYM and wheat straw (table 1) fitted in Randomised Block Design with four replications. The wheat straw was applied with and without chemical fertilizers to maize crop during *Kharif* season for its *in situ* decomposition. Then, wheat was grown after the harvest of maize with application of fertilizers as per treatments.

Pooled analysis over a period of five years i.e. from 1997-98 to 2001-02 was also carried out. The soil samples were analysed by adopting recommended procedures.

RESULTS AND DISCUSSION

Data on soil analysis for organic carbon and available major nutrients (Table 3) indicated marginal increase by wheat straw application. Vageesh *et al.* (1989) and Narang et al. (1990) reported improvement in soil fertility status due to FYM or green manuering in rice-rice and rice-wheat crop sequence, respectively. While analysis of fungal colonies isolated from soil dilution (10^4) g^{-1} soil and bacterial colonies from soil dilution (10^6) g^{-1} soil, showed significant increase in population of soil fungi and bacteria under wheat straw application treatment.

Pooled data for a period of five years in respect of maize grain, fodder yield and wheat grain, straw yield (q ha^{-1}) for all the treatments are given in Table 2.

Maize grain yield :

The treatment differences were significant. Treatment T_7 (125 % NPK + 3t WS + 200 kg FYM) exhibited highest yield level of 34.69 q ha^{-1} which was significantly

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Table 1. Treatment details.

S. N.	Treatments, Maize (*Kharif*) (ha^{-1})	Treatments, Wheat (Rabi)
T_1	200 kg FYM (as starter) control	Control
T_2	200 kg FYM + 75 % NPK	75 % NPK
T_3	200 kg FYM + 100 % NPK	100 % NPK
T_4	200 kg FYM + 125 % NPK	125 % NPK
T_5	200 kg FYM + 75 % NPK + 3 t wheat straw	75 % NPK
T_6	200 kg FYM + 100 % NPK + 3 t wheat straw	100 % NPK
T_7	200 kg FYM + 125 % NPK + 3 t wheat straw	125 % NPK
T_8	3 t wheat straw	Control

Table 2. Pooled, Maize grain/fodder and Wheat grain/straw yield (q ha^{-1}).

S. N.	Treatments (Maize and Wheat)	Maize		Wheat	
		Grain yield	Fodder yield	Grain yield	Straw
yield					
T_1	200 kg FYM (as starter) control	14.28	19.79	7.79	12.00
T_2	200 kg FYM + 75 % NPK	25.19	28.81	19.95	34.36
T_3	200 kg FYM + 100 % NPK	27.74	31.00	21.68	39.56
T_4	200 kg FYM + 125 % NPK	28.27	30.33	23.47	40.67
T_5	200 kg FYM + 75 % NPK + 3 t ws	29.11	31.79	22.91	39.57
T_6	200 kg FYM + 100 % NPK + 3 t ws	33.61*	36.03*	25.57	42.72
T_7	200 kg FYM + 125 % NPK + 3 t ws	34.69*	37.32*	27.34	45.10
T_8	3 t ws	12.68	15.58	6.04	10.00
	'F' test	Sig.	Sig.	Sig.	Sig.
	SE (m) ±	1.04	0.94	0.74	1.16
	CD at 5 %	3.08	2.83	2.22	3.40
	CV %	18.00	14.8	17.00	16.00

superior to treatments T_1, T_2, T_3, T_4, T_5 & T_8 but it was at par with treatment T_6 (Table 2). Use of treatments T_1, T_2, T_3, T_4, T_5 & T_8 should be avoided.

Maize fodder yield :

Fodder yield differences due to various treatments were found to be significant. Treatment T_7 exhibited highest yield level of 37.22 q ha^{-1}, which was significantly superior to treatments T_1, T_5 & T_8 but was at par with treatment T_6 (Table 2).

Wheat grain yield :

The treatment differences were found significant. Treatment T_7, where 125 per cent NPK was applied in *Rabi* and 3 tonne WS in *Kharif*, exhibited highest yield level of 27.34 q ha^{-1} which was significantly superior to control treatments (T_1 & T_8) and treatments T_2, T_3 and T_4 where chemical fertilizers were applied without WS. The treatment T_7 was at par with treatment T_6 where 100 per cent NPK + 3 t ws was applied (Table 2).

Wheat straw yield :

The treatment T_7 recorded highest yield level of 45.10 q ha^{-1} which was significantly superior to rest of the treatments but was at par with treatment T_6 (Table 3). Deshmukh *et al.* (1995) reported application of organic sources including wheat straw resulted in improving the soil fertility status and increased yield levels of both the crops in sorghum-wheat crop sequence.

As the results revealed, it was concluded that, in maize-wheat cropping system, application of 200 kg FYM as starter + 3 tonne WS + recommended dose of NPK to maize and application of recommended dose of NPK to succeeding irrigated wheat, significantly increases grain, fodder and grain, straw yield of maize and wheat respectively.

Table 3 : Effect of *in situ* decomposition of wheat straw on available nutrients.

S. N.	Treatments	Initial value	1998	1999	2000	2001	2002
		Organic Carbon (%)					
1.	200 kg FYM (as starter) control	0.210	0.215	0.218	0.218	0.215	0.217
2.	75 % NPK	0.210	0.218	0.221	0.220	0.224	0.254
3.	100 % NPK	0.210	0.226	0.228	0.231	0.230	0.244
4.	125 % NPK	0.210	0.228	0.227	0.231	0.238	0.240
5.	75 % NPK + 3 t wheat straw	0.210	0.265	0.270	0.278	0.271	0.276
6.	100 % NPK + 3 t wheat straw	0.210	0.285	0.286	0.284	0.286	0.289
7.	125 % NPK + 3 t wheat straw	0.210	0.287	0.288	0.288	0.293	0.306
8.	3 t wheat straw	0.210	0.245	0.246	0.249	0.248	0.251
		Available N (kg ha^{-1})					
1.	200 kg FYM (as starter) control	143	148	150	150	148	152
2.	75 % NPK	145	150	152	151	154	161
3.	100 % NPK	152	156	157	159	158	168
4.	125 % NPK	152.5	157	156	159	164	169
5.	75 % NPK + 3 t wheat straw	169.7	183	186	192	186	190
6.	100 % NPK + 3 t wheat straw	173	187	197	196	199	201
7.	125 % NPK + 3 t wheat straw	178	183	199	198	201	211
8.	3 t wheat straw	165.6	169	171	172	180	183
		Available P (kg ha^{-1})					
1.	200 kg FYM (as starter) control	18.70	18.60	18.86	18.56	18.66	18.82
2.	75 % NPK	18.70	18.72	18.65	18.81	19.04	19.92
3.	100 % NPK	18.70	18.68	18.79	19.26	20.18	21.66
4.	125 % NPK	18.70	18.92	18.98	19.82	20.54	22.06
5.	75 % NPK + 3 t wheat straw	18.70	19.02	19.36	20.72	21.64	22.84
6.	100 % NPK + 3 t wheat straw	18.70	19.46	19.54	21.06	22.45	23.89
7.	125 % NPK + 3 t wheat straw	18.70	19.52	19.48	20.90	22.68	23.88
8.	3 t wheat straw	18.70	18.60	18.68	18.90	19.02	19.36
		Available K_2O (kg ha^{-1})					
1.	200 kg FYM (as starter) control	460	450	448	446	465	458
2.	75 % NPK	460	462	465	453	460	468
3.	100 % NPK	460	465	467	465	458	465
4.	125 % NPK	460	462	462	470	468	474
5.	75 % NPK + 3 t wheat straw	460	458	462	458	465	471
6.	100 % NPK + 3 t wheat straw	460	455	464	468	473	475
7.	125 % NPK + 3 t wheat straw	460	464	468	472	478	480
8.	3 t wheat straw	460	459	455	462	460	458

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PKV Res. J. Vol. 30 (2), 2006

Studies on Control of Chlorosis in Safed Musli (*Chlorophytum borivilianum)*

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ABSTRACT

A field trial was conducted successively for three years during *Kharif* 2000-01,2001-02 and 2002-03 at Nagarjun Medicinal Plants Garden, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola [M.S.], to study the effect of various foliar applications for the control of chlorosis in Safed musli *(Chlorophytum borivilianum).* There were ten treatments under study, replicated three times. Plant samples were analysed for various nutrient contents and noted the ancillary observations. Chlorosis was found to reduce number of leaves and fresh root yield plant^{-1}. The nutrient status in the leaves of chlorotic plants was also poor particularly in respect of iron, potassium and nitrogen contents as compared to green plants. Different chemical applications significantly influenced the chlorophyll content of the leaves. Maximum chlorophyll content was obtained from humic acid complex+ ferrous sulphate applied plants. The foliar application of Humic acid + Urea, Humic acid + Ferrous sulphate and Humic acid complex significantly increased the number of roots plant^{-1}. Similar results were also obtained in respect of number of roots and fresh root yield.

Chlorosis appears frequently appeared on Safed musli at early stages of growth, but it is observed that the problem is location specific. The probable reasons identified as water logging, long dry spell, soil compaction, high temperature, calcareous soils, deficiency of iron and infection of nematodes. The range of chlorosis observed was 20-22 per cent. However, the chlorosis problem in Safed musli is most common particularly when grown on calcareous soils and it is primarily associated with iron deficiency affecting the growth and photosynthesis in the plants (Zakerzheviskli, *et. al.,* 1987). The presence of $CaCO_3$ in soils is considered to be the most important factor responsible for Fe deficiency.

Safed musli (*Chlorophytum borivilianum*) roots have assumed great importance now a days. The white product fetches more price than the pale yellow or brownish material. It has also a large and consistent market demand in the country and the current projection of the annual demand is estimated between 500 to 800 tonnes annually (Bordia, 1992). The research work carried out so far on the nutritional management to control the chlorosis in Safed musli is meager. In order to develop the suitable remedy to control the chlorosis in Safed musli, the present investigation was carried out.

MATERIAL AND METHODS

A field experiment was conducted successively for three years during *Kharif* 2000-01,2001-02 and 2002-03, to study the effect of various foliar applications on control of chlorosis in Safed musli *(Chlorophytum borivilianum) at* Nagarjun Medicinal Plants Garden, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. There were 10 treatments comprised of T1-Control (Water spray), T2-Urea (1.0%), T3-Humic acid complex (0.05%), T4-Ferrous sulphate ($FeSO_4$ 0.5%), T5- Zinc sulphate ($ZnSO_4$ 0.5%), T6- Urea + Ferrous sulphate, T7- Urea + Zinc sulphate, T8- Humic acid + Ferrous sulphate, T9- Humic acid + Zinc sulphate and T10- Humic acid +Urea, replicated thrice in randomized block design, with the gross and net plot size of 1.20m x 3.00m and 0.60m x 2.70 m,respectively. The experimental soil was slightly calcareous ($CaCO_3$ 4.8-5.2%), alkaline in soil reaction (pH 7.8), low in organic carbon, available nitrogen, phosphorus and rich in potassium. The contents DTPA Zn, Fe, Mn and Cu were 0.74, 4.80, 2.60 and 1.8, respectively. The planting of fasciculated roots on raised beds were done in the month of June. The chlorotic symptoms on leaves were noticed after 35-40 days of planting. The foliar applications as per the treatments were done twice at an interval of 15 days

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Table 1: Growth and nutrient status of green and chlorotic plants of *Safed* musli (Average of three years)

Parameters	Green plants	Chlorotic plants	Reduction (%)
Growth parameters			
No. of leaves Plant^{-1}	18.1 (16.4-19.21)	12.6 (11.0-14.0)	30.40
No. of roots Plant^{-1}	13.8 (13.4-14.0)	8.33 (7.2-9.4)	39.63
Weight of roots Plant^{-1} (g)	17.0 (14.4-18.3)	10.2 (9.4-10.8)	40.00
Nutrient status of Plant			
i) Nitrogen (%)	2.69 (2.62-2.73)	1.715 (1.60-1.776)	36.20
ii) Phosphorus (%)	0.358 (0.340-0.374)	0.304 (0.29-0.318)	15.08
iii) Potassium (%)	1.601(1.46-1.684)	0.980 (0.954-1.020)	38.80
iv) Zinc (ppm)	35.50 (33.4-37.0)	29.80 (29.3-30.2)	16.0
v) Iron (ppm)	170.80 (160-180)	98.5 (91-106)	42.30
vi) Manganese (ppm)	61.20 (59.2-64.4)	49.60 (48-51.8)	18.90
vii) Copper (ppm)	23.70 (22.4-25.4)	21.30 (20.2-22.0)	10.80

Figure in the parentheses refer to the range values.

Table 2. Number and fresh root yield of chlorotic Safed musli as influenced by various treatments

Treatments	Av. number of Roots plant^{-1}				Fresh root yield (g plant^{-1})			
	2000-01	2001-02	2002-03	Pooled mean	2000-01	2001-02	2002-03	Pooled mean
T1-Control	8.26	7.03	6.67	7.32	9.63	7.83	8.40	8.62
T2-Urea (1%)	9.40	10.30	9.00	9.56	12.06	12.66	11.17	11.97
T3-Humic acid complex (0.05%)	13.16	12.93	11.00	12.36	16.23	14.46	12.50	14.40
T4-$FeS0_4$ (0.5%)	9.00	8.73	8.33	8.68	16.80	10.46	10.43	10.57
T5-$ZnS0_4$ (0.5%)	8.76	8.79	8.67	8.74	10.60	10.46	9.90	10.32
T6-Urea + $FeSO_4$	11.70	9.50	9.00	10.06	14.00	11.50	11.57	12.36
T7-Urea + $ZnS0_4$	11.46	9.43	10.00	10.30	14.63	12.06	11.80	12.83
T8-Humic acid + $FeS0_4$	13.46	13.20	11.33	12.66	16.70	15.16	14.00	15.29
T9-Humic acid + $ZnS0_4$	12.73	11.93	11.00	11.89	16.10	14.06	13.63	14.60
T10-Humic acid + Urea	13.43	13.46	12.00	12.96	17.10	15.93	14.33	15.79
SE (m) ±	0.928	0.693	1.20	0.77	0.835	0.774	1.18	0.67
CD at 0.05%	2.760	2.060	NS	2.30	2.482	2.30	3.52	1.99
CV%	14.40	11.40	21.46	22.32	10.49	10.76	17.44	15.97

starting from first appearance of the symptoms. The plant samples were collected before and after foliar application for various chemical analysis. The yield of fasciculated roots was recorded as per the treatments. The chemical analysis of soil and plants was performed by standard procedures (Jackson, 1967, Piper, 1966, Lindsay and Norvell, 1978).

RESULTS AND DISCUSSION

The chlorotic symptoms on leaves of Safed musli were noticed after 35-40 days of planting. The intensity of the chlorosis was in the range of 20-22 per cent. Chlorosis was found to reduce number of leaves and fresh root yield plant^{-1} (Table 1). Nutrient status in the leaves of affected plants was also poor. Iron, potassium and

Table 3: Chlorophyll content, average length and girth of fasciculated roots as influenced by various treatments of foliar application

Treatments	Chlorophyll (mg g^{-1} tissue)				Av. Length (cm) of roots				Girth (cm) of root			
	2000-01	2001-02	2002-03	Mean	2000-01	2001-02	2002-03	Mean	2000-01	2001-02	2002-03	Mean
T^{0} -Control	0.320	0.340	0.320	0.326	5.96	6.13	5.60	5.89	0.706	0.610	0.610	0.642
T^{1}-Urea (1%)	0.480	0.500	0.490	0.490	7.16	7.56	6.20	6.97	0.743	0.630	0.640	0.671
T^{2}-Humic acid complex (0.05%)	0.516	0.540	0.540	0.532	8.26	7.56	7.13	7.65	0.776	0.670	0.690	0.712
T^{3}-$FeS0_4$ (0.5%)	0.470	0.490	0.490	0.483	7.73	7.00	6.97	7.23	0.740	0.630	0.640	0.670
T^{4}-$ZnS0_4$ (0.5%)	0.420	0.420	0.460	0.433	7.40	7.13	6.87	7.13	0.763	0.640	0.630	0.677
T^{5}-Urea + $FeSO_4$	0.520	0.520	0.530	0.523	8.36	6.90	6.90	7.38	0.776	0.670	0.650	0.698
T^{6}-Urea + $ZnS0_4$	0.503	0.480	0.510	0.497	7.96	7.06	6.80	7.27	0.763	0.630	0.660	0.684
T^{7}-Humic acid + $FeS0_4$	0.556	0.580	0.570	0.568	8.56	7.60	6.70	7.62	0.783	0.700	0.710	0.731
T^{8}-Humic acid + $ZnS0_4$	0.520	0.530	0.560	0.536	8.23	7.40	6.80	7.47	0.766	0.700	0.700	0.722
T^{9} -Humic acid + Urea	0.536	0.560	0.550	0.548	8.30	7.53	7.03	7.62	0.796	0.720	0.710	0.742
SE^{10} (m) $\pm$	0.011	0.016	0.027	-	0.421	0.261	0.706	-	0.015	0.037	0.029	-
CD (0.05)	0.032	0.048	0.080	-	1.253	0.777	NS	-	0.047	NS	NS	-
CV%	3.85	5.74	9.37	-	9.36	6.30	18.25	-	3.60	9.94	7.72	-

nitrogen contents were drastically reduced (42.3%, 38.8% and 36.25, respectively) as compared to green plants. Different chemical application significantly influenced the chlorophyll content of the leaves. Maximum chlorophyll content (0.568 mg 100^{-1} g) was obtained from humic acid complex + ferrous sulphate applied plants.

The pooled results (Table 2) showed that the foliar application of Humic acid + Urea. (T10), Humic acid + Ferrous sulphate (T8) and Humic acid complex (T3) significantly increased the number of roots $plant^{-1}$ over rest of the foliar applications. Similar results were also obtained in terms of fresh root yield. Lowest fresh root yield was recorded in control.

These results are in agreement with findings of a field experiment conducted at Udaipur (Anonymous 2002-03). It was reported that the soil application of elemental sulphur or two foliar

applications of $FeSO_4$ significantly increased the chlorophyll content of the leaves ,fleshy root $plant^{-1}$, length of root and fleshy root yield.

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PKV Res. J. Vol. 30 (2), 2006

Moisture Use Efficiency by Wheat Under Different Levels of Major Nutrients Applied on Vertisol

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ABSTRACT

The investigation entitled "Moisture use efficiency by wheat under different levels of major nutrients applied on Vertisol" was conducted during the *Rabi* season of 1998-99 on long term fertilizer experiment with sorghum-wheat sequence under land Resource Management Project, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The soils of the experimental site belonged to the order Vertisols with subgroup Typic Haplusterts. The field experiment was laid out in Randomized Block Design with twelve treatments replicated four times with major nutrients. Positive and highly significant correlations were found between moisture use and per cent growing season of wheat crop for all treatments. Moisture use values were found varying between 544.87 to 551.90 mm with crop factor (Kc) range of 1.025 to 1.038. Whereas, moisture use efficiency values varied from 0.306 to 7.609 kg ha^{-1} mm^{-1} with highest values under 100 per cent NPK + FYM @ 10 t ha^{-1}. It was found increasing with increasing levels of optimal NPK from 0 to 150 per cent optimal NPK. Positive and highly significant correlations were found for moisture use efficiency with available nutrients and available water capacity under long term effect of fertilizers and manure.

Efficient use of water and fertilizer is highly critical to sustained agricultural production and will continue to occupy a dominant place in future to meet a projected growing demands matching with rapidly swelling population, more particularly in the context of declining per capita land and water availability, pollution, degradation and increasing fertilizer cost, etc. The use efficiency of these inputs is very low in India. The experimental results revealed that interaction between these two costly inputs governs sustainability of high crop productivity. Higher fertilizer application is beneficial only under adequate moisture regime, nutrient availability being low under both very deficient and excess moisture. Likewise water use efficiency is higher with higher fertilizer application and the two inputs act independently beyond a threshold level.

Agriculture is the biggest user of water for irrigation but the competition for water uses from industries, urban users and other elements are increasing and agriculture will find it hard to compete unless it improves the productivity and efficiency of irrigation and reduce its negative effect (Kanwar, 1997, Chaudhary , 1995) pointed out that the water use for agriculture which is about 83 per cent of the developed water resource is likely to be reduced by 10 to 20 per cent to meet the growing vital demand for drinking water and economically more competitive demand for industrial uses. In light of this situation, he emphasized increasing efficiency of irrigation and crop water use. Further, he stressed on use of poor quality water (saline ground water, drainage water and sewage water) in supplementation with the fresh water irrigation.

MATERIAL AND METHODS

The present study was superimposed during 1998-99 on field experiment " Moisture use efficiency by wheat under different levels of major nutrients applied on Vertisol" under Land Resource Management Project at CRS, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was laid out in Randomized Block Design with twelve treatments replicated four times. The soil of experimental site was clay in texture. The treatment details are given in Table 1.

Soil samples were collected using screw agar from 0-15 cm and 15-30 cm depths at sowing and before and after each irrigation till harvest of the crop. Soil moisture content was determined gravimetrically. Evapotranspiration (ET) by crop during period was calculated ET = Kc Pan E, Kc is crop coefficient depending on the per cent of growing season of crop and Pan E is the cumulative pan evaporation during a period. Moisture use efficiency (MUE) under each treatment was calculated

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Table 1. Treatment details

Treatments	Rate (kg ha^{-1})	Source of fertilizer
T_1 – Control	-	-
T_2 – 50% NPK	60:30:30	Urea, SSP, MOP
T_3 – 75% NPK	90:45:45	Urea, SSP, MOP
T_4 – 100% NPK	120:60:60	Urea, SSP, MOP
T_5 – 150% NPK	180:90:90	Urea, SSP, MOP
T_6 – 100% N	120:00:00	Urea
T_7 – 100% NP	120:60:60	Urea, DAP
T_8 – 100% NPK + 10 kg S through gypsum	120:60:60	Urea, DAP, MOP
T_9 – 100% NPK + $ZnSO_4$ @ 10 kg ha^{-1}	120:60:60	Urea, SSP, MOP
T_{10} – 100% NPK- S free	120:60:60	Urea, DAP, MOP
T_{11} – 100% NPK + FYM @ 10 t ha^{-1}	120:60:60	Urea, SSP, MOP
T_{12} – FYM @ 10 t ha^{-1} (*Kharif*)	-	-

* SSP – Single super phosphate, DAP – Diammonium phosphate, MOP- Murate of potash

on the basis of economic yield of the crop and total moisture use (Michael and Ojha, 1983). Potential evapotranspiration of crop were accounted for accelerated water loss for the interval just after irrigation and subsequent soil moisture sampling. PET for these intervals were calculated from the regression equation established, PET = 1.93 + 0.68 PE (Kalane *et al.*, 1998). Crop factor (Kc) is calculated by moisture use (mm) divided by Pan E. Available water capacity (AWC) is the difference between moisture retention at 1/3 and 15 bar. Simple regression equations were calculated as per statistical method outlined for correlation purposes (Rao, 1983).

RESULTS AND DISCUSSION

Moisture use:

The data pertaining to moisture use by wheat crop at different per cent growing season of crop are given in Table 2. Moisture use data were correlated with per cent growing season. Positive and highly significant correlation between moisture use and per cent growing season of crop was found for all the treatments under long term effect of manure and fertilizers. This shows that moisture use increased linearly with per cent growing season of crop under all treatments. Kalane *et al.* (1998) observed linear increase of moisture use with increase in per cent growing season of hybrid sorghum on Vertisols. From the regression equation developed (Table 3) for the different treatments between moisture use and per cent growing season, moisture use under different treatments was predicted for 100 per cent growing season corresponding to moisture use by the crop (Table 4).

Crop factor, Kc:

Similarly, the crop factor values (Table 4) were found nearly equal under all treatments ranging between 1.025 to 1.038, the lowest being it under control. This shows that crop factor is not much influenced under long term effect of fertilizers and manure.

Moisture use efficiency :

Predicted moisture use efficiency values are given in Table 4. These values vary from 0.306 to 7.609 kg ha^{-1} mm^{-1} under different treatments. It was found highest as 7.609 kg ha^{-1} mm^{-1} under 100 per cent optimal NPK + 10 t ha^{-1} FYM (T_{11}). Application of FYM @ 10 t ha^{-1} (T_{12}) caused only to have moisture use efficiency values of 0.745 kg ha^{-1} mm^{-1} which was found lower than under per cent optimal NPK (T_2) treatment (2.404 kg ha^{-1} mm^{-1}). Moisture use efficiency values increased from 0.306 to 6.131 kg ha^{-1} mm^{-1} with increasing levels of NPK from 0 to 150 per cent NPK treatments. Similar, increase in water use efficiency by the application of increase in levels of fertilizers were also reported by Pandey *et al.* (1977), Rathore and Singh (1977) and Mishra *et al.* (1994).

Correlation of moisture use efficiency with available major nutrients and available water capacity:

The data pertaining to moisture use efficiency (kg ha^{-1} mm^{-1}) under different treatments of manure and fertilizers (Table 5) were correlated with available nutrients and AWC. Regression equations

Table 2. Moisture use by wheat crop at different per cent growing season

Per cent growing season (%)	Moisture use (mm)											
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}
13.88	82.015	81.541	80.671	80.817	82.543	80.807	83.310	80.855	80.604	80.861	80.532	79.854
27.78	151.956	153.592	152.453	153.327	155.467	154.839	153.037	155.203	152.993	153.138	154.144	152.401
42.59	229.051	229.702	228.07	230.322	229.832	232.874	230.491	229.604	229.536	230.486	229.624	231.258
55.55	300.898	300.846	300.869	300.662	300.934	302.473	300.665	29.598	300.397	300.727	301.014	301.879
70.37	372.024	375.97	375.613	375.022	376.181	377.592	375.128	373.987	374.642	376.701	373.729	373.364
79.63	447.71	451.167	451.739	451.997	452.806	452.613	450.76	450.873	451.261	452.725	452.266	450.039

Table 3. Correlation of per cent growing season with moisture use by wheat crop

Treatments	Regression equation	'r' value
T_1	Y = 1.473+ 5.434 X	+ 0.9980**
T_2	Y = 0.340+5.489 X	+ 0.9980**
T_3	Y = -1.341 +5.512 X	+0.9979**
T_4	Y = -0.239 + 5.499 X	+0.9979**
T_5	Y = 1.425+5.484 X	+0.9978**
T_6	Y = 0.597+5.513 X	+0.9983**
T_7	Y = 1.780+5.462 X	+0.9979**
T_8	Y = 0.974+5.467 X	+0.9981**
T_9	Y = -0.467+5.494 X	+0.9979**
T_{10}	Y = -0.768+5.513 X	+0.9980**
T_{11}	Y = 0.0649+5.492 X	+0.9977**
T_{12}	Y = -0.151+5.486 X	+0.9981**

Table 4.Predicted moisture use, crop factor and moisture use efficiency by wheat

Treatments	100% moisture use (mm)	Crop factor	Moisture use efficiency ($kg\ ha^{-1}\ mm^{-1}$)
T_1	544.873	1.025	0.306
T_2	549.240	1.033	2.404
T_3	549.859	1.034	3.006
T_4	549.661	1.034	4.845
T_5	549.825	1.034	6.131
T_6	551.897	1.038	2.091
T_7	547.980	1.031	3.372
T_8	547.674	1.030	4.876
T_9	548.933	1.033	4.666
T_{10}	550.532	1.036	4.556
T_{11}	549.135	1.033	7.609
T_{12}	548.449	1.032	0.745

Table 5. Moisture use efficiency and available nutrient status under long term effect of manure and fertilizers

Treatments	MUE (kg $ha^{-1}mm^{-1}$)	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})	AWC (mm/100cm)
T_1	0.306	176.39	7.125	221.72	199.318
T_2	2.006	194.42	9.750	285.55	193.719
T_3	3.006	197.58	10.875	305.70	193.193
T_4	4.845	241.46	15.375	317.67	171.368
T_5	6.131	268.91	20.250	389.70	195.151
T_6	2.091	228.92	13.500	324.00	196.202
T_7	3.372	235.98	14.250	332.60	199.070
T_8	4.876	252.44	16.125	359.45	220.686
T_9	4.666	238.33	16.875	346.05	214.196
T_{10}	4.556	252.44	13.125	325.87	194.188
T_{11}	7.609	307.32	22.125	463.67	225.686
T_{12}	0.745	188.15	10.500	305.72	235.066

Table 6. Correlation of MUE (kg ha^{-1} mm^{-1}) with available nutrients and AWC

S.N.	Regression equation	'r' value
1	MUE = -8.698 + 0.0535 N	+0.941**
2	MUE = - 2.759 + 0.457 P_2O_5	+0.927**
3	MUE = -7.052 + 0.032 K_2O	+0.886**
4	MUE = 3.343 + 0.0018 AWC	+0.015

** Significant at 1% level, MUE – Moisture use efficiency, AWC – Available water

relating MUE with available nutrients and AWC are given in Table 6. Positive and highly significant correlation between moisture use efficiency with available N, P and K were found. This indicates that moisture use increased linearly with the increase in available nutrient status developed as a result of long term use of manure and fertilizers. Similarly, it also linearly increased with the increase in available water capacity (AWC). However, correlation between moisture use efficiency and AWC as not significant.

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PKV Res. J. Vol. 30 (2), 2006

Post Harvest Deterioration of Andrographolide Content in Herb Powder of Kalmegh *(Andrographis paniculata)*

S.G.Wankhade[1], M.R.Kale[2], S.A.Agashe[3] and P.P.Khode[4]

ABSTRACT

A laboratory study was undertaken to study post harvest deterioration of andrographolide in Kalmegh herb powder as influenced by methods and period of storage successively for three years (2001-02 to 2003-04). The observations on moisture and andrographolide content were recorded throughout year at an interval of two months period. The moisture content in the herb powder was in the range of 6.93 to 7.78 per cent throughout the storage period of one year, however, it was significantly highest during the storage period of July (8 MAH) and September (10 MAH) months ,mainly due to weather conditions during these months. Significant reduction in andrographolide content was noticed at the storage period of 10 and 12 months. Although the reduction in andrographolide content was also noticed in the powder stored in open container but the difference due to storage methods was nonsignificant.

Genus *Andrographis* belongs to family Acanthaceae that consists about 40 species distributed in the tropical Asia. *Andrographis paniculata* and *Andrographis alata,* out of nineteen species available in India are medicinal. *Andrographis paniculata* (Burm. f.) Nees, commonly known as kalmegh is a bitter annual (perennial if maintained) herb, erect, 60 cm to 100 cm in height, stem quadrangular and much branched; self-pollinated crop.

The active bitter principle of Kalmegh is andrographolide ($C_{20}H_{30}O_5$, a diterpene lactone). It is common bitter tonic prescribed for children in liver troubles. Also used in intermittent and remittent fevers. The extracts protect alcohol induced toxic effect on liver tissue and accelerate intestinal digestion and absorption of carbohydrates. Decoction of the whole plant is blood purifier, used for cure of torbid liver, jaundice, dermatological diseases and dyspepsia.

Before marketing a crude drug, it is necessary to process it properly, so as to preserve it for a longer time and also to acquire better pharmaceutical elegance. Drying of the herb and storage methods and also period of storage are of prime importance in reference to the active principles and therefore, the present investigation was undertaken to assess the deterioration of the herb powders of Kalmegh as influenced by the drying methods, storage period and methods of storage.

MATERIAL AND METHODS

Kalmegh plants harvested in the month of November (First week) were cleaned and dried by two methods viz. Sun drying for three days and oven drying at 60° C for 24 hours Then herb powder was prepared and stored for one year in open container and airtight container. The herb powder was periodically monitored at two months intervals up to one year for changes in andrographolide and moisture contents. The moisture content was determined by A.O.A.C. (1985) methods and the andrographolide content by the procedure described by Roy and Paul (1991).The data so obtained were statistically analysed by standard procedure to draw firm conclusion.

RESULTS AND DISCUSSION

Storage Periods

From the pooled data, it is revealed that the moisture content in the herb powder was in the range of 6.93 to 7.78 per cent throughout the storage period of one year, however, it was significantly highest during the storage period of July (8 MAH) and September (10 MAH) months ,mainly due to weather conditions during these months. The higher content of moisture is not desirable during the storage ,as it hastens the deterioration process. The andrographolide content was found to decrease from 2.180 to 1.985 per cent with the advancement of storage

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Table 1: Effect of Storage periods and storage methods on andrographolide content of Kalmegh herb powder

Treatments	Moisture%				Andrographolide%			
	2001-02	2002-03	2003-04	Pooled Mean	2001-02	2002-03	2003-04	Pooled Mean
A. Storage Periods (months after harvest)								
2 MAH - (P1)	6.33	7.64	7.27	7.08	2.125	2.191	2.174	2.163
4 MAH - (P2)	6.43	7.85	7.24	7.17	2.142	2.216	2.181	2.180
6 MAH - (P3)	5.84	7.72	7.22	6.93	2.156	2.133	2.163	2.151
8 MAH -(P4)	7.93	7.95	7.47	**7.78**	2.121	2.100	2.147	2.123
10 MAH -(P5)	7.63	8.12	7.45	**7.73**	2.042	2.058	2.033	2.044
12 MAH -(P6)	7.19	7.68	7.24	7.37	1.956	1.991	2.007	**1.985**
CD (0.05)	0.243	0.291	NS	0.156	0.060	NS	NS	0.089
B. Storage methods								
Sun drying + air tight container - (St-1)	7.33	7.99	7.48	7.60	2.085	2.111	2.123	2.106
Sun drying + open container- (St-2)	7.92	8.45	7.63	**8.00**	2.057	2.083	2.089	2.076
Oven drying + air tight container- (St-3)	5.77	7.25	6.96	6.66	2.124	2.155	2.145	2.141
Oven drying+ open container- (St-4)	6.54	7.61	7.19	7.11	2.097	2.111	2.113	2.107
CD (0.05)	0.199	0.237	0.209	0.127	NS	NS	NS	NS
C. Interaction (Storage methods x periods)								
CD (0.05)	0.487	0.582	NS	0.311	NS	NS	NS	NS
CV %	4.30	4.65	4.27	4.61	3.54	13.24	8.13	9.24

*MAH-Months after harvest

Table 2: Effect of storage periods and storage methods on moisture content of Kalmegh herb powder

Treatments	B. Storage methods			
	Sun drying + air tight container - (St-1)	Sun drying + open container - (St-2)	Oven drying + air tight container- (St-3)	Oven drying+ open container - (St-4)
A. Storage Periods				
(months after harvest)				
2 MAH - (P1)	7.55	7.83	6.35	6.58
4 MAH - (P2)	7.55	7.74	6.56	6.83
6 MAH - (P3)	7.18	7.34	6.47	6.71
8 MAH -(P4)	7.88	8.67	6.82	7.76
10 MAH -(P5)	7.96	8.56	6.84	7.57
12 MAH -(P6)	7.46	7.86	6.92	7.23
CD (0.05)	0.311			

*MAH-Months after harvest

period and significantly lowest content was recorded after 12 months period (P6), however, it was at par with 10 months period (P5).

Storage methods

Significantly highest moisture content was noticed in the powder stored in open containers (St 2 and St 4), as compared to airtight containers irrespective of drying methods i.e. sun dried or oven dried. Although the reduction in andrographolide content were recorded due to storage in open container, the differences among the various storage methods were found non significant. The open containers allowed more changes in moisture content of herb powered particularly in rainy seasons, favours the microbial decomposition of active principles resulted in to reduction in the andrographolide content. As the herb powder of Kalmegh is less hygroscopic no significant loss in the content was recorded due various storage methods under study.

Significantly highest moisture content (Table-2) was noticed in the treatment combinations of storage period and storage method of open containers (P4+St2, P5+St2 and P4+St4, P5+St4). Interaction effect was found non significant in respect of andrographolide content. These results are in conformity with the findings of research work carried out at Indore (Anonymous, 2002). It had also reported non-significant change in andrographolide content due to storage methods. Being a genetic character it was least affected due to prevalent weather conditions.

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PKV Res. J. Vol. 30 (2), 2006

Heterosis for Physiological Parameters and Yield Components in Sunflower

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ABSTRACT

An experiment was conducted at the field of University Department of Agril. Botany, Dr. PDKV, Akola during 1998-1999 and 1999-2000 on vertisol (7.9 pH) on four sunflower hybrids and their parents in R.B.D. with three replications to study the heterosis for physiological parameters and yield components. Heterosis study showed positive and significant heterotic effects for most of the traits. All the hybrids showed positive and significant range of heterobeltiosis for LAI, RGR, NAR, LAD, TCC and total dry matter. Similarly, the hybrids also recorded positive and significant range of heterosis and heterobeltiosis for head diameter, percentage of filled seeds, harvest index, total dry matter and seed yield plant^{-1}. The highest heterosis of 189.50 per cent for seed yield was recorded by the hybrid PKVSH 27.

Oilseeds have been the backbone of agricultural economy of India from time immemorial. It is popularly cultivated because of its photo and thermo insensitive nature, adaptability under wide range of soils, tolerant to conditions of water stress and high oil percentage, etc. In India, it covers an area of 21.62 lakh ha with the production of 12.24 lakh tones. In Maharashtra, sunflower occupies an area of 3.21 lakh hacterage with an average production of 520.00 kg ha^{-1}, out of which in Vidarbha, it is grown on an area of 0.098 lakh hectares with an average production of 529.00 kg ha^{-1} (Anonymous, 2005).

Hybrid vigour and heterosis are the expressions often indiscriminately used to describe the superiority of hybrids over parents. Heterosis and hybrid vigour have a relationship that exists between the mechanism and its product. Consequently the factors that influence genetic expressions should affect hybrid vigour. Yield and primary physiological processes such as photosynthesis, transpiration, respiration and translocation are quantitative characters. Such characters are often conditioned by many genes with small individual effect and that there is often a sizable environmental effect.

The important physiological parameters that limit the productivity in sunflower are leaf area index (LAI), net assimilation rate (NAR) and leaf area duration (LAD), (Nanjareddy *et al.,* 1996 and Srivastava, 1998). Therefore, the present investigation is an attempt to identify and understand the relationship of such physiological components which lead to increase in vigour for seed yield in F_1 hybrids of sunflower.

MATERIAL AND METHODS

An experiment was conducted at the field of University Department of Agril. Botany, Dr. PDKV, Akola during 1998-1999 and 1999-2000 on vertisol with a pH of 7.9. The treatments were 12 including four hybrids viz. PKV-40, PKVSH-41, LSH-3 and PKVSH-27 and their eight parents, sown in randomized block design with three replications. The plot size of the experiment was 3.00 X 4.50 m (gross) with the spacing of 60 X 30 cm (rows x plants). In both the years, the crop was sown on 11th of July. Cultivation practices were followed as per the recommendations.

The heterotic effects for some important characters (averages of two years pooled data) was worked out under two headings (a) when some physiological parameters like LAI, relative growth rate (RGR), NAR, leaf area ratio (LAR), LAD and total chlorophyll content (TCC) expressed maximum value, only that stage was identified and considered for calculation of heterotic effect, (b) similarly the heterosis between yield and some yield attributes which were recorded at harvest were considered for estimation of heterosis of parents Vs hybrids. The heterosis effect i.e. the per cent increase or decrease in hybrids (F_1) over mid parent (MP), better parent (BP) and check were also worked out as per the standard procedure given by Arunachalam (1974) and were reported as heterosis, heterobeltiosis and useful heterosis (%), respectively.

RESULTS AND DISCUSSION

The two years data were pooled and heterosis was worked out on seventeen characters (Table 1 and 2). The heterotic effects over mid parent (MP), better parent (BP) and useful heterosis / standard heterosis (over check) were observed to be significant for most of the traits.

Heterosis for physiological parameters

It was observed that (Table 1), all the hybrids showed positive and significant heterobeltiosis for the

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Table 1. Distribution of heterosis (MP),heterobeltiosis (BP) and useful heterosis (Ch) for physiological parameters (pooled data) in sunflowr (%)

Hybrid	LAI			RGR			NAR			NAR		
	MP	BP	Ch	MP	BP	Ch	MP	BP	Ch	MP	BP	Ch
PKV - 40	14.07**	10.14**	-4.31	-6.99	-23.95	4.90**	40.28**	33.66**	-1.34	-30.33**	-32.92**	-3.73
PKVSH-41	56.66**	20.24**	-1.86	23.11**	20.69**	18.12**	7.05**	-14.94	10.52**	0.41*	-15.84	5.47**
LSH-3	34.47**	21.07**	-4.34	18.75**	13.39**	28.14**	36.91**	15.83**	18.51**	-15.15	-20.31	-7.16
PKVSH-27	56.14**	19.66**	-	6.34**	4.92**	-	11.21**	-9.68	-	-8.64	-25.57	-
SE (d)	0.127	0.147	0.147	0.004	0.005	0.005	0.055	0.064	0.064	5.329	6.154	6.154
CD at 5%	0.351	0.414	0.414	0.012	0.014	0.014	0.156	0.180	0.180	15.023	17.348	17.348

Hybrids	LAD			Total chlorophyll content			Total dry matter (g) plant^{-1}			Height (cm)		
	MP	BP	Ch	MP	BP	Ch	MP	BP	Ch	MP	BP	Ch
PKV-40	18.00**	13.24**	-4.16	18.72**	9.98**	16.52**	84.01**	81.82**	-8.83	45.10**	32.81	3.97
PKVSH-41	61.49**	21.97**	-0.58	68.65**	65.63**	7.18**	82.18**	57.38**	-6.02	36.57	22.84	5.74
LSH-3	35.99**	22.21**	-4.31	40.10**	32.37**	20.30**	67.38**	59.51**	-8.68	29.95	27.73	12.68
PKVSH-27	56.67**	19.89**	-	16.14**	5.71**	-	96.80**	96.55**	-	40.62**	30.81	-
SE (d)	0.985	1.137	1.137	0.164	0.189	0.189	5.352	6.180	6.180	4.870	5.623	5.623
CD at 5%	2.777	3.207	3.207	0.463	0.534	0.534	15.088	17.422	17.422	13.729	15.852	15.852

* Significant at 5 per cent level probability ** Significant at 1 per cent level probability

Table 2. Distribution of heterosis (MP),heterobeltiosis (BP) and useful heterosis (Ch) for yield and yield attributes (pooled data) in sunflower (%)

Hybrid	Days to maturity			Head diameter (cm)			Total number of seeds head^{-1}		
	MP	BP	Ch	MP	BP	Ch	MP	BP	Ch
PKV-40	7.90**	3.22**	1.34	82.75**	68.78**	-5.13	125.04	103.44	-19.08*
PKVSH-41	6.06**	4.58**	1.15*	46.92**	17.67**	-4.58	67.00	37.42	-24.55*
LSH-3	7.93**	2.82*	-1.73	60.20**	34.66**	-4.32	70.69	45.21	-23.70*
SE (d)	1.259	1.454	1.454	1.148	1.672	1.672	27.674	31.955	31.955
CD at 5%	3.551	4.101	4.101	3.236	4.173	4.713	78.013	90.082	90.082
Hybrid	Filled seed percentage			100 seed weight (g)			Harvest index (%)		
	MP	BP	Ch	MP	BP	Ch	MP	BP	Ch
PKV-40	6.59**	6.69**	-5.52	33.33**	30.77**	-10.05	53.08**	41.12**	-17.61
PKVSH-41	3.72**	1.22**	-4.40	34.76**	18.68**	-5.01	24.21**	7.47**	-14.30
LSH-3	7.62**	6.10**	-2.15	53.13**	47.39**	8.51**	50.90**	25.87**	-10.41
PKVSH-27	11.46**	10.03**	-	47.29**	45.54	-	52.02**	23.43**	-
SE (d)	0.572	0.660	0.660	0.708	0.818	0.818	1.570	1.813	1.813
CD at 5%	1.613	1.862	1.862	1.997	2.306	2.306	4.428	5.113	5.113
Hybrid	Seed yield plant^{-1}			Oil content (%)			Oil yield (kg ha^{-1})		
PKV-40	178.03**	155.41**	-23.83	1.35*	-4.02	-13.84	187.76	183.55	-34.59*
PKVSH-41	120.87**	67.85**	-19.48	-0.79	-8.71	3.74*	125.44	82.51	-16.37*
LSH-3	154.87**	121.43**	-17.38	-4.95	-9.65	-14.22	146.52	123.25	-28.76*
PKVSH-27	189.50**	130.84**	-	14.59**	14.29**	-	234.452	31.699	31.699
SE (d)	1.218	1.406	1.406	0.694	0.801	0.801	27.452	31.699	31.699
CD at 1%	3.434	3.965	3.965	1.957	2.260	2.260	77.388	89.360	89.360

* Significant at 5 per cent level probability ** Significant at 1 per cent level probability

characters like LAI, RGR, NAR, LAD and TCC. However, they showed negative and non-significant useful heterosis for the characters LAI and LAD. The positive and significant useful heterosis was also observed by the hybrid LSH 3 for TCC. Similarly all the hybrids recorded significant heterosis for RGR over the check hybrid. These findings of LAI and RGR obtained in this investigation were in agreement with the findings of Deshmukh and Bhapkar (1979) and Deore *et al.* (1997). For NAR the highest heterosis and significant and positive heterobeltiosis was recorded by the hybrid PKVSH 40, followed by LSH 3. All the four hybrids showed significant and positive heterosis and heterobeltiosis for LAD, however, they have recorded negative and non-significant useful heterosis for this character. This suggests that although individual hybrid is superior over their mid parent and better parent for LAD, however, they have recorded low values of LAD than the check PKVSH 27. Whereas, all the hybrids recorded significant and positive heterosis and heterobeltiosis for TCC showing strong heterotic effect in hybrids than parents. On a plant basis there is heterosis in chlorophyll content but on unit weight basis the hybrids follow one of the parents.

Heterosis for yield and its attributes

The data on various yield contributing characters (Table 2) noted following ranges of heterosis in four hybrids that ranges (29.95 to 45.10 %), for days to maturity (6.06 to 10.42 %), for head diameter (46.92 to 82.75 %), for total number of seeds (67.00 to 134.79 %), for percentage of filled seeds (3.72 to 11.46 %), for 100-seed weight (33.33 to 47.29 %), for harvest index (24.21 to 53.08 %), for total dry matter (67.38 to 96.80 %), for seed yield per plant (120.87 to 189.50 %), for oil content (-4.95 to 14.59 %) and for oil yield kg ha^{-1} (125.44 to 234.06 %) over their respective mid parent (Table 2).

The hybrid PKVSH 27 recorded highest positive and significant heterosis for plant height (40.66 %), 10.42 per cent for days to maturity, 68.48 per cent for head diameter, 11.46 per cent for filled seeds percentage, 47.29 per cent for test weight, 52.02 per cent for harvest index and 96.80 per cent for total dry matter over mid parent. The cumulative heterotic effects of all these characters had resulted into highest seed yield of this hybrid giving a heterosis of 189.60 per cent for seed yield. The said hybrid had also recorded a positive and significant heterosis (14.296 per cent) for oil content (Table 2).

The above results were in close agreement with the findings of Giriraj *et al.*, (1986), Singh *et al.*, (1984), Lande *et al.*, (1998), Srivastava (1998) and Naresh *et al.*, (1996) obtained during their respective studies on sunflower.

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PKV Res. J. Vol. 30 (2), 2006

Role of Cell Wall Degrading Hydrolytic Enzymes in Pod Shattering Process of Soybean (*Glycine max* (L) Merrill)

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ABSTRACT

Specific activity of two hydrolytic (Cellulase and Polygalactouranase) enzymes was assayed in the shattering and non-shattering zones of pod shell of shattering resistant (JS-335) and susceptible (Monetta) varieties of soybean (*Glycine max* (L.) Merrill). Result revealed that the cellulase activity was restricted to the non-shattering zone during the initial lag phase of both the varieties. The continuous increase of cellulase activity at shattering zone of susceptible variety indicates the involvement and role of this enzyme in pod shattering process. The shift in the activity from the non-shattering to the shattering zone in susceptible variety and vice-versa in resistant variety was also observed. Polygalactouranase adheres to its softening property, which was evident from its higher activity at the shattering zone of the resistant variety than the susceptible variety, protecting it from shattering. The resistant variety, exhibited higher Polygalactouranase activity than the susceptible one in the shattering zone during separation phase. It appears from the present investigation that combination of increased Polygalactouranase and absence of cellulase activity in the shattering zone of the resistant variety and vice-versa in the susceptible variety may be the factors leading to pod-shattering.

Pod shattering in soybean is one of the major lacunae that take heavy toll of the produce. Pod shattering refers to the opening of mature pods along with dorsal or ventral sutures and dispersal of seeds as the crop reaches maturity, as well as during harvesting. Shattering occurs due to loss of adhesion between highly active living cells. It is a result of highly coordinated sequence of biochemical events, which leads to cell wall breakdown in one or two rows of cells on either side of the shattering zone. The time course in which the induction and completion of separation takes place can usually be divided into 'lag' and 'separation' phase. During the lag phase, there is either no perceptible fall in the break strength or shallow decline. During the separation phase, the shattering layer is rapidly weakened in the adjacent tissue and ultimately fractures the cell wall. The cell wall degrading hydrolytic enzymes play an important role in the cell wall separation. Many cell wall-degrading hydrolases *i.e.*; ethylene, auxins, IAA and ABA have been reported to play a vital role in the abscission of plant parts (Saxton and Roberts, 1982).

Pod shattering in soybean is of widespread occurrence, but the process has largely failed to stimulate detailed examination at the biochemical level. As a result, little information is available on this phenomenon and this situation has retarded the development of effective manipulative strategies.

MATERIAL AND METHODS

The experiment was conducted with two varieties, *i.e.* JS-335 (10% shattering) and Monetta (90% shattering) during *Kharif* 2004. The varieties were sown with 10 rows in 3.0 m long plot. The variety Monetta was sown three days latter than JS-335 to get simultaneous flowering. At flower initiation, around 200-210 flowers were tagged. A sample of 40-50 pods were collected at four pod development stages, *i.e.* pod elongation, seed development, before physiological maturity (BPM) which was fully expanded pod stage and physiological maturity (PM), wherein pod turns yellow. The sampling was carried out between 8.00 and 9.00 a.m. on the respective stages of sampling. The pods were detached from the plants and brought to the laboratory in chilled condition. The pod samples were partitioned into two parts, *viz.* shattering zone and non-shattering zone (Fig. 1).

Two sets of acetone powder from different pod parts were prepared as per procedure described by Brynt and Forrest (1979). Chilled tissue (15-20g) was first ground in pre-chilled grinder, then macerated thrice in chilled acetone and filtered through whatman No. 1 filter paper on a buckner funnel. This powder then air-dried till the smell of acetone vanished and stored in the refrigerator. This acetone powder was used for estimation of the specific activities of different enzymes.

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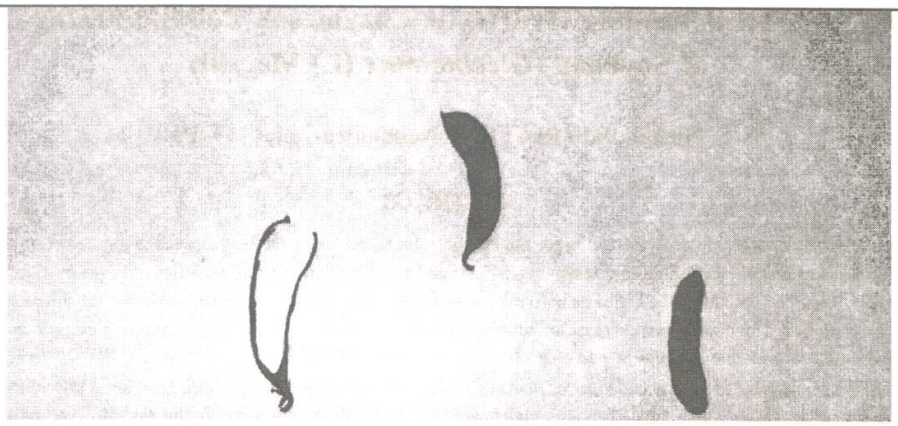

The soluble protein content of the different enzyme sources was estimated as per the procedure illustrated by Lowry *et al.,* (1951) using the folin ciocalteau regent. The UV (ultraviolet) visible Spectrophotometer was used, wherever calorimetric determinations involved. Assay for each enzyme was carried out thrice and mean enzyme activity was taken for interpretation of results.

Cellulase (β-1, 4-glucanase) activity was assayed as per Sadashivam and Manickam (1992) with slight modification. The enzyme source was prepared by grinding 100 mg acetone powder in 5 ml of chilled 0.1 M sodium citrate buffer (pH 5.0). The substrate carboxymethyl cellulase (1%) was prepared fresh for the assay. The reaction mixture consisting of 0.5 ml sodium citrate buffer, 0.5 ml CMC and 0.5 ml enzyme extract was incubated at 55^0C for 15 min in a water bath. Immediately after removing the incubated mixture from the water bath, 0.5 ml of dinitro-salicylic acid (DNS) reagent was added. However, 0.5 ml of DNS reagent was added to the blank before incubation. The mixture was kept in a boiling water bath for 5 min, cooled to room temperature and the volume was made up to 5.0 ml. The absorbance was measured at 540 nm against the blank. A standard graph of glucose was used for measuring cellulase activity. The enzyme activity was expressed as micromoles of D-glucose released per 15 min per 'mg' of protein.

The combined modified procedure described by Berger and Reid (1979) and Favaron *et al.,* (1994) was used for Polygalactouranase (PG) assay. The enzyme source was extracted with 50 mM chilled sodium acetate buffer (pH 5.0) from 100 mg acetone powder. The incubation mixture consisted of 1.0 ml of 50 mM sodium acetate buffer (pH 5.0), 0.5 ml enzyme extract, 0.5 ml sodium polypectate (0.5% w/v) containing 0.1 mg per ml of bovine serum albumin (BSA). The reaction mixture was incubated for 1h at 37^0C. A reaction mixture to which the active enzyme was added at the end of incubating period served as a blank. The reaction was terminated by adding 1.0 ml of alkaline copper reagent, mixed thoroughly and the mixture was boiled for 20 min and cooled in running tap water. Then 1.0 ml arseno molybdate was added with instant mixing for the colour development. The volume was made up to 2.5 ml and absorbance was measured at 575 nm. D-galacturnoic acid was used as standard. The activity of PG was expressed as micromoles D-galacturnoic acid released per hour per mg of protein.

RESULTS AND DISCUSSION

The mean specific activity of cellulase was 0.4271 in JS-335 and 0.3041 in Monetta in the non-shattering zone during pod elongation. The variety JS-335 (0.8840) had higher specific activity in the shattering zone compared to Monetta (0.3510) during seed development in the pod. Monetta expressed (0.3710) specific activity in the non-shattering zone during seed development in the pod. The variety JS-335 (0.4125) had higher activity in the non-shattering zone than in the shattering zone (0.3240), whereas in Monetta the activity was higher in the shattering zone (0.6405) compared to the non-shattering zone (0.1214) at BPM. At PM the specific activity was only in the non-shattering zone of JS-335 (0.7672) and the shattering zone of Monetta (0.8112) (Fig. 2A).

PKV Res. J. Vol. 30 (2), 2006

Role of Cell Wall Degrading Hydrolytic Enzymes in Pod Shattering Process of Soybean (*Glycine max* (L) Merrill)

S. S. Nichal[1], S.S. Rao[2], R. S. Nandanwar[3] and P.V. Patil[4]

ABSTRACT

Specific activity of two hydrolytic (Cellulase and Polygalactouranase) enzymes was assayed in the shattering and non-shattering zones of pod shell of shattering resistant (JS-335) and susceptible (Monetta) varieties of soybean (*Glycine max* (L.) Merrill). Result revealed that the cellulase activity was restricted to the non-shattering zone during the initial lag phase of both the varieties. The continuous increase of cellulase activity at shattering zone of susceptible variety indicates the involvement and role of this enzyme in pod shattering process. The shift in the activity from the non-shattering to the shattering zone in susceptible variety and vice-versa in resistant variety was also observed. Polygalactouranase adheres to its softening property, which was evident from its higher activity at the shattering zone of the resistant variety than the susceptible variety, protecting it from shattering. The resistant variety, exhibited higher Polygalactouranase activity than the susceptible one in the shattering zone during separation phase. It appears from the present investigation that combination of increased Polygalactouranase and absence of cellulase activity in the shattering zone of the resistant variety and vice-versa in the susceptible variety may be the factors leading to pod-shattering.

Pod shattering in soybean is one of the major lacunae that take heavy toll of the produce. Pod shattering refers to the opening of mature pods along with dorsal or ventral sutures and dispersal of seeds as the crop reaches maturity, as well as during harvesting. Shattering occurs due to loss of adhesion between highly active living cells. It is a result of highly coordinated sequence of biochemical events, which leads to cell wall breakdown in one or two rows of cells on either side of the shattering zone. The time course in which the induction and completion of separation takes place can usually be divided into 'lag' and 'separation' phase. During the lag phase, there is either no perceptible fall in the break strength or shallow decline. During the separation phase, the shattering layer is rapidly weakened in the adjacent tissue and ultimately fractures the cell wall. The cell wall degrading hydrolytic enzymes play an important role in the cell wall separation. Many cell wall-degrading hydrolases *i.e.*; ethylene, auxins, IAA and ABA have been reported to play a vital role in the abscission of plant parts (Saxton and Roberts, 1982).

Pod shattering in soybean is of widespread occurrence, but the process has largely failed to stimulate detailed examination at the biochemical level. As a result, little information is available on this phenomenon and this situation has retarded the development of effective manipulative strategies.

MATERIAL AND METHODS

The experiment was conducted with two varieties, *i.e.* JS-335 (10% shattering) and Monetta (90% shattering) during *Kharif* 2004. The varieties were sown with 10 rows in 3.0 m long plot. The variety Monetta was sown three days latter than JS-335 to get simultaneous flowering. At flower initiation, around 200-210 flowers were tagged. A sample of 40-50 pods were collected at four pod development stages, *i.e.* pod elongation, seed development, before physiological maturity (BPM) which was fully expanded pod stage and physiological maturity (PM), wherein pod turns yellow. The sampling was carried out between 8.00 and 9.00 a.m. on the respective stages of sampling. The pods were detached from the plants and brought to the laboratory in chilled condition. The pod samples were partitioned into two parts, *viz.* shattering zone and non-shattering zone (Fig. 1).

Two sets of acetone powder from different pod parts were prepared as per procedure described by Brynt and Forrest (1979). Chilled tissue (15-20g) was first ground in pre-chilled grinder, then macerated thrice in chilled acetone and filtered through whatman No. 1 filter paper on a buckner funnel. This powder then air-dried till the smell of acetone vanished and stored in the refrigerator. This acetone powder was used for estimation of the specific activities of different enzymes.

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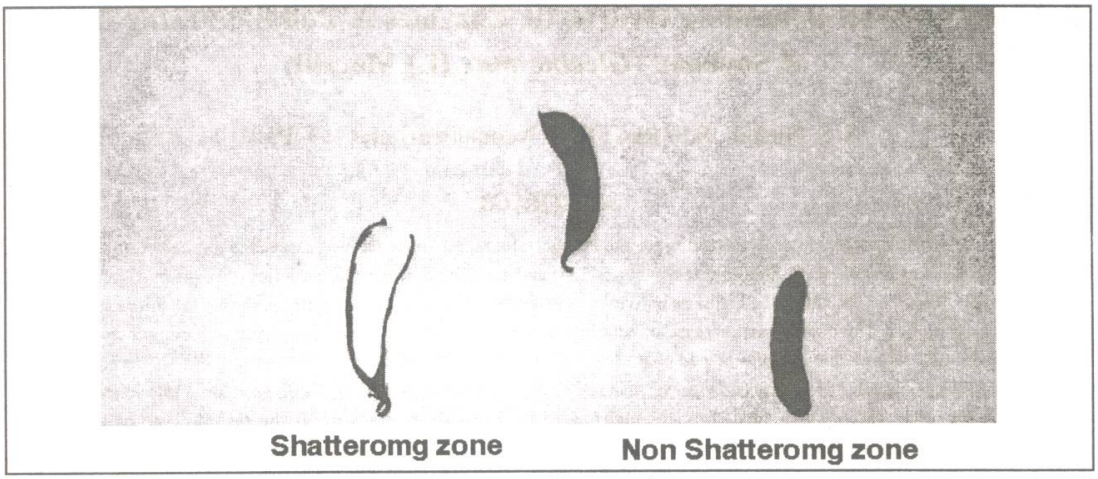

The soluble protein content of the different enzyme sources was estimated as per the procedure illustrated by Lowry *et al.,* (1951) using the folin ciocalteau regent. The UV (ultraviolet) visible Spectrophotometer was used, wherever calorimetric determinations involved. Assay for each enzyme was carried out thrice and mean enzyme activity was taken for interpretation of results.

Cellulase (β-1, 4-glucanase) activity was assayed as per Sadashivam and Manickam (1992) with slight modification. The enzyme source was prepared by grinding 100 mg acetone powder in 5 ml of chilled 0.1 M sodium citrate buffer (pH 5.0). The substrate carboxymethyl cellulase (1%) was prepared fresh for the assay. The reaction mixture consisting of 0.5 ml sodium citrate buffer, 0.5 ml CMC and 0.5 ml enzyme extract was incubated at 55^0C for 15 min in a water bath. Immediately after removing the incubated mixture from the water bath, 0.5 ml of dinitro-salicylic acid (DNS) reagent was added. However, 0.5 ml of DNS reagent was added to the blank before incubation. The mixture was kept in a boiling water bath for 5 min, cooled to room temperature and the volume was made up to 5.0 ml. The absorbance was measured at 540 nm against the blank. A standard graph of glucose was used for measuring cellulase activity. The enzyme activity was expressed as micromoles of D-glucose released per 15 min per 'mg' of protein.

The combined modified procedure described by Berger and Reid (1979) and Favaron *et al.,* (1994) was used for Polygalactouranase (PG) assay. The enzyme source was extracted with 50 mM chilled sodium acetate buffer (pH 5.0) from 100 mg acetone powder. The incubation mixture consisted of 1.0 ml of 50 mM sodium acetate buffer (pH 5.0), 0.5 ml enzyme extract, 0.5 ml sodium polypectate (0.5% w/v) containing 0.1 mg per ml of bovine serum albumin (BSA). The reaction mixture was incubated for 1h at 37^0C. A reaction mixture to which the active enzyme was added at the end of incubating period served as a blank. The reaction was terminated by adding 1.0 ml of alkaline copper reagent, mixed thoroughly and the mixture was boiled for 20 min and cooled in running tap water. Then 1.0 ml arseno molybdate was added with instant mixing for the colour development. The volume was made up to 2.5 ml and absorbance was measured at 575 nm. D-galacturnoic acid was used as standard. The activity of PG was expressed as micromoles D-galacturnoic acid released per hour per mg of protein.

RESULTS AND DISCUSSION

The mean specific activity of cellulase was 0.4271 in JS-335 and 0.3041 in Monetta in the non-shattering zone during pod elongation. The variety JS-335 (0.8840) had higher specific activity in the shattering zone compared to Monetta (0.3510) during seed development in the pod. Monetta expressed (0.3710) specific activity in the non-shattering zone during seed development in the pod. The variety JS-335 (0.4125) had higher activity in the non-shattering zone than in the shattering zone (0.3240), whereas in Monetta the activity was higher in the shattering zone (0.6405) compared to the non-shattering zone (0.1214) at BPM. At PM the specific activity was only in the non-shattering zone of JS-335 (0.7672) and the shattering zone of Monetta (0.8112) (Fig. 2A).

The mean specific activity of PG was higher in the shattering zone of JS-335 (0.2040) and Monetta (0.1180) than in the non-shattering zone of JS-335 (0.0761) and Monetta (0.0186) during pod elongation. A similar expression was observed in JS-335 during seed development in the pod stage. Monetta had slightly higher activity in the shattering zone (0.2079) and the non-shattering zone (0.1642) than the JS-335 during seed development in the pod. The specific activity at BPM indicated that JS-335 (0.9461) was having very high activity in the non-shattering zone compared to the shattering zone (0.1133), whereas in Monetta the activity in the shattering zone (0.2614) was higher than in the non-shattering zone (0.1120). At physiological maturity, JS-335 (0.3108) had higher activity than Monetta (0.1256) in the shattering zone. However, Monetta (0.6186) exhibited higher activity than JS-335 (0.0946) in the non-shattering zone at physiological maturity (Fig. 2B).

Cellulases are important hydrolytic enzymes present in the cell wall. Their activity has been demonstrated in various tissues during leaf abscission, fruit abscission, fruit ripening and senescing cotyledons. It has been established that there are different cellulase with distinct cellular functions. Among the most studied cellulases, bean abscission cellulase activity was high in the leaf abscission zone and the adjacent vascular tissues, but showed much lower activity in the neighboring petiole and stem tissue. It clearly indicates that there is partitioning of cellulase activity in different parts of the tissue (Kemmerer and Tucker, 1994). The cellulase activity was restricted to the non-shattering zone during the initial lag phase of both the varieties and its subsequent partitioning in the shattering zone leads support to the observation that the cellulase activity is expressed differently at different phases of growth in both the varieties (Fig. 2A). The increased cellulase activity in the shattering zone of middle lag phase followed by steep decline at the end of lag phase and total disappearance at the separation phase in resistant variety, envisages the role played by cellulase in development of resistance to pod-shattering. In contrast to this, the continuous increased activity in the shattering zone of the susceptible variety clearly indicated the involvement and role of cellulase in pod-shattering in soybean. In addition to this, exhibition of highest ever cellulase activity at separation phase in the shattering zone of the susceptible variety lends support to a hypothesis that cellulase has an involvement in pod-shattering process in soybean. Increased cellulase activity has been demonstrated in the shattering zone of *Brassica napus* L. by Meakin and Roberts (1990). The results indicate a shift in the activity from the non-shattering zone to the shattering zone in the susceptible variety and reverse in the resistant variety.

Out of the two hydrolases studied, PG exhibited a different trend of activity at different stages in the growth and development of the soybean pod. The observation of higher activity in the shattering zone of both the varieties (Fig. 2B) at early and middle lag phases reveals that behaviour of cellulase and PG is different during development phases. It is well known that PG has been implicated in softening of many fruits such as tomato, peaches, pears, avocado, and mango (Sadashivam and Manickam, 1992). In Soybean also, PG adheres to its softening property, which is evident from its higher activity in the non-shattering zone of the susceptible variety at separation phase. Moreover, this softening property of PG is clearer in the non-shattering zone of the resistant variety before attaining physiological maturity. It is clear that the resistant variety exhibited higher PG activity than the susceptible one in the shattering zone during the separation phase. This might have led to more softening effect of PG in the resistant variety than in the susceptible one, protecting it from shattering. Similarly, Greenberg *et al.,* (1975), observed increased PG activity in abscission zone of non-abscising mature citrus fruit. It appears from the present investigation that combination of increased PG and absence of cellulase activity in the shattering zone of the resistant variety and vice versa in the susceptible variety may be the factors leading to pod-shattering. Although no clear-cut involvement could be established between PG and cell separation, it does not imply that this enzyme has no role in abscission or pod-shattering. Since the other hydrolases such as DNAases, RNAases, proteinases, phosphatases *etc*. show increased activity during abscission (Saxton and Roberts, 1982), their role in pod-shattering cannot be ruled out.

The continuous increase of cellulase activity in the shattering zone of the susceptible variety indicates its involvement and role in soybean pod-shattering. However, PG adheres to its softening properties, protecting the pod from shattering.

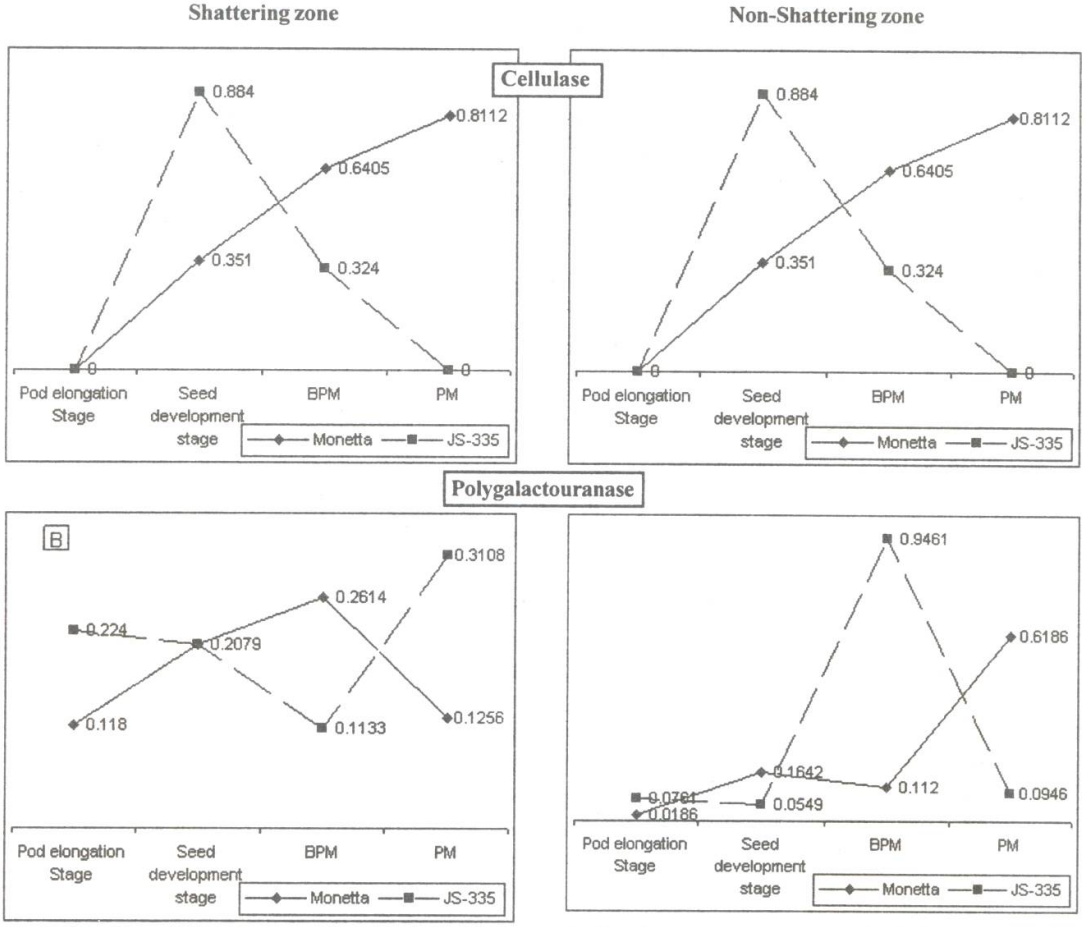

Fig. 2: Specific activity (per mg of protein) of cellulase and polygalactouranase enzymes in shattering and non-shattering zones of soybean pod.

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PKV Res. J. Vol. 30 (2), 2006

Effect of *Acetobacter* and Different Nitrogen Levels on Biomass Accumulation in Sugarcane

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ABSTRACT

A field experiment was conducted on the fields of Department of Agronomy, Marathwada Agricultural University, Parbhani during 2004-05 to study the effect of *Acetobacter diazotrophicus* on biomass accumulation in sugarcane at different N_2 levels. Significant effect of inoculation and N_2 fertilizer application on plant growth was observed. Root and shoot length, cane girth and shoot and root biomass of sugarcane were significantly improved with the inoculation of *Acetobacter* and application of N_2-fertilizer. Ultimately it had a positive effect on cane yield and saved 25 per cent of required nitrogen fertilizer.

As a component of every living cell nitrogen is indispensable and can not be replaced by any other element. It occurs in the chlorophyll molecule of plants which is an important compound required for photosynthesis. Nitrogenous chemicals account for as much as 30 per cent of total N_2 fertilizer required for agricultural crops. Usually (NO3) nitrate form of nitrogen is absorbed by plants. Sugarcane is the main source of sugar in India and assumes the position of an important agro industrial crop contributing nearly 1.9 per cent to the GDP. To overcome the environmental hazards caused during manufacture of synthetic fertilizers, BNF is gaining importance in the present day agriculture. Exploiting these nitrogen fixing bacteria will reduce our dependence on synthetic nitrogenous fertilizer. *Acetobacter diazotrophicus* is an endophytic organism that is exploited to increase the yield of sugarcane.

MATERIAL AND METHODS

The pot culture experiment was carried out at laboratory of Department of Plant Pathology, College of Agriculture, MAU, Parbhani. Randomized block design was used for the experiment. The *Acetobacter* strains available in the Department of Plant Pathology were used for inoculation of seed. The variety of sugarcane Co 86032 was used for planting. Planting was done in furrows and irrigation was given as per the requirement of the crop. Standard crop protection schedule was followed to protect the crop from diseases and pests. The observations on different growth parameters like shoot and root length and weight, cane girth were recorded at 30, 60, 90 and 120 DAP. The dry matter accumulation by root and shoot was recorded by subjecting root and shoot for oven drying at 60°C till constant weights. Cane girth was recorded by measuring the girth at bottom, middle and top portion of the selected cane. Averages were worked out and recorded as average cane girth.

RESULTS AND DISCUSSION

The effect of *Acetobacter* inoculation and nitrogen application on biometric characters of sugarcane was evaluated on 30, 60, 90 and 120 days after sowing and the data so obtained are presented in Table 1 and 2.

Root length: *Acetobacter* inoculation has increased the root length of sugarcane on all the dates of observation but the increase was significant on 30th and 120th days after planting. The increase was from 9.70 cm to 11.50 cm on 30th day and 16.72 to 17.81 cm on 120th day when *Acetobacter* inoculations were done. The significant increase in root length due to nitrogen application was from 11.85, 13.26 and 14.40 cm in control plots to 16.26, 18.13 and 21.40 cm in plots with 100 per cent RDN, on 60, 90 and 120 days after planting, respectively. Similar benefits have been reported by several workers in the past. Thangaraju and Govindarajan (2001) reported significant increase in plant growth and sugar yield with the application of *Acetobacter*.

Root fresh and dry weight: The data indicated that root fresh weight as well as root dry weight was significantly

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Table 1. Effect of different levels of nitrogen and *Acetobacter* inoculation on root length (cm) and root weight (g) of sugarcane

Treatments	Root length (cm) at DAP				Root weight (g) at DAP							
					Fresh weight				Dry weight			
	30	60	90	120	30	60	90	120	30	60	90	120
Inoculated	11.50	15.08	16.25	17.81	2.91	5.12	15.30	20.48	0.88	2.39	4.56	8.08
Uninoculated	9.70	13.96	15.07	16.72	2.64	4.47	13.50	18.17	0.64	1.88	3.54	6.76
SE (m) ±	0.41	0.18	0.16	0.25	0.12	0.11	0.31	0.44	0.07	0.06	0.07	0.18
CD at 5%	1.22	NS	NS	0.74	NS	0.33	0.93	1.32	0.21	0.20	0.23	0.55
N-application												
No- Nitrogen	10.36	11.85	13.26	14.40	1.98	3.53	10.70	13.88	0.45	1.41	2.85	4.78
N at 25% RDN	10.23	14.05	14.19	15.78	2.65	4.26	12.56	17.20	0.66	1.68	3.41	5.95
N at 50% RDN	10.65	14.65	15.85	16.56	3.23	4.70	14.26	18.81	0.96	2.06	4.23	7.05
N at 75% RDN	10.78	15.81	16.88	18.18	2.53	5.08	14.98	20.61	0.81	2.48	4.61	8.86
N at 100% RDN	11.01	16.26	18.13	21.40	3.50	6.40	19.75	26.13	0.92	2.85	5.15	10.46
SE (m) ±	0.65	0.29	0.25	0.39	0.20	0.17	0.49	0.71	0.11	0.10	0.12	0.29
CD at 5%	NS	0.88	0.77	1.17	0.59	0.52	1.48	2.10	0.33	NS	0.36	0.88

Table 2. Effect of different levels of nitrogen and *Acetobacter* inoculation on shoot length (cm) and shoot weight (g) of sugarcane

Treatments	Root length (cm) at DAP				Root weight (g) at DAP							
					Fresh weight				Dry weight			
	30	60	90	120	30	60	90	120	30	60	90	120
Inoculated	11.60	20.38	26.26	29.20	19.93	50.90	124.00	170.00	4.78	17.32	37.98	57.00
Uninoculated	9.80	18.70	23.44	27.56	18.87	45.20	86.56	152.67	4.17	15.20	31.32	45.88
SE (m) ±	0.31	0.24	0.25	0.38	0.34	1.14	2.30	3.53	0.22	0.29	0.70	1.53
CD at 5%	NS	NS	0.75	1.14	1.01	3.39	6.85	10.48	NS	0.87	2.09	4.56
N-application												
No- Nitrogen	10.28	16.91	20.61	24.28	18.41	34.16	69.00	102.25	4.07	11.43	22.11	35.25
N at 25% RDN	9.65	18.83	22.22	25.41	19.15	41.08	85.08	122.33	4.28	14.60	28.66	40.66
N at 50% RDN	10.73	19.78	24.41	26.76	18.59	48.00	105.25	142.00	4.52	16.73	35.83	45.28
N at 75% RDN	11.48	20.43	26.51	29.71	20.27	55.83	116.67	168.83	4.93	18.43	41.03	;60.33
N at 100% RDN	11.35	21.75	30.51	35.73	20.58	61.16	175.42	283.92	4.58	20.10	45.61	75.68
SE (m) ±	0.50	0.38	0.40	0.60	0.53	1.81	3.65	5.58	0.35	0.46	1.11	2.43
CD at 5%	NS	NS	1.19	1.08	1.59	5.73	10.83	16.57	NS	1.38	3.30	7.21

increased with *Acetobacter* inoculation on all the dates of observation except the root fresh weight at 30 DAP.

Nitrogen application brought about significant increase in root fresh weight as well as root dry weight. At 30th day and 120th day, the increase in root weight was from 1.98 g and 13.83 g in control plots to 3.50 g and 26.12 g in plots receiving 100 per cent RDN, respectively. Similarly, the increase in root dry weight was found to be 0.45, 2.85 and 4.78 g in control plots to 0.92, 5.15 and 10.46 g in plots receiving 100 per cent RDN at 30th, 90th and 120th days after planting, respectively. The findings of the investigation are in full agreement with those reported in the past. Bellone *et al.* (1997) observed that the growth

of sugarcane was maximum when inoculated with *Acetobacter diazotrophicus*.

Shoot length: The data (Table 2) indicated that none of the treatments could significantly improve the shoot length on 30 and 60 days but there was significant increase from 23.44 cm to 26.26 cm and from 27.56 cm to 29.20 cm as observed on 90th and 120th day after planting. Application of nitrogen significantly increased shoot length from 20.61 cm and 24.28 cm in unfertilized control to 30.51 cm and 35.73 cm in the plots receiving 100 per cent RDN on 90th and 120th day. Similarly, Paula *et al.* (1992) observed that the growth of sweet potatoes was more when inoculated with *Acetobacter diazotrophicus*.

Shoot fresh and dry weight: The data on shoot fresh and dry weight indicated that *Acetobacter* had improved the shoot fresh and shoot dry weight. Shoot fresh weight was significantly increased in inoculated plots from 18.87 g to 19.93 g at 30th day and from 152.67 g to 170.70 g at 120th day. Similarly, the significant increase in shoot dry weight was observed at 60, 90 and 120th day after planting. The increase was from 15.20, 31.32 and 45.88 g in uninoculated plots to 17.32, 37.98 and 57.00 g in plots receiving *Acetobacter* inoculation.

The shoot fresh weight was significantly increased due to nitrogen application. The increase was from 18.41, 34.16, 69.00, 170.42 and 283.92 g in plots receiving 100 per cent RDN on all dates of observation, respectively. Similarly, the shoot dry weight was significantly increased from 11.43, 22.11 and 35.25 g in unfertilized control to 20.10, 45.61 and 75.68 g in plots receiving 100 per cent of RDN at 60, 90 and 120 days. Similar results were obtained by Bansal *et al.* (1999) where they reported that the shoot length and shoot weight of bootle gourd was significantly increased with the inoculation of *Acetobacter diazotrophicus*.

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PKV Res. J. Vol. 30 (2), 2006

Management of *Alternaria* Leaf Blight of Wheat Through Different Chemicals

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ABSTRACT

The present study was conducted during *rabi* seasons of 2001-02 and 2002-03 at Wheat Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to estimate the losses due to *Alternaria* leaf blight disease of wheat. Spraying of Mancozeb 75 WP @ 0.25 per cent at 10 days interval was found best with less disease intensity recorded (23.17%). Maximum length of earhead was recorded from plots sprayed with Mancozeb at 10 days interval amongst all the treatments. Significantly higher number of grain earhead^{-1} was observed by spraying of Mancozeb at 10 days interval and it was followed by interval at 20 days. While significantly lower number of grains earhead^{-1} were observed in control. It is evident that, lowest 1000-grain weights were recorded in control. However, more 1000-grain weights were recorded in 10 days interval followed by spraying of Mancozeb at 20 days interval. The lowest grain yield were recorded in unsprayed plots while the spraying of Mancozeb at 10 days interval gave highest grain yield. Spraying of 20 days interval followed it.

Alternaria triticina is one of the important pathogens of wheat and is prevalent in all the wheat growing regions of the country due to its wide spread nature of infection (Prasada, 1968; Joshi *et al.*, 1974). It causes considerable losses in production in India mainly in Bihar, Uttar Pradesh, Maharashtra, West Bengal and Orissa (Sokhi, 1974). In Maharashtra, *A. triticina* appeared in severe form on many varieties of wheat at Wheat Research Station, Niphad in 1976-77 and 1990-91 (Borkar and Patil, 1995). In Vidarbha region, this disease recorded an almost complete loss of wheat crop grown in 300 ha at Janori village in Shegaon Panchayat Samiti of Buldhana district (Raut *et al.*, 1983). Chenulu *et al.*, (1967) estimated losses due to *A. triticina* to the extent of 99 per cent in a highly susceptible variety under artificial inoculation in pots at the boot stage. For limiting these losses proper management practice is needed. The experiment was taken, to standardize the interval for spraying of Mancozeb.

MATERIAL AND METHODS

A field trial was conducted during *Rabi* seasons of 2001-02 and 2002-03 at Wheat Research Unit, Dr. P.D.K.V., Akola to know the crop losses due to *A. triticina* and specific interval for spraying of Mancozeb.

Sowing of AKW 381 cultivar was done by hand drilling method during *rabi* seasons on November 27, 2001 and 2002 at 23 cm row to row spacing. The experiment was laid out in randomized block design (RBD), replicated five times. Mancozeb 75 WP (Manganous ethylenebisdithiocarbamate plus zinc ion; 75 WP) @ 0.25 per cent at an interval of 10, 20 and 30 days in three different treatments keeping fourth treatment as control.

The plants were inoculated with the spore suspension containing approximately 5,000 spores ml^{-1}. Under field conditions, conidial suspension was sprayed with Knapsack sprayer at evening hour and after inoculation heavy irrigation was given to provide sufficient humidity in the plot.

The incidence of *Alteanaria* leaf blight was recorded as per new double- digit scale 0-9 on flag leaf and one leaf below flag leaf (Anonymous, 1999). The observations were recorded on randomly selected 25 plants from each plot and per cent disease index (PDI) was calculated. Observations on growth parameter were also recorded and data generated were statistically analyzed.

Per cent loss associated with a unit, increase in intensity of *Alternaria* leaf blight disease was calculated as per following formula suggested by Khare and Khuswaha (1974) by using yield and infection data -

a) Yield in kg ha^{-1} in control plot
b) Intensity of disease (PDI) in control plot
c) Yield in kg ha^{-1} in plot having best treatment
d) Intensity of disease (PDI) in best treated plot
e) The apparent loss in yield associated with ' X ' disease intensity was calculated by formula.

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ALA with ' X ' PDI = Yield in best treated plot – Yield in control plot.

' X ' PDI = PDI in control – PDI in best treated plot.

f) Apparent loss associated with 1 per cent disease intensity (PDI) was calculated by formula.

$$\text{ALA with 1 \% PDI} = \frac{\text{ALA with 'X' PDI}}{\text{'X' PDI}}$$

g) Yield loss associated with intensity in control plot was calculated by formula

YLA with PDI in control = b x f

= PDI in control x ALA with 1 %

h) Estimated potential yield (EPY) without infection was calculated by the formula

EPY without infection = a + g

= Yield in Kg ha^{-1} in control + YLA with PDI in control.

i) Per cent loss association with an unit increase in PDI was calculated by the formula.

$$\text{PLA with unit increase in PDI} = \frac{f}{h} \times 100$$

$$= \frac{\text{ALA with 1 PDI}}{\text{EPY without infection}} \times 100$$

In losses study, in order to estimate the correlation between grain yield and morphological and yield attributing characters, simple correlation coefficients were worked out between grain yield as dependent variable ('Y') and morphological and yield attributing characters as independent variables ('X').

RESULTS AND DISCUSSION

The loss in yield of wheat caused by *Alternaria* blight incidence and effect of application of fungicide (Mancozeb) has been compared. A study was, undertaken to evaluate spray schedule of Mancozeb at 10, 20 and 30 days interval during both the years (Table 1).

The spraying of Mancozeb @ 0.25 per cent at 10 days interval was significantly superior over other treatments (23.17 %) with maxium per cent disease control (60.31). The spraying of Mancozeb at 20 days interval, was less effective as compared to 10 days interval and recorded disease intensity (30.86 %) with a per cent disease control (47.19).

Significantly maximum plant height (96.51 cm) was recorded by Mancozeb (0.25%) sprayed at 10 days interval followed by the spraying at 20 days interval (92.35 cm), and 30 days interval (89.58 cm). Significantly lower plant height (84.90 cm) was recorded from plant grown under unsprayed plot.

The data of spraying of Mancozeb (0.25%) at 10 days interval proved its superiority for increasing earhead length (10.73 cm) while, unsprayed plot recorded significantly gave shorter earhead length (7.48 cm).

Table 1 revealed that, the spraying of Mancozeb at 10 days interval was significantly superior to other treatments, as it was recorded significantly higher number of grains $earhead^{-1}$ (41.05) followed by the spraying at 20 days interval (34.26) and at 30 days interval (29.78). The plots grown without any spraying for control of *A. triticina* recorded significantly minimum number of grains $earhead^{-1}$ (25.50).

The grain weight has been considered an important component for decrease of yield due to *Alternaria* leaf blight disease at varied intensity levels. spraying of Mancozeb at 10 days interval recorded higher 1000-grain weight i.e. 46.52 g it was followed by spraying at 20 days interval (40.77 g) 30 days interval (34.35 g). Lower 1000-grain weight was minimum from unsprayed plot (26.24 g).

From the Table 1, it is evident that highest grain yield (29.25 q ha^{-1}) was recorded from plot spraying with Mancozeb at 10 days interval, followed by spraying at 20 days interval (25.49 q ha^{-1}) and spraying at 30 days interval (21.22 q ha^{-1}). Significantly lower grain yield was recorded from control plot (17.59 q ha^{-1}). It was observed that with the increasing intensities of *Alternaria* leaf blight there was decrease in grain yield of AKW 381.

It was also observed that there was definite increase in grain yield of AKW 381 with spraying of Mancozeb at different interval over control. Per cent increase in yield (66.40 %) over control was recorded when Mancozeb was sprayed at 10 days interval followed by 20 days interval (45.24 %).

Estimation of losses due to *Alternaria* leaf blight disease

Per cent loss associated with an unit, increase in intensity of *Alternaria* leaf blight disease was calculated as per formula suggested by Khare and Khuswaha (1974) by using yield and infection data.

Table 1. Effect of fungicide at different intervals on the disease intensity, morphological yield attributing characters and grain yield of wheat affected by *Alternaria* leaf blight

Tr. No.	Treatments	No. of Sprays	Per cent Disease Intensity		Per cent Disease Control	Plant Height (cm)	Earhead length (cm)	No. of grain earhead^{-1}	1000-grain weight (g)	Per cent increase in 1000-grain weight over control	Grain yield (q ha^{-1})	Per cent increase in yield over control
			Initial Disease Intensity	Disease Intensity after Spraying								
T_1	Spraying of Mancozeb 75 WP (0.25 %) at 10 days interval	5	3.15 (10.23)	23.17 (28.73)	60.31	96.51	10.73	41.05	46.52	77.32	29.25	66.40
T_2	Spraying of Mancozeb 75 WP (0.25 %) at 20 days interval	3	3.15 (10.23)	30.86 (33.69)	47.19	92.35	9.50	34.26	40.77	55.42	25.49	45.24
T_3	Spraying of Mancozeb 75 WP (0.25 %) at 30 days interval	2	3.15 (10.23)	40.51 (39.49)	30.53	89.58	8.90	29.78	34.35	31.04	21.22	20.88
T_4	Control (Unsprayed)	-	3.15 (10.23)	58.26 (49.76)	-	84.90	7.84	25.50	26.24	-	17.59	-
	SE (m) ±			0.67		0.51	0.18	0.54	0.45		0.24	
	CD at 5%			2.07		1.56	0.56	1.66	1.39		0.72	

a) Yield in kg ha^{-1} in control plot = 1759 kg ha^{-1}

b) Intensity of disease (PDI) in control plot = 58.28 %

c) Yield in kg ha^{-1} in plot having best treatment=2925kg ha^{-1}

d) Intensity of disease in best treated plot=23.17 %

e) The apparent loss in yield associated with ' X ' disease intensity was calculated by formula.

ALA with ' X ' PDI = Yield in best treated plot – Yield in control plot.

= 2925 – 1759 = 1166 kg ha^{-1}

' X ' PDI = PDI in control – PDI in best treated plot.

= 58.26 – 23.17 = 35.09 %

f) Apparent loss associated with 1 per cent disease intensity (PDI) was calculated by formula.

$$\text{ALA with 1 \% PDI} = \frac{\text{ALA with 'X' PDI}}{\text{'X' PDI}}$$

$$= \frac{1166}{35.09} = 33.23$$

g) Yield loss associated with intensity in control plot was calculated by formula

YLA with PDI in control = b x f

= PDI in control x ALA with 1 %

= 58.26 x 33.23 = 1935.98

h) Estimated potential yield (EPY) without infection was calculated by the formula

EPY without infection = a + g

= Yield in Kg ha^{-1} in control + YLA with PDI in control.

= 1759 + 1935.98 = 3694.98

i) Per cent loss association with an unit increase in PDI was calculated by the formula.

$$\text{PLA with unit increase in PDI} = \frac{f}{h} \times 100$$

$$= \frac{\text{ALA with 1 PDI}}{\text{EPY without infection}} \times 100$$

$$= \frac{33.23}{3694.98} \times 100 = 0.90\ \%$$

Thus, per cent loss associated with an unit increase in disease intensity in AKW 381 was 0.90 per cent.

These results are in accordance with the findings of Ram and Joshi (1979), Alam *et al.* (1995), Villareal *et al.*(1995), Bagga and Kumar (1999), Sharma *et al.* (2000), Shivankar *et al.* (2000), Pandey and Tewari (2001), Dange *et al.*(2002) and Singh *et al.* (2002).

Shivankar *et al.* (2000) reported that the inoculated plots of Vijay cultivar showed highest intensity of leaf blight disease within the range of 58.42 to 64.91 per cent and gave the significant reduction in the yields in the range of 19.95 to 39.32 per cent and also reduction in 1000-grain weight i.e. 6.80 to 17.08 per cent, as compared to un-inoculated (sprayed with Mancozeb 75 WP @ 0.25%) plots of Vijay.

The present reports on yield loss and 1000-grain weight are also in conformity with earlier reports of Pandey and Tewari (2001). They demonstrated that fungicidal sprays reduced the disease intensity and increased grain yield and 1000-grain weight as compared to unsprayed check.

Whereas dange *et al.* (2002) also evaluate six different schedules of 0.25 per cent Mancozeb as to when it should be sprayed and on control were compared. They found that four sprays given at 35, 50, 65 and 80 days after sowing were effective followed by five sprays given at 30, 40, 50, 60 and 70 days after sowing.

Hence it could be concluded from present study that spraying of Mancozeb 75 WP @ 0.25 per cent at 10 days interval is best for limiting the losses in *Alternaria* leaf blight of wheat.

Correlation study :-

Table 2 revealed that grain yield was significantly and positively correlated with plant height, earhead length, number of grains $earhead^{-1}$ and 1000-grain weight. Grain yield was significantly and negatively associated with per cent disease index.

One thousand grain weight was significantly and positively associated with plant height, earhead length and number of grain $earhead^{-1}$ and was significantly and negatively correlated with per cent disease index. Whereas, Number of grains $earhead^{-1}$ exhibited significantly and positively correlated with plant height and earhead length but it expressed significant and negative association with per cent disease index.

Table 2 : Correlation of losses study between grain yield with morphological and yield attributing characters of wheat against *Alternaria* leaf blight during 2001-02 and 2002-03

Particulars	Per cent disease index	Plant height (cm)	Earhead length (cm)	No. of grains earhead^{-1}	1000-grain weight (g)	Grain yield (q ha^{-1})
Per cent disease index	1	-0.8681**	-0.8083**	-0.8459**	-0.9342**	-0.9351**
Plant height (cm)		1	0.9430**	0.9380**	0.9587**	0.9389**
Earhead length (cm)			1	0.9487**	0.9208**	0.8929**
No. of grains earhead^{-1}				1	0.9606**	0.9484**
1000-grain weight (g)					1	0.9844**
Grain yield (q ha^{-1})						1

* Significance (P = 0.05) and ** Significance (P = 0.01)

Earhead length was significantly and negatively correlated with per cent disease index and positively with plant height. Whereas, plant height exhibited significantly and negatively correlated with per cent disease index.

Our results also confirm the results of above discussed investigators and Hiremath (1991) and Sundaresh and Hiremath (1981) by using correlation techniques for estimating the parameters and judging the fitness of the model.

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Biodiversity of Phosphate Solubilizing *Bacillus subtilis* Isolated from Saline Tract of Vidarbha

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ABSTRACT

Fifty phosphate solubilizing *Bacillus subtilis* strains were isolated from saline tract of Vidarbha and identified on the basis of morphological, cultural and biochemical characteristics. All these strains were studied for phosphate solubilization in relation to physiological and metabolic diversity. The phosphate solubilizing efficiency was qualitatively and quantitatively performed. These strains were further studied to determine the effect of carbon and nitrogen sources, temperatures, and pH on its phosphate solubilization ability. UPGMA Hierarchical clustering analysis showed dissimilarity among all the strains, however these are clustered in to three groups; 17 in one 10 in another and 23 in third group.

Biodiversity is a concept used to describe the range of living organism in a given area and the variety of life forms. Microorganisms represent the richest repertoire, of molecular and chemical diversity in nature, as they comprise the most diverse form of life with adoption to extremely diverse environments and have developed an extensive range of metabolic pathways. Microbial Diversity acts as an indicator of soil quality and plant productivity (Kapur and Jain, 2005).

Groundwater Survey and Development Agency (GSDA) has reported the salinity affected area in Vidarbha region due to alluvial valley of Purna river which covers 185 villages of Akola, 136 of Amravati and 103 of Buldana District, which are severely affected with salinity (Bhokre and Tambekar, 2003).. Most Indian soil contains insoluble inorganic phosphate but it is of no use to the crops unless it is solubilized. Phosphate solubilizing microorganisms are capable of solubilizing calcium, aluminium and iron phosphate as well as rock phosphates and mineralizing organic phosphorus making the phosphorus present in the soil available to the crops (Tambekar, 1998). The most efficient and dominant phosphates solubilizers belong to bacterial groups are *Bacillus spp. and Pseudomonas spp.* The growth and physiological activity of microbes may also be affected with the change in the soil condition such as salinity, pH, moisture, and carbon and nitrogen sources. Salinization is responsible for low fertility status of soils (Bilolikar, 1996). Insufficient organic matter in soils, alkaline pH, high temperature, low fertility, salinity of soils seems to restrict Phosphate Solubilizing bacterial density and diversity (Kapoor and Mishra, 1989). Hence the present study was carried out to isolate local salinity affected and ecologically adopted diverse strains of phosphate solubilizing *Bacillus subtilis* from salinity affected villages of Vidarbha and to study them for ecological variations and the effect of nutritional and environmental factors on the phosphate solubilizing potential, so that biofertilizers produced from these specific strains can help to derive maximum benefits in agricultural production.

MATERIAL AND METHODS:

Screening of Phosphate solubilizing *Bacillus subtilis*: A total of 424 soil samples were collected from salinity-affected villages of Amravati, Akola and Buldhana district of Vidarbha region in plastic bags and screened for the presence of Phosphate solubilizing *Bacillus subtilis*. One gm of each soil sample was dissolved in 10 ml distilled water and heated at 80°C for 10 minutes to kill the vegetative cells. The soil suspension was point inoculated on Pikovskaya's agar medium and incubated at 28°C for 4-5 days for obtaining Bacillus strains capable of dissolving phosphate solubilization. Such isolates are maintained on Nutrient Agar slant and were further identified on the basis of their morphological, cultural and biochemical characteristics as *Bacillus subtilis.* The only strains identified as *Bacillus subtilis* were further studied for phosphate solubilizing activities influenced by various carbon and nitrogen sources, temperatures and pH on the ability of dissolving tricalcium phosphates.

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Inoculum preparation: The identified strains were inoculated in nutrient broth and the cells population were separated from the medium by centrifugation at 10,000 rpm for 20 minutes, washed twice with sterile distilled water and resuspended in sterile distilled water and made the resulting suspension which containing 6.56 x 10^7 cells ml^{-1} (1.0 O.D. at 660 nm) was used as an inoculum.

Phosphate Solubilizing activity: To observe phosphate solubilization in liquid medium, sterilized Pikovskaya's broth was inoculated with 1.0 ml inoculum 100 ml^{-1} broth and incubated at 28°C. For estimation of phosphorus, 10 ml broth culture was withdrawn from each flask at 1-5 days after incubation and centrifuged at 10,000 rpm for 10 minutes and the clear supernatant was used for soluble phosphorus estimation. The soluble phosphorus content in the culture broth was estimated calorimetrically. The effect of carbon source on the solubilization of TCP was studied in Pikovaskaya's medium by replacing 1per cent glucose by either by fructose or galactose or mannitol or sucrose. Same way the effect of nitrogen source was studied by replacing 0.05 per cent ammonium sulphate with ammonium nitrate, calcium nitrite, potassium nitrate, sodium nitrate, and urea (Gaur, 1990). Effect of temperature was studied by incubating the flask at 30°C, 35°C, 40°C, 45°C, and 50°C and effect of pH by adjusting the pH of medium to 5, 6, 7 and 8. Similarity and dissimilarity matrix among diverse strains were studied by UPGMA hierarchical clustering method by preparing their Dendrogram.

RESULTS AND DISCUSSION

A total of 425 soil samples of saline belt of Vidarbha region were analysed for PSB and 50 strains of *Bacillus subtilis* were isolated and identified. All the fifty strains were screened for their PS activity on Pikovaskaya's agar medium (Liquid and solid) and identified on the basis of morphological, cultural and biochemical characteristics. These strains were further analysed for studied for phosphate solubilization in relation to physiological and metabolic diversity.

Solubilization of tri-calcium phosphate by all the strains was examined on Pikovaskaya's agar medium and the zone of solubilization was measured from 1 to 5 days of incubation. All the strains showed solubilizing zones in the range of 2 – 20 mm. Among the fifty strains PS-16 and PS-19 showed larger zone. The amount of tricalcium phosphate solubilized in the Pikovskaya's broth ranged from 12-60-ppm 100 ml^{-1} broth whereas the single strain (PS-22) released 64-ppm 100 ml^{-1} broth in presence of galactose as a carbon source. The phosphate solubilization was found to be influenced by the types of carbon and nitrogen sources used. Varying pH and temperature range on solid as well as in the liquid medium. On the basis of phosphate solubilization results, glucose was found to be the best source of energy followed by sucrose, galactose, mannitol and fructose. When glucose was replaced by sucrose in the medium PS-19 released the highest soluble phosphorus (52 ppm). In presence of galactose PS-22 released 64 ppm; in presence of mannitol PS-29 and in presence of fructose PS-1 released 50 ppm of phosphorus (Fig.1) Tambekar and Bhokre (2005) also reported similar type of phosphate solubilizing activity in isolated PS bacteria and fungi.

Previous work of Gaur (1990) with *Pseudomonas striata* and Tambekar and Bhokre (2006) also reported similar findings of effective carbohydrates in the order listed. While studying the influence of N source ammonium sulphate was found to be the best source utilized by maximum number of strains as the constituents of Pikovaskaya's medium, followed by ammonium nitrate, potassium nitrate, sodium nitrate, calcium nitrite and urea; whereas PS-34 released maximum amount of phosphorus (52 ppm) in presence of ammonium nitrate, PS-4 (45 ppm) in presence of potassium nitrate, the strain PS-21 (50 ppm) in presence of sodium nitrate, PS-23 and PS-9 released (50 ppm) in presence of calcium nitrite and PS-22 released (45 ppm) in presence of urea (Fig. 2). Sodium and potassium nitrates were preferred to ammonium nitrate as an N source. But amongst the ammonium salts, ammonium sulphate was preferred as compared to ammonium nitrate.

Among the environmental factors that control the availability of soil phosphorus, pH is of prime importance. Experiments dealing with optimization of pH revealed that *Bacillus subtilis* showed varying degree of TCP solubilization. The medium having pH of 6.0 was the most favorable with maximum number of strains. Followed by pH 5.0, 7.0 and 8.0. Highest TCP solubilization was recorded by strain PS-19 and PS-20 (52 ppm) with pH-6, followed by PS-20 (45 ppm) with pH-5 and PS-34 (45 ppm) with pH-7. The fall in pH clearly indicates the production of organic acids, which is considered to be the sole mechanism responsible for solubilization of insoluble

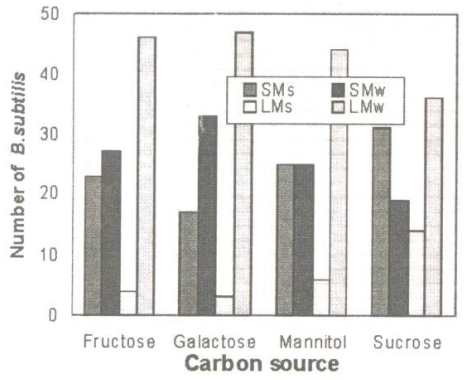


Fig 1: Effect of carbon sources on the PS activities of isolated *B. Subtilis*

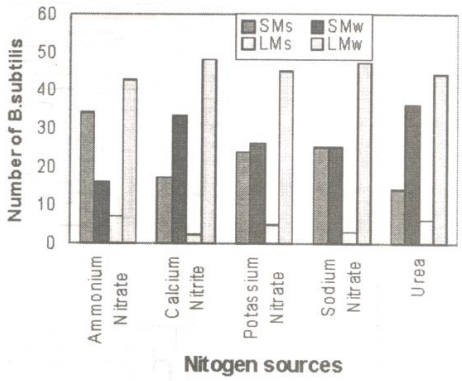
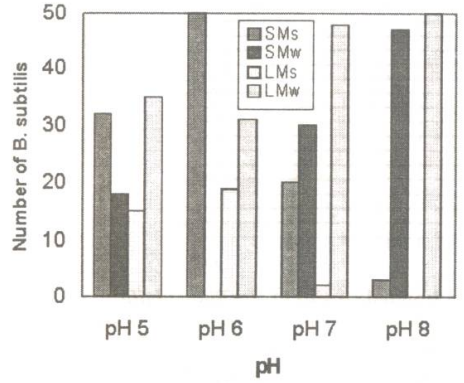
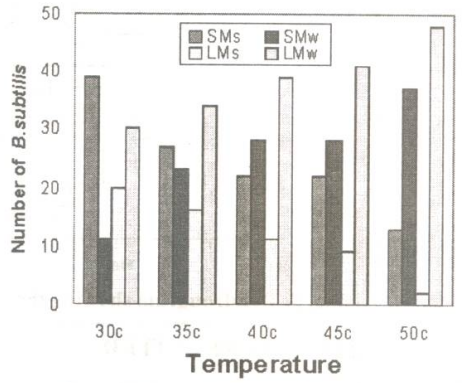


Fig 2: Effect of nitrogen sources on the PS activities of isolated *B. Subtilis*



SMs: Solid medium strong PS activity
Lms: Liquid medium strong PS activity

Fig 3: Effect of pH on the PS activities of isolated *B. Subtilis*



SMw: Solid medium weak PS activity
LMw: Liquid medium weak PS activity

Fig 4: Effect of temperature on the PS activities of isolated *B. subtilis*

inorganic phosphates (Dave *et al.*2002). In all cases, pH decreased towards acidic range with the days of incubation and remained between 5.0 and 4.0 (Fig. 3). The optimum temperature for PS activity by maximum number of strains was proved to be 30°C followed by 35°C, 40°C, 45°C and 50°C. The highest PS activity was recorded by the strain PS-24 (65 ppm) and (63 ppm) at 30°C and 35°C respectively. The strain PS-23 was found to be efficient at both the temperature 40°C and 45°C, which solubilized 50 ppm and 60 ppm respectively. PS-32 was found to be efficient at 50°C with PS activity (50 ppm) (Fig. 4). The TAXAN software package on Unweighted Pair Group method with Arithmetic Average to cluster the strains from metrics of similarity was used to construct a dendrogram (Sneath and Sokal, 19973). Hierarchical clustering analysis showed dissimilarity among all the strains, however these are clustered in to three groups; 17 in one 10 in another and 23 in third group. According to Euclidean distance type all 50 strains were showed 76 per cent distance whereas PS-22, PS-36, PS-11 and PS-12 showed 39 per cent. These isolated strains most ecological adopted and have optimum PS activities at various nutritional and environmental condition hence biofertilizers produced from these specific strains can help to derive maximum benefits in agricultural production.

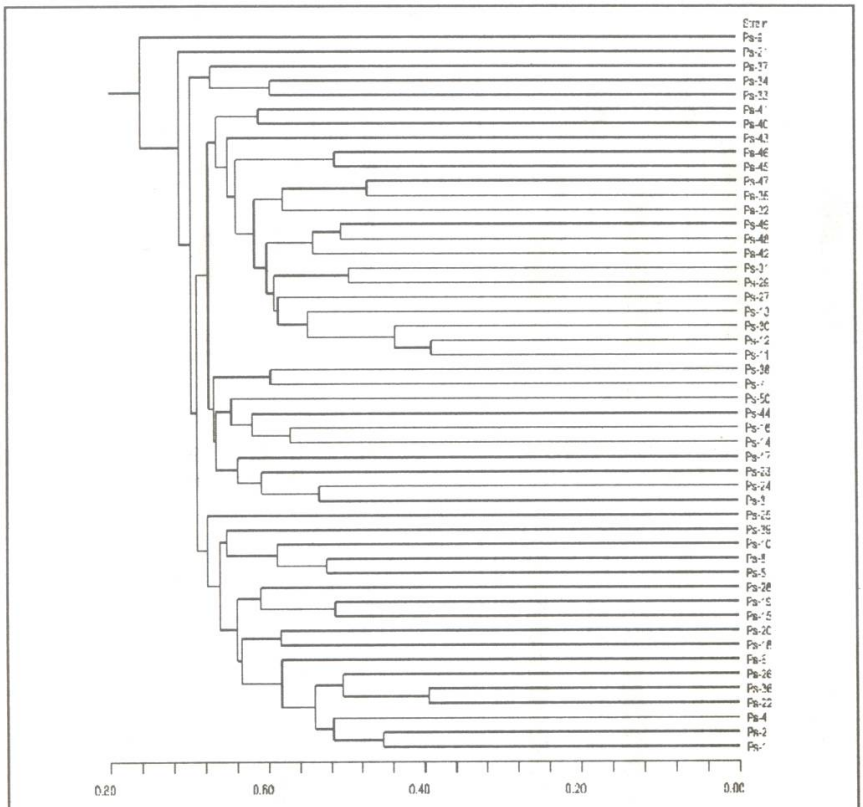


Fig. 5. Dendrongram showing the similarity in isolated strains of *Bacillus subtilis*

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PKV Res. J. Vol. 30 (2), 2006

Evaluation of Some Newer Insecticides as Seed Treatment Against Sorghum Shoot Fly, *Atherigona soccata* Rondani in *Rabi*

H.G. Kandalkar[1] and S.S. Wanjari[2]

ABSTRACT

The seed treatment with Thiamethoxam 70 WS recorded the minimum 29.38 per cent dead hearts of shoot fly on 28th day which was followed by the treatment imidacloprid 70 WS (33.35%dh), Imidacloprid 600 FS (35.99% dh) and carbosulfan 25 DS (37.41% dh), were at par with each other. Remaining treatments did not differ statistically from untreated control. However, on the basis of Incremental cost benefit ratio and to obtain effective control of shoot fly and grain yield of sorghum, the treatment with Imidacloprid 600 FS was the best which recorded the highest ICBR i.e. 6.61 and it was followed by the treatments with carbosulfan 25 DS, Imidacloprid and thiamethoxm in which 3.65, 2.76 and 1.40 ICBR were recorded, respectively.

More than 150 pest species attack sorghum crop (Sheshureddy, 1983). Amongst all, shoot fly is one of the most widespread pests of significant importance which attack sorghum seedlings during one to four weeks. The crop sown early in the monsoon escape the damage of shoot fly in the state of Maharashtra. Severe incidence of shoot fly is generally noticed on late sown crop in monsoon and also in*Rabi* season. Therefore, specific and economical control to keep the incidence below ETL, is rather very difficult. Keeping these points in view, this experiment against sorghum shoot fly in *Rabi* season was conducted continuously for three years to identify economical and effective seed dresser against shoot fly.

MATERIAL AND METHODS

The field experiment was conducted at the farm of Sorghum Research Unit, Dr. Panjabrao Deshmukh Krishi Vidypaeeth, Akola (M.S.) during *Rabi* season of 2002, 2003 and 2004 in a Randomised Block Design with three replications having plot size of 6.75 m^2 (3.00 x 2.25 m) and sowing was done with sorghum hybrid AKSV 13 (R) at the spacing of 45 x 15 cm on dated 29.11.2002, 17.10.2003 and 8.10.2004 in the respective years. In all, eight treatments including six seed dressers and one recommended insecticide i.e. endosulfan spray 0.05 per cent on 7th to 17th day after emergence of crop along with untreated control were evaluated. The treatment details are given in Table 1. The observations were recorded on shoot fly eggs $plant^{-1}$ on 7th, 14th and 21st day after emergence on ten plants randomly selected. The dead hearts were recorded on 14th and 28th day after emergence of crop by counting total plants and damaged plants. The data, thus obtained, were transformed in to arc sine and analysed accordingly. Grain yield was also recorded in each treatment. ICBR was also worked out for cost economics.

RESULTS AND DISCUSSION

The results are included in Table 1

i) Shoot fly ovi position on 7th, 14th and 21st day after emergence.

The shoot fly eggs were not observed on 7th day. The results were statistically non-significant on 14th and 21st day after crop emergence and therefore, compression against the treatments could not be done.

ii) Shoot fly dead hearts on 14th day a.e. :

The data in Table 1 revealed that there were three significant difference within the treatments. The treatment of Thiamethoxam 70 WS recorded significantly minimum per cent dead hearts due to shoot fly (6.43% dh). It was followed by the treatment Imidacloprid 70 WS (6.84% dh) and Imidacloprid 600 FS (11.43% dh). All these treatments were at par with each other. Thiamethoxam 70 WS and Imidacloprid 70 WS treatments were significantly superior to rest of the treatments. The treatments Acephate 75 SP (22.45% dh), Acetamiprid 20 SP (17.18% dh), carbosulfan 25 DS (15.47 % dh) and Endosulfan spray (15.64% dh) did not exhibit any statistical significance over the untreated control.

iii) Shootfly dead hearts on 28th day a.e.

The results were statistically signficant Minimum incidence (29.38% dh) was observed in the treatment Thiamethoxam 70 WS which was followed by the treatment with Imidacloprid 70 WS (33.35% dh) and Imidacloprid 600 FS (35.99% dh) and carbosulfan 25 DS (37.41%dh) and were at par with each other. Remaining

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Table 1. Effectiveness of some newer insecticides as seed dressers against sorghum shoot fly *Atherigona soccata* Rondani

S.N.	Treatments	Av. eggs. laid plant^{-1} on		Av. per cent shoot fly dead hearts on		Grain yield	ICBR
		14th day	21st day	14th day	28th day	q ha^{-1}	
1.	Acephate 75 SP @ 30 g kg^{-1} seed	1.27	3.08	22.45 (25.47)	47.02 (43.58)	6.32	-7.40
2.	Acetamiprid 20 SP @ 20 g kg^{-1} seed	1.54	2.71	17.18 (21.69)	37.40 (37.88)	7.31	0.27
3.	Thiamethoxam 70 WS @ 10 g kg^{-1} seed	1.76	3.35	6.43 (11.08)	29.38 (28.85)	19.77	1.40
4.	Imidacloprid 70 WS @ 10 g kg^{-1} seed	1.36	3.10	6.84 (12.36)	33.35 (32.81)	17.64	2.76
5.	Imidacloprid 600 FS @ 10 m kg^{-1} seed	1.38	3.01	11.43 (17.15)	35.99 (35.13)	15.09	6.61
6.	Carbasulfan 25 DS @ 20 g kg^{-1} seed	1.64	3.35	15.47 (20.17)	37.41 (36.53)	10.26	3.65
7.	Endosulfan 35 EC 0.05 % spray on 7th and 17th day a.e.	1.55	3.00	15.64 (21.95)	40.29 (39.09)	8.70	-0.91
8.	Untreated control	1.28	3.30	19.53 (24.61)	41.80 (40.55)	8.64	-
	F test	N.S.	N.S.	Sig.	Sig.	Sig.	-
	SE (m) ±	0.20	0.31	2.45	2.87	2.52	-
	CD at %%	-	-	7.44	8.71	7.00	-
	CV %	23.82	17.43	22.00	13.51	21.61	-

Figures in the parentheses are arcsin value

treatments did not differ statistically from untreated control.

vi) Grain yield (q ha^{-1})

The pooled data presented in table indicated that there were three significant differences within the the treatments, Thiamethoxam 70 WS recorded the highest grain yield 19.77 (q ha^{-1}) of *Rabi* sorghum and was closely followed by the treatment of Imidacloprid 70 WS (17.64 q ha^{-1}) and Imidaclorpid 600 FS (15.09 q ha^{-1}). All these treatments were at par with each other except the treatment Imidacloprid 600 FS which was significantly superior over rest of the treatments including untreated control.

v) Increment cost benefit ratio (ICBR)

Amongst all the treatments, Imidacloprid 600 FS had shown maximum 1:6.61 ICBR. The rest of the treatments such as Carbosulfan 25 DS, Imidacloprid 70 WS and Thiamethoxam 70 WS recorded 1:3.65, 1:2.76 and 1:1.40 ICBR, respectively.

On the basis of Incremental cost benefit ratio and for the effective control of sorghum shoot fly and to obtained the maximum grain yield, the seed treatment of Imidacloprid 600 FS @ 10 ml kg^{-1} of seed seems to be useful

The results of this study in case of Imidacloprid 70 WS are in agreement with the work of Kandalkar *et. al.*, (1999) and Balikai (1999). The results of remaining newer insecticides could not be compared for want of literature on this aspect.

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PKV Res. J. Vol. 30 (2), 2006

Effect of Bt Cotton Hybrids as IPM Component on Population of Sucking Pests and Natural Enemies Under Rainfed Condition

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ABSTRACT

A field experiment was conducted at Cotton Research Unit of Dr. PDKV, Akola during *Kharif* season of 2004-05 under rainfed condition in randomized block design with four replications. Three Bt cotton hybrids viz., MECH-12 Bt, MECH-162 Bt and MECH-184 Bt with two check hybrids PKV-Hy-2 and NHH-44 were grown at 90 x 60 cm spacing for these studies. The ETL based plant protection packages were adopted under IPM which were developed and recommended by Dr. PDKV, Akola during 2003-04 on all the above varieties for the control of sucking pests and bollworms and the effect of these hybrids on the population of sucking pests and natural enemies was evaluated. From this it can be concluded that 3 to 5 prays were required to be given for the control of sucking pests on Bt cotton hybrids, where as three sprays each were required for the control of sucking pests on check hybrids PKV-Hy-2 and NHH-44 Minimum population of aphids and thrips was recorded on MECH-12 Bt and jassids on PKV-Hy-2. The whitefly population was below ETL in all the cotton hybrids during the crop season. However, there were no significant differences amongst the Bt cotton and check hybrids as regards the population of natural enemies.

After commercial release of Bt cotton hybrids for cultivation in India in March 2002 it is now grown in six states i.e. Madhya Pradesh, Gujrat, Maharashtra, Andhra Pradesh, Karnataka and Tamilnadu. The area under cultivation is at increasing trend i.e. in 2002 it was grown on 72,000 acres, in 2003 on 2,30,000 acres and in 2004 on 13,00,000 acres (Manjunath 2004) Bt cotton gives effective control of bollworms leading to significant reduction in chemical insecticidal sprays required to be given for bollworm control.

Taking into consideration the effectiveness of Bt transgenic cotton hybrids against cotton bollworms and there by reduction in chemical insecticidal sprays required for bollworm control, these Bt cotton hybrids can be fitted in IPM programme as one of the component of IPM. However chemical insecticidal sprays will be required for the control of sucking pests on these Bt cotton hybrids which may have also the effect on natural enemies. Hence the present study was planned and undertaken to see the effect of various Bt transgenic cotton hybrids as one of the component of IPM on population build up of sucking pests and natural enemies.

MATERIAL AND METHODS

A field experiment was conducted at Cotton Research Unit, of Dr. PDKV, Akola, Maharashtra, India during Kharif season of 2004-05 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 popular check hybrids viz. PKV-Hy-2 and NHH-44 were grown at 90 x 60 cm in IPM module as one of the component. The IPM module was developed and recommended by Dr. PDKV, Akola during and 2003-04, the details of plant protection packages to be undertaken under IPM module were -

1) Thiomethoxam 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
5) Spraying of Spinosad 45 SC @ 0.01 per cent for bollworms based on ETL.
6) Spraying of Beta - cyfluthrin 2.5EC @ 0.0025 per cent for bollworms based on ETL.

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Table 1 : Details of treatment actually undertaken on various cotton hybrids under IPM module

S.N.	Treatments	Cotton hybrids				
		MECH-12 Bt	MECH 162 Bt	MECH 184 Bt	NHH-44	PKV-Hy-2
1	Seed treatment with Thiomethoxam One 70 WS @ 4.28 g kg^{-1} of seed	One	One	One	One	
2	Spraying of Acetamiprid 20 SP @ 0.003 per cent	3 sprays 5 sprays	3 sprays	3 sprays	3 sprays	
3	Release of *T. Chilonis* egg parasitoid @ 1-5 lakh.ha^{-1}	Twice	Twice	Twice	Twice	Twice
4	Spraying of Azadirachtin 300 ppm @ 5 ml lit^{-1}	-	-	-	1 spray	1 spray
5	Spraying of Spinosad 45 SC @ 0.01 per cent	-	-	-	2 spray	2 spray

The impositions of treatments were based on economic threshold level of a particular pest. Where as, seed treatment and parasitoid releases were undertaken at specific time and interal. Weekly observations were recorded to ascertain the pest load.

The following ET levels were considered for major pests of cotton for imposition of above treatments

Sucking pests :

1) Aphids : 10 nymphs $leaf^{-1}$

2) Jassids : 2 nymphs $leaf^{-1}$

3) Thrips : 10 $leaf^{-1}$

4) White flies : 8-10 adults or 20 nymphs $leaf^{-1}$

The observations of sucking pests i.e. aphids, jassids, thrips, white flies and natural enemies i.e. chrysopa eggs, chrysopa larvae, lady bird beetle and spiders were recorded from 15 DAG, to see the effect of Bt cotton and check hybrids on the population of sucking pests and natural enemies.

RESULTS AND DISCUSSION

A] Effect of various Bt cotton hybrids on the population of sucking pests (Table 2)

1) Aphids : The results presented in Table 2 revealed that there were significant differences amongst the various cotton hybrids as regards the population of aphids. The lowest population was observed on MECH-12 Bt (0.50 $leaf^{-1}$) and rest of the cotton hybrids were at par with each other. However maximum population of aphids was observed on PKV-Hy-2 (1.02 $leaf^{-1}$). The population was below ETL in all the cotton hybrids through out the crop season. Hence, no isnecticidal spray was required to be given for the control of aphids on any of the cotton hybrids during the crop season.

2) Jassids : As regards the population of jassids (Table 2) the maximum population was recorded on MECH-12 Bt (0.83 $leaf^{-1}$) in spite of three sprays for the control of jassids on this hybrid, as MECH-12 Bt was highly susceptible to jassids Minimum population of jassids was observed on PKV-Hy-2 (0.13 $leaf^{-1}$) and it was at par with MECH-162 Bt, MECH-184 Bt and NHH-44 inspite no sprays for control of jassids in these hybrids.

3) Thrips : The population of thrips (Table 2) also shows significant differences amongst the various cotton hybrids. Minimum population was noticed in MECH-12 Bt (1.27 $leaf^{-1}$) and it was at par with PKV-Hy-2 (1.37 $leaf^{-1}$) Maximum population was observed in MECH-162 Bt (1.77 $leaf^{-1}$) which was at par with NHH-44 (1.73 $leaf^{-1}$) ETL based two sprays were required to be under taken in MECH-12 Bt and three sprays each were required to be under taken on remaining four hybrids for control of thrips.

4) Whiteflies : As regards the population of whiteflies (Table 2) minimum population was observed in MECH-162 Bt (0.14 $leaf^{-1}$) and it was at par with MECH-12 Bt and MECH-184 Bt. Maximum population of whiteflies was noticed in NHH-44 (0.23 $leaf^{-1}$) which was at par with PKV-Hy-2 (0.19 $leaf^{-1}$). The population of whiteflies was below ETL in all the cotton hybrids through out the crop season and no spray was required to be undertaken for the control of this pest on all the cotton hybrids during the crop season.

Table 2 : Cumulative average population of sucking pests in various cotton hybrids under rainfed conduction during crop season

S.N.	Cotton Hybrids	Average population of sucking pest / leaf				No. of ETL based sprays for control of sucking pests during crop season.
		Aphids	Jassids	Thrips	White flies	
1	MECH-12 Bt	0.50	0.83	1.27	0.17	Five
		(0.70)	(0.91)	(1.12)	(0.41)	
2	MECH-162 Bt	0.78	0.28	1.77	0.14	Three
		(0.88)	(0.52)	(1.32)	(0.37)	
3	MECH-184 Bt	0.82	0.30	1.48	0.14	Three
		(0.0)	(0.55)	(1.21)	(0.38)	
4	PKV-Hy-2	1.04	0.13	1.37	0.19	Three
		(1.02)	(0.51)	(1.17)	(0.44)	
5	NHH-44	0.85	0.30	1.73	0.23	Three
		(0.92)	(0.55)	(1.31)	(0.48)	
	SE (m) ±	0.05	0.02	0.02	0.02	
	CD at 5%	0.15	0.06	0.06	0.06	

Figure in parantheses are square root values.

Table 3 : Cumulative average population of natural enemies in various cotton hybrids under rainfed condition during crop season.

S.N.	Cotton Hybrids	Average population of natural enemies plant^{-1}			
		Chrysopa eggs	Chrysopa larva	Lady bird beetles	Spiders
0.111	MECH-12 Bt	0.30	0.10	0.14	0.09
		(0.54)*	(0.77)**	(0.37)*	(0.29)*
0.112	MECH-162 Bt	0.31	0.10	0.14	0.09
		(0.55)	(0.77)	(0.37)	(0.29)
3	MECH-184 Bt	0.35	0.12	0.09	0.11
		(0.58)	(0.79)	(0.29)	(0.33)
4	PKV-Hy-2	0.41	0.15	0.09	0.08
		(0.63)	(0.80)	(0.29)	(0.27)
5	NHH-44	0.36	0.17	0.13	0.09
		(0.59)	(0.82)	(0.35)	(0.29)
	SE (m) ±	0.04	0.02	0.05	0.03
	CD at 5%	-	-	-	-

( )* $\sqrt{x + 0.5}$ ( )** sq. root.

B] Effect of various Bt cotton hybrids on the population of natural enemies (Table 3)

During the present investigation the results showed non significant differences amongst the various cotton hybrids as regards the population of natural enemies (Table 3) i.e. chrysopa eggs, chrysopa larve, lady bird beetles and spiders.

The above findings of sucking pests were supported by Anonymous (2002) and Ghodki (2004). Ghodki (2004) observed minimum population of aphids on MECH-12 Bt and maximum on PKV-Hy-2 as regards jassids he reported that the MECH-12 Bt was susceptible to jassids. Anonymous (2002) reported similar type of results that MECH-12 Bt was found more succeptible to

jassids at all location in Sonth Zone and required more number of sprays for jassids. Ghodki (2004) reported the minimum population of thrips on MECH-12 Bt and maximum on MECH-162 Bt, he also reported maximum population of white flies on PKV-Hy-2 and minimum on MECH-12 Bt. The findings of Badrinarayana (2002) in conformity with present findings because in present findings also three sprays each were required for the control of sucking pest on MECH-162 Bt, MECH-184 Bt, PKV-Hy-2 and NHH-44. During present study also minimum population of aphids and thrips were recorded on MECH-12 Bt and minimum population of jassids on PKV-Hy-2 where as maximum population of jassids on MECH-12 Bt, thrips on MECH-162 Bt and aphids and white flies on PKV-Hy-2. Badrinarayana (2002) reported that Bt cotton still need control of other (non lepidopteron) pests like sucking pest attacking the crop in early stage. Anonymous (2003) from the findings of Matin Qaim and David Zilbermann reported that since Bt gene did not protect against sucking pest, the sprays were same for Bt and non Bt varieties.

As regards the findings of natural enemies the present findings were supported by the findings of Cui-Jin Jie *et al* (1997) and Wang Chun Yi *et al.* (1997) Cui-Jin Jie *et al.* (1997) observed no significant differences in total number of natural enemies of cotton pests recorded in Bt transgenic cotton and non Bt cotton Wang Chun Yi *et al* (1997) observed same incidence dynamics of major predators in Bt transgenic cotton and conventional cotton hybrids.

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PKV Res. J. Vol. 30 (2), 2006

Efficacy of Pheromone, Botanical and Biopesticide for Management of *Helicoverpa armigera* (Hubner) on Cotton

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ABSTRACT

A study was undertaken to assess the efficacy of pheromone, botanical and biopesticide alone and in combination for the management of *H. armigera* on cotton. *Helicoverpa* pheromone 15 ml + HaNPV 250 LE ha^{-1} recorded the superior result in reducing the per cent infestation of *H. armigera* on squares, flowers and green bolls with minimum per cent damage of bolls, 2, 7 and 10 days after treatment followed by *Helicoverpa* pheromone 7.5 ml + HaNPV 250 LE ha^{-1} and *Helicoverpa* pheromone 15 ml + NSE 5 per cent and the alone treatment of HaNPV 250 LE ha^{-1} and *Helicoverpa* pheromone 15 ml ha^{-1}. The botanical i.e., NSE 5 per cent was better than the untreated control. Similar trend was found in reducing per cent of bad *Kapas* with highest yield of seed cotton. Thus, mixing of HaNPV 250 LE ha^{-1} and NSE 5 per cent *Helicoverpa* pheromone caused effective management of *H. armigera* with the increase in yield of seed cotton.

Cotton (*Gossypium* spp.) is one of the most important cash crops popularly known as "White Gold". India is one of the largest cotton growing countries in the world. However, productivity of seed cotton is very low as compared to world's productivity. Amongst the several factors responsible for its low production, the attack of insect pests is one of the limiting factors. Among these pests, American bollworm, *Helicoverpa armigera* (Hubner) is one of the most destructive pest all over the country causing as high as 41 per cent boll damage in cotton (Anonymous, 1994). Chemical insecticides is most popular method commonly used for control of bollworm, but the excessive and indiscriminate use of chemical insecticides to control *H. armigera* led to several problems like development of resistance in insect to insecticides (Dhingra *et al.,* 1998), mammalian toxicity, pest resurgence, adverse effect on bioagent and environment (Anonymous, 2001). The efforts were made to search upon effective, safe and eco-friendly alternative measures to chemical insecticides for the management of *H. armigera* on cotton.

In recent years, in IPM, pheromone considered to be an essential component because they are used for monitoring and detecting the economic threshold level of pest population as a direct pest suppression measure (Yadav, 1999 and Tamhankar *et al.*, 2001). The pheromone causes the deorientation of male insect which make disruption in mating. Neem is one of the best alternatives to synthetic insecticides, economic and eco-friendly being an antifeedant which reduces the growth and development of *H. armigera* and have less residual problems (Rane, 1995). Amongst the biopesticide, Nuclear Polyhedrosis Virus (NPV) is a miraculous bio-agent, exhibits high level of virulence only against *H. armigera.* Hence, the present study was planned and undertaken to evaluate the efficacy of pheromone, botanical and biopesticide to resolve the problem of *H. armigera* on cotton.

MATERIAL AND METHODS

A field experiment was conducted in the experimental field of Department of Entomology, College of Agriculture, Nagpur (M.S.) during the *Kharif* season 2004-05. The experiment was conducted with nine treatments viz., *H.* pheromone 15 ml ha^{-1}, *H.* pheromone 7.5 ml ha^{-1}, NSE 5 per cent, HaNPV 250 LE ha^{-1}, *H.* pheromone 15 ml + NSE 5 per cent, *H.* pheromone 15 ml + HaNPV 250 LE ha^{-1}, *H.* pheromone 7.5 ml + NSE 5 per cent, *H.* pheromone 7.5 ml + HaNPV 250 LE ha^{-1} and control (water spray) and replicated thrice in Randomized Block Design (RBD) on cotton crop (Variety-PKV Hy-4). HaNPV and Neem seed extract were prepared in the laboratory of Entomology section, College of Agriculture, Nagpur, while the liquid pheromone obtained from other source.

Periodical observations were taken to see the incidence of *H. armigera* prior to first application. First application was made as soon as the infestation of *H. armigera* was noticed. All three applications were given at 15 days interval. For recording observations, five plants were selected randomly from each plot and labelled. The pre-treatment observations were recorded 24 hours before the application of treatment and post-treatment observation at 2, 7 and 10 days after spraying. Requistic

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observations were recorded at different growth periods of cotton crop to generate the data on per cent infestation squares, flowers and green bolls. The observations were further pooled together for computing cumulative per cent infestation. Similarly, the per cent of bad *Kapas* and the yield of seed cotton was noted from the net plot treatments and replication wise. The data thus obtained were subjected to statistical analysis

RESULTS AND DISCUSSION

The data, 2 days after all three spray (Table-1) revealed that, the lowest per cent infestation (3.34 %) was recorded in combination treatment *H.* pheromone 15 ml + HaNPV 250 LE ha^{-1}. Next to this treatment, *H.* pheromone 7.5 ml + HaNPV 250 LE ha^{-1} recorded 5.40 per cent infestation which was found superior over all the remaining treatments, followed by alone treatment i.e. HaNPV 250 LE ha^{-1} where 5.97 per cent damage was recorded. Combination treatments *H.* pheromone 15 ml + NSE 5 per cent and *H.* pheromone 7.5 ml + NSE 5 per cent recorded 6.29 and 6.69 per cent infestation of *H. armigera*, respectively and were at par with each other. The without combination treatments *H.* pheromone 15 ml ha^{-1}, NSE 5 per cent and *H.* pheromone 7.5 ml ha^{-1} were found to be significantly superior over control. More or less similar trend was noticed on cumulative per cent infestation on squares, flowers green bolls 7 and 10 days after all three sprays. Bhamburkar and Kranti (1992) observed promising result of alone and in combination treatment of botanical and biopesticide against *H. armigera*. The alone application treatment efficacy of biopesticide over botanicals was reported by Sarode *et al.*, (1995). As regard, the pheromone treatment i.e. alone and in combination, Bisane, *et al.*, (2003) reported superior efficacy of liquid pheromone with NSE and HaNPV against *H. armigera*. These studies are more comparable with the present findings.

Average per cent of bad *Kapas* given in Table 1 revealed that, amongst the various treatments, application of *H.* pheromone 15 ml + HaNPV 250 LE ha^{-1} was found effective in minimizing the percentage of bad *Kapas* to

Table 1: Efficacy of pheromone, botanical and biopesticide against *H. armigera* infestation and yield of seed cotton

S.N.	Treatments	Cumulative per cent infestation on squares, flowers and green boll			Per cent bad *Kapas*	Yield of seed cotton (q ha^{-1})
		2 DAT	7 DAT	10 DAT		
T_1	*Helicoverpa* pheromone 15 ml ha^{-1}	7.46 (2.73)	7.81 (2.79)	8.04 (2.83)	16.22 (4.02)	10.32
T_2	*Helicoverpa* pheromone 7.5 ml ha^{-1}	8.88 (2.97)	9.78 (3.02)	9.35 (3.05)	18.10 (4.25)	9.72
T_3	Neem Seed Extract (NSE) 5 %	7.66 (2.76)	7.89 (2.80)	8.07 (2.84)	16.88 (4.10)	10.19
T_4	HaNPV 250 LE ha^{-1}	5.97 (2.44)	6.26 (2.50)	6.42 (2.53)	13.46 (3.66)	12.29
T_5	*Helicoverpa* pheromone 15 ml + NSE 5 %	6.29 (2.50)	6.59 (2.56)	6.76 (2.60)	14.62 (3.82)	12.00
T_6	*Helicoverpa* pheromone 7.5 ml + NSE 5 %	6.69 (2.58)	6.92 (2.63)	7.08 (2.66)	15.55 (3.94)	11.72
T_7	*Helicoverpa* pheromone 15 ml + HaNPV 250 LE ha^{-1}	3.34 (2.32)	3.52 (1.87)	3.71 (1.92)	10.54 (3.24)	14.10
T_8	*Helicoverpa* pheromone 7.5 ml + HaNPV 250 LE ha^{-1}	5.40 (2.32)	5.65 (2.37)	5.89 (2.42)	12.09 (3.47)	12.50
T_9	Control (water spray)	11.59 (3.40)	12.04 (3.46)	12.30 (3.50)	20.71 (4.55)	8.09
'F' test		Sig.	Sig.	Sig.	Sig.	Sig.
S.E. (m) ±		0.046	0.043	0.042	0.084	0.45
CD at 5 %		0.13	0.13	0.12	0.25	1.35

Note: Figure in parentheses are the corresponding square-root transformation values.

the extent of 10.54 per cent as against 20.71 in the control plot. It was followed by the treatment of *H.* pheromone 7.5 ml + HaNPV 250 LE ha^{-1} and alone treatment HaNPV 250 LE ha^{-1} were found effective than other treatments.

The yield of seed cotton was significantly highest in the combination treatment *H.* pheromone 15 ml + HaNPV 250 LE ha^{-1} (14.10q ha^{-1}). Out of next better treatments, *H.* pheromone 7.5 ml + HaNPV 250 LE ha^{-1} and HaNPV 250 LE ha^{-1} (15.50 and 12.29 q ha^{-1}), followed by *H.* pheromone 15 ml + NSE 5 per cent (12.00 q ha^{-1}) and *H.* pheromone 7.5 ml + NSE 5 per cent (11.72 q ha^{-1}). The other alone treatments, *H.* pheromone 15 ml ha^{-1}, NSE 5 per cent and *H.* pheromone 7.5 ml ha^{-1} also produced significantly higher yield than control plot (8.09 q ha^{-1}). These findings of combination treatment are in accordance with the findings of Busoli (1993) and Sarode, *et al.,* (1996). The combination and alone of liquid pheromone treatment conducted by Bisane *et al.,* (2003) compared the present findings in reducing per cent infestation and ultimately increased yield of seed cotton.

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PKV Res. J. Vol. 30 (2), 2006

Studies on Propagation of Aonla by Soft Wood Grafting and Patch Budding

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ABSTRACT

Softwood grafting and patch budding methods of propagation were tried throughout the year to find out suitable method for commercial propagation of aonla. In the present investigation, soft wood grafting and patch budding propagation practices were carried out on local seedlings (Rootstock) of Aonla having 2.0 - 2.5 cm girth at collar region and scion of 8-10 cm length having 4-6 buds. Among the methods, softwood grafting was found most successful method for aonla propagation and among the different periods used for propagation, December - January period was found to be the best for higher success in softwood grafting.

Aonla *Phyllanthus emblica* Linn. (Syn. *Emblica officinalis* Gaertn.) also known as Indian gooseberry is an important dry land fruit crop originated in South East Asia (India) and belongs to the family "Euphorbiaceae". It contains vitamin 'C' 600 mg 100 g^{-1} of the edible portion. Maximum vitamin 'C' formed in mature fruits than immature fruits. Tree is widely grown in tropical countries, and also used in agro-forestry as well as social forestry planting programmes. It is commonly propagated by seed, but the seed germination is very poor. Aonla being a cross-pollinated crop, which leads to heterozygous plants and hence, it requires propagation by vegetative method to produce true to type and genetically uniform planting material. Traditionally, Aonla is propagated by budding method i.e. Patch budding on one year old seedling rootstock in July – August in U.P. In Maharashtra conditions, union of rootstock with scion takes place, but scion bud does not sprout for several months though it remains green even up to 6-8 months after budding. Therefore, soft wood grafting and patch budding both were tried for getting better success.

MATERIAL AND METHODS

The investigation was carried out in Main Garden, Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola for finding out the best method of propagation by vegetative means, therefore, patch budding and soft wood grafting methods were selected to serve the purpose. Local seedlings were raised in polythene bags. Seeds were extracted from selected well ripen fruits of Aonla and allowed it to dry under sun until the seed coat started breaking. These seeds were separated and sown in polythene bags of 25 cm x 20 cm and 200 gauge thickness filled with the mixture of soil, sand and farm yard manure in a ratio of 2:1:1. Vigorously growing seedlings having girth of 1.5-2.00 cm at collar region were used as root stocks, thirty seedlings each for patch budding and soft wood grafting were selected and operation was carried out (Propagation) in every month of the year during 2001,2002 and 2003.

In soft wood grafting, the shoot of the rootstock was decapitated at 10 - 15 cm height from the collar region. A cut of 5 cm deep was made in the middle of the stock with sharp knife, then prepared the detached scion of 8-10 cm length by giving two slanting cuts of about 4-5 cm long on both sides of the basal end. Scion was inserted and fixed in the straight cut portion of the stock and tied firmly with transparent polythene strip of 1.5 cm in width and 30 cm of length.

In patch budding, the bud sticks were selected from past season growth having pencil size thickness with 4-5 plumpy buds swollen up to 2 mm. The bud removed along with bark in patch size from bud stick and also equal portion of patch size removed from seedling with the help of budding knife. Then the bud along with bark from bud stick was fitted over the portion removed in equal in size from seedlings and tied firmly with polythene. The aonla variety NA-7 was used as a scion for both the methods of propagation.

The budlings and grafts were kept in open for further observation regarding final success during June.

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RESULTS AND DISCUSSION

Soft wood grafting

Data from the Table 1 indicated that, softwood grafting had more success over patch budding. Significantly the maximum percentage of soft wood grafting was obtained when grafting was done from the month of November to February (64.44 to 94.44%). Among the different months tried for soft wood grafting, significantly maximum success was observed in the month of January during 1st and 2nd year (95.00 and 84.00%), followed by December (80% during both the year). However, during third year, significantly maximum success was observed in the month of December (94.00 %) followed by January (90.00%).

Patch Budding

Data presented in Table 2 revealed that patch budding method of propagation in Aonla was tried through out the year and very less success was recorded in patch budding. Among the different months tried for patch budding, significantly maximum success was observed in the month of August during all the years of study (44.44, 40.00 and 44.44%, respectively).

Pooled Result

Among the different months tried for softwood grafting in aonla, significantly the maximum success of softwood grafting was observed when the grafting was done in the month of January (89.83 %) followed by December (84.81%) as against upto 43.70 per cent success

Table 1 : Success of soft wood grafting in Aonla

S.N	Period	Per cent success			Pooled mean
		2000-01	2001-02	2002-03	
1.	August	00.00	15.55	30.00	15.18
			(23.21)	(33.18)	(19.02)
2.	September	00.00	40.00	50.00	30.00
			(39.22)	(44.83)	(28.01)
3.	October	60.00	54.43	65.50	59.97
		(52.72)	(47.56)	(54.07)	(51.40)
4.	November	70.00	65.55	80.00	71.85
		(56.64)	(54.10)	(63.05)	(57.93)
5.	December	80.00	80.00	94.44	84.81
		(56.38)	(63.32)	(76.51)	(65.62)
6.	January	95.00	84.00	90.00	89.83
		(77.42)	(66.45)	(71.72)	(71.86)
7.	February	84.43	70.00	64.44	72.95
		(63.12)	(56.88)	(53.35)	(57.80)
8.	March	60.00	55.55	50.00	55.18
		(50.77)	(46.17)	(44.83)	(47.92)
9.	April	15.55	15.55	20.00	17.03
		(23.21)	(23.21)	(26.51)	(24.31)
10.	May	20.00	20.00	16.16	18.72
		(26.51)	(26.51)	(27.35)	(25.68)
11.	June	00.00	00.00	8.88	2.96
				(17.29)	(5.76)
12.	July	5.55	5.55	12.22	7.77
		(13.49)	(13.33)	(20.40)	(15.79)
	SE (m) ±	1.50	1.28	1.85	0.66
	CD at 5%	4.47	3.82	5.50	1.99

(Figure in parentheses are arcsine values)

Table 2 : Success of patch budding in Aonla

S.N	Period	Per cent success			Pooled mean
		2000-01	2001-02	2002-03	
1.	August	45.55	40.00	45.55	43.70
		(42.26)	(39.3)	(42.45)	(40.34)
2.	September	20.00	30.00	40.00	30.00
		(26.51)	(33.20)	(39.23)	(32.97)
3.	October	15.55	15.55	0.00	10.36
		(23.21)	(23.21)		(15.47)
4.	November	0.00	5.55	15.55	7.03
			(13.49)	(23.29)	(12.23)
5.	December	5.50	5.55	15.55	8.88
		(13.49)	(13.49)	(23.11)	(16.69)
6.	January	0.00	0.00	0.00	0.00
7.	February	0.00	0.00	0.00	0.00
8.	March	0.00	0.00	0.00	0.00
9.	April	0.00	0.00	0.00	0.00
10.	May	20.00	0.00	0.00	6.66
		(26.51)			(8.88)
11.	June	0.00	0.00	0.00	0.00
12.	July	25.55	25.55	34.44	28.51
		(30.36)	(30.36)	(35.89)	(32.20)
	SE (m) ±	0.82	0.85	0.96	0.44
	CD at 5%	2.44	2.54	2.85	1.34

(Figure in parentheses are arcsine values)

was recorded by patch budding in the month of August.

The similar finding was reported by Amin (1978) with 70 per cent success of Soft Wood Grafting in Aonla. Joshi (1998) reported that highest success has been achieved by SWG in Custard apple and Shalini (1999) reported good result in Aonla by SWG. The findings are in close agreement with Joshi (1998), in custard apple, Shalini (1999) and Raut (2000) in aonla. Vasalakumari *et al.* (1998) also reported that wedge grafting is successful method of propagation in aonla.

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PKV Res. J. Vol. 30 (2), 2006

Decomposition of Total Agricultural Output Growth in Vidarbha

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ABSTRACT

This study is an attempt to analyse the growth of crop production and crop productivity in Vidarbha through decomposition analysis. The study was based on secondary data collected from various Government publications and pertains to the period of 32 years i.e. from 1970-71 to 2000-2001. In order to examine the relative contribution of various factors in the growth of crop production and productivity, data were subjected to analysis by components. For this purpose seven factor decomposition model developed by Minhas and Vaidyanathan has been used to quantify the relative contribution of each component. Decomposition analysis of total agricultural output growth revealed that productivity growth was the major factor that accounted for the growth of crop output in Vidarbha. Contribution of joint effect between yield and cropping pattern also showed increase in the growth of total crop output of Vidarbha during recent years of the study.

In the predominantly agricultural country like ours, the rate of economic development is largely dependent on the growth rate of agricultural sector. Knowledge about sources of output growth in agriculture and their relative importance in different parts with different agro-climatic conditions is desirable for effective planning at regional level. It also helps in deciding the priorities of investment in agricultural development programs. Performance of agricultural crops and a quantitative assessment of contribution of the various factors to growth of crop output at regional level is helpful in reorienting the programs and setting priorities of agricultural development so as to achieve higher growth rates in agricultural production. There are so many factors generally believed to affect the agricultural production. Among these area, productivity and cropping pattern are the major one. Studies conducted in our country with regard to componentr analysis Mimhas and Vaidyanathan (1965), Sharma and Singh (1986), Lakshami and Pal (1988), Narender *et. al.*, (1989) have revealed different magnitudes of contribution to the growth of output by various components. In this study an attempt has been made to analyse the growth of crop production in Vidarbha through decomposition analysis.

MATERIAL AND METHODS

The study has been confined to the Vidarbha region of Maharashtra state. Time series secondary data on the area, production, yield and farm harvest prices of various crops were obtained from various Government publications. The data pertain to the period of 32 years i.e. from 1970-71 to 2001-02.

Analytical Tools

Decomposition of total agricultural output growth: In order to examine the relative contribution of various factors in the growth of crop production and productivity, data were subjected to analysis by components. For this purpose seven factor decomposition model developed by Minhas and Vaidyanathan (1965) has been used to quantify the relative contribution of each component. The results of decomposition scheme are worked out for three sub periods and overall period. The following is the seven factor decomposition scheme used in the present study

Definition :

$$P_0 = A_0 S_i W_i C_{io} Y_{io} \quad \text{..... (I)}$$

$$P_t = A_t S_t W_i C_{it} Y_{it} \quad \text{..... (II)}$$

From the identities (I) and (II) we can write

$$\frac{P_t - P_0}{P_0} = \frac{A_t - A_0}{A_0} + \frac{\Sigma W_i C_{io} Y_{io} \left[\frac{Y_{it} - Y_{io}}{Y_{io}}\right]}{W_i C_{io} Y_{io}} + \frac{\Sigma W_i C_{io} Y_{io} \left[\frac{C_{it} - C_{io}}{C_{io}}\right]}{S W_i C_{io} Y_{io}} + \frac{A_t - A_o}{A_o} \frac{\Sigma W_i C_{io} Y_{io} \left[\frac{Y_{it} - Y_{io}}{Y_{io}}\right]}{S W_i C_{io} Y_{io}}$$

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$$+ \left[\frac{A_t - A_o}{A_o}\right] \frac{\Sigma W_i C_{io} Y_{io} \left[\frac{C_{it} - C_{io}}{C_{io}}\right]}{\Sigma W_i C_{io} Y_{io}}$$

$$+ \frac{\Sigma W_i C_{io} Y_{io} \left[\frac{C_{it} - C_{io}}{C_{io}}\right] \left[\frac{Y_{it} - Y_{io}}{Y_{io}}\right]}{\Sigma W_i C_{io} Y_{io}}$$

$$+ \frac{A_t - A_o}{A_o} \frac{\Sigma W_i C_{io} Y_{io} \left[\frac{C_{it} - C_{io}}{C_{io}}\right] \left[\frac{Y_{it} - Y_{io}}{Y_{io}}\right]}{S W_i C_{io} Y_{io}}$$

Where

P_t = Crop output in the current year 't'.

P_O = Crop output in base year 'o'.

A_t = Gross cropped area of crop in current year 't'.

A_o = Gross cropped area of crop in base year 'o'.

Y_{it} = Yield per hectare of i^{th} crop in current year 't' .

Y_{io} = Yield per hectare of i^{th} crop in base year 'o' .

C_{it} = Proportion of area under i^{th} crop to the total cropped area in current year 't'.

C_{io} = Proportion of area under i^{th} crop to the total cropped area in base year 'o'.

W_i = Constant price weight represents the three year average of farm harvest price.

RESULTS AND DISCUSSION

Decomposition of total agricultural output growth in Vidarbha

Relative contribution of various components to aggregate growth of crop output in Vidarbha are presented in Table 1. Out of the total growth in crop output in Vidarbha during overall period as high as 51.74 per cent is attributed to the change in yield, 7.57 per cent to the change in cropping pattern and 6.76 per cent to the acreage expansion. The first order interaction between area yield, area cropping pattern and yield cropping pattern contributed positively to the output growth. Interaction between yield and cropping pattern contributed by 21.66 per cent, indicating that the yield rates of crops increased due to shift in cropping pattern. The second order interaction between area, yield and cropping pattern also contributed positively by 3.28 per cent in total agricultural output growth. It is thus revealed that the growth in yield of selected crops and joint effect of yield and cropping pattern were mainly responsible for increasing agricultural production during overall period in Vidarbha.

The results of component analysis for different periods revealed that during first period (1970-71 to 1979-80) increased growth of crop output, in the Vidarbha was significantly attributed by increase in yield growth of the selected crops. The yield was the main factor accounting for 85.85 per cent in growth of output, followed by area i.e. 5.77 per cent and cropping pattern 2.67 per cent. The first and second order interaction also contributed positively. Thus the increase in aggregate output in the Vidarbha during first period was due to the increasing trend in yield of most of the crops.

Table 1 . Relative contribution of various components to aggregate growth of crop output in Vidarbha (per cent)

S.N.	Component elements	Period I (1970-71 to 1979-80)	Period II (1980-81 to 1989-90)	Period III (1990-91 to 2000-01)	Overall period (1970-71 to 2000-01)
1.	Area effect	5.77	16.48	11.72	6.76
2.	Yield effect	85.85	58.62	45.53	51.74
3.	Cropping pattern effect	2.67	12.86	13.41	7.57
4.	Interaction between Area and Yield	3.59	3.89	2.36	7.84
5.	Interaction between area and cropping pattern	0.12	0.85	0.69	1.15
6.	Interaction between yield and cropping pattern	1.91	6.85	24.98	21.66
7.	Interaction between area, yield and cropping pattern	0.08	0.45	1.29	3.28

The results of the decomposition analysis for second period revealed that most of the increase in output growth brought by the growth in yield of crop. The yield was the main factor accounting for 58.62 per cent in output growth, followed by area expansion 16.48 per cent and cropping pattern 12.86 per cent. The first and second order interaction also contributed positively.

It could further be seen from Table 1 that ha^{-1} yield has been largely responsible for the growth in total crop output in Vidarbha during third period too. The share of yield in the total growth was lowest to the extend of 45.53 per cent in the third period as compared to other periods. The area and cropping pattern contribution towards output growth were 11.72 per cent and 13.41 per cent, respectively. First order interaction between yield and cropping pattern contributed to the extent of 24.98 per cent which is highest among all the periods. This indicates that the yield rate of crops has been increased due to shift in cropping pattern. It is thus revealed that yield growth and joint effect of yield and cropping pattern were the major factors in increasing crop output in the Vidarbha during third period.

CONCLUSION

The decomposition of total agricultural out put growth in Vidarbha region showed that yield growth was the major factor accounting large share in the total output growth of Vidarbha. It is an indication of revolution in yield rate brought about by high yielding varieties. The introduction of high yielding varieties increased crop output many fold. The contribution of yield growth was highest during first period; subsequently it was decreased during second and third period. The contribution of area and cropping pattern was less during first period of the study i.e. (1970-71 to 1979-80), however it was increased during second and third period, respectively. In the recent years i.e. third period (1990-91 to 2000-01) of the study, contribution of joint effect between yield and cropping pattern increased towards the growth of output. This might be due to more diversification observed in the recent years which resulted in increased share of joint effect of yield and cropping pattern in growth of total crop output.

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Sourcewise Irrigation in Maharashtra

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ABSTRACT

In Maharashtra, temporal and spatial changes have been observed in area under different sources of irrigation. The result of study revealed that growth of surface irrigation was the highest in Marathwada and the lowest in Vidarbha. The share of well irrigation in their respective gross irrigated area was higher in Marathwada and Western Maharashtra regions during the period of forty years.

The development of irrigation in Maharashtra State during last forty years has contributed significantly in productivity improvement, diversification, risk reduction, rise in income, social upliftment, etc. There has been variation in irrigation growth among the regions of the state. The proportion of net irrigated area to net sown area has increased from 6.00 per cent in 1960–61 to 16.78 per cent in 2001-02 and the proportion of gross irrigated area to gross sown area has increased from 6.48 per cent in 1960-61 to 16.39 per cent in 2001-02 showing a significant growth in irrigated area in the state of Maharashtra. Since the historical period, irrigation got importance in the Maharashtra state. Water tanks in the reign of Yadav, Canal construction in the period of Tughlag, Phad System in Khandesh, Malgujari tanks in Vidarbha, Khajana well in Beed district are the main historical sources of irrigation development in Maharashtra. The average annual availability of water resources consists of 164 km3 of subsurface resources. (Anonymous, 1999) The four river basins Krishna, Godavari, Tapi and Narmada, comprise 92 per cent of the cultivable land and 75 per cent of the people living in rural settlements and fast growing towns and industrial area (Anonymous, 2003). The share of well irrigation in gross irrigated area is 65 per cent. Past studies have been evident of spatial variation in sourcewise irrigation. In the present study, attempt is made to identify sourcewise irrigation in the regions 1.Western Maharashtra, 2.Konkan, 3.Marathwada and 4.Vidarbha region of the state.

MATERIAL AND METHODS

In the present study, the state was divided into four major revenue divisions viz., Western Maharashtra, Konkan, Marathwada and Vidarbha for estimating soursewise irrigation. The soursewise irrigated area for different regions for the period of 40 years i.e. from 1960-61 to 2000 was obtained from various published sources. The two main sources of irrigation i.e. surface and well irrigation were considered for the study. Surface irrigation included canals, tanks, lift, ponds, etc., as sources of irrigation. The changes in sourcewise irrigated area were estimated on the basis of triennial averages for the periods 1960-63, 1970-73, 1980-83, 1990-93 and 1997-2000 (Dhawan, 1997).

Percentage share of area under each source of irrigation in gross irrigated area has been computed for all regions in the state. Percentage change over a period of time has been obtained by taking the 1960-63 (triennial average) as a base period; where figures were not available in base period, the next period figures have been considered as base period.

RESULTS AND DISCUSSION

Since the formation of Maharashtra state in 1960, area under surface and well irrigation is continuously rising. Construction of irrigation tanks, watershed, canals, project work, wells, etc., led to increase in area under irrigation. Regular efforts were made through various Irrigation Corporations and Directorate of Groundwater Development for development of irrigation potential, which resulted into an increase in irrigated area in Maharashtra state.

In the state as a whole, irrigated area under surface irrigation had increased by 95.20 per cent, while area under well irrigation had gone up by 162.50 per cent during the period under study. It indicated that exploitation of ground water was high as it is exploited at more places than surface water. In the case of surface irrigation, the highest change was observed in 1997-2000 over 1970-73 in Marathwada (358.33 %), followed by Konkan region (300 %). It was because of weak base period (1970-73) as compared to Vidarbha and Western Maharashtra regions. The well irrigation had shown an excellent growth in all the regions of the state except Konkan region during the past 30 years.

In Konkan region, though there is abundance of water, it is not possible to divert it to irrigation easily due

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to the geographical features of the region *viz.*, sloppy land, rocks and soil conditions. Further these features make difficult the exploitation of ground water and arrest of surface water. Special efforts and practices are required to increase irrigated area in Konkan region.

Percentage share of well irrigation in gross irrigated area (Table.2) was high during all the periods in Marathwada and Western Maharashtra regions, while reverse trend was found in Konkan and Vidarbha regions.

In Vidarbha region, there is a good potential for ground water exploitation and, therefore, a consistent good growth was observed in well irrigation but there is less scope to harvest surface water as compared to other regions of the state.

For the state as a whole, the share of well irrigation increased from 58.32 to 65.30 per cent, as against the share of surface irrigation which decreased from 41.68 to 34.70 per cent during the past three decades. This results similar with Anonymous, 1999.

CONCLUSION

In the state, growth of well irrigation was observed to be higher than surface irrigation. Among the regions, the growth of surface irrigation was the highest in Marathwada and the lowest in Vidarbha region as compared to other regions during the period from 1970-73 to 1997-2000. The proportion of well irrigation was higher (65.30 %) than surface irrigation in gross irrigated area of

Table 1: Growth in surface and well irrigation in Maharashtra State (lakh hectares)

Regions	Source	Periods				
		1960-63	1970-73	1980-83	1990-93	1997-2000
	Surface Irrigation	NA	0.11	0.22	0.38	0.44
			(100.00)	(100.00)	(245.45)	(300.00)
Konkan	**Well Irrigation**	NA	0.11	0.11	0.13	0.18
			(100.00)	(0.00)	(18.18)	(63.64)
	Gross Irrigated Area	0.19	0.22	0.33	0.51	0.62
		(100.00)	(15.78)	(73.68)	(168.42)	(226.32)
	Surface Irrigation	NA	2.66	3.31	3.68	4.38
			(100.00)	(24.43)	(38.35)	(64.66)
Vidarbha	**Well Irrigation**	NA	0.89	1.92	2.74	3.56
			(100.00)	(115.73)	(207.87)	(300.00)
	Gross Irrigated Area	2.72	3.55	5.23	6.42	7.94
		(100.00)	(30.51)	(92.28)	(136.03)	(191.91)
	Surface Irrigation	NA	0.48	1.64	2.44	2.20
			(100.00)	(241.66)	(408.33)	(358.33)
Marathwada	**Well Irrigation**	NA	1.95	3.79	5.95	6.76
			(100.00)	(94.35)	(205.12)	(246.66)
	Gross Irrigated Area	1.79	2.43	5.43	8.39	8.96
		(100.00)	(35.75)	(203.35)	(368.71)	(400.55)
	Surface Irrigation	NA	3.21	4.32	4.82	5.59
			(100.00)	(34.58)	(50.15)	(74.14)
Western Maharashtra	**Well Irrigation**	NA	6.09	9.02	12.61	13.23
			(100.00)	(48.11)	(106.90)	(117.24)
	Gross Irrigated Area	7.24	9.30	13.34	17.43	18.82
		(100.00)	(28.45)	(84.25)	(140.74)	(159.94)
	Surface Irrigation	NA	6.46	9.49	11.32	12.61
			(100.00)	(46.90)	(75.23)	(95.20)
Maharashtra State	**Well Irrigation**	NA	9.04	14.84	21.43	23.74
			(100.00)	(64.15)	(137.05)	(162.50)
	Gross Irrigated Area	11.94	15.50	24.33	32.75	36.34
		(100.00)	(29.98)	(103.76)	(174.28)	(204.35)

NA : Not available (Figure in parentheses are the percentage changes over the respective base year)

Table 2. Share of surface and well irrigation in gross irrigated area in Maharashtra state (Lakh hectares)

Region	Source	Period			
		1970-73	1980-83	1990-93	1997-2000
Konkan	**Surface Irrigation**	0.11	0.22	0.38	0.44
		(50.00)	(66.67)	(74.50)	(70.97)
	Well Irrigation	0.11	0.11	0.13	0.18
		(50.00)	(33.33)	(25.50)	(29.03)
	Gross Irrigated Area	0.22	0.33	0.51	0.62
		(100.00)	(100.00)	(100.00)	(100.00)
Vidarbha	**Surface Irrigation**	2.66	3.31	3.68	4.38
		(74.93)	(63.29)	(57.32)	(55.16)
	Well Irrigation	0.89	1.92	2.74	3.56
		(25.07)	(36.71)	(42.68)	(44.84)
	Gross Irrigated Area	3.55	5.23	6.42	7.94
		(100.00)	(100.00)	(100.00)	(100.00)
Marathwada	**Surface Irrigation**	0.48	1.64	2.44	2.20
		(19.75)	(30.26)	(29.08)	(24.55)
	Well Irrigation	1.95	3.79	5.95	6.76
		(80.25)	((69.74)	(70.92)	(75.45)
	Gross Irrigated Area	2.42	5.42	8.39	8.96
		(100.00)	(100.00)	(100.00)	(100.00)
Western Maharashtra	**Surface Irrigation**	3.21	4.32	4.82	5.59
		(34.52)	(32.38)	(27.65)	(29.70)
	Well Irrigation	6.09	9.02	12.61	13.23
		(65.48)	(67.62)	(72.35)	(70.30)
	Gross Irrigated Area	9.30	13.34	17.43	18.82
		(100.00)	(100.00)	(100.00)	(100.00)
Maharashtra State	**Surface Irrigation**	6.46	9.49	11.32	12.61
		(41.68)	(39.00)	(34.56)	(34.70)
	Well Irrigation	9.04	14.84	21.43	23.73
		(58.32)	(61.00)	(65.44)	(65.30)
	Gross Irrigated Area	15.50	24.33	32.75	36.34
		(100.00)	(100.00)	(100.00)	(100.00)

(Figure in parentheses are the percentage share of surface and well irrigation in the respective Gross Irrigated Area)

the state. The share of well irrigation in their respective gross irrigated area was higher in Marathwada and Western Maharashtra regions during the period from 1970-73 to 1997-2000. Construction of irrigation projects of various types, irrigation tanks, watersheds, canals etc. can be done only through public investments by the state government, which is a base for surface irrigation development. Expenditure of state government is lower on irrigation project as compared to the requirement. Therefore this has resulted in to a slow growth of surface irrigation in the state. Wells can be digged and constructed by farmers on their own which has helped to boost the area under well irrigation in the state.

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Cropping Pattern Changes and Crop Diversification in Vidarbha Region of Maharashtra

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ABSTRACT

In this study an attempt has been made to examine the changes in cropping pattern and the trend in crop diversification and cropping intensity of Vidarbha region of Maharashtra . The study was based on secondary data collected from various Government publications and pertains to a period of 31 years i.e. from 1970-71 to 2000-2001. The results showed that there existed wide temporal changes in the cropping pattern of Vidarbha. Over a period of study the proportions of area under *Kharif* Jowar and Cotton were reduced in Vidarbha, whereas it was increased in respect of Pulses . Soybean attained prestigious position in the cropping pattern of Vidarbha. The trends in crop diversification and cropping intensity of Vidarbha region were increased significantly over a period of study.

The study of cropping pattern assumes a great significance, as it is one of the important paths for balanced development of agriculture to meet the human requirement. The adoption of better cropping pattern optimally suited to the technological changes is an important one for augmenting agricultural growth (Hayami *et al.*, 1971). Cropping pattern of a particular area either state, region, districts etc., emerges and also changes through the interaction of physical, social, economical, technological and infrastructural factors. It is function of climatic elements, their periodicity expressed in terms of seasons, nature of soils, physiography and man introduced factors like irrigation, fertilizers, etc. Cropping pattern has been dynamic to cope up the changing scenario and to meet ever-changing demands of growing population. The decisions of a farmer regarding cropping pattern are based on monetary returns, availability of production technologies, accessibility of resources and many others. During last three decades, considerable changes have been occurred in the agricultural scenario. These changes have resulted into drastic changes in the cropping pattern of the region. Considering above facts it was proposed to investigate the cropping pattern changes and crop diversification in Vidarbha region of Maharashtra with the following objectives:

1) To examine the changes in cropping pattern of Vidarbha.
2) To examine the trend of crop diversification and cropping intensity in Vidarbha.

MATERIAL AND METHODS

The study has been confined to the Vidarbha region of Maharashtra state. The study was based on secondary data collected from various Government publications. The data pertains to a period of 31 years i.e. from 1970-71 to 2000-01. For the study all the major food grain and non food grain crops of Vidarbha region were selected. Selected crops occupied more than 85 per cent of the gross cropped area.

Analytical Tools:

Analysis of cropping pattern changes:

The cropping pattern changes have been studied by tabular analysis for all the major crops. Cropping pattern in terms of percentage share of individual crops in gross cropped area has been worked out at seven points of time. The time points at which analysis of cropping pattern has been done are 1970-71, 1975-76, 1980-81, 1985-86, 1990-91, 1995-96 and 2000-01 (Venkataramanan and Prahaladachar, 1980).

Quantification of trend in crop diversification:

The trend in crop diversification was examined using the crop diversification index (CDI) which was calculated by following equations.

Herfindahl Index:

The index was computed by taking the sum of squares of area proportion of each crop in the total

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Table 1 : Changes in cropping pattern in Vidarbha region during 1970-71 to 2001-2002 (Area in "00" hectares)

Crops	Years						
	1970-71	1975-76	1980-81	1985-86	1990-91	1995-96	2000-2001
Rice	5908.00	6260.00	6130.00	6688.00	7195.00	6825.00	6674.00
	(11.27)	(11.31)	(10.96)	(11.90)	(12.31)	(11.32)	(11.07)
Wheat	2881.00	3906.00	3252.00	2545.00	2329.00	2023.00	1648.00
	(5.50)	(7.06)	(5.81)	(4.53)	(3.98)	(3.36)	(2.73)
Kh.Jowar	12137.00	13080.00	12666.00	11902.00	11066.00	7582.00	6627.00
	(23.15)	(23.63)	(22.64)	(21.18)	(18.93)	(12.58)	(11.00)
Rabi Jowar	2704.00	2887.00	2399.00	2296.00	1786.00	1583.00	820.00
	(5.16)	(5.22)	(4.29)	(4.09)	(3.06)	(2.63)	(1.36)
Bajra	383.00	488.00	410.00	211.00	357.00	309.00	230.00
	(0.73)	(0.88)	(0.73)	(0.38)	(0.61)	(0.51)	(0.38)
Other Cereals	237.00	237.00	253.00	222.00	185.00	418.00	589.00
	(0.45)	(0.43)	(0.45)	(0.40)	(0.32)	(0.69)	(0.98)
Tur	2236.00	2367.00	2202.00	3538.00	4386.00	5088.00	5049.00
	(4.27)	(4.28)	(3.94)	(6.30)	(7.50)	(8.44)	(8.38)
Gram	662.00	894.00	800.00	939.00	1673.00	2284.00	1761.00
	(1.26)	(1.62)	(1.43)	(1.67)	(2.86)	(3.79)	(2.92)
Other Pulses	4057.00	4226.00	4213.00	4570.00	5673.00	6193.00	6467.00
	(7.74)	(7.64)	(7.53)	(8.13)	(9.71)	(10.27)	(10.73)
Kharif Groundnut	1510.00	1441.00	1192.00	885.00	935.00	563.00	265.00
	(2.88)	(2.60)	(2.13)	(1.57)	(1.60)	(0.93)	(0.44)
Soybean	-	-	-	-	1643.00	4951.00	9199.00
	(0.00)	(0.00)	(0.00)	(0.00)	(2.81)	(8.21)	(15.26)
Safflower	296.00	496.00	651.00	694.00	1010.00	1026.00	220.00
	(0.56)	(0.90)	(1.16)	(1.24)	(1.73)	(1.70)	(0.37)
Sunflower	- -	-	2.00	162.00	339.00	610.00	251.00
	(0.00)	(0.00)	(0.00)	(0.29)	(0.58)	(1.01)	(0.42)
Summer G.nut	- -	-	48.00	67.00	176.00	137.00	106.00
	(0.00)	(0.00)	(0.09)	(0.12)	(0.30)	(0.23)	(0.18)
Cotton	16281.00	15248.00	15765.00	17162.00	17169.00	17153.00	15770.00
	(31.06)	(27.55)	(28.18)	(30.54)	(29.37)	(28.46)	(26.17)
Sugarcane	32.00	47.00	42.00	86.00	169.00	178.00	221.00
	(0.06)	(0.08)	(0.08)	(0.15)	(0.29)	(0.30)	(0.37)
Other Crops	3098.00	3768.00	5928.00	4224.00	2360.00	3354.00	4369.00
	(5.91)	(6.81)	(10.59)	(7.52)	(4.04)	(5.56)	(7.25)
Gross cropped Area	52422.00	55345.00	55953.00	56191.00	58451.00	60277.00	60266.00
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Note : Figure in parentheses are percentages over gross cropped area in the respective period

cropped area (De, 2000). Mathematically the index was calculated as

$$\text{Herfindahl Index} = \sum_{i=1}^{N} P_i^2$$

Where

N = The total no. of crops.

P_i = proportion of area under i^{th} crop to total cropped area

Crop Diversification Index (CDI) = 1 - Herfindahl Index

CDI was calculated for every year i.e from 1970-71 to 2000-01, then simple linear trend equation was estimated in which (CDI) crop diversification index was used as a dependent variable (Pandey and Sharma, 1996). Similarly cropping intensity for each year i.e. from 1970-71 to 2000-01 was calculated and regressed with the time variable.

RESULTS AND DISCUSSION

Changes in cropping pattern of Vidarbha region:

The changes in cropping pattern of Vidarbha region during 1970-71 to 2000-01 are presented in the Table 1. Figures shown in the first period i.e. 1970-71 revealed that out of the gross cropped area of 52.42 lakh hectares, 16.28 lakh hectares were occupied by Cotton and 12.13 lakh hectares under *Kharif* Jowar altogether contributed 54.21 per cent of the gross cropped area. In the span of thirty years, cropping pattern of Vidarbha has changed substantially. In case of Kharif Jowar, its share in gross cropped area has fallen to the level of 11 per cent in 2000-01 from 23.15 per cent in 1970-71. Over a period of time the proportion of area under Cotton has reduced by 5 per cent. The proportion of area under Rice in gross cropped area observed to be stationary during the entire period of study i.e. 11 per cent. The proportion of area under Tur crop was 4.27 per cent in 1970-71 and it has increased to double i.e. 8.38 per cent in the year 2000-01. Decreasing proportions of area were observed in respect of Wheat, *Rabi* Jowar, *Kharif* Groundnut. The share of Other Pulses showed slightly increasing trend, it was 7.74 per cent in the year 1970-71 which increased to 10.73 per cent in the year 2000-01. Soybean crop is emerged as one of the major crops of region occupying 15.26 per cent of gross cropped area of the region. The proportions of area under Gram, Sunflower and Sugarcane are less but these crops showed increasing trend in their area proportions over entire period of the study. No desirable trend was observed in case of Bajra and Safflower. The gross cropped area was 52.42 lakh hectares which showed continuous increasing trend during the entire period of the study and it was 60.26 lakh hectares in the year 2000-01 i.e. 13 per cent increase over the base year. This increase in area might be attributed to the intensity of cropping.

High association between area and price of the crop resulted in the growth of oilseeds especially summer groundnut and soybean. Oil commission established by Government of India, announced incentives to boost growth of oil seeds to mitigate oil shortages in the country. In this context the farmers appeared to have given thought to increase the area under summer groundnut. Decrease in area of cotton might be due to unsettled market of cotton in the state. Areas under cereal crops mainly jowar, bajra and wheat were decreased, might be due to response of the farmers to go for higher value of crops to reap economic benefits. Areas under cereal and cotton were decreased and these were diverted to soybean and pulses.

Trend in Crop diversification indices and cropping intensity

Table 2: Trend in Crop Diversification Indices and Cropping Intensity from 1970-71 to 2000-01 in Vidarbha

	Crop Diversification	Cropping intensity
a	0.815591	103.0201
b	0.001539**	0.658058**
(SE)	(0.007062)	(1.783399)
R^2	0.80	0.92

(**Note :** ** indicates statistical significance at 1 per cent level of significance)

Table 2 presents the trend in crop diversification indices and cropping intensity of Vidarbha. It is observed from the Table 2 that the regression coefficient value for crop diversification indices were positive and highly significant at 1 per cent level. This indicates that the

diversification was increased over a period of study in Vidarbha. The regression coefficient of cropping intensity for Vidarbha also showed positive and significant value. Hence it indicates that the cropping intensity showed increasing trend during study period.

Diversification is an integral part of the process of structural transformation of an economy. Results shown in the foregoing paragraph indicated that diversification within agriculture of Vidarbha took place over the period of last three decades i.e. 1970-71 to 2000-01. The inherent features underlined in diversification is crop movements towards viable commercial crops so as to have higher income from the farm and therefore the crops shift toward value added crops found discernible over the study period. Profitability might be considered as one of the important reasons for crop diversity.

CONCLUSION

1) There exists wide temporal changes in the cropping pattern of Vidarbha.
2) The proportion of area under *Kharif* jowar and *Kharif* groundnut has reduced in Vidarbha.
3) Area under pulses increased in Vidarbha.
4) Soybean attained prestigious position in cropping pattern of Vidarbha
5) Over a period of study, crop diversification and cropping intensity were significantly increased in Vidarbha.

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Temporal Growth of Cropped and Irrigated Area in Maharashtra

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ABSTRACT

The expansion of cropped area and the irrigated area in the Maharashtra state has contributed in growth of production, productivity and modernization of agriculture in last forty years. In the present study growth in cropped area and the irrigated area revealed that Gross cropped area has increased because of increase in irrigated area. The percentage share of gross irrigated area in gross cropped area had increased from 6.38 to 16.46 per cent in forty years , mainly due to efforts of government in construction of irrigation projects. The decline in net area is due to construction in the area.

In underdeveloped economy, where large percentage of population derive their livelihood from agriculture, the development of agriculture plays an important role in initiating and stabilizing the overall process of growth in economy. Development of agriculture could be possible because of research, extension and area expansion. Growth in cropped area and irrigated area has contributed in increase in production, input use, improvement in productivity. Utilization of modern inputs has been possible and production has increased due to irrigation and area expansion under cultivation. The important input 'irrigation' provides stability to some extent for the agriculture productivity. Irrigation ensures a secure harvest, acts as insurance against inadequate and inconsistent monsoon. It increases the net area cultivated and more importantly, the "gross cropped area" by enhancing the crop intensity through double or multiple cropping. It diversifies and transforms the cropping pattern.

Since the marginal productivity of irrigated land is higher than that of un-irrigated land, it is economically more profitable to cultivate an irrigated hectare of land rather than un-irrigated hectares of land. The growth in area has not been smooth over entire state and there exists disparities in growth of cropped and irrigated area in different regions of Maharashtra (Mitra, 1990).

Looking to the importance and nature of the regionwise disparities in area expansion from past evidences, it is essential to study the regionwise growth in cropped area and irrigated area. The attempt is made to estimate temporal and spatial growth in cropped area and irrigated area in Maharashtra

MATERIAL AND METHODS

In the present study, the state has been divided into four major revenue divisions as Western Maharashtra, Konkan, Marathwada and Vidarbha region for estimating changes and trends in cropped and irrigated area. The changes in cropped and irrigated area were estimated on the basis of triennial averages for the periods 1960-63, 1970-73, 1980-83, 1990-93 and 1997-2000. The entire period of 40 years from 1960-61 to 1999-2000 is divided into four decadal sub-periods for the trend analysis(Anonymous, 2003). The cropped and irrigated area in different regions was obtained from various published sources. The trends in cropped area and irrigated area were estimated by the following exponential function.

$Y=ab^t$

Where

Y = Cropped/Irrigated area in hectares

t = time trend

b = trend value (coefficient)

a = intercept

Compound growth rate= (Antilog b-1) x 100.

The significance of the estimated compound growth rates was tested with the 't' test.

T Test = b / Standard error of b.

RESULTS AND DISCUSSION

1. Changes in cropped and irrigated area

Gross irrigated area under different crops had been increased; it led to diversification in the cropping pattern of the state. Major reason for these changes was an increase in irrigated area over a period of time. The contribution of net and gross irrigated area in net and

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Table1. Coverage of irrigation in Maharashtra state (Lakh hectares)

Regions		Period				
	Particulars	1960-63	1970-73	1980-83	1990-93	1997-2000
Konkan	Net cropped area	8.71	7.63	7.98	9.23	8.18
	Net irrigated area	0.18	0.21	0.27	0.44	0.54
	Percent of NIA to NCA	2.07	2.75	3.38	4.77	6.60
	Gross cropped area	9.03	7.88	8.57	9.65	8.91
	Gross irrigated area	0.19	0.22	0.33	0.51	0.62
	Percent of GIA to GCA	2.10	2.79	3.85	5.28	6.96
Vidarbha	Net cropped area	47.29	50.17	49.98	50.92	50.23
	Net irrigated area	2.70	3.46	4.30	5.19	6.35
	Percent of NIA to NCA	5.71	6.90	8.60	10.19	12.64
	Gross cropped area	49.70	52.87	54.35	58.62	60.62
	Gross irrigated area	2.72	3.55	5.23	6.42	7.94
	Percent of GIA to GCA	5.47	6.71	9.62	10.95	13.10
Marathwada	Net cropped area	44.58	44.45	48.18	48.83	46.55
	Net irrigated area	1.57	2.18	4.10	6.64	7.02
	Percent of NIA to NCA	3.52	4.90	8.51	13.60	15.08
	Gross cropped area	48.22	47.29	53.01	58.70	62.16
	Gross irrigated area	1.79	2.43	5.43	8.39	8.96
	Percent of GIA to GCA	3.71	5.14	10.24	14.29	14.41
Western Maharashtra	Net cropped area	75.30	66.95	73.34	72.60	72.30
	Net irrigated area	6.23	7.56	10.46	14.58	15.52
	Percent of NIA to NCA	8.27	11.29	14.26	20.08	21.47
	Gross cropped area	80.24	71.51	80.31	83.66	89.11
	Gross irrigated area	7.24	9.30	13.34	17.43	18.82
	Percent of GIA to GCA	9.02	13.01	16.61	20.83	21.12
Maharashtra State	Net cropped area	175.89	169.21	179.49	181.59	177.27
	Net irrigated area	10.69	13.42	19.14	26.87	29.45
	Percent of NIA to NCA	6.08	7.93	10.66	14.80	16.61
	Gross cropped area	187.21	179.56	196.26	210.64	220.81
	Gross irrigated area	11.94	15.50	24.33	32.75	36.34
	Percent of GIA to GCA	6.38	8.63	12.40	15.55	16.46

gross cropped area was determined on triennial averages of net and gross cropped area as well as irrigated area and results are presented in Table.1. At the state level as a whole, the share of gross irrigated area in gross cropped area had increased from 6.38 per cent during 1960-63 to 16.46 per cent in 1997-2000. Increase in share of net irrigated area in the net cropped area was similar to that of gross irrigated area. An increase in the share of gross irrigated area in gross cropped area for the period from 1980-83 to 1990-93, was conspicuous in the state. However, in the case of share of net irrigated area in net cropped area, quite a good increase was seen during 1990-93 and 1997-2000 in the state. It was because of completion of some major projects like Jayakwadi Irrigation Project as well as due to exploitation of ground water through dugout wells, tubewells, etc.

Among the regions, Western Maharashtra shared major chunk of irrigated area (21.12 %) in cropped area, followed by Marathwada (14.41 %) region during the period 1997-2000. The Marathwada region was third in 1960-63 and 1970-73 but came to second rank during 1997-2000, owing to completion of Jayakwadi and Painganga Irrigation Projects. The extent of irrigated area in Konkan region remained on lower side as compared to other regions of the State because of undulating terrain, high land slopes, etc. To make more specific, proportion

of net irrigated area in the net cropped area was 21.47, 15.08, 12.64 and 6.60 per cent in the Western Maharashtra, Marathwada, Vidarbha and Konkan region, respectively during the period 1997-2000.

2. Growth rates of irrigated and cropped area in different regions of Maharashtra state

The annual rates of compound growth in net cropped area, gross cropped area, net irrigated area and gross irrigated area for the four regions as well as the state of Maharashtra as a whole for different time periods are presented in Table2. For the state as a whole, the net cropped area has mostly remained more or less the same during the period of last forty years since the growth rate was only 0.039 per cent which turned out to be non-significant. However, the net cropped area in the state showed a significant increase during the decade 1960-70 to 1980-90 but subsequently declined significantly by 0.38 per cent per annum. This was mostly because of diversion of cultivated land towards different developmental activities such as roads, irrigation works, industrial establishments and house constructions. The gross cropped area in the state has increased at an annual growth rate of 0.46 per cent all throughout the periods under consideration showing continuous efforts of the farmers to increase cropping intensity in the irrigated as well as rainfed areas with assured rainfall. These findings conformed the results reported by Shete (1995). The critical examination of the growth rates of net cropped area and gross cropped area revealed that Western Maharashtra region experienced a marginal decrease in the net cropped area during the last forty years. In Konkan, Vidarbha and Marathwada regions, however, both net and gross

Table2.Compound growth rates of irrigated and cropped acreage in Maharashtra State

Region		Period				
	Particulars	1960-70	1970-80	1980-90	1990-2000	1960-2000
Konkan	**NCA**	0.0739	0.8810**	1.7050**	-1.4375**	0.1410*
	GCA	0.0386	1.1444***	1.2861***	-0.8990	0.2244***
	NIA	3.6250**	6.1210***	5.3660***	3.4880**	3.1210***
	GIA	4.4720*	6.1070***	4.5810	3.7630***	3.3140***
Vidarbha	**NCA**	0.7810***	0.3090**	0.3113**	-0.3127	0.1070***
	GCA	0.7644**	0.6930***	1.0808***	0.4134	0.5080***
	NIA	2.7360***	3.2870***	0.7290	3.2380***	2.2040***
	GIA	3.0130***	5.6010***	1.1570	3.2540***	2.8875***
Marathwada	**NCA**	1.1326***	1.0480	0.4028	-0.0693**	0.1480**
	GCA	1.0134**	1.5201**	2.1450***	0.7580	0.7133***
	NIA	7.4890***	11.8910***	6.2370***	0.8372	4.291***
	GIA	7.0220***	12.6280***	6.0530***	0.9806	4.7661***
WesternMaharashtra	**NCA**	0.0668	1.0464*	-0.0400	-0.1107	-0.0875*
	GCA	-0.1972	1.5390**	0.6570**	0.8370***	0.3020***
	NIA	2.4280***	3.7780***	2.1080**	1.2220**	2.6550***
	GIA	3.0730***	4.4477***	1.4330***	1.4110***	2.6710***
Maharashtra State						
	NCA	0.5480***	0.8198*	0.2593**	-0.3861***	0.0394
	GCA	0.3929**	1.2670**	1.2124***	0.6330**	0.4659***
	NIA	3.3660***	5.2720***	2.8760***	1.5580***	2.8890***
	GIA	3.7340***	6.2630***	2.5920**	1.6980***	3.1550***

(*, ** and *** are the levels of significance at 10, 5 and 1per cent, respectively)
(NCA=Net Cropped Area, GCA=Gross Cropped Area, NIA=Net Irrigated Area and GIA=Gross Irrigated Area)

cropped areas had increased respectively, at the rate of 0.14, 0.10 and 0.14 per cent and 0.22, 0.50 and 0.71 per cent, annually during the period under consideration.

Looking to conditions of scanty rainfall in some parts and seasonality of rainfall in other parts, Maharashtra could be considered as one of the water resource scare states in India (Anonymous, 1999).

The growth rates of net irrigated area and gross irrigated area, spell out the efforts of the state government and of the farmers as well in exploiting surface and ground water resources for irrigation purpose with the massive investment in minor, medium and major irrigation works under public and private sectors. For Maharashtra as a whole, net irrigated area and gross irrigated area have increased significantly at the rate of 2.88 and 3.15 per cent annum^{-1}, respectively, during the period of last forty years. The rate of increase in irrigation was comparatively higher during the earlier decades *viz*., 1960-70 and 1970-80 as compared to the decades later. Among the four regions in Maharashtra State, the growth in net irrigated area as well as gross irrigated area was most conspicuous during the earlier decades viz., 1960-70, 1970-80 and 1980-90 in Marathwada as compared to other regions. The rate of compound growth during the period under study was 4.29 and 4.76 annum^{-1} in Marathwada region, which was highly significant. The significant growth in the irrigated area was also observed in other regions *viz*., Western Maharashtra, Vidarbha and Konkan region during the period under study. This happens because of persistent efforts made by the state government to increase area under irrigation by completion of irrigation projects with massive investment.

CONCLUSION

The less growth and decline in net cropped area in some periods indicate diversion of cultivated land towards different developmental activities such as roads, irrigation works, industrial establishments and house constructions. In Maharashtra, percentage share of gross irrigated area in gross cropped area had increased from 6.38 in 1960-63 to 16.46 in 1997-2000. The annual rate of compound growth in gross irrigated area was 3.15 per cent during the period from 1960-61 to 1999-2000 in the State. Among regions, annual rate of compound growth in gross irrigated area of Marathwada was the highest (4.76 per cent), followed by Konkan (3.31 %) and was the lowest (2.67 %) in Western Maharashtra region. Gross cropped area has increased because of increase in irrigated area. Growth in irrigated area is due to efforts of government in construction of irrigation projects.

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PKV Res. J. Vol. 30 (2), 2006

Profitability of Safed Musli as Perceived by Farmers

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ABSTRACT

The present price, which is received by the farmers of Jhadol (Udaipur) and other parts is around Rs.800 to 1400 kg^{-1}. The investigation was carried out to find out the farmers' perception of the profitability of safed musli. It is recorded that among tribal and non-tribal farmers, safed musli has come to be proved as most profitable crop in the study area as compared to cereal and cash crops based on matrix ranking.

Safed musli (*Chlorophytum borivilianum*) is one of the most important medicinal plants. Roots are the economic parts of this medicinal herb. It's roots are generally used in powdered form. In recent years, many farmers are getting attracted and showing interest in its cultivation on a large scale due to very high profitability.

MATERIAL AND METHODS

The present study, in the year 2003, was undertaken in Jhadol panchayat samiti of Udaipur district the criterion being that it had maximum number of farmers cultivating this profitable medicinal crop. All the villages of the panchayat samiti where safed musli was grown by the farmers were selected for the purpose. From the villages so selected, a comprehensive list of all the farmers growing safed musli was prepared. There were 80 tribal and 40 non-tribal farmers who were undertaking the cultivation of this wonder crop. The study sample consisted of 120 farmers i.e. 80 tribal and 40 non-tribal farmers. These two groups were considered so as to have comparative picture. Experimental design could not be used due to paucity of time. Data were collected by the investigator with the help of a well-prepared and structured schedule employing personal interview technique as well as matrix ranking technique of PRA. Thereafter, data were analysed, tabulated and interpreted in the light of objective of the study. The comparative analysis was made to find out the difference in both the categories of the farmers regarding the parameters under study.

RESULTS AND DISCUSSION

Table-1 shows that the medicinal plant (safed musli) was perceived to be most profitable in comparison with cereal crops viz., wheat, barley, maize and rice. This is because of the reason that, as per the matrix ranking, farmers expressed highest weightage to the characteristics of safed musli viz., income ha^{-1}, fertilizer requirement, trialability, observability, market value and compatibility to the tune of 100, 100, 100, 100, 90 and 80, respectively. These weightages were higher as compared to other cereal crops. According to these weightages safed musli was ranked as first, followed by maize and barley possessing a score value of 896, 859 and 844, respectively.

It meant that, as per the matrix ranking, safed musli was proved to be most profitable crop among non-tribals, followed by maize and barley. Rice crop was least profitable to them. It might be due to many reasons, for example, low income ha^{-1}, low market value, unavailability of irrigation water, cost of cultivation, fodder availability, complexity and trialability.

Irrespective of matrix ranking procedure, non-tribals were also requested to express their preferences or choices towards the cultivation of cereal crop along with safed musli. While knowing the preference of farmers regarding crops, matrix ranking's rank was not taken into account. This was his own biased preference, due to many reasons. Interestingly, it was found that the maize crop, followed by wheat and safed musli, was perceived to be most profitable crop in Jhadol area of Udaipur district. This might be on account of the fact that maize and wheat are the two important crops, which fulfil the foodgrain requirement of the non-tribals, here the safed musli had been placed at 3rd position as per their choice. Further, it may be due to the fact that, of course, scientifically safed musli proved to be advantageous, but due to foodgrain shortage for last four years, non-tribals might be thinking

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Table 1 : Determination of profitability of safed musli as compared to other cereal crops and cash crops among non-tribal farmers in the study area (Matrix ranking-PRA technique)

	Attributes of crops	Cereal crops (weightage)				Safed	Other cash crops							Safed
		Wheat	Barley	Maize	Rice	musli	Turmeric	Ginger	Arbi	Yam	Brinjal	Garlic	Onion	musli
1.	Income ha^{-1}	45	40	35	30	100	45	75	40	65	35	75	30	95
2.	Market value	50	40	35	30	90	60	75	40	65	40	65	40	95
3.	P.P. Measures	73	73	78	68	55	70	30	50	45	50	60	75	80
4.	Irrigation	40	50	70	30	65	45	35	50	50	60	65	65	95
5.	Cost of cultivation	48	48	63	43	28	70	40	70	50	60	55	65	30
6.	Labour	60	80	70	50	40	63	43	58	63	55	45	53	33
7.	Fertilizer	45	55	55	65	100	60	20	30	65	45	40	40	0
8.	Inter culture operations	50	60	30	70	60	53	28	43	68	53	48	48	38
9.	Use of FYM	50	60	50	65	40	60	50	50	50	60	55	55	40
10.	Fodder availability	60	55	70	20	0	0	0	0	49	0	0	2	0
11.	Compatibility	80	80	80	80	80	55	85	70	75	65	75	65	95
12.	Complexity	58	73	78	48	38	70	40	65	50	70	60	65	40
13.	Trialability	20	20	20	20	100	20	83	43	23	50	13	0	100
14.	Relative advantage	50	40	45	15	0	0	0	0	0	0	0	0	0
15.	Observability	80	70	80	80	100	15	20	20	15	40	15	20	85
	Total	809	844	859	714	896	686	624	629	724	683	671	623	793
	Rank	IV	III	II	V	I	III	VII	VI	II	IV	V	VIII	I
	Farmer's own choice irrespective of attributes	II	IV	I	V	III	III	V	IV	II	VII	VIII	VI	I

Table 2 : Determination of profitability of safed musli as compared to other cereal crops and cash crops among tribal farmers in the study area (Matrix ranking-PRA technique)

Attributes of crops	Cereal crops (weightage)				Safed musli	Other cash crops							Safed musli
	Wheat	Barley	Maize	Rice		Turmeric	Yam	Arbi	Ginger	Brinjal	Garlic	Onion	
1. Income ha^{-1}	50	45	40	35	100	50	70	40	65	35	75	30	95
2. Market value	55	45	40	35	95	60	65	55	75	40	65	40	95
3. P.P. Measures	70	70	75	70	55	60	25	45	50	50	60	75	80
4. Irrigation	40	50	70	30	65	50	55	55	40	65	70	70	100
5. Cost of cultivation	45	45	80	40	30	70	50	70	40	60	55	65	30
6. Labour	60	65	75	50	40	60	60	55	40	65	45	45	35
7. Fertilizer	45	50	60	65	100	50	65	30	25	45	40	40	0
8. Inter culture operations	50	60	70	70	60	50	65	40	25	50	45	45	35
9. Use of FYM	50	60	50	65	40	40	40	40	40	70	55	50	40
10. Fodder availability	60	55	70	20	0	0	40	0	0	0	0	2	0
11. Compatibility	70	70	70	70	70	70	80	75	80	70	80	70	100
12. Complexity	55	75	80	50	40	60	40	55	35	60	50	55	30
13. Trialability	20	20	20	20	100	20	25	45	80	40	15	0	100
14. Relative advantage	40	35	60	15	0	0	0	0	0	0	0	0	0
15. Observability	80	70	80	80	100	15	20	20	15	40	15	20	95
Total	830	815	840	715	895	655	700	625	610	610	670	607	835
Rank	III	IV	I	V	II	V	II	VI	VII	III	IV	VIII	I
Farmer's own choice irrespective of attributes	II	IV	I	V	III	III	I	IV	VIII	V	VII	VI	II

for cultivation of cereals as against safed musli. This finding is similar to the finding of Madalia (1979).

Similarly, safed musli was compared with other cash crops for scientific judgement of its profitability. Non-tribals accorded top priority to safed musli as far as its profitability. The highest score, 793 clearly depicts the results in Table-1. Second profitable crop expressed by the non-tribals, that is yam, followed by turmeric. On the other hand, farmer's own choice in case of non-tribals corresponds with the matrix ranking results.

Table-2 reveals results in connection with tribals, safed musli's profitability was measured with help of matrix ranking – PRA technique. Tribals prioritised maize at the top being as profitable in the area giving second rank to safed musli. This is because tribals give importance to maize being the staple crop. Safed musli may be more advantageous, but it is their perception. Perception is individualised, it can not be termed as wrong or right. This is the case when they were asked to compare safed musli with cereals. Farmers own choice reflects that maize was most advantageous to them followed, by wheat.

Further, Table-2 also provides evidences that medicinal plant safed musli has been proved to be most profitable among tribals when compared with seven cash crops. Among cash crop yam appeared to be the next profitable crop to the safed musli. But it is striking that tribals opined yam to be the first and foremost crop as regard its profitability. This is based on their face value irrespective of matrix ranking characteristics. Similar findings were reported by Khemnar (1994), and Koshta and Chandrakar (1997).

The overall conclusion regarding the profitability of safed musli is that the cultivation of this medicinal plant has been proved to be very profitable as compared to cereal crops and cash crops among both the categories of respondents of the study area. Second important crop being realized by the farmers as profitable was yam.

Therefore, it is recommended that cultivation of this cash crop should be encouraged in the study area and elsewhere similar to this geographical and climatic conditions.

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PKV Res. J. Vol. 30 (2) 2006

Role Performance of Women Member of Grampanchayat

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ABSTRACT

The study was conducted in Parbhani district of Marathawada region of Maharastra state with a view to know the role performance of Grampanchayat women member and its relation with their profile. Twenty Grampanchayat from Parbhani taluka and sixty Grampanchayat women member from the selected Grampanchayat were selected randomly. It was found that majority of women member had low overall role performance and in that half of them had high role performance in agriculture while education, social participation, leadership experience and value orientation were the crucial variables which influenced the role performance of elected women members of Grampanchayat.

Grampanchayat is the basic unit of Panchayat Raj System. Seventy third amendment has strengthened the Democratic Decentralization. This amendment has given special reservation to women. Onethird of the seats of Grampanchayat members are reserved for women. Even the seats of Sarpanch are also reserved in rotation for them. In this context, there are some issues like whether women have really got their share in it; whether they are aware about their role as a member of Grampanchayat ? Hence the present study entitled Role performance of woman members of Grampanchayat was undertaken with following objectives :

1 To know the role performance of women member of Grampanchayat.
2 To assess the relationship of profile of women member with role performance.

MATERIAL AND METHODS

The study was conducted in Parbhani district of Marathwada region of Maharastra state. For the study Parbhani Taluka and 20 Grampanchayat from the Taluka were selected randomly. Sixty women members of Grampanchayat were selected as respondents for the study. The respondents were personally interviewed with the help of constructed and pre- tested interview schedule. Statistical tools like frequency, percentage and pearson's co-rrelation co-efficient were used for the analysis of the data.

RESULTS AND DISCUSSION

I) Overall role performance of women members of Grampanchayat

Table 1: Distribution of the respondents according to their overall role performance

S.N.	Category	Frequency	Percentage
1	Low	34	56.66
2	Medium	11	18.34
3	High	15	25.00
	Total	60	100

The data from Table 1 show that majority (56.66 %) of the women member of Grampanchayat had low overall role performance, followed by 25.00 per cent having high overall role performance. While 18.34 per cent of the women members had medium overall role performance. Similar findings werer reported by Lohia (2000).

Table 2 showed that half of woman members of Grampanchayat had high role performance in agriculture, followed by 40.00 per cent performing high role in social welfare activities. It was further observed that three fourth (75.00 %) of women member had low role performance in developmental scheme to be implemented by Grampanchayat, while 71.66 per cent and 83.34 per cent had low role performance in the administration of Grampanchayat and in social forestry, respectively.

II] Relationship between profile of women members of Grampanchayat with their role performance

Table 3 indicates that the personal and socio-economic characteristics of the women member of Grampanchayat namely education, annual income, land holding, occupation, socio-economic status, leadership

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Table 2. Distribution of the respondents according to their item wise role performance.

S.N.	Role performance	Low	Medium	High	Total
1	Developmental scheme	45 (75.00%)	5 (8.34%)	10 (16.66%)	60 (100%)
2	Administration	43 (71.66%)	6 (10.00%)	11 (18.34%)	60 (100%)
3	Agriculture	0.0 (0.0%)	30 (50.00%)	30 (50.00%)	60 (100%)
4	Education	35 (58.33%)	7 (11.67%)	18 (30.00%)	60 (100%)
5	Social welfare	27 (45.00%)	9 (15.00%)	24 (40.00%)	60 (100%)
6	Health and sanitation	23 (38.00%)	15 (25.00%)	22 (36.37%)	60 (100%)
7	Social forestry	50 (83.34%)	6 (10.00%)	4 (6.66%)	60 (100%)
8	Other	45 (75.00%)	10 (16.66%)	5 (8.34%)	60 (100%)

Table 3. Cor-relation and multiple regression analysis

S. N.	Characteristics	'r' value	Regression co-efficient	't' value
1	Age	0.016	0.116	0.523
2	Education	0.143**	0.267	3.187**
3	Caste	0.007	0.373	0.358
4	Annual income	0.404**	0.0002	0.167
5	Land holding	0.385**	1.445	0.590
6	Occupation	0.409**	0.470	0.268
7	Socio-economic status	0.354**	0.187	0.618
8	Social participation	0.205	4.041	3.032**
9	Leadership experience	0.936**	12.11	11.27**
10	Knowledge	0.742**	1.059	0.785
11	Cosmopoliteness	0.506**	0.653	0.710
12	Value orientation	0.695**	1.103	2.002**

* Significant at 0.05 level of probability ** Significant at 0.01 level of probability

$b_0 = 38.17$, $R^2 = 0.909$ ** 'F' value = 39.007

experience, knowledge, cosmopoliteness and value orientation were positively and significantly related with the role performance of women members in Grampanchayat. These findings are in agreement with Pimprikar (1979), Kadam and Valunj (1982), Patil (1984) and Wankhede (1994).

Further it was found that (Table 3) 90.90 per cent role performance of women member was explained by set of 12 independent variable selected for the study. Co-efficient of multiple determination (R^2) was significant at 0.01 level of probability. Data furthr revealed that education, social participation, leadership experience, value orientation had contributed significantly to role performance of elected women members in Grampanchayat. It can be concluded that role performance of women member of Grampanchayat was very low. Low role performance was observed particularly in developmental scheme, administration and education. The relational analysis indicated that education, social participation, leadership experience and value orientation were significant contributors to role performance.

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Influence of Water Flow Rate on the Absorption of Carbon Dioxide

S. H. Thakare[1] and T.K. Bhattacharya[2]

ABSTRACT

Continuous removal of carbon dioxide from biogas using water as an absorption medium was evaluated using scrubbing system. The experiment was performed on absorption of carbon dioxide by passing raw biogas at 2, 3, 4 and 5 m^3h^{-1} gas flow rate through 150, 200 and 250 mm diameter towers. The raw biogas containing 41.6 per cent carbon dioxide was passed at 588 kPa pressure counter currently through the falling wash water having 1, 1.5, 2.0 and 2.5 m^3h^{-1} flow rate. A 5 m high wash water column was maintained and tests were performed with and without spherical balls packing in scrubbing towers. The maximum absorption of 68.11 per cent carbon dioxide was achieved at 2.5 m^3h^{-1} wash water flow rate and 2 m^3h^{-1} gas flow rate in 250 mm diameter of scrubbing tower with 1 m height of packing.

During the last two decades, the world has witnessed dramatic changes in the energy scene. As per the estimated figures, the energy demand of developed countries in 2020 A.D. would be around 9.7 and 10.4 gega tonnes of oil equivalent $year^{-1}$ (Bhandari, 1983). In India, commercial energy sources like coal, oil, gas and nuclear contributes to about 60 per cent of our primary energy demand and balance 40 per cent is met from non-commercial sources mainly fire wood, agricultural and animal waste. The recycling of animal and agricultural waste for production of biogas has received more attention as it is an excellent fuel for cooking, lighting and internal combustion engines. A study revealed that 18 per cent of carbon dioxide may be required in a biogas to run a compression ignition engine on dual fuel (Mishra et al, 1990). Since, biogas contains along with methane (55-70%), a large proportion of carbon dioxide (30-40%), it is necessary to remove carbon dioxide from biogas for better engine performance.

MATERIAL AND METHODS

A scrubbing process design for carbon dioxide was developed using three HDPE pipes each of 6 m height, having 150, 200 and 250 mm diameter, respectively. The pipes were made air tight with the help of top ends and bottom ends. The top ends had an inlet for wash water and an outlet for scrubbed biogas. The bottom end had an inlet for raw biogas and an outlet for discharge of carbonated water. The water pump coupled with 1.5 kW single phase electric motor was used to supply wash water to the towers and water level indicators were provided to maintain a constant height of water in the towers. The carbonated water from outlet was not circulated due to less absorption of carbon dioxide. The measuring equipment such as energy meter, gas flow meter, Nucon 5700 gas chromatograph, Junkers type gas calorimeter and Philips digital pH meter were used to measure energy invested in scrubbing, per cent carbon dioxide present in the gas, calorific value and pH of water, respectively. The raw biogas derived from biogas plants was compressed at 588 kPa.

RESULTS AND DISCUSSION

The effect of wash water flow rate on the absorption of carbon dioxide at the inlet gas pressure of 588 kPa, inlet gas flow of 2, 3, 4 and 5 m^3h^{-1} for 150, 200, and 250 mm diameter scrubbing towers without any packing and with 1 m high packing is shown in Fig. 1 and 2. The figure indicates that the absorption of carbon dioxide increased with the increase in wash water flow rate. It was observed that the absorption of carbon dioxide was lowest at 1 m^3h^{-1} of wash water flow rate and increased with the increase in wash water flow rate. The highest absorption was observed when wash water flow rate was 2.5 m^3h^{-1}. The above trend was noticed at all inlet gas flow rates. It is also evident from the figures that for all the selected levels of wash water flow rates, there was decrease in absorption of carbon dioxide with the increase in gas flow rate for every diameter of the scrubbing tower.

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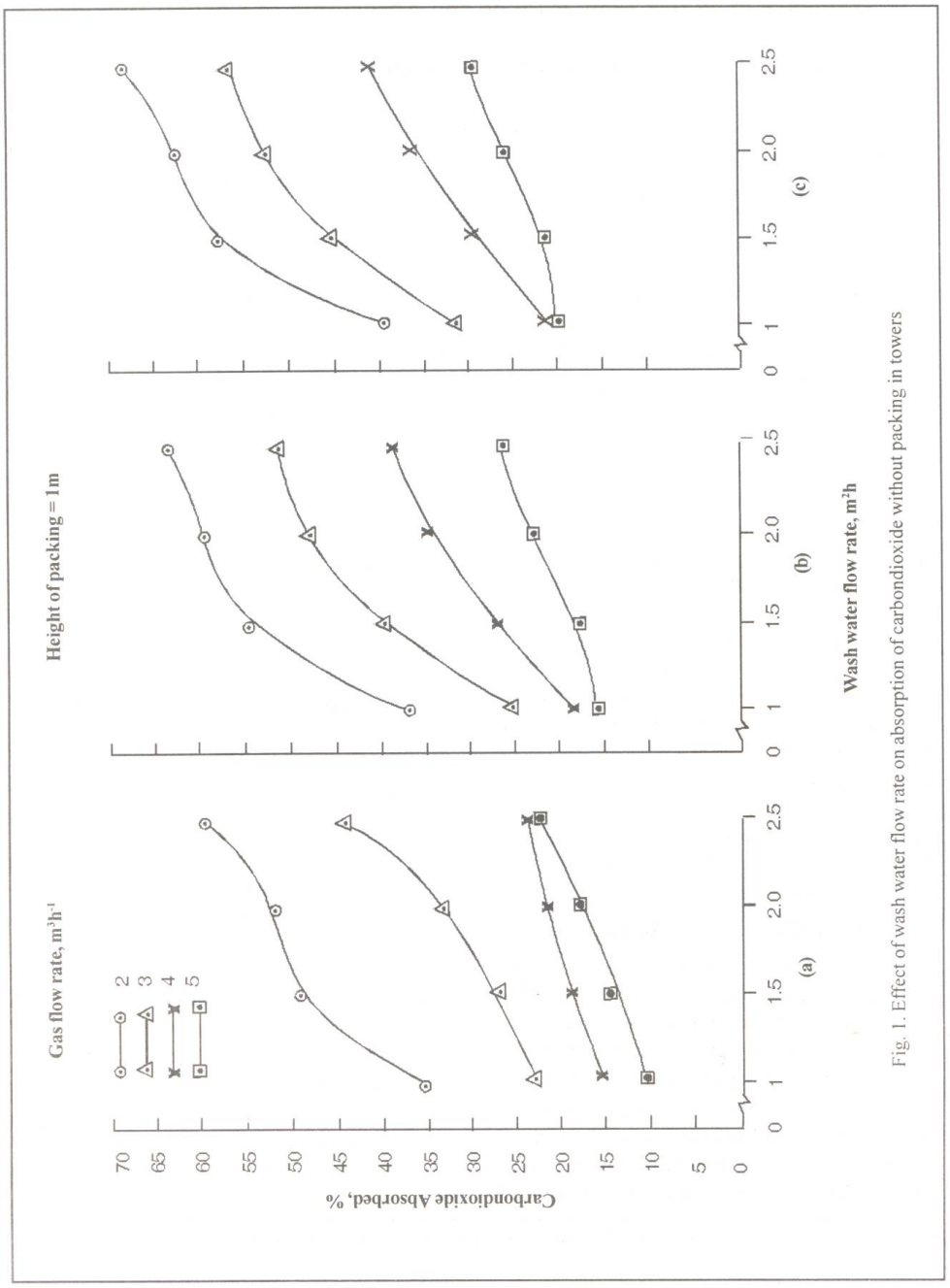

Fig. 1. Effect of wash water flow rate on absorption of carbondioxide without packing in towers

Fig. 1(a) indicates that maximum absorption of carbon dioxide for 2, 3, 4, and 5 m^3h^{-1} gas flow rate at 2.5 m^3h^{-1} wash water flow rate in 150 mm diameter scrubbing tower without packing was 49.20, 31.76, 21.64 and 16.07 per cent, respectively. In both the figures, wash water column height and inlet gas pressure was kept constant at 5 m and 588 kPa, respectively. It is also clear that absorption was lowest at 1, 1.5, and 2.0 m^3h^{-1} wash water flow rate as compared to 2.5 m^3h^{-1} at all the gas flow rates.

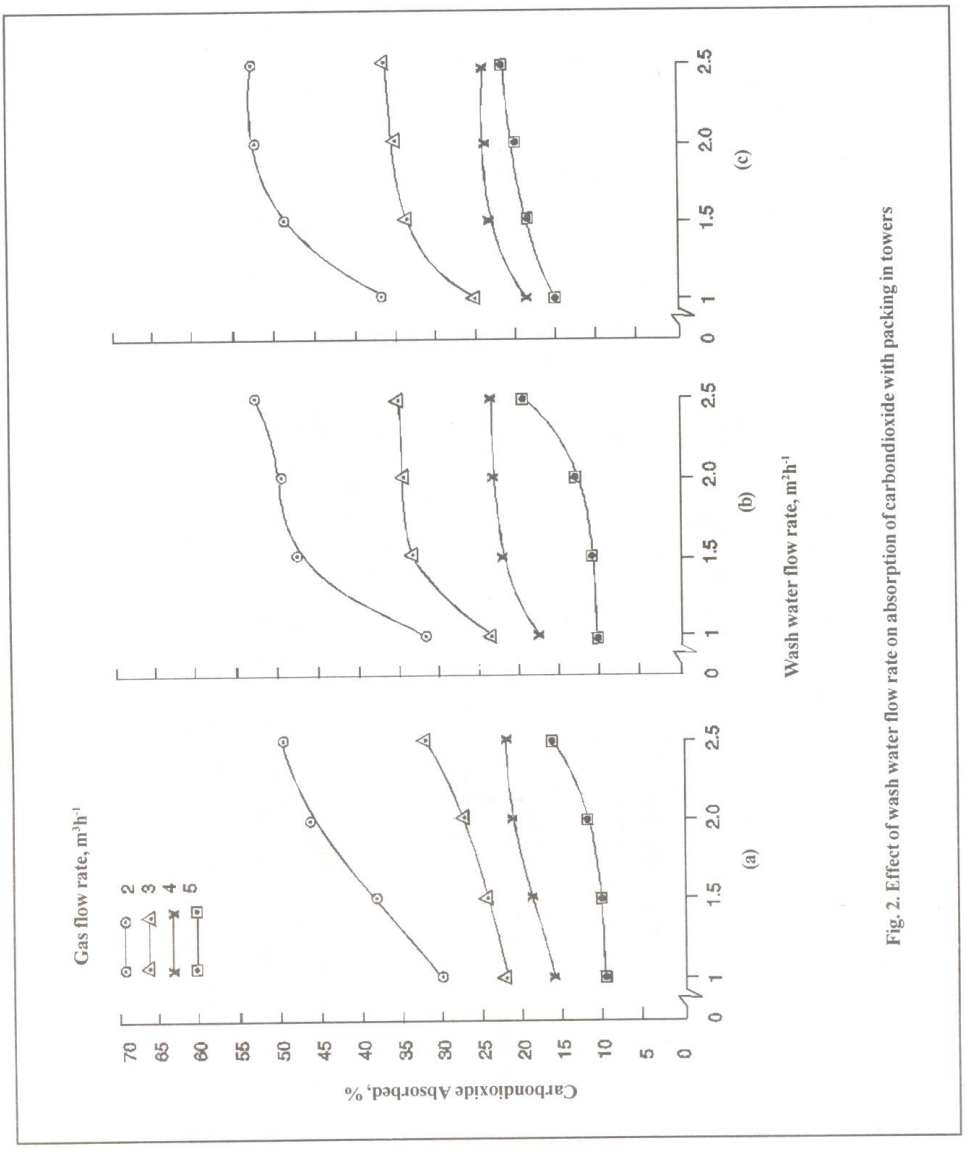

Fig. 2. Effect of wash water flow rate on absorption of carbondioxide with packing in towers

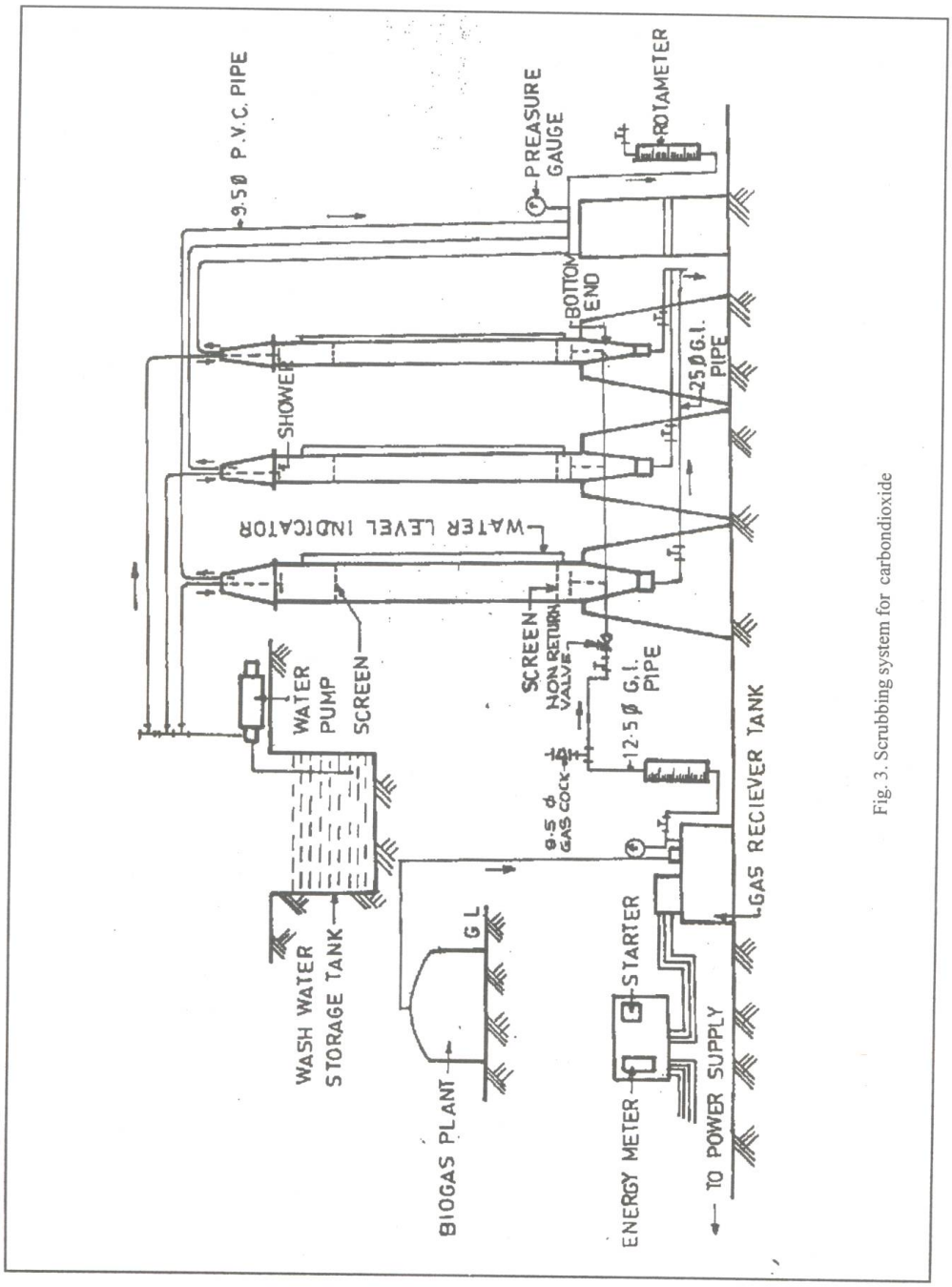

Fig. 3. Scrubbing system for carbondioxide

Table 1. Analysis of variance for absorption of carbon dioxide

Wash water column height = 5 m
Inlet gas pressure = 588 kPa
Wash water flow rate = 2.5 m^3h^{-1}
Diameter of the tower = 250 mm

Source of variance	df	ss	mss	F_{cal}
G	3	10208.207	3402.755	7856.643*
P	3	2230.391	743.463	1716.588*
GP	9	25.484	2.331	6.537*
Error	32	13.859	0.433	
Total	47	12478.00		

* significant at 0.05% level of probability

S.E.M. 1 = 0.1899 S.E.M. 2 = 0.1899 S.E.M. 3 = 0.3799 C.D. 1 at 5 % = 0.5472
C.D. 2 at 5 % = 0.5472 C.D. 3 at 5 % = 1.0954 C.V. = 1.177902

Fig. 1(b) shows that maximum absorption of 51.75, 34.47, 22.92 and 19.36 per cent carbon dioxide occurred at 2, 3, 4 and 5 m^3h^{-1} gas flow rates through 200 mm diameter scrubbing tower without packing, respectively. The wash water flow rate for the above condition was 2.5 m^3h^{-1} at which maximum absorption of carbon dioxide occurred as compared to 1, 1.5 and 2.0 m^3h^{-1}.

Fig. 3(c) reveals that 52.18, 36.01, 23.42 and 21.21 per cent absorption of carbon dioxide was seen when the raw biogas was passed at 2, 3, 4 and 5 m^3h^{-1} gas flow rate through a 250 mm diameter scrubbing tower, respectively. The above trend was observed for wash water flow rate of 2.5 m^3h^{-1} and when there was no packing in the tower. The minimum absorption occurred at wash water flow rate of 1 m^3h^{-1}.

Fig. 2(a) indicates that at 2.5 m^3h^{-1} water flow rate in 150 mm diameter scrubbing tower with 1 m pack of spherical balls, the maximum absorption of carbon dioxide of 60.61, 44.90, 24.07 and 23.78 per cent occurred at 2, 3, 4 and 5 m^3h^{-1} gas flow rates, respectively. Similarly minimum absorption was occurred at 1 m^3h^{-1} of wash water flow rate for all gas flow rates.

Fig. 2(b) reveals that 63.64, 51.34, 38.39 and 26.06 per cent absorption of carbon dioxide was achieved at 2.5 m^3h^{-1} water flow rate and 2, 3, 4 and 5 m^3h^{-1} gas flow rate in 200 mm scrubbing tower with 1 m high pack of spherical balls, respectively. It is also clear that absorption of carbon dioxide was minimum at 1, 1.5 and 2.0 m^3h^{-1} wash water flow rate as compared to 2.5 m^3h^{-1} at all levels of gas flow rates.

Fig. 2(c) shows that maximum absorption of carbon dioxide of 68.11 per cent was achieved at 2.5 m^3h^{-1} wash water flow rate and 2 m^3h^{-1} gas flow rates in 250 mm diameter of scrubbing tower with 1 m height of packing. At 1, 1.5 and 2.0 m^3h^{-1} wash water flow rate minimum absorption was occurred at all levels of gas flow rate as compared to 2.5 m^3h^{-1}

Thus, it is evident from the investigation that the absorption of carbon dioxide is a function of wash water flow rate and it increases with increase in wash water flow rate. The increased absorption of carbon dioxide at 2.5 m^3h^{-1} wash water flow rate achieved was due to the reason that raw biogas received a comparatively more fresh charge of water at the above wash water flow rate. Since, the wash water flow rate has a distinct effect on absorption of carbon dioxide, an analysis based on energy requirement for filling the tower and maintaining the rate of wash water flow rate was performed. An energy investment of 5371.2 kJh^{-1} was required for each tower in order to maintain the wash water flow rate of 2.5 m^3h^{-1}. A statistical analysis (Table 1) at 5 per cent level of significance also indicated significant results for absorption of carbon dioxide at 2.5 m^3h^{-1} wash water flow rate.

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Performance Enhancement of Gravity Separator by Automation

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ABSTRACT

Looking towards the alarming need to achieve higher efficiency in seed gradation, improved quality output and high degree of reliability in performance first time the focus is given on automation of gravity separator. Automation in gravity separator is achieved by applying various sophisticated mechanical systems, sensors and electronic systems. Automated gravity separator gives reliable working with consistency in maintaining quality output. Automated machine reduces the cost of processing, improves quality of output along with increased productivity.

Presently throughout the world manually controlled Gravity Separator Machines are used for gradation of seeds and grains of various types on the basis of their specific weight. Manually controlled gravity has its own problem and limitations such as improper setting of parameter, excessive setting time, more grading cost and dependency on operator. Worldwide, millions of tones of grains and seeds are processed every year for qualitative and quantitative improvement. Grains are graded to provide good quality food grain for daily consumption, while seeds are graded to provide good quality seed to the farmers for sowing in the field. Good quality seeds have high percentage of germination. Value addition depends on quality of gradation. Quality seed is the basic requirement for sustainable agriculture. Post harvest management has a great importance in seed industry. At present Indian seed processing industry is based on conventional, time consuming and laborious process. This is a seasonal and time bound activity to fulfill the market demand. Gravity is used for gradation of seeds or grains on the principle of difference in specific weight of seeds. Existing gravity separator machines has a manual setting facility for the change in every type and size of seed. Thus quality of gradation completely depends on skill of operator and every chance of mismanagement leads to deterioration of quality as well as reduction in quantity of processed seed.

Worldwide, seed processing industry is multi billion-dollar business where billion tons of seeds are being processed every year. Quality seeds fetches 30 to 40 per cent more price in market. Liberalization of trade policies, internationally competitive market and increasing demand has forced Indian seed processing industry to modernize and update grading systems.

To tackle this problem systematically the mechatronics concept has been implemented for automation of gravity separator. The automation helps to maintain consistency in regards to yield and quality with reduction in processing time and cost. The paper also emphasizes redesigning of mechanisms responsible for easy adjustment of various setting parameters. The uses of electromechanical, pneumatic, pneumo-hydraulic and electronic systems are required for auto adjustment and control of process parameters. The feedback system provided takes care of process and safety interlocks to avoid bottlenecking and breakdown in the machineries.

Gravity separator separates seeds of similar in size and shape, but having different specific gravity. The grains are fed to the deck though the storage hopper. Deck is the rectangular top with wire mesh surface supported by MS Structure and seeds are fed though the storage hopper. The wire mesh surface allows the formation of air cushioning on the deck surface. The bottom side of deck is provided with blowers for generating air in desired quantity and pressure. There is a provision for deck oscillation and adjustment of longitudinal and transverse slope.

MATERIAL AND METHODS

Present conventional method of gravity machine setting consists of manual adjustment of four important parameters namely,

1) Longitudinal slope adjustment of deck. 2) Transverse slope adjustment of deck. 3) Oscillation speed adjustment of deck.4] Adjustment of damper position of blowers

which are responsible for efficient grading of seeds. The desired changes made in the mechanism of manually controlled gravity separator were pneumatic, electromechanical and pneumo-hydraulic systems for operating various mechanisms that are easily adoptable for automaton. The provision of sensors and electronic control panel with programmable logic controller made it possible to control all parameters precisely from operators desk (Harry, 1987 and Piter and Gorden, 1987).

Mechatronics concept: The system designed for governing various adjustments for efficient grading is as follows,

1.Sr. Lecturer, Production Engineering Department, College of Engineering and Tech. Akola and 2. Head, Agro Product Development Research Center, Dr. PDKV, Akola.

1. System for Longitudinal slope adjustment of deck - The pneumo-hydraulic cylinder of same capacity were provided at both ends of deck base swiveling frame that helped to lift the deck for slope adjustment. The synchronized pneumatic circuit was designed and provided to ensure motion of both the cylinders at same speed as shown in Fig. 3. This avoids twisting in deck. It is necessary to open locking nut before lifting the frame by rotating air motor provided therein. After achieving desired deck slope the lock nut are to be tighten by reverse rotation of pneumatic motor as shown in Fig. 1.The details of lifting force and torque requirement is given in Table1.
2. System for transverse slope adjustment of deck: The higher capacity cylinder and air motor was provided to sustain the increased load, however the working mechanism is same as above. The details of lifting force and torque requirement is presented in Table1 whereas the working is shown in Fig. 2.
3. Adjustment of blower damper: Separate air motors provided for each damper did the blower damper adjustment. The air motor torque required to operate damper is given in Table-1 whereas the detail working is shown in Fig. 4.The airflow is shown in Fig. 5.
4. System for adjustment of deck oscillation speed: Provision of variable speed pulley was given for online adjustment of speed of oscillation. The speed of oscillation can be adjusted even if the machine is in operating state. The speed pulley is mounted on oscillating frame which moves up or down with the help of screw rod as shown in Fig. 2.The clockwise/ anticlockwise rotation of screw changes speed of oscillation. The flow pattern of the seed is shown in Fig. 6.

Control panel: Two modes are provided for operation i.e. Auto Mode, Semi Auto mode.

Auto Mode: The setting data for adjusting various

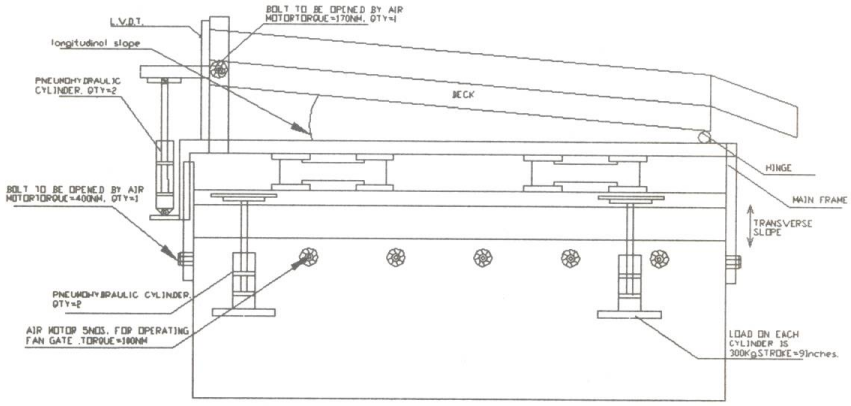

Fig. 1. Provision of air motor and pneumo-hydraulic cylinder for longitudinal slope adjustment

Table 1 . Torque And Force Requirement for various adjustment

Type of setting		Force required	Torque required
Longitudinal slope adjustment	Bolt loosening torque		130N-m
	Deck lifting force longitudinally	2300N	
Transverse slope adjustment	Bolt loosening torque		224N-m
	Deck lifting in transverse direction	4420N	
Damper position adjustment	Torque Required		70N-m
Oscillation speed adjustment	Torque Required		70N-m

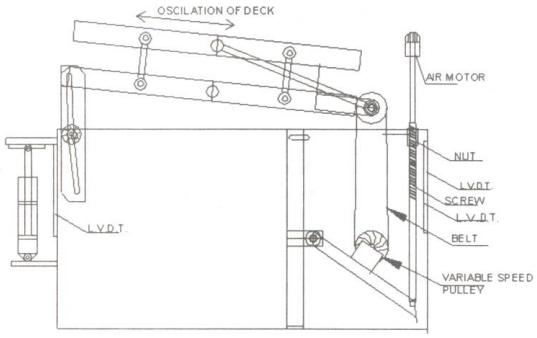

Fig. 2. Provision for adjustment of transverse deck slope and oscillation speed

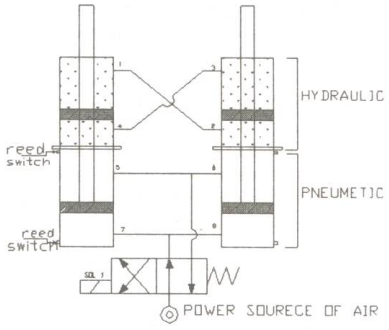

Fig. 3. Syncronising circuit for two cylinder to adjust slope of deck

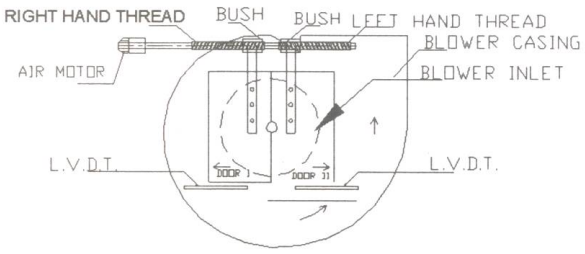

Fig. 4. Adjustment of blower air damper

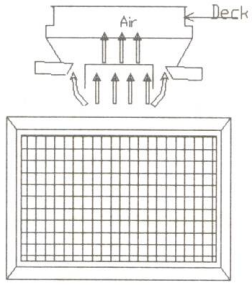

Fig. 5. Air flow in deck

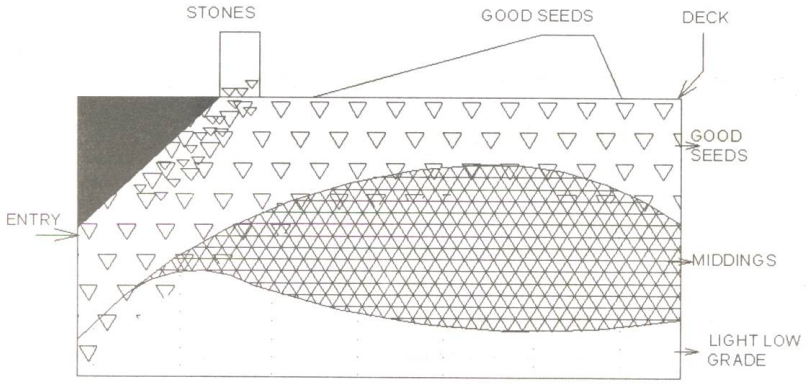

Fig. 6. Flow Pattern of seed

Table 2 . Qualitative and quantitative benefits of auto gravity separator (Capacity of model 2 tonnes h^{-1})

Particular	Manually controlled M/c Actual output =1.5 ton (Output = 75per cent)		Automatic control machine Actual output =1.7 ton (Output = 85per cent)		Cost saved by Auto M/c/ton
Power	7.5 HP =5.6 kw	Rs.5.6x@6= 33.6/h. 33.6/1.5= 22.33/ton	5 HP =3.75kw	Rs.3.75x@6= 22.5/h. 22.5/1.7= 13.23/ton	Rs 9.10/ tonnes of seed processed. (40% of power required in manual m/c.)
Labour	3 labour	Rs.450/- (@150 labour) 450/8= Rs.56.25/h 56.25/1.5= =Rs.37.5/tone	1 operator	@ Rs.120/ shift 120/8= Rs.15/h 15/1.7= =Rs.8.82/ton	Rs.28.87/ton of seed processed. (76.5% of power required in manual m/c.)
M/c setting	1h settin^{-1} g shift^{-1}	@ Rs.18.75/ shift 18.75/8=2.4 h^{-1} 2.34/1.5= Rs.1.56/ton	1 min /setting /shift.	Nil	Rs. 1.56/ ton
Processing cost/ shift		Rs.61.39/ton		Rs.22/ton	Rs.39.53 /ton

Table 3 . Benefits season^{-1} of 8 months by Auto gravity (26 working days month^{-1})

Particular	Manually control M/c	Automatic M/c	Benefits
Total production	7488 Tonnes	8486 Tonnes	936 ton extra production by auto m/c
Processing cost for 8486 Ton seed processed	8486 X 61.39 = Rs 5,20,955/-	8486 x 22 = Rs1,86,692/-	Cost saved in processing per seasons is Rs 3,34,263/-
Cost of machine	Ranging from 2.5 to 3 lac	6.5 to 7 lac	Extra cost burden of Rs3.54 to 4 lac for Automation in Auto gravity.

parameters is stored in the data memory of programmable logic controller for various types and varieties of seeds. Operator has to select type of seed from chart and press button "Enter" of the PC. Automatically all the setting like slope of deck in longitudinal and transverse direction, speed of oscillation and adjustment of air dampers for different blowers are made. If operator needs some marginal changes in setting there is a provision of button titled as 'SET' on the operator's console. The Operator has to press button 'SET' then change the slopes, speed of oscillation, blower damper setting by the push buttons provided on panel. Once he gets satisfied results he will again press button 'SET-OVER'. The latest setting will now be stored in the data for that particular grain and old will go in history sheet provided in PC. Position Sensors are provided for getting exact feed back of deck slope position, air damper position. Transducer is used to get exact feed back speed of oscillation of deck. Safety

Table 4 . Other benefits of auto gravity

Particular	Manually control m/c	Automatic machine	Benefits
Production Increase	12.0 Ton shift^{-1}	13.6 Ton shift^{-1}	1.6 Ton shift^{-1}
Valve addition	Say Rs 1000/- (market price ton^{-1})	Rs1250/- (market price ton^{-1})	25per cent value addition.
Export market to final produce	Limited potential for export.	Potential of export market due to uniform quality.	Good export potential
Export market to Gravity machine	No export market	Its unique feature generates export market for gravity	Good export potential to auto gravity machine
Labour requirement	Skilled operator needed	Skill do not require for setting.	Auto setting facility.

interlocks are incorporated in the program to ensure safer operation. Even in semi auto mode these interlocks are operational (Mickell, 1999 and Peter, 1979)

Semi auto mode: In this mode, operator can control operations from operator's console by changing detent type knob from auto to semi auto mode. The push buttons are provided for performing various operations. World wide the gravity separator with grading capacity 2 Tonnes h^{-1} (2 TPH) is popularly used. Hence, 2 ton h^{-1} capacity model is taken for performing work (Annonymou, 2003).

RESULTS AND DISCUSSION

The comparative data of manually operated and automatically controlled gravity separator presented in Table 2 revealed that the power cost saving is Rs. 9.10/- tonne^{-1} of seed processed. The labour required reduced up to 76.48 per cent, which helped in saving of Rs28.87/- tonne^{-1} of output. Automatic setting of machine saved Rs1.56/- tonne^{-1}. The total reduction in processing cost due to automation was up to Rs. 39.53/- tonne^{-1} which led to saving of 65.15 per cent processing cost over manually operated gravity separator.

From Table 3, it is clear that, on an average during 8 months of seed processing season the total of 8486 tonnes seeds were processed by automated of gravity separator which reflected in saving of Rs3,34,263/- season^{-1} machine^{-1}.

Automation of gravity separator resulted into 25 per cent value addition due to quality output from machine. The automation of gravity separator mainly consist of auto adjustment of deck slope, oscillation speed and air flow by using electro mechanical, pneumatic, pneumo-hydraulic and electronic systems to control activity from operators control desk. In manually controlled machine the adjustment of slope and speed of machine is totally dependent on the skill and energy of operator. However, due to seed type and specific gravity wise control data fed to the controller of auto machine ensured the exact adjustments resulted in increased quality and quantity output of gravity separator.

Automatic gravity separator not only gives quality output at less processing cost but also the other benefits like export grade output, increase production rate value addition in agro produce etc. Compared to these advantages the cost incurred in automation of machine i.e. Rs. 4.00 lacks is negligible and can be recovered only in one season by saving in processing cost. Good quality seed gives more yields because of more germination and vigor of seed.

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PKV Res. J. Vol. 30 (2), 2006

Field Evaluation of Air Assisted Sleeve Boom Sprayer

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ABSTRACT

Air assisted sleeve boom sprayer was developed to direct the spray to converge on the canopy. The system consisted of a boom fitted with hydraulic nozzles along with flexible air sleeve having a series of holes to deliver air. The field experiment was conducted in the field of cotton crop (NHH-44) at ASPEE farm, Tansa, with an optimum combination of independent parameter (Air velocity- 26 ms^{-1}, Air sleeve angle- 30^0, Nozzle angle– 35^0 and Height of boom-70 cm) obtained from the laboratory experiment to study the performance of air assisted sleeve boom in terms of droplet density and droplet size. To facilitate the evaluation of spray penetration into the canopy of the cotton plant, the plant was divided into six different positions. At lower leaf surface and at the top position of the plant the droplet density was within the range, whereas at middle and bottom position of the plant the droplet density deposited was almost 40 per cent below the required limit. Similarly, the maximum droplet size of 122.2 VMD was observed during the field evaluation on the top position of the plant and upper leaf surface. The maximum value of deposition index was found be 1.82 at top position of the plant and on upper leaf surface.

World have been aware of serious food shortages during the past 50 years, and in recent years, they have become critical. All available technologies must be utilized to maximum efficiency and agriculture research must continue to develop technology to increase crop productivity. The use of plant protection measures must be significantly stepped up if full benefits of capital investments in fertilizer, irrigation, improved cultivars, machinery and management practices are to become a reality. Successful crop production depends upon the efficient use of resistant cultivars, cultural practices, pesticides, bio-control agents, and any other effective measure to control existing enemies of crop plants.

The control of pests can only be achieved effectively if pesticides are properly applied the correct rate, at the right time, on the target by appropriate equipment. Our greatest concern is about loss of pesticides during its movement from atomizer to the target area. Droplets may evaporate to become air borne and drift away at considerable distances from the target areas. Droplets get influenced by the environmental factors present between the atomizer tip and target area. Air assisted sprayers were modified by providing adjustable air outlets to direct the spray to converge on the canopy. Such configurations have been found to reduce the drift losses ranging from 15 to 50 per cent and to improve the deposition efficiency (Pergher, *et al.*, 1977).

It is important that the equipment be designed so that the pesticide can be applied as much of the leaf area as possible. The geometry and orientation of leaves also affect deposition (Brass and Charlton, 1968). Pesticide droplets must travel in and around plant canopy in order to cover as many leaves as possible. A similar concept of air assisted boom sprayer has been developed to deliver air from the nozzle.

MATERIAL AND METHODS

Air assisted sleeve boom sprayer was developed to direct the spray to converge on the canopy (Fig.1) and the specifications of the sprayer is given in Table 1. The experiment was conducted in the field of cotton crop (NHH-44) at ASPEE farm, Tansa. The relative humidity and wind velocity in that area during the experiment ranged from 32 to 46 per cent and 3.2 to 4.4 kmh^{-1}, respectively. The seeds were sown in the plastic bag on 25th May, 2003 to raise the seedlings in the nursery. The seedlings were transplanted in the field after 15 days of sowing in 1.5 acres of land. The plant-to-plant and row-to-row spacing i.e., 90 × 90 cm was maintained during transplantation as per the recommendation. The experiment was conducted with at an optimum combination of independent parameter (Air velocity 26 ms^{-1}, Air sleeve angle 30^0, Nozzle angle 35^0 and Height of boom 70 cm) obtained from the laboratory experiment to study the performance of air assisted sleeve boom in terms of droplet density and droplet size. The experiment was conducted randomly in three different sub plots (Piche, 2000).

Before commencement of experiment it was ensured that the tractor was set at selected gear and

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Table 1. Details of air sleeve boom sprayer

S.N.	Particulars	Dimension
1	Length of sleeve, mm	5000
2	Inlet diameter of sleeve, mm	300
3	Number of orifices on the sleeve	55
4	Centre to centre distance of orifice, mm	90
5	Horizontal triplex pump:	
	Maximum discharge, l/min (at pressure 28 $kgcm^{-2}$)	35
6	Air duct	
	i. Diameter, m	0.25
	ii. Length, m	2.5
7	Nozzle (hollow cone mist)	HCN/PB-80450
	discharge rate, $ccmin^{-1}$	150

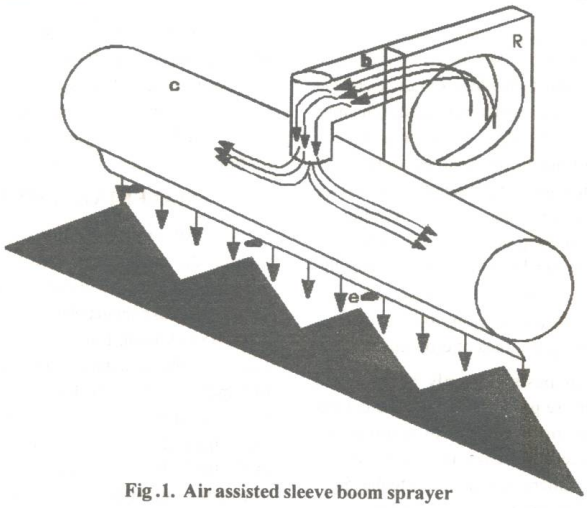

Fig .1. Air assisted sleeve boom sprayer

throttle position to get specified travel speed and air velocity. The air velocity was measured 100 mm below the orifice in the static position of the test set-up. A digital type vane anemometer was used to measure the air velocity. Three glossy papers were stapled on the leaves at each position to observe the deposition of the droplets. After making all adjustments, setup of the equipment was run for 30 minutes before actually starting the experiment. In order to achieve uniform exposure of crop to the spraying, the setup was started 3 m before the canopy and was stopped immediately after passing the canopy.

The spray deposition was collected on the sample cards of the glossy paper. Sample cards of size 62 mm × 44 mm were used to collect the sample. Royal blue indigo dye was mixed with water to prepare a coloured spray solution. The coloured spray was allowed to fall onto the sample glossy photographic paper. After the experiment, the sample cards were carefully removed and then taken for further analysis in the laboratory. Digital image analyzer was used to determine stain diameter and droplet size, which analyzed these samples after 24 hours of application to ensure that droplets had stopped spreading.

An ideal spraying resulted in deposition of 20-25 droplets of the size 100-150im VMD per square cm of

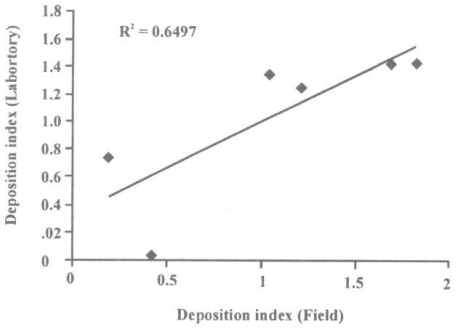

Fig. 2. Regression between laboratory and field

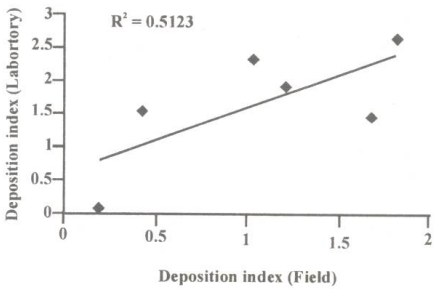

Fig. 3. Regression between laboratory and field deposition index at angle 35^0

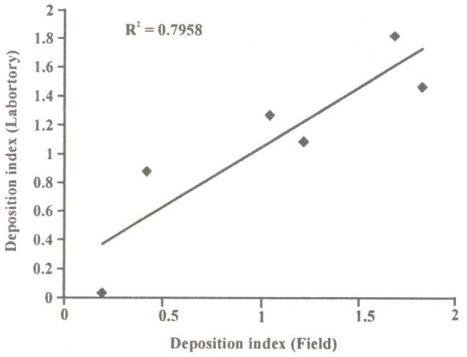

Fig. 4. Regression between laboratory and field deposition index at air sleeve angle 30^0

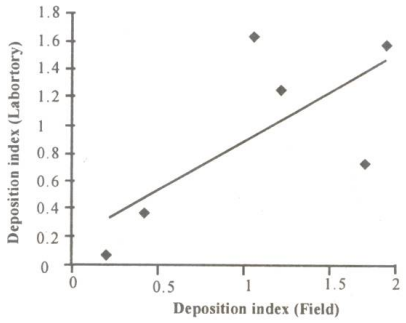

Fig. 5. Regression between laboratory and field deposition index at height of boom 70 cm

the leaf area. Therefore, volume of liquid deposited per square cm of leaf area by ideal spraying was calculated using relationship as given below.

$$Vo = 4/3\ Đ\ (d/2)^3\ X\ n$$

Where,

Vo- ideal volume deposited,

d- droplet size, VMD

n- number of droplets cm^{-2}

Therefore deposition index (DI) is calculated as-

$$DI = \text{Applied volume} / Vo$$

The index should be one for the perfect spraying. If the index is less than one then there is under spraying and volume to be applied has to be increased. If it is more than one then there is over spraying and runoff start at an index of 4.63.

Considering spray volume per plant and number of plants covered per minute, the discharge rate of the individual nozzle was calculated. The smaller spray angle nozzles give slightly larger droplet size as compared to larger spray angle for given type and pressure of nozzle (Jose, 1987 & Womac, 1992). Taking into the consideration the above facts, HCN/PB -80450 Hallow Cone Mist Spray Nozzle was selected for the experiment (spray angle 80^0,

Table 2. Field evaluation of air assisted sleeve boom sprayer

S.N.	Position	Surface	Droplet density No.cm^{-2}	Droplet size VMD	Volume ml cm^{-2}	Deposition Index
1	Top	Upper	26.4	119.8	2.3×10^5	1.82
2		Lower	23	122.2	2.2×10^5	1.68
3	Middle	Upper	21.2	107	1.3×10^5	1.04
4		Lower	12.6	75.9	2.5×10^6	0.19
5	Bottom	Upper	21	113	1.5×10^5	1.21
6		Lower	14.2	90.8	5.5×10^6	0.42

discharge rate 150 ccmin^{-1}) among the best available nozzles. To facilitate the evaluation of spray penetration into the canopy of the cotton plant, the plant was divided into six different position viz., top position of the plant and upper leaf surface, top position of the plant and lower leaf surface, middle position of the plant and upper leaf surface, middle position of the plant and lower leaf surface, bottom position of the plant and upper leaf surface, and bottom position of the plant and lower leaf surface.

RESULTS AND DISCUSSION

The analysis of data indicated that the droplet density was in the range at top, middle and bottom position of the plant and upper leaf surface. However, at lower leaf surface and at the top position of the plant the data showed that the droplet density was within the range, whereas at middle and bottom position of the plant the droplet density deposited was almost 40 per cent below the required limit. The data in Table 2 revealed that the maximum value of 122.2 VMD was observed during the field evaluation on the top position of the plant and upper leaf surface. The VMD observed on upper leaf surface at top, middle and bottom position of the plant as well as on lower leaf surface at top position of the plant was well within the recommended zone. However, the VMD observed at middle and bottom position of the plant at lower leaf surface was below the recommended zone.

The deposition index was calculated for the field experiment and maximum value of deposition index was found be 1.82 at top position of the plant and on upper leaf surface. However, the deposition index at almost all position of the target plant was slightly higher than one except at middle and bottom position of the plant and lower leaf surface. The deposition index observed at optimum levels of air velocity, air sleeve angle, nozzle angle and height of boom in the laboratory experiment was compared to that observed during field evaluation of air assisted sleeve boom presented in Fig.2 through Fig.5.The value of regression coefficient was observed as 0.64, 0.79, 0.51 and 0.50 for air velocity, air sleeve angle, nozzle angle and height of boom, respectively. The value of regression coefficient indicated that the results of field experiment conformed the results of laboratory experiment conducted to determine the effect of air velocity, air sleeve angle, nozzle angle and height of boom. The R^2 value indicated that the effect of air velocity and air sleeve angle is more comparable than the results obtained as an effect of nozzle angle and height of boom.

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Micro- Elements in Anoestrus and Repeat Breeder Cows

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ABSTRACT

Thirty cows were selected and subjected to gynaecological examination. Selected cows were divided as per the reproductive disorder in five groups. Each group consisted 6 cows. Blood samples were collected from cows in all the groups on day 10, 21, 31 and 41. The trace elements namely zinc, iron, copper and manganese were estimated and observed that the zinc and copper levels were low in repeat breeders. There was no significant difference between these blood constituent in normal cycling, anoestrus, subestrous and repeat breeder cows.

In dairy animals, lowered fertility is serious economic problem, resulting into loss of milk, reduced calf generation and early depreciation of potentially superior cows. The lowered fertility may be due to pathological, managerial, hereditary and nutritional causes resulting to repeat breeding syndrome.

Out of major reproductive problem in India, the incidence of anoestrus in heifers has been reported from 12.37 to 68.41per cent. Sexena and Gupta (1992) reported that 13.4 per cent of heifers were culled because of anoestrum. Among the many factors governing the oestrus cycle length, macro and microelements have been suggested from time to time. Among indispensable nutrients, the significant role played by micro or trace elements like Iron, Copper, Manganese and Zinc, etc., either independently or collectively in the production and reproduction of cows, has been greatly emphasized by Hignett(1959), Laing (1970), Underwood (1977).

MATERIAL AND METHODS

Thirty cows were selected and subjected to periodical gynaecological examination. Those, which failed to exhibit oestrus and both ovaries smooth and inactive with flaccid and atonic uterus, were taken as true anoestrus cows. Those which showed the evidence of ovulation by the presence of normal corpus luteum but did not exhibit oestrus were taken as suboestrus cows. Those having active ovaries with various grades of palpable corpus luteum and exhibiting oestrus were taken as normal cycling cows.

After a study of previous breeding record and regular gynaecological investigation, the cows with nearly normal oestrus cycle having no anatomical abnormalities but which failed to conceive in three consecutive inseminations or natural service were considered as repeat breeders.

Selected cows were divided as per the reproductive disorder given as below.

Group wise details of the cows.

Group No.	Number of cows	Status of cows	Type of group	Treatments
I(G1)	6	Normal cyclical	Control group	No treatment
II(G2) consecutive days.	6	True anoestrus	Treatment	Cap. Prajana@ 2 cap day^{-1} for 5
III(G3) consecutive days.	6	True anoestrus	Treatment	Cap. Heatinee @ 2 cap day^{-1} for 5
IV(G4)	6	Suboestrus	Treatment	Inj. Dinoprost @ 5 ml i/m once.
V(G5)	6	Repeat breeder cases associated with Infection	Treatment	Antibiotic therapy according to sensitivity test. The antibiotics used were Gentamicin and Chloramphenicol.

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The normal cycling cows acted as control animals in respect of reproductive status and biochemical parameters for all the groups.

Blood samples were collected from cows in all the groups on day 10, 21, 31 and 41.

For this purpose, clean and sterilized 16 gauze needle and vials containing (1%) EDTA (Di-sodium salt of ethylene diamine tetra acetate) as an anti coagulant for haematologiocal studies and vials containing (1%) sodium flurorides oxalates for blood glucose were used. These samples were analysed within 3 hours of collection. For serum collection, clean and sterilized large wide mouth 15 ml test tubes were used. Blood from all cows was collected from jugular vein with all aseptic precaution. Smears were prepared simultaneously on clean, dry glass slides. The test tubes containing blood were kept in slanting position over night to facilitate clotting of serum. Serum was carefully separated next day into clean and sterilized vials after centrifugation. One drop of one per cent merthiolate solution was added as a preservative. These vials were then suitably marked with glass marking pen for identification, sealed with rubber cork and preserved in deep freeze till analysed. All the biochemical estimations were carried out within seven days of serum collection.

The estimations of serum magnesium and trace minerals including copper, manganese, zink and iron were done by using Automatic Absorption Spectrophotometer (AAS) Model 1202 (Varian Techton Ptv. Ltd.) Melbourne, Australia (Plate 3).

RESULTS AND DISCUSSION

The present investigation indicated that the normal levels of zinc, copper, iron and manganese, in normal cycling cows were 86.66, 175.50, 122.36 and 29.20 mcg/dl, respectively. This study further indicated that expecting zinc and copper levels in repeat breeding cows, the level of other trace minerals differed non-significantly in anoestrous and suboestrus group from the values in the normal group. The levels of zinc (30mcg dl^{-1}) and copper (165.00mcg dl^{-1}) in repeat breeders were significantly lower than those in normal cycling cows. These observations contradict the earlier observation of Manickam *et al.* (1977); Saxena and Gupta (1992) and Behera *et al.* (1993), who have reported significant low values of various trace minerals in the cows with various types of reproductive disorders including delayed puberty, anoestrum, suboestrum and repeat breeding, while studying the interrelationship of some biochemical constituents in the serum of fertile cows. Reddy and Reddy (1988) stated that some trace elements differed significantly in their levels in different reproductive conditions. Whereas other did not show any change. They further postulated that these minerals either behaved synergistically or might have no effect on others. From these observations and observation in the present investigation, it could be inferred that fertility in dairy cows was influenced by trace elements which should be at optimum levels and at the same time, should maintain required relationship with other minerals. It is further inferred that the deficiency of one or the other trace elements in single or its excess in the blood serum might not affect the reproductive ability of the females. Feeding of microelements may only be effective if the diets are fully adequate in other respects and mere supplementation of microelements without considering the other micro constituents in the diet may prove useless or may actually prove harmful. The controlled nutritional experiments are essential to understand the exact role of trace elements in the various reproductive processes. Such studies could prove highly beneficial in controlling the unknown causes

Table. 1- mean values of different trace elements in different groups.

S.N.	Parameters	Groups				
		G_1	G_2	G_3	G_4	G_5
1	Ziinc mcg /dl	86.66[a]	94.33[b]	87.66[a]	90.66[b]	70.00[a]
2	Copper mcg/dl	175.5[a]	173.33[a]	174.66[a]	180.66[a]	165.00
3	Iron mcg/dl	122.36a	120.66a	125.5a	127.0a	121.83a
4	Manganese mcg/dl	29.2a	29.0a	30.0a	29.4a	28.2a

- Common superscript indicates non-significant differences.

Table. 2- Analysis of variance for trace elements in different groups of anoestrus cows.

Source of variation	Degree	Zinc		Copper		Iron		Manganese	
	of freedom	M.S.S	F. cal	M.S.S	F. cal	M.S.S	F. cal	M.S.S	F. cal
Replication	5	401.07	1.52	1365.0	3.80**	767.0	3.71**	46.0	1.45
Combination	24	179.89	0.683	281.9375	0.786	49.95	0.242	3.06	0.096
Groups	4	847.88	3.21**	963.375	2.68**	212.5	1.02	12.83	0.406
Period	4	124.34	0.472	148.00	0.412	16.87	0.081	0.306	0.009
GxP	16	26.82	0.101	145.06	0.404	17.59	0.085	1.30	0.041
Error	120	263.82		158.57		206.39		31.62	
CD for group		8.29		9.68		-		-	

** -Significant at P<0.01

of infertility, which might have arisen due to deficiency of trace elements.

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Ultilization of Pulses Straw in Pelleted Complete Diet and its Effect on Growth Performance and Rumen Profile of Local Goats

V.B. Madavi[1], D.H. Rekhate[2] and A.P. Dhok[3]

ABSTRACT

An experiment was conducted on 24 non descript local goats divided into four treatments group on pulses straw based pelleted complete diet for 110 days. The effect on growth performance and rumen profile of local goats was also sutdied . The goats under treatment T_1 were fed on pelleted complete diet of 60 per cent arhar straw and 40 per cent concentrate (15% CP, 60% TDN), T_2 - pelleted complete diet of 30 per cent arhar straw + 30 per cent gram straw and 40 per cent concentrate (15% CP, 60% TDN), while T4 offered sole arhar straw pellets with supplementation of 300 g concentrate pellets (18% CP and 70% TDN). The daily DMI significantly ($P<0.01$) varied. The DMI 100^{-1} kg body weight in groups was 4.31 ± 0.10, 4.45 ± 0.13, 4.85 ± 0.15 and5.25 ± 0.20 kg. The feed conversion efficiency was better in T_3 group. The average daily gain in treatment T_1, T_2, T_3 and T_4 was 83.52 ± 3.43, 108.14 ± 18.28, 85.82 ± 9.38 and 94.83 ± 18.85 g, respectively. The DCP and TDN content in different treatment diets were 9.52 ± 0.03, 53.41 ± 1.39, 10.81 ± 0.22, 55.03 ± 2.17, 10.51 ± 0.36, 54.48 ± 2.39, 8.99 ± 0.39 and 58.05 ± 1.65 per cent in T_1, T_2, T_3 and T_4 group, respectively. The goats under all the treatments were in positive nitrogen, calcium and phosphorus balance. The rumen liquor constitutents were in the normal range. It was concluded that goats fed on different pelleted completed diet performed batter in respect of weight gain.

The crop residues can play an increasingly important role in the feeding of livestock and contribute 20 to 80 per cent of the dry matter for livestock during the different seasons particularly in Rajasthan, Maharashtra and Andhra Pradesh (kelly *et. al.*, 1991). A major problem in utilization of crop residues is their low bulk density. To improve their utilziation and reduce the bulk to make easy transportation and storge, efforts have been made to densify the crop residues by way of mash, pellets, cubes, briquettes and blocks of complete feeds, which implies the uniform mixture of ingredients procssed in such a way, so as to avoid differential selection by the animals. India is the largest producer and consumer of pulses in the world. This accounts 33 per cent of the total area and 22 per cent of world production of pulses (Singhal, 2003) The efforts have been made to utilize pulses straw in pelleted complete feeds inthe present study.

MATERIAL AND METHODS

Twenty four local non descript goats of average age 10.63 ± 0.05 M and average weight 21.46 ± 0.45 kg were divided into four treatments and fed on four different rations containing 15 per cent CP and 60 per cent TDN for 110 days. The goats under treatment T_1 were fed on pelleted complete diet of 60 per cent arhar straw and 40 per cent concentrate, T_2 were fed on pelleted complete diet of 60 per cent gram straw and 40 per cent concentrate, T_3 were fed on pelleted complete diet of 30 per cent arhar straw + 30 per cent gram straw and 40 per cent concentrate while T_4 were offered sole arhar straw pellets with supplementation of 300 g concentrate pellets (18 % CP and 70 % TDN).

Composition of different diets under various treatments

Composition	T1	T2	T3	T4	
				Arhar straw pellets	Conc. pellets
Arhar straw	60	-	30	100	-
Gram straw	-	60	30	-	-
Jowar	18	09	13	-	18
Arhar chunni	03	04	04	-	24
Gram chunni	03	04	04	-	24
Cotton seed cake	06	08	07	-	13
Groundnut cake	07	12	09	-	17
Mineral mixture	02	02	02	-	03
Common salt	01	01	01	-	01

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The daily DMI and weekly body weight were recorded. The metabolic trial of 7 days collection period was conducted at the end of experiment. the rumen profile pH, NH -N (Conway, 1957), TVFA (Bernett and Reid, 1957), total nitrogen (AOAC, 1990), TCA-ppt-N (Mc Kenzie and Wallace, 1954) and NPN were estimated at every fortnight. The feed samples, faeces and urine samples collected during the study were subjected to proximate composition as per AOAC (1990) and fibre composition as per Van Soest (1967). The data collected during the study were analyzed as per Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

The chemical composition of pelleted complete diet (Table 1) indicates that all the diets were isonitrogenous. The performacne of goats (Table 2) revealed significantly higher ($P < 0.01$) DMI under T_4 than other groups. Similar DMI was recorded by Nageshwararao *et. al.*, (1996) in bucks fed on eight iso-notrogenous complete rations having different roughage sources. The DMI 100^{-1} kg body weight was significantly ($P<0.01$) higher in T_4 groups fed on sole arhar straw pellets supplemented with concentrate pellets, however, DMI 100^{-1} kg body weight for T_1 and T_2 was comparable with Reddy and Reddy (1983) who reported slightly lower DMI 100^{-1} kg body wieght in Nellroe sheeps fed pelleted rations where as Ramaprasad *et. al.*, (1988) reported higher DMI 100^{-1} kg body weight in Nellore weaner lambs than observed in the present sutyd, however, Raut *et. al.*, (2002) reported 4.20 ± 0.28 DMI 100^{-1} kg body weight day^{-1} in goats fed pelleted complete ration of Arhar straw (60) and concentrate (40). The daily CP intake was significantly ($P<0.01$) higher in treatment T_4 as compared to other treatments which might be due to higher dry matter intake, while CP intake in T_2 and T_3 was comparable.

The initial body weights for treatment T_1, T_2, T_3 and T_4 were 22.40 ± 1.19, 22.05 ± 1.84, 20.57 ± 0.91 and 20.83 ± 0.85 kg, respectively, where as body weights at the end of experiment were 31.76 ± 1.43, 34.16 ± 2.00, 30.18 ± 1.00 and 31.45 ± 2.71 kg for the respective groups. An increasing trend was observed in body weights of goats in allt he treatmetns from 0th day till the end of experiment and increase in the body weight for 110 days among T_1, T_2, T_3 and T_4 was 9.36, 12.11, 9.61 and 10.62 kg, respectively. The mean weekly body weights varied significantly ($P<0.01$) for various treatments and it was significantly higher in T_2 treatment (Gram straw 60:40 concentrate group). The body weight gain recorded during the early period of experiment was found better in each treatment than the later stage. The average daily gain of 108.14 ± 18.28 g was better in T_2 group. The avera daily gain observed in the present study was higher than 69.62 g, reported by Reddy and Raghavan (1987) in goats fed on 30:70 roughage to concentrate ratio and also higher than 75.00 ± 8.83 g as reproted by Raut *et. al.* (2002) in goats fed on arhar straw based pelleted complete feed. The value for ADG in the experiment corroborates with Rekhate *et.al.*, (2005) recorded in local goats. The feed conversion efficiency did not reveal any signifi8cant varistion. All the treatment groups showed higher feed conversion efficiency in the present study than reported by Rama Prasad *el. al.*, (1988). The higher feed conversion efficiency might be due to the age of animals under experimentation.

The degestibility coeffieicnts for various nutrients found to be non signficiant, however digestibility coefficient for CP and hemicellulose were significantlyh ($P=0.01$) higher in T_2 groups fed on pellets of gram straw (60) and concentrate (40). The DM digestibility coefficients in the present study was lower than those reported by nageswararao *et. al.*, (1996) as 61.20 ± 1.46 and 63.61 ± 1.09 in goats fed tree leaves based pelleted feed. The DCP and TDN content for pelleted complete diets T_1, T_2, T_3 and T_4 were 9.52 ± 0.03, 53.41 ±1.39, 10.81 ± 0.22, 55.03 ± 2.17, 10.51 ± 0.36, 54.48 ± 2.39 and 8.99 ± 0.39, 58.05 ± 1.65 per cent, respectively. The nitrogen, calcium and phosphorus balances did not vary signficantly, however, all the goats in the experiment under different treatments were in positive balance. The N-balance found in rpesent study was in accordance with Reddy and Reddy (1983) who reported 11.51 ± 1.90, 14.17 ± 1.32 g/d in goats fed with pelleted complete ration, however, higher calcium and phosphorus balance was reported than observed inthe present study. Whereas Syamadayal *et. al.*,(1995) reported lower N, Ca and P balance on three differnt completed rations than the present study.

The rumen liquor profile study (Table 3) conducted at every fortnight showed significant variation for all parameters between different treatmetns. The values

for rumen liquor pH are comparable with Rekhate *et. al.*, (2005) reported in goats. The value obtained for NH_3-N in the study corroborates with the vlaues reported by Singhal and Mudgal (1983) in gaots, however Sridhar *et. al.*, (1999) reported lower values as 10.33, 8.76 and 8.36 on low energy, medium energy and high energy diet, respectively in deccani sheep. The TVFA values obtained inthe study are comparable with 7.28 $\pm$ 0.91 reported by Raut *et. al.*, (2002) in goat fed arhar straw based pelleted complete feed. The total nitrogen and TCA-ppt-N value were comparable with Sridhar *et. al.*, (1999) in Deccani sheep fed varying level of energy. The NPN values were much higher than reproted by Sridhar *et. al.*, (1999).

It is concluded that, the average daily gain and feed conversion efficiency was higher in goats under T_2 treatment fed with pelleted complete diet of gram straw 60 per cent and concentrate mixture 40 per cent having 10.81 DCP and TDN 55.03 per cent which can meet the requirements of tgoats growing 108 g d^{-1}. Therefore, it is recommended that complete feed ration may be fed to goats under stallfed condition.

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RESEARCH NOTES

Influence of Sowing Dates on Petal Yield and Oil Content of Safflower Genotypes

Safflower (*Carthamus tinctorius* L.) is a multipurpose crop grown for edible oil, medicinal and industrial uses. It has been under cultivation in India either for its coloured florets (Petals) and much valued oil. The oil is considered to be the best for heart patient due to high degree of polyunsaturated fatty acids. Safflower petals are used in China for treatment of many diseases. The water soluble yellow dye, carthamidin and a water insoluble red dye, carthamin, which is readily soluble in alkali and can be obtained from florets. Carthamin is found in florets to the extent of 0.3 to 0.5 per cent and imparts a bright red colour to cotton and silk fabric. Florets can be collected after the crop ripens. This has also resulted in small revival for safflower dyes. Carthamin is the only chalkone type pigment suggested for colouring foods in India. Flowers of safflowers regarded as stimulant, sedative and as a promoter of menstrual discharge. The main active ingredient in safflower medicine is safflower yellow, which is water soluble and present in the dried florets to the extent of 26 to 36 per cent. With the aforesaid facts under consideration, it is necessitated to study the response of safflower genotypes for petal yield and oil content under different sowing dates. Thus, an experiment was carried out to study the influence of sowing date on petal yield and oil content of safflower genotypes.

The field experiment was conducted during *Rabi* 2002 – 2003 at the farm of Department of Agronomy, Marathwada Agricultural University, Parbhani. The experiment was laid out in split plot design with three replications.

Treatments included 4 sowing dates 1st October (40th MW) 15th October (42nd MW), 30th October (44th MW) and 15th November (46th MW) in main plots and 3 genotypes (Sharda, PBNS–12 and NARJ–6) in sub plots making 12 treatment combinations, maintaining 45 x 20 cm spacing. The crop received a uniform dose of 60:40:00 kg NPK ha^{-1} and a basal dose of 50 per cent nitrogen and full dose of Phosphate was applied at the time of sowing and remaining 50 per cent nitrogen at the time of top dressing.

Among the sowing dates, the sowing of safflower on 30th October recorded highest seed yield (2710.00 kg ha^{-1}) and among the genotypes PBNS–12 recorded highest seed yield (2345.60 kg ha^{-1}) as compared to other genotypes.

As regards to petal yield, the sowing of safflower

Table 1 : The petal yield and oil content of safflower as influenced by sowing dates and genotypes.

Treatments	Seed yield kg ha^{-1}	Biological yield kg ha^{-1}	Petal yield kg ha^{-1}	Oil content (%)
Sowing Dates				
1st October	1290.10	3777.50	105.90	30.41
15th October	2024.40	6835.90	167.11	30.73
30th October	2711.00	8486.90	190.45	30.66
15th November	1623.80	5202.80	165.30	31.42
S. E. (m) ±	102.89	433.26	7.66	0.27
C.D. at 5%	307.98	1296.90	22.94	N. S.
Genotypes				
Sharda	1942.70	5687.20	144.59	29.99
PBNS – 12	2345.60	8093.40	146.66	29.93
NARI – 6	1448.60	4450.50	180.31	32.49
S. E. (m) ±	119.48	377.54	4.64	0.27
C.D. at 5%	357.64	1130.20	13.90	0.82

on 30th October recorded highest petal yield (190.45 kg ha^{-1}) which was significantly superior over other dates of sowing. The lowest petal yield (105.90 kg ha^{-1})was recorded when sowing of safflower undertaken on 1st October. The sowing time had no much influence on oil content Hulihali (1997) reported similar findings.Among the genotypes, NARI–6 recorded highest petal yield of 180.31 kg ha^{-1} and significantly superior over Sharda and PBNS–12. The NARI–6 also recorded highest oil content (32.49 %) than Sharda and PBNS–12.

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Humus Fraction and their Relationship With Physico-Chemical Properties of Soil Under Long Term Fertilization and Manuring

About 2000 m tonnes of raw organic material through cattle dung, urine, night soil, farm waste and crop residues, other animal waste and biological resource are available annually which contribute 16.89 m tonnes of nutrients including mineralized carbon resource (Gaur and Singh, 1982). Organic matter is the single soil property which influences soil fertility, soil formation and profile development, soil structure, soil physical, organo-chemical and biotic characterstics in addition to serve as a source of food and energy for micro-organisms (malewar *et. al.*, 1998). Hence, the present study was undertaken to evaluate a relationship between humus fraction and different physico-chemical properties of soil.

The experiment was laid out in a randomized block design with 14 treatment combinations involving NPK fertilizer alone and also incombination with FYM, wheat straw, glyricidia and subabul with three replications. The soil mechanical analysis, pH, EC and organic carbon were determined by adopting standard procedures. The soil were analyzed for available N (Subbiah and Asija, 1956), Available P and available K (Jackson, 1967). Isolationa nd separation of different humus fractions were carried out as per proceudre described by Stevenson (1982). The statistical analysis was made as per the method given by Panse and Sukhatme (1985).

It is evident (Table 1) that various soil properties had influenced the different humus fractions detected in the soil. Organic carbon was negatively and significantly related with humin but highly significant and positively related with humic acid, fulvic acid and humic acid, fulvic acid ratio by higher correlation coefficients (0.965**, 0.604** and 0.683**, respectively). However, clay content of soil showed negative relationship with humin and positive with fulvic acid but results were not reached to the level of statistical significance. Moreover, clay showed positive and significant relationship with humic acid (0.44*) and humic acid : fulvic acid ratio (0.741**). Similar result was also reported by Arshad and Lowe (1966). CEC of soil influenced all the fractions of humus significantly showing negative impact on humid (-0.820**) and positive on humic acid (0.801**), fulvi acid (-.676**) and humic acid : fulvic acid ratio (0.503**).

It was further revealed that 'R^2' values (Table 2) indicated that available N and P had significant negative relationship with humin,whereas N and P significantly and positively influenced with humic acid, fulvic acid and humic : fulvic acid ratio. Similar correlation was also reported by Joshi and Saxena (1972).

The results given in Table 3 pointed out that humin, humic acid, fulvic acid and HA:FA ratio were dependent on organic carbon, clay, CEC, available N,

Table 1. Simple correlation coefficient between humus fraction and soil properties

S.N.	Fractions/Soil properties	Humin (%)	Humic acid*%)	Fulvic acid (%)	HA:FA
1.	Organic carbon	-0.918**	0.965**	0.604**	0.683**
2.	Clay	-0.300	0.440*	0.043	0.741**
3.	CEC	-0.820**	0.801**	0.676**	0.503**
4.	Available N	-0.848**	0.749**	0.881**	0.745**
5.	Available P	-0.772**	0.823**	0.484**	0.693**
6.	Totan N	-0.736**	0.731**	0.630**	0.381**
7.	Total P	0.871**	0.906**	0.576**	0.653**
8.	Total S	-0.820**	0.801**	0.676**	0.503**

* Significant at 0.05 per cent level of probability ** Significant at 0.01 per cent level of probability

Table 2. Multiple regression equations showing relationship with humus fraction and soil properties

1.	Humin (Y_1)	+71.44-20.039** (Org. C) +1.39** (Clay)-0.0342 (Avail. N) +0.569** (Avail. P) - 0.1711(CEC)..... R^2=0.993**
2.	Humic acid (Y_2)	-21.192-24.220** (Org. C) - 0.581** (Clay) + 0.010 (Avail. N) - 0.498** (Avail. P) + 0.0126 (CEC) ..... R^2 = 0.892**
3.	Fulvic acid (Y_3)	+22.006-7.009** (Org. C) - 0.573** (Clay) + 0.0426 (Avail. N) + 0.204 (Avail. P) + 0.0300 (CEC) ..... R^2 = 0.903**
4.	Humic acid Fulvic acid (Y_4)	-0.485 + 4.389** (Orc. C) + 0.0264 (Clay) - 0.0088 (Avail. N) - 0.0536 (Avail. P) - 827.37** (CEC) ..... R^2 = 0.833**

* Significant at 0.05 per cent level of probability ** Significant at 0.01 per cent level of probability

Table 3. Simple correlation coefficient between humus fraction and yield parameters

S.N.	Yield humus^{-1} fractions	Sorghum		Wheat	
		Grain yield	Fodder yield	Grain yield	Straw yield
1.	Humin	-0.803**	-0.711**	-0.921**	-0.686**
2.	Humic acid	0.815	0.733**	0.910**	0.718**
3.	Fulvic acid	0.599**	0.437**	0.705**	0.469**
4.	HA:FA ratio	0.485**	0.554**	0.448**	0.436*

* Significant at 0.05 per cent level of probability ** Significant at 0.01 per cent level of probability

available P, total N, total P and total S and this dependency was noted from 83 to 99 per cent. The multiple regression equation between yield parameters and humus fractions also showed dependency of sorghum-grain yield on humin, humic acid, fulvic acid and HA:FA ratio to significant level (0.430*). Sorghum fodder yield and wheat grain yield and wheat straw yield were also found dependent on humus fraction to the tune of 59,86 and 53 per cent, respectively. As per rating, equation 1 and 3 are good fit to the data, however equation 2 and 4 are moderately fit. The R^2 values of all the equations are more than 0.66 and as per Sharma and Gangwar (1997), if R^2 value is above 0.66, equation is good to fit the multiple regression equation and in the present investigation R^2 value ranged from 0.833** to 0.993** and hence these R^2 value were good fit in all the equation.

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Effect of Different Levels of Major Nutrients on Yield of Wheat and Fertility Status of Vertisol

Wheat (*Triticum* spp.) is the second important food crop being consumed next to rice and contributed to the extent of 25 per cent of food grain. In India, the area under wheat is 244.3 lakh hectare with annual production of 571.6 lakh tonnes and the average yield of 2323 kg ha^{-1}. In Maharashtra, wheat is cultivated on about 6.80 lakh hectare area, with its annual production of 7.98 lakh tonnes and the average yield of 1,174 kg ha^{-1}. Average yield of wheat in our state is very low compared with yield values of 2,231 and 3,770 kg ha^{-1} from U.P and Punjab, respectively (Anonymous, 1996). In Vidarbha, wheat is being grown under 2.161 lakh hectare with its production of 2.045 lakh tonnes (Anonymous, 1997).

Agricultural production being an integrated interactive effect of soil-water-fertilizer-climate continuum, a wise scientific management of the complex system is crucial for enhancing crop productivity on a sustained basis without any detriment to the environmental ecology. Among the various inputs, water and fertilizer are considered as the two key inputs making maximum contribution to crop productivity. For any crop cultivar to achieve its genetic yield potential, efficient management of these two costly inputs together with synergistic interaction with other appropriate production factor is most critical to keep the "Green Revolution" evergreen without degradation of the natural resource base.

The present investigation was undertaken during the year 1998-1999 on the long term fertilization experiment started since 1988. There were twelve treatments replicated four times in a randomized block design comprised of NPK levels with and without FYM, S and Zn is given in Table 1.

The soils of the experimental site was characterized as Vertisols, family of Typic Haplusterts. The soil was slightly alkaline in reaction, medium in organic carbon, low in available nitrogen and phosphorus and high in available potassium. The soil was analyzed for different physico-chemical properties as described by

(Piper, 1966, Jackson, 1967, Subbiah and Asija, 1956).

Grain and straw yield data are presented in Table 1. Grain and straw yield data under various treatments were found statistically significant. Grain yield of 41.785 q ha^{-1} was obtained from 100 per cent optimal NPK when combined with 10 t ha^{-1} FYM (T_{11}) recorded significantly highest grain yield followed by T_5 (150 % NPK), T_4 (100% NPK) and T_8 (100% NPK + 10 kg S through gypsum). It was found that the grain yield increased significantly with the increasing levels of optimal NPK applied from 0 to 150 per cent and it varied between 1.67 and 33.71 q ha^{-1}. Naphade *et al.* (1993) observed that maximum grain yield of wheat was with application of 150 per cent of the recommended dose. Nanwal (1998) reported that conjunctive use of organic and inorganic fertilizers proved beneficial at all the levels in wheat.

Straw yield of 77.07 q ha^{-1} was obtained from 100 per cent optimal NPK when combined with 10 t ha^{-1} FYM (T_{11}) recorded highest straw yield followed by T_5 (150% NPK), T_4 (100% NPK), T_8 (100% NPK + 10 kg S through gypsum) and T_9 (100% NPK + 10 kg ha^{-1} Zinc sulphate). Straw yield obtained under FYM alone was found significantly lower than the yields from 100 per cent optimal NPK (T_4) alone and in combination with 10 t ha^{-1} FYM (T_{11}). Lal and Lal (1989) reported that combined application of NP and NPK increases grain and straw yield of wheat crop over N alone application. Singh (1991) pointed out that in wheat crop, grain and straw yield increased significantly with increasing levels of nitrogen and phosphorus.

Table 1. Grain and straw yield of wheat under different treatments

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1 – Control	1.67	3.052
T_2 – 50% NPK	13.205	24.302
T_3 – 75% NPK	16.53	29.977
T_4 – 100% NPK	26.63	48.880
T_5 – 150% NPK	33.71	64.887
T_6 – 100% N	11.542	21.347
T_7 – 100% NP	18.48	33.967
T_8 – 100% NPK + 10 kg S through gypsum	26.705	49.202
T_9 – 100% NPK + $ZnSO_4$ @ 10 kg ha^{-1}	25.615	47.357
T_{10} – 100% NPK – S – free	25.085	45.922
T_{11} – 100% NPK + FYM @ 10 t ha^{-1}	41.785	77.007
T_{12} – FYM @ 10 t ha^{-1} (*Kharif*)	4.085	6.830
SE(m)±	0.542	0.943
CD at 5%	1.571	2.733

The data regarding fertility status of soil before

Table 2. Available nutrient status under different treatments

Treatments	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})	Organic carbon (%)
T_1 – Control	176.39	7.125	221.72	0.1792
T_2 – 50% NPK	194.42	9.750	285.55	0.4167
T_3 – 75% NPK	197.58	10.875	305.70	0.4627
T_4 – 100% NPK	241.46	15.375	342.60	0.5470
T_5 – 150% NPK	268.91	20.250	389.70	0.5847
T_6 – 100% N	228.92	13.500	324.00	0.4280
T_7 – 100% NP	235.98	14.250	332.60	0.4665
T_8 – 100% NPK+10 kg S through gypsum	252.44	16.125	359.45	0.5275
T_9 – 100% NPK+$ZnSO_4$ @10 kg ha^{-1}	238.33	16.875	346.05	0.5312
T_{10} – 100% NPK – S – free	252.44	13.125	325.87	0.4970
T_{11} – 100% NPK + FYM @ 10 t ha^{-1}	307.32	22.125	463.67	0.7037
T_{12} – FYM @ 10 t ha^{-1} (Kharif)	188.15	10.500	305.72	0.5237
SE(m)±	2.56	1.601	22.13	0.0044
CD at 5%	7.43	4.639	64.10	0.0128

Table 3. Correlation of yield with available nutrients and organic carbon content

S.N.	Regression equation	'r' value
1	Yield = -47.766 + 0.294 n	+ 0.941**
2	Yield = -15.144 + 2.512 P_2O_5	+ 0.927**
3	Yield = -38.718+0.178 K_2O	+ 0.885**
4	Yield = -17.621+77.796 organic carbon	+ 0.819**

** Significant at 1% level

sowing of wheat crop are given in Table 3. The nutrient content in soil were highest in 100 per cent NPK when combined with 10 t ha^{-1} FYM, followed by 150 per cent NPK and 100 per cent NPK. Similar results are also reported by Ravankar *et al.* (1998). Application of 100 per cent RD NPK through S containing fertilizer increased the organic carbon, available N, P and K over 100 per cent recommended dose of NPK through S free fertilizer. Application of Zn in combination with recommended dose of NPK increased available, N, P and K over 100 per cent NPK. Similar results are also reported by Mathan *et al.* (1978).

Positive and highly significant correlation (Table 4) for yield with available N, P, K and organic carbon content was found, showing that yield of wheat increased linearly with increase in available nutrient status developed and organic carbon content. Regression equations obtained for these correlations of yield with available nutrient status are given in Table 4.

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Evaluation of Sweet Sorghum Cultivars for Quality Bagasse and its Bio-enrichment

With the increasing commercialization and derived demand for milk products, the livestock production is growing rapidly and is expected to continue in the future. The crossbred animals require special attention regarding nutritional aspects of feed. Hence, growing sorghum as fodder for livestock is the stabilizing force of the area under sorghum.

The bagasse from sweet sorghum has a higher biological value than that of from sugarcane when used as forage for animals. With the available newer technologies and energy efficiency in sugar industries bagasse can be saved and processed as feed or also used as a source in manufacturing paper. Bagasse can be successfully used for other cogeneration of electricity. However, feed usage of bagasse should be more focused. Sweet sorghum bagasse should be directed towards animal feed use or as a source of paper manufacture rather than for cogeneration of electricity as the economic benefits of feed usage and paper making can outweigh the benefits from electricity cogeneration.

Hence, this work attempt to study chemical properties of sweet sorghum bagasse and bio-enrichment of bagasse for animal feed.

The experiment was conducted with 14 sweet sorghum genotypes at Agro Product Development Research Centre, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. Fourteen sweet sorghum genotypes viz, HES-4, NSS-4, AKSSV-16, BJ-248, Wray, Keller, IS-

Table 1 : Sweet sorghum bagasse yield and its composition

Cultivars	Bagasse yield ($q\ ha^{-1}$)	Hemicellulose (%)	Cellulose (%)	Lignin (%)
HSE – 4	218.26	20.70	30.20	14.50
NSS – 4	269.09	16.40	29.95	13.40
AKSSV – 16	189.73	22.30	35.00	16.50
BJ – 248	210.50	21.85	33.35	15.55
Wray	302.35	24.70	36.05	16.45
Keller	247.63	20.15	30.55	12.65
IS – 8007	277.81	20.50	37.00	16.70
SSV – 84	185.26	17.85	32.30	15.55
Madhura	226.04	16.45	31.90	13.50
RSSV – 9	249.41	19.80	35.20	14.65
NSS – 104	252.51	22.15	35.55	17.25
IS – 20962	198.45	17.80	32.60	16.10
NSS – 208	125.02	20.50	30.50	14.80
AKSSV – 22	250.32	17.60	34.50	12.30

Table 2 : Sweet sorghum bio-enriched bagasse analysis

Treatments	Cellulose(%)	Crude protein (%)
Initial	33.47	3.12
After soaking in H_2SO_4	33.42	3.19
After sterilization	32.60	3.18
After ammonia addition	32.52	3.45
Inoculation with *Penicillium funiculosm* (Sterilize bagasse)	20.05	9.52
Inoculation with *Penicillium funiculosm* (Non sterilize bagasse)	22.38	6.27

8007, SSV-84, Madhura, RSSV-9, NSS-104, IS-20962, NSS-208 and AKSSV-22 were studied for their bagasse yield and its quality. Fertilizer dose of 120 : 60 kg N and P_2O_5 ha^{-1} was given. Half dose of N and full dose of P_2O_5 ha^{-1} were given at the time of sowing. Remaining half N was given at 30 days after sowing. Crop was harvested at physiological maturity. Ear heads were separated and stalks were passed through roller crusher to extract the juice. This bagasse remained after juice extraction allowed to dry and chipped. Hemicellulose, cellulose and lignin content were determined according to the method described by Anonymous (1978). The bagasse yield of different genotypes were also recorded. The bio enrichment study for improvement of bagasse quality was conducted. 15 kg of bagasse was soaked in 45 L of 0.5 N H_2SO_4 for overnight. Then sterilized at 15 psi for 15 minutes. Liquor ammonia was added @ 80 ml in 800 ml of water for 1 kg of substrate. After the evaporation of ammonia fumes, *Penicillium funiculosum* was inoculated @ 5 per cent. The fungus was allowed to grow on substrate for 3 days and the substrate was dried in sunlight till complete evaporation of moisture. Bagasse obtained after this treatment was analysed for its cellulose and crude protein content (Anonymous, 1984).

Results (Table 1) revealed that, bagasse yield obtained from different genotypes ranged between 302.35 to 125.02 q ha^{-1}. However, the maximum yield (302.35 q ha^{-1}) was recorded by Wray genotype followed by IS–8007 (277.81 q ha^{-1}). NSS – 208 showed the lowest bagasse yield (125.02 qha^{-1}) amongst all. Regarding hemicellulose, its highest per cent was found in Wray bagasse (24.70 %) followed by AKSSV-16 (22.30%). Whereas, its lowest content was recorded by NSS-4 (16.40 %). Cellulose content found to be maximum in IS-8007 (37.00%). Other genotypes also showed the higher content of cellulose in their bagasse. Although, NSS-4 noted the lower per cent of cellulose (29.95%), differences in hemicellulose and cellulose content may be due to genetic variation, which influenced the homopolysaccharides formation from phatosynthates. Considering lignin factor, it was put forth to note that the lowest content of lignin (12.30%) was recorded in AKSSV-22 bagasse followed by Keller (12.65 %). However, its higher content was obtained in NSS-104 (17.25%).

Results obtained from bio-enrichment study of bagasse (Table 2) inferred that due to inoculation of Cellulolytic fungus *Penicillium funiculosum* there was reduction in cellulose content up to 20.05 per cent in sterilize bagasse. Whereas, it was 22.38 per cent in without sterilize bagasse over its initial cellulose content (33.47 %). It was seen that ammonia addition treatment also helped to decrease the cellulose per cent in bagasse. Regarding crude protein content, it was noticed that the initial protein content of bagasse was 3.12 per cent and it increased up to 9.5 per cent and 6.27 per cent in the sterilized and without sterilize bagasse respectively.

Close examination of the results reveals that Wray and IS-8007 were found best high bagasse yielding genotypes in this study. Genotype NSS-4 and AKSSV-22 showed the lowest per cent of hemicellulose, cellulose and lignin respectively. Bio-enrichment study inferred that, by using Cellulolytic fungus @ 5 per cent improved the quality of bagasse by reducing its cellulose content, simultaneously increasing the crude protein per cent in sterilized bagasse treatment.

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Association and Metroglyph Analysis in Rice Genotypes (*Oryza sativa* L.)

The grain yield is of very complex nature in majority of cases because its expression depends upon several other plant characters, referred to as yield components. The genetic architecture of seed yield can be better resolved through component character rather than it's *per se* performance. To study the genetic variability present in large number of germplasm lines, metroglyph analysis (Anderson, 1957) was undertaken. Therefore, keeping this in view, the present study was carried out to investigate the association, direct and indirect effects and genetic variability using index score method among yield and yield attributing traits.

One hundred and ninety-eight rice germplasm lines along with six standard checks were grown under rainfed situation at the Research Farm, Indira Gandhi Agricultural University, Raipur, during *Kharif* 2000 in Augmented design. Six improved cultivars were used as checks, IR-36 and Poornima (early), Chapti gurmatiya and Mahamaya (medium) and Safri-17 and Basmati (late). Out of 198 germplasm accessions, 36 were from Madhya Pradesh state (15 from Jabalpur; 10 from Narsingpur; 10 from Damoh and I from Sagar) and 162 from Chhattisgarh (114 from Bastar; 40 from Ambikapur and 8 from Raipur). Five competitive plants were selected randomly for recording the observation on 13 quantitative characters. Averages of the data from the sample plants were used for association (Searle, 1961), direct and indirect effects and for genetic variability study using metroglyph index score method.

Knowledge of the relationships among the quantitative characters is of great importance in breeding for rice yield because it facilitates breeders to choose the most efficient selection criteria. The correlation coefficients (r) among the various traits measured in this study are shown in Table 1. The seed yield per plant exhibited highly significant and positive association with biological yield plant^{-1} (Shivani and Reddy, 2000), number of filled spikelets, harvest index (Lu *et al.,* 1988), plant height, number of tillers (Shanthakumar *et al.,* 1998), total number of spikelets (Reddy *et al.,* 1997) and hundred seed weight (Singh *et al.,* 2000 and Rani *et al.,* 2001).

The path coefficient analysis was carried out by using the correlation coefficients between the thirteen characters to restore direct and indirect effects of different characters on seed yield plant^{-1} (Table 1). The highest direct and positive effect of biological yield plant^{-1} on seed yield plant^{-1} was shown. In addition to this, high direct effects were also contributed by harvest index while, total number of spikelets and plant height showed moderate positive effect on seed yield. In contrary, number of unfilled spikelets showed negative and moderate direct effect on seed yield. Sarawgi *et al.,* 1997 and Ganesan *et al.,* 1998 had also reported similar results.

Morphological variations in rice germplasm were studied using score index and metroglyph methods. A total of 198 germplasm of rice and six check varieties were classified on the basis of days to 50 per cent flowering into three maturity groups viz., early, medium and late duration groups. Based on index score and metroglyph methods the index values of range of variability were divided into 4 groups using range. All traits except plant height and seed yield plant^{-1} were represented on X and Y axis. The performance of the genotype is denoted by its score and is presented by rays on the glyph. The two variables i.e., plant height and seed yield plant^{-1} are the selected characters. Plant height is used on the X-axis and the other, seed yield plant^{-1} is taken on the Y-axis, where the means of the seed yield are plotted against the means of plant height for each genotype. Thus each genotype is represented by a glyph on the graph. Apart from seed yield and the plant height, days to 50 per cent flowering, number of tillers, panicle length, number of filled spikelets, total number of spikelets, hundred-grain weight, kernel length and kernel breadth of rough rice are represented by rays on the glyph. The mean data on 8 characters of 81 early genotypes 45 medium genotypes and 78 late genotypes are used. All the genotypes considered here were arbitrarily divided into four groups. For instance, in early genotypes, for days to 50 per cent flowering showed four index scores, genotypes having days to 50 per cent flowering below 99.5 are given index score 1, the genotypes in between 99.5 to 103 is included in index-score 2, genotypes in between 103 to 106.8 are

Table1: Correlation and Path coefficient analysis of different characters on seed yield per plant.

Characters	PH	NT	PL	NFS	NUFS	TNS	HSW	BYP	HI	LRR	BRR	L: BRR	SYP (r)
PH	**0.125**	-0.022	-0.021	-0.048	-0.004	0.114	-0.020	0.306	-0.155	-0.014	-0.002	0.005	0.264**
NT	-0.028	**0.099**	-0.003	0.023	-0.021	-0.040	-0.017	-0.010	0.225	0.005	0.003	-0.001	0.227**
PL	0.072	0.008	**-0.037**	-0.025	-0.024	0.075	-0.033	0.139	-0.047	-0.015	0.007	0.004	0.116
NFS	0.062	-0.024	-0.009	**-0.097**	-0.023	0.241	-0.047	0.294	-0.114	-0.020	0.003	0.004	0.269**
NUFS	0.005	0.020	-0.008	-0.021	**-0.105**	0.117	-0.035	-0.031	-0.041	-0.008	0.002	0.006	-0.104
TNS	0.057	-0.016	-0.011	-0.094	-0.049	**0.250**	-0.052	0.255	-0.111	-0.020	0.003	0.004	0.216**
HSW	-0.025	-0.017	0.012	0.047	0.037	-0.133	**0.098**	0.054	0.078	0.026	-0.005	-0.004	0.168**
BYP	0.049	-0.011	-0.005	-0.031	0.003	0.069	0.005	**0.919**	-0.482	0.001	0.01	0.001	0.522**
HI	-0.222	0.025	0.002	0.012	0.005	-0.032	0.008	-0.508	**0.872**	-0.001	-0.004	0.003	0.355**
LRR	-0.041	0.001	0.012	0.045	0.019	-0.117	0.058	0.029	-0.038	**0.044**	0.003	-0.016	0.000
BRR	0.000	-0.011	0.001	0.011	0.008	-0.031	0.019	-0.051	0.161	-0.005	**-0.025**	0.013	0.090
L: BRR	-0.031	0.008	0.006	0.022	0.003	-0.054	0.018	0.002	-0.133	0.033	0.016	**-0.021**	-0.131

Residual effect= 0.09, Bold figures indicate direct effects; (r) = Correlation coefficient on seed yield per plant.

given index-score 3 and the genotypes having days to 50 per cent flowering above 106.5 days are considered in index-score 4. Similarly, all the other characters in early, medium and late duration genotypes are plotted in the graph and on each glyph a specific position is fixed for a particular character. The performance of a genotype is thus denoted by the index-score of that genotype. Metroglyph analysis has been used for variability assessment in rice (Kotaiah *et al.,* 1986). All the traits, except plant height and seed yield per plant showed high variability and the rest of the characters were represented by rays on the glyph (Singh *et al.,* 1986). Index values of range of variability were divided into 4 groups using class intervals. The preference of particular cultivars is denoted by its index-score. Metroglyph revealed that genotypes were quite distinct and fell into four groups (Chauhan *et al.* 1991).

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Effect of Nitrogen Fertilization on Yield and Yield Attributes of Soybean (*Glycine Max.* (L) Merril.)

Fertilizer application to soybean is an important practice as it is high value crop. Nitrogen being a constituent of protein plays important role in crop production. Although soybean can fix large amount of nitrogen the entire requirement cannot be met through nitrogen fixation, especially when yields are expected. All soils in India are low to medium in nitrogen content, therefore, application of nitrogen is frequently attempted. It is well known that soybean is an exhaustive crop and comparatively inefficient nitrogen fixer. (Song Haxing, Shensile, Ma Shuying (1977)). Therefore, additional supply of nitrogen may be required to boost up yield potential.

The present research work was carried out during *Kharif* season of 2001 at Department of Agricultural Botany, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. In split plot design with three replications and eight main along with three sub treatments. The cultivars TAMS – 38, PKV-1 and JS-335 were used for present study. P_2O_5 @ 75 kg ha^{-1} was applied uniformly as basal dose and K_2O was nil. The main and sub-treatments were:

Main treatments

N_0 = 0.0 kg N ha^{-1} (control)

N_1 = 30 kg N ha^{-1} (Basal)

N_2 = 30 kg N ha^{-1} (Basal) + 15 kg N at 45 DAS (days after sowing)

N_3 = 30 kg N ha^{-1} (Basal) + 30 kg N at 45 DAS

N_4 = 45 kg N ha^{-1} (Basal)

N_5 = 45 kg N ha^{-1} (Basal) + 45 kg N at 45 DAS

N_6 = 30 kg N ha^{-1} (Basal) + 2 % urea spray 45 DAS

N_7 = 45 kg N ha^{-1} (Basal) + 2 % urea spray 45 DAS

Sub-treatment

V_1 = TAMT-38

V_2 = PKV - 1

V_3 = JS - 355

The observations on number of nodules $plant^{-1}$ and yield contributing characters namely number of pods $plant^{-1}$, number of grains pod^{-1}, 100 seed weight, grain yield $plot^{-1}$, biological yield $plot^{-1}$ and harvest index were recorded. Cultivar and interactions mean differences were found non-significant (Table 1).

Maximum number of pods $plant^{-1}$ was noted in N_1 (65.66) while minimum in control (N_0) (38.44). N_1V_2, N_2V_2 showed highest number of pods $plant^{-1}$. In case of number of grains pod^{-1} it was maximum in N_5 (3.55) this finding corroborated the findings of (Benjamin and Hoover, 1971). Cultivar JS-335 showed significantly higher number of $pods^{-1}$plant than TAMS-38 and PKV-1. All N treatments had significantly higher 100-grain weight over N_0 and N_1. All treatments recorded significantly higher grain yield $plot^{-1}$ over N_0.

Cultivar TAMS – 38 showed significantly higher grain yield $plot^{-1}$. N_4V_1, N_5V_1 showed highest grain yield $plot^{-1}$. (Katiyar and Pant, 1993) Biological yield $plot^{-1}$ showed significant mean differences amongst N treatments, cultivars and interactions. Maximum biological yield $plot^{-1}$ was observed in N_5. All the treatments exhibited significantly higher biological yield than N_0. Cultivars exhibited similar trends N_5V_1 showed highest biological yield $plot^{-1}$. Treatments N_1, N_2 had significantly higher harvest index. Rest of the treatments were at par with control. Cultivar TAMS – 38 was superior to rest of cutlivars.

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Table 1 : Effect of nitrogen fertilization on yield and yield attributes of soybean

Treatments	No. of pods plant^{-1}				No. of grain pod^{-1}				100 seed wt. (g)			
	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean
N_0	38	37.33	40	38.44	2.33	2	2.66	2.33	10.6	10.68	10.63	10.63
N_1	65	67	65	65.66	2.33	3	3	2.77	11.76	11.8	11.93	11.83
N_2	65.33	67	63.33	65.22	2.33	3	3	2.88	12.78	12.63	12.71	12.7
N_3	62	60	59.33	60.44	3	2.66	3.33	3	12.86	12.72	12.81	12.79
N_4	61	63	59.33	61.11	3.33	3.66	3.33	3.44	12.92	12.98	12.9	12.93
N_5	53.33	58	57.33	56.22	3	4	3.66	3.55	12.51	12.6	12.58	12.56
N_6	63.33	61	62	62.11	3	3.66	3.33	3.33	12.6	12.71	12.65	12.65
N_7	58	55	54	55.66	2.33	2.66	3.33	2.77	12.5	12.57	12.51	12.52
Mean	58.25	58.54	57.33		2.75	3.08	3.2		12.31	12.33	12.34	
SE (m)±	0.6276	0.4103	1.6067		0.228	0.1482	0.4194		0.0313	0.0238	0.0675	
CD 5 %	1.896	—	3.33		0.69	0.425			0.094	—		

	Grain yield plot^{-1} kg				Biological yield plot^{-1} kg				Harvest index %			
	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean
N_0	0.29	0.28	0.27	0.28	1.008	0.98	0.99	0.99	29.15	29.183	28.05	28.79
N_1	0.3	0.3	0.39	0.33	1.06	1.05	1.04	1.05	29.15	28.7	34.65	30.83
N_2	0.38	0.33	0.3	0.34	1.11	1.1	1.11	1.11	34.32	29.96	27.92	30.73
N_3	0.38	0.34	0.33	0.35	1.26	1.25	1.21	1.24	33.74	27.92	28.01	29.89
N_4	0.41	0.34	0.33	0.36	1.34	1.35	1.34	1.36	29.63	95.77	25.24	26.88
N_5	0.4	0.38	0.34	0.37	1.4	1.39	1.38	1.39	28.91	27.75	24.98	27.21
N_6	0.39	0.35	0.33	0.36	1.38	1.35	1.34	1.35	28.69	26.59	25.75	26.67
N_7	0.29	0.29	0.29	0.29	1.14	1.14	1.11	1.13	23.39	25.84	25.83	25.05
Mean	0.36	0.33	0.32		1.21	1.2	1.19		29.62	27.71	27.44	
SE (m)±	0.0008	0.0003	0.0010		0.005	0.0027	0.0078		0.551	0.311	0.88	
CD 5 %	0.0026	0.0010	0.0028		0.015	0.0077	0.022		1.66	0.89	2.52	

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

Rice (*Oryza sativa* L) is the world's most important food crop after wheat. It is the staple food and also a major source of livelihood for more than 250 million households. The bulk of Asian population – the urban poor , landless rural population and the marginal farmers-spend more than half of their income on rice, being the dominant food staple (Singh *et al.* 2000). Although, a marked increase in area and productivity has decades, it is still very for level of some other countries. The main reason for low productivity is the lack of high yielding rice varieties adapted to different seasons, cropping systems and agronomic conditions. Thus, there is an urgent need of developing high yielding varieties of rice so that this crop can fulfill its potential in combating the malnutrition prevalent in primarily vegetarian population of our country.

Five midland rice varieties namely, R 1097-44-1, ORS 1206-25-1, Triguna, Mahamaya, R1057-1631-1 were undertaken for the study and was carried out at the Research Farm, Department of Plant Breeding and Genetics, IGAU, Raipur. The trial was conducted in RBD with 3 replications. Observations on five randomly selected plants were recorded on nine yield attributing traits *viz.,* plant height, number of tillers, panicle length, number of filled spikelets, number of unfilled spikelets, hundred seed weight, biological yield plant^{-1}, harvest index and seed yield plant^{-1}.

The estimates of phenotypic (PCV) and genotypic (GCV) coefficient of variation for nine yield attributing characters of midland rice varieties are represented in Table 2. Number of unfilled spikelets showed very high PCV along with high GCV, followed by harvest index and seed yield plant^{-1}. Characters like number of filled spikelets, hundred seed weight and plant height also showed high (> 20 %) PCV along with high GCV. Number of tillers and panicle length showed moderate (10-20 %) and low (< 10 %) PCV and GCV, respectively. These results are in confirmation with the findings of Rather *et al.* (1998), Verma and Mani (1998) and Ganesan *et al.* (1995). Heritability estimates in broad sense (Table 2) were high for hundred seed weight, plant height, harvest index and number of unfilled spikelets and moderate for seed yield, number of tillers and number of filled spikelets. It was low for the rest of the characters. Similar results were obtained by Patil *et al.* (1993), Chaudhary *et al.* (1980). The seed yield plant^{-1} exhibited highly significant and positive genotypic correlation (Table 3) with number of filled spikelets, hundred seed weight, number of unfilled spikelets and harvest index whereas, number of tillers was the only character which

Table 1: Mean performances of midland rice varieties for 9 yield attributing characters.

Source of variation	Mean sum of squares		
	Replication DF: 2	Treatment DF: 4	Error DF: 8
Plant height (cm)	1203.59	1183.81	43.52
Number of tillers	0.69	3.48	0.52
Panicle length (cm)	0.69	8.87	2.84
Number of filled spikelets	12012.00	90809.08	18583.70
Number of unfilled spikelets	8271.37	111583.31	5296.79
Hundred seed weight (g)	0.04	0.81	0.01
Biological yield per plant (g)	299.57	153.30	52.38
Harvest index (%)	81.84	537.85	19.84
Seed yield per plant (g)	3.41	68.81	9.48

Table 2: Genetic parameters of nine yield attributing characters in midland rice varieties.

Characters	Mean	Range		PCV	GCV	Heritability
		Min	Max.	(%)	(%)	
Plant height (cm)	94.01	82.87	128.73	21.89	20.74	89.7
Number of tillers	8.45	7.07	10.07	14.56	11.75	65.2
Panicle length (cm)	22.57	21.20	24.80	9.76	6.28	41.4
Number of filled spikelets	540.08	252.20	717.40	38.24	28.73	56.4
Number of unfilled spikelets	312.43	156.60	647.50	64.59	60.25	87.0
Hundred seed weight (g)	2.03	1.19	2.62	26.14	25.36	94.2
Biological yield per plant (g)	39.85	30.84	47.14	23.27	14.55	39.1
Harvest index (%)	29.04	7.31	40.38	47.77	45.24	89.7
Seed yield per plant (g)	11.36	2.95	14.74	47.60	39.13	67.6

Table 3: Phenotypic and genotypic correlation coefficients in 9 yield attributing characters of midland rice varieties

Characters		PH	NT	PL	NFS	NUFS	HSW	BYP	HI	SYP
Plant height (cm)	G	*1.000*	-0.002	0.845	0.759	-0.604	0.138	0.704	0.209	0.527
	P	*1.000*	0.045	0.619	0.610	-0.482	0.156	0.578	0.141	0.507
Number of tillers	G		*1.000*	-0.301	-0.802	0.791	0.967**	-0.353	0.922*	-0.988**
	P		*1.000*	0.125	-0.366	0.775	0.855	-0.465	-0.783	-0.514
Panicle length (cm)	G			*1.000*	0.616	-0.694	0.164	-0.396	0.529	0.387
	P			*1.000*	0.665	-0.315	0.166	0.341	0.366	0.554
Number of filled spikelets	G				*1.000*	-0.135	0.797	0.026	0.800	0.976*
	P				*1.000*	-0.743	0.649	0.430	0.687	0.951*
Number of unfilled spikelets	G					*1.000*	-0.902*	-0.215	-0.888*	0.931*
	P					*1.000*	-0.838	0.055	-0.811	-0.793
Hundred seed weight (g)	G						*1.000*	-0.323	0.945*	0.938*
	P						*1.000*	-0.132	0.878	0.803
Biological yield per plant (g)	G							*1.000*	-0.560	-0.123
	P							*1.000*	-0.297	0.330
Harvest index (%)	G								*1.000*	0.909*
	P								*1.000*	0.761
Seed yield per plant (g)	G									*1.000*
	P									*1.000*

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

showed highly significant but negative association with seed yield plant^{-1}. Characters, hundred seed weight and number of tillers were the only characters which showed highly significant but positive association with harvest index but number of unifilled spikelets was the only character which showed highly significant and negative association. Likewise, number of tillers showed positive and significant association and number of unfilled spikelets showed negative and significant association with hundred seed weight. Shivani and Reddy (2000) and Singh *et al.* (2000) also reported the similar pattern of association among the characters. The direct and indirect effects for nine characters are represented in Table 4. The results revealed that number of filled spikelets showed highest positive direct effect on seed yield plant^{-1}, followed by hundred seed weight. However, harvest index and biological yield plant^{-1} exerted high negative direct effect on seed yield. Number of filled spikelets showed positive indirect effect on seed yield via plant height. Hundred seed weight showed negative and harvest index showed positive indirect effect on seed yield through number of tillers. Likewise, number of unfilled spikelets

Table 4: Genotypic path-coefficients in 9 yield attributing characters of midland rice varieties

Characters	PH	NT	PL	NFS	NUFS	HSW	BYP	HI
Plant height (cm)	**-0.161**	0.001	0.020	0.674	0.053	0.097	-0.071	-0.084
Number of tillers	0.001	**0.171**	-0.007	-0.711	-0.070	-0.744	-0.036	0.409
Panicle length (cm)	-0.136	-0.051	**0.024**	0.547	0.061	0.114	0.040	-0.212
Number of filled spikelets	-0.122	-0.137	0.015	**0.887**	0.100	0.555	-0.003	-0.320
Number of unfilled spikelets	0.097	0.135	-0.016	-1.007	**-0.088**	-0.629	0.022	0.355
Hundred seed weight (g)	-0.022	-0.182	0.004	0.707	0.079	**0.697**	0.033	-0.378
Biological yield per plant (g)	-0.101	-0.113	0.060	-0.009	0.023	0.019	**-0.225**	0.224
Harvest index (%)	-0.034	-0.175	0.013	0.710	0.078	0.659	0.057	**-0.400**

Residual = 0.0236

showed negative and harvest index showed positive indirect effect on seed yield plant^{-1} through hundred seed weight. Similar results were also recorded by Ganesan *et al.* (1995), Singh *et al.* (2000) and Shivani and Reddy (2000). Thus it can be concluded that the characters, number of filled spikelets, hundred seed weight, harvest index and biological yield are of utmost importance as these can be considered for improving the seed yield plant^{-1}.

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Biological Management of Wilt of Chickpea

Wilt caused by *Fusarium oxysporum* f. sp. *ciceri* is most important disease of chick pea. *Trichoderma* spp. are recently introduced in controlling many soil borne pathogens. In present study, the beneficial effects of *Trichoderma* inoculation on soil borne pathogens has been studied under field conditions in different varieties of chickpea. Experiments were carried out in a wilt sick plot at the Agriculture Research Station, Badnapur. The seeds of highly susceptible (JG 62) and moderately resistant (BDNG 154) was obtained from ARS, Badnapur. Isolates of four *Trichoderma* spp. viz., *T. viride*, *T. harzianum*, *T. hamatum* and *T.koningii* were inoculated on potato dextrose broth. Standard commercial inoculant was made with carrier material and FYM. The factorial experiment laid in RBD was used for the experiment. Observations on seedling mortality (wilt count) were recorded at 30, 50 and 70 DAS, respectively and also the yield was recorded in g plot^{-1} and converted into kg ha^{-1}. The inoculations with *Trichoderma* spp. singly and in combinations had no significant effect on seedling emergence. However emergence of chickpea in field trials clearly indicated that *Trichoderma* used as seed + soil inoculation has improved the chickpea emergence as compared to soil inoculation alone. This increment however, statistically non significant. Similar variations due to different methods of inoculation had been reported by different workers in past (Harman *et al.*, 1980; Sivan et al., 1984). Gangopadhyay and Joshi (1997) reported better plant stand of cotton and chickpea with the soil application of *Trichoderma* than seed treatment alone.Seedling mortality in different methods of inoculation was significantly different except for the wilt

Table 1. Effect of *Trichoderma* inoculation on seedling emergence, seedling mortality and yield of chickpea

Treatments	Emergence	Wilt count (plants plot^{-1}) at				Yield	
	plants plot^{-1}	30 DAS	50 DAS	70 DAS	At harvest	g plot^{-1}	kg ha^{-1}
Soil inoculation	112.76	4.54	6.15	8.57	22.84	425.28	886.00
Soil + seed inoculation	116.79	3.66	5.09	7.54	20.44	450.45	938.00
SE±	2.27	0.22	0.25	0.37	0.97	13.61	—
CD at 5%	NS	0.60	0.71	NS	NS	NS	—
No inoculation	104.33	4.50	6.50	9.83	25.16	414.17	862.71
T. viride	117.00	4.33	6.33	9.66	21.66	430.83	897.41
T. harzianum	114.00	3.83	5.16	7.00	20.50	420.00	874.86
T. hamatum	115.00	4.00	5.50	7.83	23.50	456.67	951.24
T. koningii	110.00	4.33	6.33	8.83	20.50	435.83	907.83
T. viride + *T. harzianum*	121.00	4.50	6.00	8.66	19.50	455.83	949.49
T. viride + *T. hamatum*	115.83	3.66	4.83	7.00	21.33	435.83	906.10
T. viride + *T. koningii*	120.17	3.50	4.66	6.16	20.66	416.67	867.92
T. harzianum + *T. hamatum*	112.83	4.16	5.66	8.33	20.00	500.00	1041.50
T.harzianum + *T. koningii*	111.33	4.33	5.50	7.33	20.16	481.67	1003.31
T. hamatum + *T. koningii*	120.50	4.00	5.33	8.00	19.18	519.17	1081.43
SE (m) ±	5.32	0.51	0.60	0.86	2.27	31.91	—
CD at 5%	NS	NS	NS	NS	NS	NS	NS
M x I							
SE (m) ±	7.53	0.73	0.85	1.22	3.22	45.13	—
CD at 5%	NS	NS	NS	NS	NS	NS	

count recorded at 70 DAS and at harvest. Soil inoculation alone recorded highest wilt count, while seed + soil inoculation recorded the minimum wilt count at 30, 50, 70 DAS and at harvest. The combination of *T. viride* + *T. koningii* recorded the minimum wilt count at 30 DAS (3.5 plants/plot), while combination of *T. hamatum* + *T. koningii* recorded the lowest wilt count at harvest (19.18 plants plot $^{-1}$). The results obtained in present investigation are in full agreement with those reported in the past. Sivan *et al.* (1984) reported significant reduction in seedling mortality of cotton when seeds were inoculated with *T. harzianum*. Xu *et al.* (1993) observed reduction in seedling mortality with the application of *Trichoderma* similarly.

Soil + seed inoculations of *Trichoderma* spp. recorded higher yield (938 kg ha^{-1}) as compared to soil inoculation alone (886 kg ha $^{-1}$), although the differences in the yields were statistically non significant. The inoculations of different *Trichoderma* spp. singly and in combinations considerable influenced the yield in chickpea. The combination of *T. hamatum* + *T. koningii* recorded maximum yield (1081.44 kg ha $^{-1}$), followed by *T. harzianum* + *T. hamatum* (1041.50 kg ha $^{-1}$) and *T. harzianum* + *T. koningii* (1003.31 kg ha^{-1}). De et al. (1996) studied the comparative efficacy of biocontrol agent of chickpea using *T. harzianum*, *T. viride* and *Bacillus subtillis* and reported significant disease reduction with increase in seed yield of chickpea with the application of biocontrol agent.

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Goniophthalmus halli an Active Larvo-Pupal Parasitoid in Pigeonpea Eco-System of Vidarbha

Pigeonpea is a major pulse crop cultivated in Vidarbha region of Maharashtra as inter-crop and as a sole crop. There are about 250 species of insects reported on this crop, out of which *Helicorpea armigera* is a major one. Aherkar *et. al.*, (2002) reported 100 per cent loss due to *H. armigera* on pigeonpea.

To know the effective parasitic fauna on this pest in pigeonpea eco-system, the present study was conducted for which the *Helicoverpa* larvae were collected from the pigeonpea field from 12th November, 2003 to 8th Jan. 2004 i.e. from bud formation stage to the maturity of the crop. Total 15 larvae were collected randomly at an interval of 8 days and were replicated 5 times. The collected larvae were reared up to adult emergence.

From the collected larvae the active parasitiods recorded were *Apanteles* sp., *Eriborus* sp., *Campoletis chlorideae* and *Goniophthalmus halli*. Out of these, the most active parasitoid was *G. halli*. It is a larvo-pupal parasitoid belonging to the family Tachinidae of order Diptera. Female of this fly lays a single egg in the head region of the larva from which the maggot emergs and enters inside the body of larva leaving a black spot on the head region of the larva. The maggot feeds on the larva, but such parasitised larva pupates and after pupation of larva the white colour maggot is found to emerge out of the pupa, which is found to pupate out side the host pupa in brown colour puparium from a single pupa a single maggot emerges out.

The activity of this parasitoid was recorded from collected larvae of 19th Nov. and it was found active till 17th Dec., as detailed in Table 1.

Table 1. Average per cent parasization recorded due to G. halli.

S.N.	Date of collection	Average % parasitization
1.	12 Nov. 03	0%
2.	19 Nov. 03	21.43%
3.	26 Nov. 03	20.00%
4.	03 Dec. 03	33.33%
5.	10 Dec. 03	36.36%
6.	17 Dec. 03	33.33%
7.	24 Dec. 03	0%

The activity of this parasitoid in Vidarbha region is studied on pigeonpea for the first time. However, Bilapate (1989) reported the activity of this parasitoid on *H.armigera* in Marathawada region of Maharashtra.

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Population Dynamic of *Chrysoperla carnea* in Various Cotton-Based Intercropping Systems

Cotton is the major agricultural consumer crop as well as basic resource for thousands of industrial products manufactured in India and plays an important role in national economy (Mayee and Rao, 2002). The area under this crop in India is about 76.10 lakh ha with production of 167.5 lakh bales and productivity of only 375 kg lint ha^{-1} as against world average productivity of 620 kg lint ha^{-1} (Anonymous, 2004). Owing to the importance of cotton crop, boosting of its productivity is of prime importance. Among several factors responsible for its low productivity, the most limiting factor is the pest menace.

The farmers are using chemical pesticides to manage this pest menace (Agrawal *et. al.*, 1979). The indiscriminate use of pesticides resulted in to several problems including disturbances in natural balance of pests and their natural enemies. Several workers have been reported the effective role of natural enemies in pest management, hence study was undertaken to see the population dynamic of *Chrysoperla carnea*, a natural enemy of various pest of cotton in different cotton based intercropping system.

The material required and used during the study was provided by the Department of Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was conducted in Randomized Block Design with three replications and eight treatments of intercropping in 1:1 proportion including sole cotton as a

Population dynamics of Chrysopa in different intercropping system

Treatments	Number of Chrysoperla $plant^{-1}$ in different meteorological weeks								Average
	35	36	37	38	39	40	41	42	
T_1 - Sole cotton	1.00	1.66	1.0	1.66	2.66	2.33	1.33	1.66	1.66
	(1.22)	(1.46)	(1.17)	(1.46)	(1.76)	(1.67)	(1.34)	(1.46)	(1.44)
T_2 - Cotton + Greengram	1.66	2.33	1.66	1.66	2.33	3.00	1.33	1.66	2.16
	(1.46)	(1.67)	(1.46)	(1.46)	(1.67)	(1.85)	(1.34)	(1.46)	(1.54)
T_3 - Cotton + Blackgram	1.33	1.66	1.66	1.00	1.66	1.66	1.60	2.33	1.62
	(1.35)	(1.46)	(1.46)	(1.17)	(1.46)	(1.46)	(1.46)	(1.67)	(1.43)
T_4 - Cotton + Cowpea	1.0	2.33	2.33	2.66	3.00	3.00	2.33	3.00	2.45
	(1.22)	(1.67)	(1.67)	(1.94)	(1.85)	(1.85)	(1.67)	(1.85)	(1.71)
T_5 - Cotton + Sorghum	0.0	1.00	0.33	1.66	3.00	1.00	0.33	1.00	1.04
	(0.70)	(1.17)	(0.87)	(1.46)	(1.85)	(1.17)	(1.87)	(1.17)	(1.15)
T_6 - Cotton + Maize	1.33	0.66	0.66	6.00	4.33	2.33	0.66	1.33	1.95
	(1.35)	(1.05)	(0.99)	(2.54)	(2.18)	(1.56)	(1.22)	(1.34)	(1.52)
T_7 - Cotton + Marigold	3.0	2.66	2.66	3.00	3.33	2.66	2.33	2.66	2.78
	(1.73)	(1.85)	(1.76)	(1.85)	(2.09)	(1.76)	(1.67)	(1.76)	(1.80)
T_8 - Cotton + Soybean	1.00	2.33	2.33	1.66	1.33	1.66	1.00	1.00	1.53
	(1.22)	(1.67)	(1.67)	(1.46)	(1.17)	(1.44)	(1.17)	(1.17)	(1.37)
Total	10.32	14.63	12.63	19.3	21.64	17.64	10.97	14.64	-
Average	1.29	1.82	1.57	2.41	2.70	2.20	1.37	1.83	-
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) $\pm$	0.404	0.141	0.154	0.138	0.142	0.204	0.135	0.150	0.14
CD at 5%	-	0.398	0.433	0.389	0.399	-	0.381	0.421	0.41
CV (%)	-	16.31	19.29	14.37	13.91	-	17.81	17.46	16.42

(Figure in parentheses are x + 0.5 transformation)

control crop. The experiment conducted during 2003-04 at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola under the unprotected condition. The observations on the population of *Chrysoperla carnea* was recorded weekly on randomly selected 5 plants from net plot on whole plant basis and from this average population plant^{-1} was worked out. The data obtained were transformed appropriately and put to statistical analysis to test the level of significance of various treatments as per Gomez and Gomez (1984) and the results are given under experimental findings.

The observations recorded in Table revealed that the population of *Chrysoperla carnea* was found statistically significant in different intercropping treatments in each meteorological week (MW) from 35th to 42nd, except 35th and 40th M.W. when the population was non-significant. The highest population of *chrysoperla* (2.78 plant^{-1}) was found on cotton intercropped with marigold, followed by cotton + cowpea, cotton + greengram, cotton + maize, sole crop of cotton and cotton + black gram intercrop systems, regarding the population of 2.45, 2.16, 1.95, 1.66 and 1.62 plant^{-1}, respectively. All the above six treatments of intercrop were found statistically at par with each other.

However, cotton + sorghum intercrop recorded the lowest population i.e. 1.04 plant^{-1} and it was statistically at par with that of cotton + soybean, cotton + black gram, sole cotton, cotton + maize and cotton + green gram intercrop systems. In general, only the two intercropping systems viz. cotton + marigold and cotton + cowpea were found very effective in conservation of *Chrysoperla carnea* on cotton crop.

Wu (1986) also reported that the dominant natural enemies were markedly increased when cotton is intercropped with food crops attracting naturl enemies, which were effective in controlling noctuids and *Aphis gossypii*. The dominant sp. was *Chrysopa* spp. during mid June to early September. Likewise Swaminathan *et. al.* (1999) also reported that cotton with cowpea in paired row system favoured *Chrosoperla carnea*, which conforms the present results.

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Evaluation of Thiamethoxam (Cruiser 70 WS) Towards its Phytotoxicity and Effect on Natural Enemies of Insect Pests on Hybrid Sorghum

A field trial in Ramdomized Block Design was conducted at farm of sorghum Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during late *Kharif* season of 2003 to know the phytotoxicity of Thiamethoxam 70 WS (cruiser) as seed dresser in various concentrations to sorghum crop. The variety CSH 14 was sown on 4.8.2003 at the spacing at 45 x 15 cm in the plot size 3.00 x 1.35 m. The seed treatment was applied by preparing slurry by mixing the required quantity of cruiser 70 WS with 10-20 ml. of water for each kg of seed to be treated. This slurry was added to the seed and rotated in plastic bag until the seed were evenly covered. The thiamethoxam 70 WS (cruiser) was treated to sorghum seed @ 2 g.a.i., 3 g.a.i., 6 g.a.i. and 12 g.a.i. kg^{-1} of seed and evaluated along with untreated control.

The observations on phytotoxicity as leaf injury, wilting, vein clearning, necrosis, epinasty and hyponasty were recorded, 1,2,7,10,15 and 30 days after germination and the population of natural enemies was counted on 30 and 45 days after germination in each treatment.

The results indicated that none of the treatments of the test product cruiser 70 WS (Thiamethroxam) shown any type of phytotoxic sympotoms on sorghum leaves/ seedlings at different concentration used in the experiment.

The data in table regarding the natural enemies i.e. ladybird beetle, the results were statistically significant at 30th days observations. The highest 19.75 LBB $plot^{-1}$ was observed in the treatment thiamethroxam (cruiser 70 WS) @ 12 g.a.i. kg^{-1} seed and found significantly superior to rest of the treatments. Other doses of thamethroxam 70 WS treatment were at par with untreated control.

The maximum of 20.50 LBB $plot^{-1}$ was noticed on 45th day after crop emergence in the treatment of thiamethroxam 70 WS (cruiser) @ 12 g.a.i. kg^{-1} seed and found significantly superior to rest of the treatments. The remaining doses of thiamethroxam treatments were at par with untreated control except the treatment thiamethroxam 6 g.a.i. kg^{-1} seed (11.50 LBB $plot^{-1}$).

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

Table 1. Average ladybird population $plot^{-1}$ in the evaluation of thiamethroxam 70 WS (cruiser) and effect on Natural enemies of insect pests on sorghum

S.N.	Treatments	Av. LBB population on	
		30th day	45th day
1.	Thiamethoxam 70 WS (cruiser) 2 g.a.i. kg^{-1} seed	3.25	3.25
2.	Thiamethoxam 70 WS (cruiser) 3 g.a.i. kg^{-1} seed	5.25	6.25
3.	Thiamethoxam 70 WS (cruiser) 6 g.a.i. kg^{-1} seed	10.00	11.50
4.	Thiamethoxam 70 WS (cruiser) 12 g.a.i. kg^{-1} seed	19.75	20.50
5.	Untreated control	2.75	4.75
	'F' test	Sig.	Sig.
	SE (m) ±	2.63	1.77
	CD at 5%	7.39	4.99
	CV %	14.20	18.43

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Effect of Chelated Micronutrients on Brinjal Shoot and Fruit Borer

In order to ascertain the role of chelated micronutrients in the resistance of brinjal plants to *Leucinodes orbonalis* Guen. an experiment was conductd using susceptible variety "Puneri Kateri". The susceptibility of this variety was tested during field screening of twenty four genotypes against *L. orbonalis* at Department of Entolomogy, Dr. PDKV,Akola in 2000-2001. Chelated micronutrients were obtained from AVA chemicals, Mumbai. The chelated micronutrients viz. Fe-EDTA (2.00 ppm), Mg-EDTA (2.00 ppm), Zn-EDTA 2.00 ppm and Boron-Iron complex (1.00 ppm) were used for the foliar spray by keeping untreated susceptible variety as control. Concentrations were taken as suggested by Panda *et. al.* (1975). The study was undertaken on 60 days old potted brinjal plants. The moths were kept inside the portable nylon field cages. Each treatment was replicated for four times. Five pairs of freshly emerged moths were released inside the cage during the dusk for oviposition and the total number of eggs laid on each plant were recorded on the fourth day of emergence.

In another related experiment each of the treated as well as untreated brinjal plants were artificially infested with five just hatched larvae released over the apical shoots in order to determine the survival percentage. Observations were taken 72 hours after infestation. the top shoots and leaves were sampled uniformly from all the plants under treatment. The samples were oven-dried and used for analysis. Ash contents as influenced by various treatments were also estimated in the vegetative parts of the brinjal plant.

The data(Table 1) indicated that all the chelated micronutrients significantly suppressed the feeding of first instar larva as compared to control. It was observed that only 20 per cent first instar larvae could survive on susceptible cultivar, 'Puneri Kateri' after spraying with Fe-EDTA and 30 per cent due to Mg-EDTA as compared to control (65%). Besides this, the weight of the survivors was remarkably lower (3.125 to 3.675 mg) in all the treatments as compared to that of the control (4.875 mg larva^{-1}).

Table 1. Oviposition and feeding on shoots of brinjal (Cv. 'Puneri Kateri') as influenced by chelated micronutrients

Treatments	Chelated micronutrients	Survival of 1st instar larvae (%)	Av. Wt. of survival larvae (mg)	Ovipositional preference (eggs plant^{-1})	Ash content in the shoot (%)
T_1	Zn-EDTA	25.00	3.250	22.00	10.96
	(2.00 ppm)	(29.72)			
T_2	Mg-Chelated	30.00	3.675	26.25	10.18
	(2.00 ppm)	(32.89)			
T_3	Fe-EDTA	20.00	3.125	22.00	11.48
	(2.00 ppm)	(26.56)			
T_4	Bo-Fe complex	20.00	3.175	20.25	11.44
	(1.00 ppm)	(26.56)			
T_5	Control	65.00	4.875	59.50	0.09
	(unsprayed)	(53.98)			
	'F' test	Sig	Sig	Sig	Sig
	SE (m) ±	2.60	0.087	1.77	0.58
	CD at 5%	7.72	0.258	5.27	1.72
	CV %	15.30	4.81	11.89	9.58

These chelated micronutrients also significantly acted as ovipositional deterrent by recording 20.25 to 26.25 eggs plant^{-1} as compared to control 59.50 eggs plant^{-1}. Hence, the susceptible cultivar like 'Puneri Kateri' could protect by enhancing the resistance ability imparted by foliar sprays of chelated micronutrients over control. However, all the treatments were statistically at par with each other and signficantly superior over control.

The data (Table 1) indicated that significantly more ash content were recorded in Fe-EDTA and Bo-Fe complex treated plants (11.48 and 11.44%, respectively), followed by Zn-EDTA and Mg-chelated treated plants (10.96 and 10.18%, respectively) as compared to control (9.09%).

The overall result indicated that there was decreasing level of survival, weight of survived larva and oviposition with increasing percentage of ash content. it can be inferred that the foliar spray of chelated micronutrients enhanced the level of ash contents in the susceptible cultivar, which imparted resistance against the brinjal shoot and fruit borer by antibiosis mechanism of resistance.

Panda *et. al.*, (1975) and Patil *et. al.*, (1994) reported high level of ash content in the shoots of resistant cultivars which suppressed the pest population.

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Evaluation of Some Sorghum Nursery Lines for Resistance to Shoot Pests

Fourty six sorghum nursry lines were evaluated for the resistance to shoot fly and stemborer at Sorghum Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Kharif* season of 2000. The experiment was conducted in a Ramdomized Block Design and each entry was replicated thrice in a plot size of 3.00 x 0.90 m with the spacing of 45 x 15 cm. All the agronomic package of practices were followed to raise good crop without plant protection measures. The observations on dead hearts due to shoot fly were recorded on 20th day after emergence of crop by counting total plants and plants showing dead hearts. Similarly, the observations on stem borer leaf injury were recorded on 60th day and stem borer peduncle damage at harvest. The data, thus obtained, were transformed into arc sine and analysed statistically.

The data in Table 1 indicated that there were significant differences within the entries in case of shoot fly dead hearts, stem borer leaf injury and peduncle damage.

I) Shoot fly dead hearts on 20th day

The resistant check entry IS 2312, recorded significantly lowest i.e. 25.28 per cent dead heart and found superior than rest of the entries. However, five entries viz, SR 770-7, SU 663, RSE 9745, AKENT 12, AKENT 13, recorded upto 50 per cent encidence and found promissing than other entries.

II) Stem borer leaf injury

The results were statistically significant : The entry SR 1333 recorded the minimum of 19.10 per cent leaf

Table 1. Reaction of various sorghum nursery lines to shoot pests

S.N.	Entry	Shoot fly Av. % dh		SB LIP %		SB PD %	
1	SR666	58.35	(49.87)	23.20	(28.77)	20.85	(27.06)
2	SR 770-7	40.46	(39.44)	30.40	(33.34)	25.00	(29.88)
3	SR 833-21-1	80.30	(63.71)	36.95	(37.43)	11.25	(19.56)
4	SR 970-2	62.75	(52.51)	26.67	(30.91)	21.25	(26.95)
5	SR 1022-1	56.75	(48.88)	46.10	(42.90)	30.00	(33.21)
6	SR 1030-1	89.45	(48.88)	23.61	(29.06)	21.10	(27.33)
7	SR 1333	83.20	(65.89)	19.10	(25.90)	25.00	(29.88)
8	SR 1483	86.10	(68.20)	21.75	(27.73)	22.50	(28.28)
9	SR 1660-1	83.45	(66.55)	32.80	(34.91)	20.00	(26.56)
10	SR 1676-1	60.85	(51.27)	28.75	(32.22)	16.70	(24.12)
11	SR 1713-1	66.65	(54.73)	22.85	(28.47)	10.00	(18.43)
12	SR 1738	75.40	(60.45)	36.07	(36.91)	17.15	(24.39)
13	SR 1992	74.60	(59.86)	39.25	(38.79)	17.15	(24.39)
14	SR 2324	67.45	(55.21)	27.55	(31.59)	12.15	(20.32)
15	SR 2348	58.85	(50.11)	23.75	(29.13)	22.50	(28.28)
16	SRF 113-8	73.20	(58.83)	38.11	(38.09)	11.25	(19.56)
17	SRF 142	77.22	(61.98)	36.20	(36.98)	18.25	(25.16)
18	SRF 254-9	61.75	(58.87)	29.96	(33.15)	13.35	(21.27)
19	SRF 269	78.65	(62.49)	39.41	(38.84)	30.00	(33.21)
20	SRF 321	82.80	(65.61)	30.96	(33.79)	24.30	(29.44)
21	SRF 2102	73.20	(58.83)	35.90	(36.80)	15.00	(22.50)
22	SUR 879	64.00	(53.17)	42.55	(40.69)	22.50	(28.28)
23	SUR 880	81.65	(64.81)	31.10	(33.89)	15.00	(22.50)
24	SU 663	50.00	(45.00)	25.90	(30.59)	17.15	(24.39)
25	SU 556	73.75	(59.21)	38.05	(38.06)	33.30	(35.24)
26	RSE 9714	55.80	(48.05)	36.95	(37.43)	30.00	(33.21)
27	RSE 9727	56.25	(48.61)	43.75	(41.40)	25.00	(30.00)
28	RSE 9741	56.95	(48.99)	37.51	(37.74)	18.35	(24.55)
29	RSE 9745	50.00	(45.00)	34.65	(36.03)	29.15	(32.62)
30	RSV 50 K	65.00	(54.21)	55.00	(47.88)	24.30	(29.44)
31	RSV 54 K	50.35	(49.88)	28.15	(32.00)	16.25	(23.63)
32	RSV 65 K	63.50	(52.83)	39.85	(39.13)	20.00	(25.56)
33	RSV 77 K	79.66	(63.28)	44.85	(42.04)	20.85	(27.06)
34	RSV 78 K	69.80	(56.46)	47.50	(43.70)	10.55	(18.94)
35	RSV 79 K	78.90	(62.66)	42.20	(40.50)	15.00	(22.50)
36	AKENT 12	41.45	(40.07)	30.50	(33.52)	10.00	(18.43)
37	AKENT 13	49.25	(44.56)	26.10	(30.70)	16.25	(23.63)
38	PFGS 97	57.55	(49.35)	30.55	(33.36)	23.60	(29.05)
39	PFGS 98	53.80	(47.19)	45.00	(42.11)	16.25	(23.63)
40	PFGS 100	67.95	(55.52)	46.20	(42.82)	18.25	(25.16)
41	IS 2312 (R Check)	25.28	(30.13)	44.05	(41.57)	16.25	(23.63)
42	DJ 6514 (S Check)	87.10	(69.32)	24.85	(29.97)	18.15	(25.18)
43	SE 1	56.65	(48.83)	36.67	(37.24)	17.15	(24.39)

Cont....

S.N.	Entry	Shoot fly Av. % dh		SB LIP %		SB PD %	
44	SE 2	61.80	(51.82)	38.56	(38.35)	22.50	(28.28)
45	SE 3	65.70	(54.21)	43.80	(41.42)	16.25	(23.63)
46	SE 4	67.95	(55.52)	42.35	(40.58)	26.50	(30.90)
	F' Test	Sig		Sig		Sig	
	SE (m) ±	3.07		2.21		2.43	
	CD at 5%	8.47		6.09		6.71	
	CV%	7.94		8.66		13.25	

injury and found significantly superior over rest of the entries including resistant check IS 2312 except the entries SR666, SR 970-2, SR 1031-1, SR 1483, SR 1333, SR 1713-1, SR 2324, SR 2348, SU663, AKENT 13 and DJ 6514.

III) Stem borer peduncle damage :

Two entries viz. SR 1713-1 and AKENT12, recorded minimum 10 per cent peduncle damage amongst all the entries and found at par with resistant check IS2312, (16.25%). All the remaining entries except SR 1022-1, SRF269, SU 556, RSE 9714, RSE 9745 and SE 4 were at par with resistant check IS 2312.

The results of the present study are in agreement with the results of Jhansi (2004) who reported some forage entries as resistant in single cut and multi cut trials.

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Biology of *Spilosoma obliqua* Walker and its Natural Enemies on Soybean

Soybean is important oil seed and pulse crop. It contains 20 per cent edible oil and 40 per cent protein. It also helps in maintaining soil fertility and fixes atmospheric nitrogen. Among various pests of soybean, *Spilosoma obliqua* walker is also known as Bihar hairy caterpillar is the most dominant field pest. Infestation of *S. obliqua* during initial podding of late sown plants resulted in yield losses of about 80 per cent, whereas infestation at an advanced stage resulted in satisfactory seed development, but a reduction in seed size by about 40 per cent (Ram, *et al.*, 1989). Larvae of *S. obliqua* are much susceptible to parasitoides and pathogens and found to take a heavy toll of the young pest (Bhattacharjee, 1986). Looking to the apparent importance of the pest, very little information on biology of *S. obliqua* on soybean is available under Nagpur region. Keeping this in view, the present studies were undertaken to study the biology of *S. obliqua* and its natural enemies on soybean in the Department of Entomology, College of Agriculture, Nagpur during *Kharif* season of 2002-03.

To observe the development of larvae, the eggs which were laid by the adults were separated and larvae of first instar was kept in petridish individually and fed on tender soybean leaves. Before entering the larvae into second instar, they were transferred to the glass goglets with the help of hair brush and fed daily with soybean leaves. The different larval instars were decided on the basis of casted exuviae. When the larvae were finally matured, the bottom of the glass goglet was provided with fine layer of soil for pupation. The emerged males and females were paired and transferred to bell jar. The studies on the colour, shape, size and periods of eggs, larva, pupa and adults were studies. The pre-oviposition, ovipostion and post-oviposition periods and longevity of adults were also recorded. In addition to biology, the information regarding the natural enemies affecting *S.*

obliqua was also recorded. The experimental findings of the present investigations on the biology of *S. obliqua* on soybean are presented in Table 1, 2 and 3.

Eggs: The eggs were spherical and light green in colour and laid in batches on the leaves, but the egg colour changes to black before hatching. Incubation period was ranged from 4.75 to 6.17 days with an average of 5.44 days (Table-2). The observations are very much similar with the findings of Singh and Gangrade (1974[a]) who reported the incubation period ranged from 6–9 days.

Larva: The larva passed through seven instars. The average body length and width of head capsule of first, second, third, fourth, fifth, sixth and seventh instar larva was 4.58 mm, 8.46 mm, 13.08 and 1 mm, 18.5 and 1.25 mm, 24.41 and 1.79 mm, 29.13 and 2.33 mm and 37.2 and 2.79 mm, respectively (Table 1). The width of first and second instar was not recorded. The total larval period lasted for 25.03 to 31.66 days with an average of 27.8 days (Table-2).

Pupa: The pupa was dark brown in colour and observed in soil at 3 – 5 cm depth. Larva goes into pupation by spinning a coccon around its body with silken thread. The length of pupa measured 14 to 16 mm with an average of 14.91 mm and width of pupa ranged from 4 to 5 mm (average was 4.58 mm) (Table 1). The pupal duration was from 11.04 to 13.21 days with an average of 12.06 days (Table-2). The results of Singh and Gangrade (1974[b]) are comparable with the present findings regarding larval and pupal morphology.

Adult: The head of moth was yellowish in colour with dark black compound eyes. The female moths were comparatively bigger in size than males. Antennae were filiform type. The length of body and width of thorax was 19.25 mm and 5.33 mm in female and 15.33 mm and 4.25 mm in male, respectively (Table-1). The females had shorter life span (5.02 days) than the males i.e. 7.21 days. The female fecundity ranged from 335 to 1280 eggs with an average of 742 eggs per female (Table-2). The above findings are comparable with the observations of Singh and Gangrade (1974[a]).

Pre-mating and mating period: The average pre-mating and mating periods were 15.18 and 4.58 hr, respectively (Table 2).

Duration of entire life span: From the present studies it was noted that the total life cycle of *S. obliqua* male and female completed their life period in 52.51 and 50.32 days, respectively (Table-2).

Natural enemies: The observations on mortality due to natural enemies are given in Table 3. The larvae which were collected from the field and observed to have been attacked by the natural enemies i.e. *Apanteles*, Tachinid fly and fungus. *Apanteles* sp. was found emerging from the second instar larva and recorded 2.5, 12.5 and 7.5 per cent mortality. The total mortality due to natural enemies was 22.5 per cent. It indicated that, it caused higher mortality when the larva was in the younger stage. Shetgar *et al.* (1990) studied that the larvae of *S. obliqua* were parasitized by *Apanteles obliquae* and *A.*

Table 1: Measurement of different stages of *S. obliqua*

Stage	Length (mm)			Width (mm)		
	Min.	Max.	Av.	Min.	Max.	Av.
Larva						
I instar	4	5.5	4.58	-	-	-
II instar	7.5	10	8.46	-	-	-
III instar	11	15	13.08	1	1	1
IV instar	16.5	22	18.5	1	1.5	1.25
V instar	21	28.5	24.41	1.5	2	1.79
VI instar	26	32.5	29.13	2	2.5	2.33
VII instar	31.5	42	37.2	2.5	3	2.79
Pupa	14	16	14.91	4	5	4.58
Adult						
Male	12.5	19	15.33	3	5	4.25
Female	16.5	22	19.25	4	6	5.33

Table 2: Period of various stages of *S. obliqua* reared on soybean

Stages	No. Observed	Min.	Max.	Av.
Egg period	20	4.75	6.17	5.44
Larval period	12			
I instar		2.92	3.13	3.06
II instar		4.12	4.29	4.20
III instar		4.75	5.83	5.42
IV instar		4.91	6.91	5.75
V instar		3.75	4.92	4.22
VI instar		2.75	3.75	3.03
VII instar		1.83	2.83	2.12
Total larval period		25.03	31.66	27.80
Pupa	12	11.04	13.21	12.06
Adult period				
Male	7	6.08	8.08	7.21
Female	5	4.75	5.29	5.02
Total life period				
Male	7	-	-	52.51
Female	5	-	-	50.32
Pre-mating period (hr)	5	13.00	18.30	15.18
Mating period (hr)	5	3.30	6.00	4.58
Fecundity (eggs female^{-1})	5	335	1280	742

Table 3: Per cent mortality caused due to natural enemies

Larva affected by	Scientific name	No. of larva affected	Stage of pest attacked	% mortality
1) Apanteles	*Apanteles* sp.	1	II instar larva	2.50
2) Tachinid fly	*Carcelia* sp.	5	Larvo-pupal	12.50
3) Fungus	*Metarhizium anisopliae*	3	Pupa	7.50
Total mortality				22.50

No. of larva observed = 40

residus to the extent of 15.12 per cent, whereas, Pandit and Sharma (1995) reported that, two entomogenous fungi viz., *Beauveria bassiana* and *M. anisopliae* attack *S. obliqua*. These results were also obtained in the present findings.

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Development of Some Sorghum Nursery Lines for Resistance to Stemborer *Chilo partellus*

About twenty five sorghum nursery lines were screened for the resistance to sorghum stem borer at Sorghum Research Unti, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during Kharif 2002. The experiment was laid out in randomised block design and each entry was replicated thrice in a plot size of 4.00 x 0.45 m with the spacing of 45 x 45 cm. All the agronomic package of practices were followed to raise good crop without plant protection measures. The observations on stem borer leaf injury was recorded on 60th day after germination of crop by counting total plants and plants with leaf damage symptoms in each entry. The peduncle damage was recorded at harvest. The data, thus collected, were tranformed in to arc sine and analysed statistically.

The data presented in Table 1 revealed that there were significant differences in case of leaf injury and peduncle damage in different entries.

i) Stem borer leaf enjury

Eighteen entries viz, CSV 15, ICSV 1, ICSV 112, ICSV 700, ICSV 708, ICSV 714, ICSV 717, IS 1044, IS1054, IS2122, IS 2123, IS 2263, IS 2269, IS2312, IS4646, IS 4776, IS 18551 and PB 15881-3 recorded cmparatively lowest leaf injury in the range of 5.99 to 11.90 and were at par with resistant check IS 2205 (6.45%).

ii) Stem borer peduncle damage :

Out of twenty five nursery line, two lines viz. ICSV 745 and ICSV 93046 recorded significantly lowest 45 per cent leaf injury and showed the superiority over rest of the entries, expect the entries viz., BT x 623, CSV 15; ICSV 12, ICSV 700, ICSV 714, ICSV 93043, ICSV 2123, IS 2263, IS 2269 and PB 1588-3 which were at par with each other. All remaining entries were at par with resistant check IS 2205 (66.07%).

Table 1. Reaction of various sorghum nursery lines to stem borer

S.N.	Entry	Stemborer			
		LIP %		peduncle damage %	
1	BT X 623	13.39	(21.42)	50.00	(45.00)
2	CSV 15	8.68	(16.94)	55.55	(48.24)
3	ICSV 1	7.17	(15.44)	73.33	(59.07)
4	I CSV 112	8.84	(17.22)	58.33	(49.85)
5	ICSV 700	6.90	(15.17)	58.33	(49.85)
6	ICSV 708	11.90	(19.74)	73.33	(59.07)
7	ICSV 714	10.79	(19.08)	62.50	(52.50)
8	ICSV 717	6.62	(14.78)	49.99	(44.97)
9	ICSV 745	13.24	(21.24)	45.00	(42.11)
10	ICSV 88092	18.33	(25.30)	58.33	(49.85)
11	ICSV 93046	12.69	(22.10)	45.00	(42.11)
12	IS1044	8.11	(16.45)	75.00	(60.00)
13	IS 1054	6.25	(14.42)	82.50	(65.78)
14	IS 2122	11.25	(19.57)	83.75	(66.41)
15	IS 2123	8.12	(16.43)	60.00	(50.77)
16	IS 2205 ®	6.45	(14.65)	66.07	(54.54)
17	IS 2263	6.33	(14.35)	50.00	(45.00)
18	IS 2269	6.66	(14.83)	61.90	(51.89)
19	IS 2312	7.29	(15.58)	77.08	(62.00)
20	IS 4646	5.99	(13.98)	82.85	(65.61)
21	IS 4776	10.71	(18.28)	77.37	(61.46)
22	IS 18551	11.86	(19.37)	73.21	(58.52)
23	PB 15520	19.09	(25.87)	71.42	(58.43)
24	PB 15881 - 3	9.72	(18.10)	60.71	(51.33)
25	DJ 6514 (S)	16.66	(24.04)	70.23	(57.48)
	F' Test	Sig		Sig	
	SE (m)	2.29		5.30	
	CD at 5%	6.44		14.90	
	CV %	17.85		13.87	

The findings of present investigation are supported by Taneja and Leuschner (1985).

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Effect of Various Intercropping Systems on Population of *Coccinelids* on Cotton Crop

Cotton, the white gold, plays an important rolein national economy as it is the major agricultural consumer crop as well as basic resource for thousands of industrial products manufactured in India (Mayee and Rao, 2002). The area under this crop in India is about 76.10 lakh ha with production of 167.5 lakh bales and productivity of only 375 kg lint ha^{-1} as against world average productivity of 620 kg lint ha^{-1} (Anonymous, 2004). Owing to the importance, among several factors responsible for its low productivity, the most limiting factor is the pest menace (Agrawal *et. al.*, 1979). The indiscriminate use of

Population dynamics of lady bird beetle

Treatments	Number of lady bird beetle $plant^{-1}$ in different meteorological weeks								Average
	35	36	37	38	39	40	41	42	
T_1 - Sole cotton	0.33	2.33	1.00	1.33	5.00	5.66	1.00	2.00	2.33
	(0.87)	(1.67)	(1.17)	(1.34)	(2.22)	(2.35)	(1.17)	(1.58)	(1.54)
T_2 - Cotton + Greengram	1.00	1.00	1.00	1.00	3.00	4.33	1.33	1.00	1.78
	(1.17)	(1.17)	(1.17)	(1.17)	(1.71)	(2.10)	(1.34)	(1.17)	(1.37)
T_3 - Cotton + Blackgram	1.66	1.00	1.66	0.66	4.66	4.00	1.00	1.00	1.92
	(1.46)	(1.17)	(1.46)	(1.05)	(2.12)	(2.03)	(1.17)	(1.17)	(1.45)
T_4 - Cotton + Cowpea	2.0	1.66	1.33	2.33	5.00	5.33	3.00	2.00	2.83
	(1.58)	(1.44)	(1.34)	(1.67)	(2.33)	(2.33)	(1.71)	(1.58)	(1.74)
T_5 - Cotton + Sorghum	0.33	1.00	0.00	1.33	1.66	4.00	1.00	1.0	1.29
	(0.87)	(1.17)	(0.70)	(1.34)	(1.27)	(1.98)	(1.17)	(1.17)	(1.20)
T_6 - Cotton + Maize	0.00	0.66	0.00	0.33	5.66	5.00	1.33	1.33	1.70
	(0.70)	(1.05)	(0.70)	(0.87)	(2.37)	(2.23)	(1.34)	(1.34)	(1.32)
T_7 - Cotton + Marigold	1.0	3.0	2.66	3.00	3.00	3.00	3.00	1.66	2.54
	(1.17)	(1.71)	(1.76)	(1.71)	(1.71)	(1.71)	(1.71)	(1.27)	(1.62)
T - Cotton - Soybean	2.33	0.66	0.33	1.33	4.66	1.66	1.00	1.00	1.62
	(1.67)	(1.05)	(0.87)	(1.34)	(2.14)	(1.13)	(1.17)	(1.17)	(1.31)
Total	8.65	11.31	7.98	11.31	32.64	32.98	12.66	10.99	-
Average	1.08	1.41	0.99	1.41	4.08	4.12	1.58	1.37	-
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) $\pm$	0.154	0.223	0.171	0.162	0.180	0.154	0.139	0.205	0.17
CD at 5%	0.434	0.628	0.481	0.457	0.545	0.434	0.392	0.578	0.49
CV (%)	22.51	26.25	25.80	21.15	16.45	13.38	17.19	26.76	21.18

(Figures in parentheses are $x + 0.5$ transformation)

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pesticides, resulted into several problems including disturbance in natural balance of pests and their natural enemies. Several workers have reported effective role of natural enemies in pest management, hence study was undertaken to see the population dynamics of lady bird beetle , a natural enemy of aphids in various cotton based intercropping systems.

The material required and used during the study was provided by the Department of Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was conducted in randomized Block Design with three replications and eight treatments during 2003-04 under unprotected cultivation. The observations on the population of lady bird beetle was recorded weekly on randomly selected 5 plants from net plot on whole plant basis and from this average population plant^{-1} was worked out. The data obtained were transformed appropriately and put to statistical analysis to test the level of significance of various treatments as per Gomez and Gomez (1984) and the results are given under experimental findings.

The observations recorded in Table revealed that the population of *coccinelids* was found statistically significantly in different intercropping treatments in all meteorological week (MW) observed from 35th to 42nd M.W. The highest population of (2.83 plant^{-1}) was found on cotton intercropped with cowpea, followed by cotton + marigold, sole cotton, cotton + blackgram, cotton + green gram, cotton + maize, cotton + soybean, cotton + sorghum intercropping system recording the population of 2.54, 2.33, 1.92, 1.78, 1.70, 1.62 and 1.29 plant^{-1} , respectively. All the above seven treatments of intercrops were found statistically at par with each other.

However, cotton + sorghum recorded the lowest population i.e. 1.29 plant^{-1} and it was statistically at par with rest of eight treatments except cotton + cowpea intercropping.

Similar results of favouring the increasing population of *coccinelids* due to intercropping of cotton + cowpea, also reported by Daware *et.al.*, (2004), recording highest population in cotton + cowpea intercropping. Anonymous (2003) also reported the large population of *coccinelids* on sole cotton during 45 and 60 days after sowing, when there was out-break of aphids on cotton, which conforms the present findings.

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Reaction of sorghum Nursery Lines to Shoot Fly *Atherigona Socotta* Rondani and Stem Borer *Chilo partellus* Swinhoe

A field experiment was conducted at the farm of Sorghum Reseach Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Kharif* 2002 to see the reaction of some sorghum nursery lines against shoot pests. The experiment was laid out in a Randomised Block Design in a plot size of 4.00 x 0.45 with three replications and sowing was done by dibbling method at a spacing of 45 x 15 cm. All the agronomic practices were followed to raise good crop except the plant protection measures. The observations on shoot fly was recorded at 20th day after emergence of crop by counting total plants and plants showing dead hearts in each entry. The stem borer leaf injury was observed on 60th day after emergence and peduncle damaged was reocrded at harvest. The data, thus collected, were converted into arc sine and then analyzed statistically.

Table 1. Reaction of various sorghum nursery lines to shoot fly *Atherigona sococatta* Rondani and Stem Borer *Chilo partellus* Swinhoe

S.N.	Entry	Shoot fly Av.% dh on 20th day		Stem borer			
				LIP%		Peduncle damage%	
1	168 11 101	75.49	60.83	8.01	16.37	73.21	58.83
2	168 11 108	64.14	53.17	9.09	17.46	76.38	60.91
3	168 11 112	59.37	50.49	12.69	20.80	76.66	61.33
4	168 11 122	46.52	42.96	11.30	19.44	68.33	55.78
5.	168 11 209	76.57	61.32	15.55	23.01	70.83	57.38
6	168 IU 1021	83.85	66.56	10.55	18.95	63.33	52.77
7.	168 UU 1006	85.11	68.20	13.33	22.24	66.66	54.77
8.	168 UU 1022	84.71	67.48	8.68	16.94	73.21	58.83
9.	200 IU 1005	80.73	64.07	21.11	27.33	65.71	54.22
10.	200 UU 1011	70.04	56.93	9.16	17.59	66.66	54.70
11.	CSV-15	54.50	47.64	11.11	19.46	65.47	53.97
12.	GMSB-4	77.08	61.58	16.02	23.53	75.00	60.00
13.	GMSB-5	79.63	63.19	16.25	23.63	70.83	57.35
14.	GMSB-69	84.72	68.15	8.88	17.17	70.83	57.35
15.	GMSB-76	87.45	69.82	11.11	19.46	66.07	54.54
16.	GMSB-131	74.17	59.46	13.33	21.22	73.33	59.07
17	IS 18551 (R)	31.64	34.35	5.13	13.18	71.66	58.32
18.	IS 2205 (R)	35.18	36.35	8.33	21.24	61.10	51.43
19.	SFCR 1047	82.10	65.01	10.04	18.37	70.83	57.35
20.	SFCR 1058	64.21	53.28	10.55	18.95	77.50	61.72
21.	SFCR 1070	59.64	50.59	11.85	19.88	58.57	49.92
22.	SFCR 1105	49.16	44.48	7.29	15.58	77.85	62.28
23.	SFCR 1111	57.73	49.43	6.34	14.50	70.83	57.38
24.	SFCR 1143	59.41	50.42	10.42	18.73	73.33	59.07
25.	DJ - 5614 (S)	87.76	69.66	11.80	20.08	55.00	47.88
	FTest		Sig		Sig		NS
	SE (m) ±		3.75		1.84		3.22
	CD at 5%		10.54		5.17		-
	CV%		9.37		13.45		8.04

The data in Table 1 revealed that there were significant differences within the various nursery lines incase of shoot fly dead hearts and stem borer leaf injury. However, non significant differences were observed in case of stem borer penducle damage.

As regards to shoot fly the resistant check IS 18551, recorded the lowest 31.64 per cent dead hearts closely, followed by IS 2205 (35.18% dh), entry 168.11 122 (46.52% dh) and were at par with each other and found significantly superior to rest of the entries. The range of infestation in remaining entries was 49.16 to 87.76 per cent.

Regarding stemborer damage based on leaf injury results were significant. Five entries viz. 168 II, 101, 168 UU, 1022, GMSB 69, SFCR 1105 and SFCR 1111, recorded comparatively minimum per cent leaf injury i.e. 8.01, 8.68, 8.88, 7.29 and 6.34 per cent, respectively and found at par with resistant check IS 18551 (5.13%).

In case of peduncle damage due to stemborer the results were non significant. However, the range of incidence in various nursery lines was 55.00 to 76.66 per cent. The results of present investigations are similarly supported by Jhansi (2004).

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Activity of Egg Parasitoids of *Papilio demoleus* (Lepidoptera : Papilionidae) in Akola Vicinity

Citrus is one of the most important horticultural corps in india, particularly in Vidarbha region which is famous as Nagpur mandarin in the world. Area under citrus plantation is increasing year after year. However, problem of citrus decline is a matter of great concern. There are so many factors influencing the declination of citrus crop, the insect pest is one of them. Citrus leaf eating caterpillar commonly known as Lemon butterfly, *papilio demoleus* is a key pest of citrus in India. Serious outbreak of *P. demoleus* has been recorded in 1969 on *Chloroxylon sweetenia* in India. Serious outbreak of *P. demoleus* has been recorded in 1969 on *Chloroxylon sweetenia* in Vidarbha region of Maharashtra (Thakare and Borle, 1974). The natural enemies play an important role in insect pest suppression, provide better alternatives to chemical insecticides to some extent. With this view, studies on the activity of natural parasitoid in Akola vicinity have been carrid out at Dr. PDKV,Akola.

Extent of natural parasitization in *P. demoleus* was estimated by collecting eggs of *P. demoleus* from the Citrus (*Citrus aurantifolia*) orchards of All India Co-ordinated Research Project (TF), Dr. PDKV, Akola during 2004-05. Such eggs were brought to the laboratory and were kept into the glass vials (7.5 x 1.2 cm) singly by providing honey streak for the parasitoid supposed to emerge. Such glass vials plugged with cotton swab were kept under observation. Natural parasitization was calculated on the basis of adult emergence. Different parasitoids were observed under stereoscopic microscope for their identification.

The data presented in Table 1 revealed that the parasitoides were quite active during the course of study. Three egg parasitoids viz. *Trichogramma chilonis, Telenomus* sp. and *Ooenchyrtus papilionis* were recorded. Highest parasitization (56.25%) was observed in the fourth week of July. Parasitization below 20 per cent was recorded during first (16.60%), second (12.50%) weeks of August, second week of September (18.75%), second week of October (17.64%), third week of November (18.75%) and first (16.66%), second (13.40%) and third (18.75%) weeks

Table 1. Natural parasition caused by various parasitoids in eggs of *Papilio demoleus*

Month	No.of week	% parasit-ization (total egg observed)	% parasitization by			Number of adults emerged egg^{-1}			%egg hatching	% Enhat-ched eggs
			T. chilonis	*Telenomus* spp.	*Ooencyrtus papilionis*	*T. Chilonis*	*Telenomus* spp.	*Ooencyrts papilionis*		
1	2	3	4	5	6	7	8	9	10	11
July	4th	56.25 (16)	25.00	18.75	12.5	2-4 (3.00 ± 0.81)	3-4 (3.50 ± 0.70)	.2-3 (2.50 ± 0.70)	43.75	0.00
August	1st	16.60 (12)	16.00	-	0	2-3 (3.00 ± 0.81)	0.00	0.00	75.01	16.74
	2nd	12.50 (16)	12.50	-	0	3-4 (3.50 ± 0.70)	0.00	0.00	56.25	31.25
	3rd	33.32 (21)	23.80	9.52	0	2-9 (5.00 ± 3.24)	2-3 (2.50 ± 10.70)	0.00	57.14	9.54
	4th	29.42 (17)	17.66	11.76	0	2-4 (2.60 ± 1.15)	2-3 (2.50 ± 0.70)	0.00	58.82	11.76
September	1st	26.31 (19)	10.52	15.78	0	3-6 (4.50 ± 2.12)	1-3 (3.50 ± 1.15)	0.00	63.18	10.52
	2nd	18.75 (16)	12.50	6.25	0	2-4 (3.00 ± 1.4)	2	0.00	81.25	0.00
	3rd	31.57 (19)	10.52	21.05	0	2-13 (7.50 ± 1.13)	1-3 (4.00 ± 1.15)	0.00	68.43	0.00
	4th	25.00 (16)	12.50	12.5	0	2-7 (4.50 ± 3.5)	2-3 (2.50 ± 0.70)	0.00	75	0.00
October	1st	26.66 (30)	16.66	10	0	2-12 (5.00 ± 4)	1-3 (3.00 ± 1)	0.00	73.34	0.00
	2nd	17.64 (17)	5.00	11.76	0	2	2-3 (2.50 ± 0.70)	0.00	70.58	11.78
	3rd	23.52 (17)	11.76	11.76	0	2-5 (3.50 ± 2.12)	2-3 (2.50 ± 0.70)	0.00	76.48	0.00
	4th	20.00 (15)	13.33	6.66	0	2-3 (2.50 ± 0.70)	2	0.00	80	0.00
November	1st	13.33 (15)	6.66	6.66	0	2	0.00	0.00	86.44	0.00
	2nd	20.00 (15)	6.66	13.13	0	3	2-3 (2.50 ± 0.70)	0.00	73.33	6.67
	3rd	18.75 (16)	6.25	12.5	0	2	2-3 (2.50 ± 0.70)	0.00	75	6.25
	4th	26.66 (15)	6.66	20	0	2	2-4 (4.00 ± 1.15)	0.00	73.34	0.00
December	1st	16.66 (18)	5.50	11.11	0	3	2-3 (2.50 ± 0.70)	0.00	72.22	11.12
	2nd	13.40 (15)	0.00	13.4	0	0.00	2-4 (3.00 ± 1.41)	0.00	80	6.60
	3rd	18.75 (16)	6.29	12.25	0	3	2-3 (2.50 ± 0.70)	0.00	81.25	00.00
	4th	20.00 (15)	6.66	13.34	0	3	2-3 (2.50 ± 0.70)	0.00	73.34	6.66

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1	2	3	4	5	6	7	8	9	10	11
January	1st	20.00 (15)	6.66	13.33	0	3	2-4 (3.00 ± 1.4)	0.00	80	0.00
	2nd	26.00 (15)	13.33	13.33	0	3-9 (6.00 ± 4.24)	2-4 (3.00 ± 1.41)	0.00	73.34	0.00
	3rd	21.70 (23)	13.04	8.69	0	3-5 (6.00 ± 1.00)	2-3 (2.50 ± 0.70)	0.00	69.99	8.61
	4th	26.66 (15)	13.33	13.33	0	4-6 (5.00 ± 1.41)	2-3 (2.50 ± 0.70)	0.00	60	13.34
	Mean	23.58%	11.55%	11.33%	0.70%				70.01	6.41%

of December, while in remaining weeks higher parasitization was recorded (20.00-56.25%). *O. papilionis* could parasitize the eggs only in the fourth week of July. Mean of the total parasitization (23.58%), *T. chilonis* accounted for 11.55 per cent, *Telenomus* spp. 11.33 per cent and *O. papilionis* could 0.70 per cent parasitization. The results are in corroboration with the work reported by krishnamoorthy and Singh (1986) regarding two egg parasitoids of *Papilio* spp. namely *T. chilonis* and *Telenomus* spp. in 1984 at IIHR, Bangalore. In another experiment Krishnamoorthy and Singh (1988) reported the extent of parasitism by *T. chilonis* and *Telenomus* spp. ranged between 0-65 and 10-78 per cent, respectively. They further reported that though both the egg parasitoids occurred simultaneously in the field, *T. chilonis* was dominant for namely eight months. Dadmal (2004) reported three egg parasitoids viz., *T. chilonis*, *Telenomus* spp. and *O. Papilionis* on eggs of *P. demoleus* with 23.07 - 71.57, 0.00 - 15.38 and 0.00-7.69 per cent parasitization, respectively at IIHR farm, Bangalore in Nov.- Dec., 2003.

It was also revealed from results that *T.chilonis, Telenomus* spp. and *O. papilionis* yielded maximum of 2-13 (7.5 ± 7.13), 2-4 (3±1.41) and 2-3 (2.5 ± 0.70) adults, respectively from single egg which might be due to superparasitism in *P. demoleus*. Krishnamoorthy and Singh (1986) recorded 8-27 adults of *T. chilonis* from single *Papilio* egg. Krishnamoorthy and Singh (1986) recorded 8-27 adults of *T. chilonis* from single *Papilio* egg. Krishnamoorthy (1987) recorded 1-3 adults of *Telenomus* spp. Jalali and Singh (1990) recorded 3-7 adults of O. *papilionis* from a single *Papilio* egg. Dadmal (2004) reported that *T. chilonis* yielded 4-18 (9.5 ± 2.8), *Telenomus* spp. 2-4 (3±0.8) and 2-3 (2.7± 0.5) adults, respectively from single egg. thus, these findings are also in close proximity with the present findings. It is also clearly revealed from the result (Table 1) that due to low parasitization per cent egg hatching into host larvae was maximum (43.75-86.64%) during the investigation. Dadmal (2004) recorded per cent egg hatching into host larvae was maximum in eggs collected from *Ruta graveolens* (66.67-100%) as compared to *Citrus aurantifolia* (28.57-42.85%) which is in close agreement with the present findings.

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Constraints Encountered by Farmers in Adoption of Intercropping Practices in Dryland Farming

Indian being an agricultural country, agriculture is a black bone of Indian economy. About 26 per cent of National income is derived from agriculture. In India 65 per cent area comes under dryland farming. In dryland farming the crop failure occurs mostly due to shortage of water. The soil and water is required to be managed properly. The intercropping system has become an integral component of dryland agriculture for risk aversion and has assumed greater signficance. Intercropping refers to growing of two or more crops simultaneously on the same piece of land with a definite row pattern.

Cotton is major cash crop and sorghum is major stable food crop in Vidarbha region and large area comes under these crops. Dr. Panjabrao Deshmukh Krishi Vidypaeeth, Akola has identified and recommended intercropping practices in cotton and sorghum (Anonymous 2002). The cotton based intercropping Cotton + Green gram / Black gram (1:1) and Cotton + Pigeonpea / Green gram (3:3). The knowledge and adoption of intercropping practices is very essential for increasing the yield and to overcome the problem of crop failure. However, it was observed that farmers are not fully aware of the intercropping practices and adopt only few components of the intercropping at a given time. It may be because of certain constraints. The constraints may be related to the intercropping practices itself or to the farmers themselves and their situation. It is, therefore, thought desirable to identify the constraints faced by the farmers in its use and adoption. This will help in deciding the strategies for promoting the use of this intercropping practices by the farmers in the area. The use and adoption of technology will also help in increasing the production in dryland farming areas. Looking to the importance of intercropping practices in dryland farming, a study was undertaken during 2002-2003 in Akola Panchayat Samiti of Akola District of Mahashtra state. The specific objective of study was to study the constraints encountered by farmers in adoption of intercropping practices in dryland farming.

The present study was carried out in Akola Panchayat Samiti in Akola district of Maharashtra state, due to the large area coming under dryland condition. Out of 210 villages in Akola Panchayat Samiti, 10 villages were selected purposively for the study due to large area coming under cotton and sorghum crop. The list of farmers in the selected villages was prepared in consultation with Talathi and Sarpanch. From the list, 15 farmers were selected purposively from each village by disproportionate random sampling method. thus, 150 farmers were selected as respondents for the present study. In the present study, constraints have been operationally defined as the problem or difficulty encoutered by the farmers in adoption of recommended intercropping practices.

The constrints in adoption of intercropping practices were identified by collecting the responses of respondent farmers through an open end question. The constrints were recorded . The frequency and percentge of each constraints was worked out to decide the intensity of the constraints encountered by the respondents.

Constraints faced by farmers :

Constraints encountered by the respondents in adoption of intercropping practices were recorded in interview schedule. The barriers that stood in way of adoption of intercropping practices were classified into following four heads viz. situational constraint, economic constraint, technical constraint and general constraint. After critically examination the responses given by the respondents in response to querry made, they were classified under the respective category. Frequency and percentge for each constraint were worked out and the results, thus obtained, have been presented in Table 1.

The data presented in Table 1 regarding constraints in respect of situational aspects revealed that a great majority of the respondent (91.33%) were found to be of the opnion that more labourer were required at the time of sowing by intercropping system, followed by 79.33 per cent of respondents stating non availability of rain water at proper time. There were 72.66 per cent of the respondents expressing about non availability of labourers at proper time. The labourers were also found reluctant for intercropping practices particularly cotton + sorghum + pigeonpea + sorghum (32%).

As regards economic constraints, it is observed that a great majority of the respondents expressed about inadequacy of capital for undertaking costly and labourious intercropping practice (82.66%), followed by 68.66 per cent of them expressing about high labour charges. Non availability of credit from different sources was also constraint for majority of the respondents (59.33%). At the same time, respondents also expressed about high cost of fertilizer (39.33%). Only 10.66 per cent of respondents were of the opinion that high cost of seed was a constraint for them.

Technical constraints also act as a barrier in sum

Table 1. Distribution of respondent according to the constraint faced by farmer

S.N.	Constraints	Frequency n=150	Percentage
	Situation		
1.	Non availability of rain water at proper time	119	79.33
2.	More labour required at the time of sowing	137	91.33
3.	Non availability of labour at proper time	109	72.66
4.	Labours are reluctant to intercropping practices particularly cotton + sorghum + pigeonpea + sorghum	48	32.00
	Economic		
1.	Inadequacy of capital	124	82.66
2.	Non availability of credit	89	59.33
3.	High cost of fertilizers	59	39.33
4.	High cost of seed	16	10.66
5.	High labour charges	103	68.66
	Technical		
1.	Lack of knowledge about recommended seed rate of main crop	36	26.00
2.	Lack of knowledge about recommended spacing between two rows of main crop	74	49.33
3.	Lack of knowledge about recommended spacing between two plants of main crop	120	80.00
4.	Difficulty in sowing	11	7.33
5.	Lack of knowledge about chemical fertilizers	65	43.33
	General		
1.	Risk and uncertainity in dry land corp production	96	64.00

of percentage is more then 100 due to multiple responses adoption of intercropping practices. The data in Table 1 revealed that lack of knowledge about recommended spacing between two plants of main crop was expressed as constraint by a great majority of the respondents (80%), followed by lack of knowledge about recommended spacing between two rows of main crop (49.33%), lack of knowledge about chemical fertilizers 43.33 per cent, lack of knowledge about recommended seed rate of main crop 26.00 per cent. Only 7.33 per cent of the respondents were of the opinion that intercropping practices cotton + sorghum + pigeonpea + sorghum was difficult in sowing.

About general constraints, it is revealed that risk and uncertainty in dry land crop production was expressed as constraint by majority of the respondents (64%).

This indicates that the recommendation about intercropping practices which are suitable for sowing, incurring low cost suitable for maintaining ratio of intercropping requiring less labour shuld be developed and advocated by Dr. Panjabrao Deshmukh Krishi Vidypaeeth, Akola. it is necessary to make efforts for giving information about intercropping practices through arranging demonstrations by extension agency. If this is done, it will help in increasing the adoption of recommended intercropping practices by the farmers and would increase the production in dry land farming.

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Effect of Climate on Persistency of Lactation in Crossbred Cows During Winter Season

A knowledge of the relative impoartance of some climate factors affecting the traits of economic importance is of great significance in determining the optimum selection criteia for bringing improvement inthe persistency of lactation, Kulkarni (1996) indicated the importance of some climatic factors affecting peak yield in indigenous and exotic breed of dairy cattle. Present study reports the effect on climate on persistency in crossbred cows (Jersey and H. Friesian) under climatic conditions prevailing during winter climate of Akola (Vidarbha region).

Ten years (1989 to 1998) data were collected from Livestock instructional Farm located at University Department of Animal Husbandary and Dairying, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola in respect of only half breds (Jersey and H. Friesian) maintained on scientific line. The yearly data were further divided into 3 seasons as under-

4. Rainy (June to September)
5. Winter (October to January)
6. Summer (February to may)

The weekly meteorological data for winter season in respect of Temperature (max. and min.), Relative Humidity (max. and min.) Sunshine hours, Wind velocity and wet and dry bulb temperature collected from Dept. of Agronomy were utilized for calculating indices i.e. Temperature-Humidity-Index (THI) and Temperature - Humidity-Sunshine-index (THSI) (Thomus and Acharya, 1981).

The weekly milk yield of crossbred cows calved in different months up to 26 weeks of lactation was analysed for calculated persistency of lactation.

The data were analysed by calculating the correlation, regression and path coefficient with step down methods suggested by Croxton and Cowden (1974), Amble (1975) and Singh and Choudhari (1979).

Correlation coefficient between climatic attributes and persistency are presented in Table 1.

It was evident that average weekly milk yield persistency during winter season was -0.015 $\pm$ 0.05 and -0.018 $\pm$ 0.06 in case of Jersey and H. Frisian crosses, respectively. It indicates that the rate of decline in milk production was slightly at higher rate in HF crosses than of Jersey crosses.

The climatic attributes like minimum temperature and wind velocity were significantly related with the

Table 1. Mean values and correlation coefficient of climatic attributes with weekly persistency in crossbreds during winter season

Variable	Average values with	Jersey		H. Friesian	
		Correlation coefficient	% contribution	Correlation coefficient	% Contribution
Max. Temp. (^{0}C)	31.09+0.47	0.243 NS	5.90	0.239 NS	5.117
Min. Temp. (^{0}C)	13.14$\pm$0.90	(-)0.582**	33.87	(-)0.576**	33.17
Max. Hum. (%)	75.07$\pm$0.58	0.074 NS	0.54	0.058 NS	0.33
Min. Hum (%)	32.98$\pm$1.54	0.574**	33.06	0.558**	21.17
Sunshine Hrs.	8.39$\pm$0.16	(-) 0.274NS	6.14	(-) 0.240 NS	5.76
Wind velocity (km hr^{-1})	3.78$\pm$0.10	(-)0.498*	24.40	(-)0.501**	25.10
THI	67.24$\pm$0.69	0.244 NS	5.01	0.217 NS	4.70
THSI	58.39 $\pm$ 1.11	0.277 NS	5.15	0222 NS	4.92
Weekly milk yield persistency		(-)0.015$\pm$ 0.05		(-) 0.018$\pm$0.06	

Significant at 1 % level Significant at 0.5% level Significant at 0.01% level

Table 2. Selected climatic factors contributing the variation in persistency of crossbred during winter season

Variable	Estimated regression coefficient	SE of (b)	t value
Min. Temp. (^{0}C)	-0.095	0.051	1.964+
	(-0.099)	(0.053)	(1.972+)
Min Hum. (%)	0.056	0.020	2.817*
	(0.084)	(0.032)	(2.597*)
Wind velocity (km hr.$^{-1}$)	0.769	0.0177	4.336**
	(-0629)	(0.148)	(4.243**)
THSI	0.075	0.035	2.291*
	(0.079)	(0.037)	(2.105*)
Intercept	-0.35		
	(-7.35)		

R = 0.664 (0.648) F - 5.45* (5.07*)

Significant at 1 % level Significant at 0.5% level Significant at 0.01% level

Table 3. Path analysis of selected climatic attributes and their

Variable	Min. Temp. (^{0}C)	Min. Hum. (%)	Wind Velocity (km hr^{-1})	THSI	Total effect (r)
R = 0.664 (0.648) F - 5.45* (5.07*)					
Min. Temp. (^{0}C)	-2.384	1.150	-1.168	0.820	-0.582
	(-1.450)	(0.501)	(-0.185)	(1.457)	(-0.576)
Min. Hum. (%)	-1.149	1.385	-0.846	1.184	0.574
	(-0.914)	(-0.795)	(-0.666)	(1.342)	(0.558)
Wind velocity (km hr^{-1})	-0.448	0.233	-1.256	0.273	-0.498
	(-0.465)	(0.512)	(-1.034)	(0.485)	(-0.501)
THSI	-1.335	1.115	0.403	0.850	0.327
	(-0.398)	(0.453)	(-0.332)	(1.159)	(0.222)

Figure in parentheses method with H. Friesian crossbred cow Underlined figures indicates direct effect

persistency in both the crosses. The rest of the climatic factors could not established their association with the persistency in both the crosses. The minimum temperature and wind velocity indicated negative influences. The correlation values were -0.582 and -0.576 for minimum humidity in Jersey and HF crosses, respectively. The corresponding values for wind velocity were -0.498 and -0.501, respectively.

The coefficient of regression (Table 2) with weekly persistency for minimum temperature, minimum humidity and wind velocity and THSI were found significant and contributed for 66.70 and 66.80 per cent of variability in persistency in jersey and HF crosses, respectively during winter season. All the coefficients of regression were more or less same in both the crosses, indicating the weekly milk yield persistency in Jersey and HF crosses were affected to equal degree by winter climate.

The results on path analysis (Table 3) indicated that highest negative direct effect contributed by minimum temperature (-2.384), followed by positive effect of minimum humidity towards highest direct positive effect (1.159), followed by minimum temperature (-1.450) in HF

crosses, respectively during climatic conditions prevailing during winter season.

Thus, the results on the effect of winter climate on persistency of Jersey and HF crosses clearly indicated that variation in the rate of milk secretion in cows during winter months was mainly due to climate, particularly the minimum temperature and minimum humidity. Therefore, the climate can be considered as major non-genetic factors responsible for contributing the variation in persistency particularly in crossbred cows.

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CONTENTS

Vol. 30 No. 2 July, 2006