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Combining Ability Studies in Sesamum

M.A. Siddique[1], K.S. Baig[2] and P.V. Patil[3]

ABSTRACT

In the study, 7 parents were crossed in diallel fashion. The 21 F_1s along with 7 parents were grown to estimate gca and sca for 11 yield and its contributing characters. In gac effects, the parental line Co 1 was best general combiner for plant height, number of branches plant^{-1}, days to maturity, number of capsules plant^{-1}, length of capsule, 1000 seed weight and oil content. The variety AHT 123 and TKG 105 were best for days to flowering and days to 50 per cent flowering. Among hybrids, the best performance for seed yield and oil content and sca effects were depicted by cross TC 25X RT 161, followed by AHT 123 X TKG 117, Co 1x TKG 105 and C0 1 x TKG 117 exhibiting importance of both non additive and additive types o gene action.

Combining ability analysis helps in selecting desirable parents in crossing programme and in deciding the breeding strategy. Such improvement programme in *Sesamum indicum* L. is oriented to develop new varities with better yielding potential, high oil content and wider adaptability.To achieve these objectives, it is essential to know the nature and magnitude of gene action and combining ability of the prents and crosses. For this, the diallel mating system has been extensively used. The present experiment was undertaken to study the combining ability effects of some genotypes for seed yield and its components in sesamum.

MATERIAL AND METHODS

The present investigation was carried out by involving seven parental lines and their 21 F1 hybrids (excluding reciprocals). The experiment was laid out at experimental farm of Department of Genetics and Plant Breeding, Marathwada Agricultural University, Parbhani.

The 21 F_1s along with 7 parents were grown in ramdomized block design with three replications during *Kharif*, 1998. The observations were recorded on five ramdomly selected plants of each genotype per replication for eight quantitative characters viz., days to first flowering, days to 50 per cent flowering, days to maturity, number of branches plant^{-1}, plant height (cm), numbr of capsules plant^{-1}, weight of seeds capsule^{-1}, length of capsule (cm), 1000 seed weight (g), oil content (%) and seed yield plant^{-1} (g).

The analysis of variance was done as per method suggested by Panse and Sukhatme (1967). The combining ability analysis was carried out as per the procedure given by Griffng (1956), Model - I and Method - II.

RESULTS AND DISCUSSION

Analysis of variance for combining ability (Table 1) revealed that the mean sum of squares (MSS) due to general combining ability variances were also highly significant for all the characters except days of flowering. The general combining ability variances were higher than specific combining ability variances for plant height, days to first flowering, days to 50 per cent flowering, days to maturity, number of capsules plant^{-1}, weight of seeds capsule^{-1}, length of capsule, 1000 seed weight and yield plant^{-1} and oil content (%) had higher specific combining ability variances than general combining ability. These results are in comformity with those reported by Sharma and Chavan (1984) and Pathak and Dixit (1978). Estimates of gca effects for different characters in sesamum (Table 2) indicated that out of 11 parents, Col was the best general combiner for days to maturity (3.37), number of branches plant^{-1} (0.15), plant height (10.88), number of caspules plant^{-1} (4.17), length of capsule (0.05), 1000 seed weight (0.26), oil content (0.27) and yield plant^{-1} (0.80). AHT-123 was the best general combiner for days to first flowering (0.55), and days to 50 per cent flowering (1.23). TKG 105 was best general combiner for days to flowering (0.44), days to 50 per cent flowering (0.97), days to maturity (2.56), plant height (6.22), weight of seeds capsule^{-1} (0.02), length of capsule (0.05) and

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Table 1. Analysis of variance for combining ability (mean and squares) for eleven characters in F_1 diallel

Source of variation	d.f.	Mean sum of squares of characters										
		Days to first flowering	Days to 50 % flowering	Days to maturity	No. of braqnches plant^{-1}	Plant height (cm)	No. of capsules plant^{-1}	Weight of seeds capsule^{-1}	Length of capsule (cm)	1000 seed weight (g)	Oil content (%)	Yield plant^{-1}
GCA	6	1.86**	10.6**	91.05**	0.079**	389.1**	134.8**	0.0025**	6.019**	0.136**	0.290**	3.45
SCA	21	0.44	3.1**	16.29**	0.090**	120.6**	55.5**	0.007**	0.010**	0.065**	0.702**	2.02**
Error		54	0.32	0.53	0.90	0.005	2.28	0.75	0.00001	0.001	0.0009	0.361
δ_g		0.152	0.83	8.30	0.001	29.8	0.81	0.0002	0.001	0.007	-0.045	0.158
δ_s		0.17	2.57	15.39	0.085	116.32	54.75	0.0006	0.009	0.064	0.341	0.09
δ_g/δ_s		0.89	0.32	0.54	0.011	0.25	0.160	0.333	0.11	0.109	-0.131	0.08

** Significant at p = 0.01

Table2. Estimates of general combining ability effect of parents

Parents	Days to first flowering	Days to 50% flowering	Days to maturity	No. of branches plant^{-1}	Plant height (cm)	No. of capsules plant^{-1}	Weight of seeds capsule^{-1}	Length of capsule (cm)	1000 seed weight (g)	Oil content (%)	Yield plant^{-1} (g)
Co 1	0.25	1.0**	3.37**	0.17**	10.88**	4.17**	0.00	0.05**	0.26**	0.27**	0.80**
TKG32	0.07	-0.48*	-0.82*	0.03	-3.90**	2.21**	0.00	-0.06**	-0.13**	0.04	-0.67**
TC 25	-0.63*	-1.03**	-3.12**	0.02	-7.05**	-5.70**	-0.01**	0.03*	-0.07**	-0.14	-0.60**
AHT 123	0.55*	1.23**	3.14**	-0.14**	1.98**	2.47**	-0.03**	-0.05**	-0.02	-0.08	-0.22
TKG 105	0.44*	0.97**	2.56**	0.00	6.22**	0.49	0.02**	0.05**	0.00	0.11	0.85**
TKG 117	-0.19	-0.18	-1.01*	-0.01	-4.49**	1.51**	0.00	-0.02	0.00	0.07	-0.27**
RT 161	-0.49	-1.51**	-4.45**	-0.06*	-3.62**	-5.15**	0.02**	0.07	-0.05**	-0.28**	0.11
SE (gi) ±	0.177	0.226	0.292	0.022	0.466	0.268	0.001	0.011	0.009	0.058	0.103
SE (gi - gi)	0.270	0.344	0.447	0.035	0.712	0.410	0.001	0.017	0.014	0.089	0.157
CD at 5%	0.43	0.55	0.71	0.053	1.137	0.653	0.002	0.026	0.021	0.141	0.251
CD at 1%	0.65	0.83	1.08	0.081	1.72	0.991	0.003	0.040	0.033	0.214	0.381

* and ** = Singnificant at 5 and 1 per cent respectively.

Table3. Estimates of specific combining ability effect in promising crosses of sesamum

Crosses	Days to first flowering	Days to 50% flowering	Days to maturity	No. of branches plant^{-1}	Plant height (cm)	No. of capsules plant^{-1}	Weight of seeds capsule^{-1} (g)	Length of capsule (cm)	1000 seed weight (g)	Oil content (%)	Yield plant^{-1} (g)
Col 1 x TKG 32	-0.12	1.35*	1.74*	0.39**	0.10	0.15	0.00	0.03	-0.02	-0.27	0.39**
Co 1 x TC 25	0.58	2.57**	6.37**	0.06	5.35**	3.73**	0.00	0.11**	0.16**	-0.86**	-0.65**
Co 1 x AHT 123	0.06	-2.02**	-2.89**	-0.24**	-5.71**	-4.44**	-0.03**	-0.07**	0.10**	-0.39	-1.09**
Co 1 x TKG 105	0.18	-0.09	1.04	0.35**	15.82**	8.94**	0.04**	0.06*	0.46**	0.32	1.50**
Co 1 x TKG 117	0.47	1.39*	2.93**	-0.01	4.16**	4.72**	-0.02**	0.03	0.07**	-0.03	1.29**
Co 1 x RT 161	0.10	-2.28**	-4.30**	0.01	2.42*	-2.29**	0.01**	-0.07**	0.48**	0.84**	0.51**
TKG 32 x TC 25	0.77	3.39**	8.56**	0.04	8.33**	-1.58*	-0.01**	0.02	0.02	0.34	-0.18**
TKG 32 x AHT 123	-0.08	-1.87**	-3.04**	0.23**	-8.47**	-7.48**	0.03**	-0.03	-0.03	0.71**	-0.89**
TKG 32 x TKG 105	-0.31	-2.61**	-5.78**	-0.34**	-0.70	5.63**	-0.01**	0.07**	-0.08**	0.42	-0.06
TKG 32 x TKG 117	-0.34	-0.80	-2.22**	0.23**	-3.13*	-7.12**	-0.02**	-0.09**	-0.03*	-0.13	-1.01**
TKG 32 x RT 161	1.29**	0.20	0.89	-0.46**	3.97**	2.97**	-0.01**	0.11**	-0.05*	-1.52**	-0.16*
TC 25 x AHT 123	-1.05*	-2.65**	-5.74**	-0.29**	-7.22**	-11.57**	-0.01**	0.08**	-0.01	-0.15	0.46**
TC 25 x TKG 105	-0.27	-1.72**	-3.15**	0.24**	24.52**	11.53**	-0.05**	-0.19**	-0.10**	1.33**	-3.10**
TC 25 x TKG 117	-0.31	-0.24	-2.54**	0.04	-0.61	0.54	-0.01**	0.05*	0.09**	-0.89**	-0.11
TC 25 x RT 161	0.66	0.09	-0.48	0.25**	-0.66*	3.42**	0.06**	-6.21**	-0.10**	0.12	2.48**
AHT 123 x TKG 105	0.45	1.35*	1.59*	-0.24**	-1.18	10.84**	0.02**	-0.07**	-0.06*	-1.26**	-1.32**
AHT 123 x TKG 117	0.51	1.5*	4.15**	0.17**	18.79**	12.68**	0.01**	0.03	-0.05*	0.31*	2.38**
AHT 123 x RT 161	0.14	1.5*	1.93*	-0.05	14.51**	-7.22**	-0.03**	0.14**	0.41	-1.54*	-1.18**
TKG 105 x TKG 117	0.95*	1.43*	5.74**	0.20**	7.838*	0.06	0.02**	0.13**	0.31	0.49*	0.57**
TKG 105 x RT 161	0.08	0.43	1.52*	0.34**	-5.61**	0.59	-0.04**	-0.10**	-0.23	-1.66**	-0.62
TKG 117 x RT 161	-1.79**	-1.09	-3.26**	-0.52**	-11.31**	-8.06**	-0.03**	-0.03	-0.10**	0.78**	-1.39**
SE (gi) ±	0.43	0.55	0.72	0.05	1.15	0.66	0.002	0.021	0.022	0.21	0.06
SE (gi - gi) ±	0.76	0.97	1.26	0.09	2.01	1.16	0.005	0.048	0.041	0.25	0.44
CD at 5%	0.89	1.14	1.49	0.104	2.39	1.37	0.004	0.049	0.045	0.043	0.124
CD at 1%	1.21	1.55	2.03	0.141	3.25	1.86	0.005	0.067	0.062	0.54	0.169

* and ** = Singnificant at 5 and 1 per cent respectively.

yield plant^{-1} (0.85). Among the parents, TC 25 was best general combiner for days to first flowering (-0.63), days to 50 per cent flowering (-1.03) and days to maturity (-3.12) depicting its earliness. Among the parents TKG 32, AHT 123 and TKG 117 were good general combines for number of capsule plants^{-1}. These results are in agreement with those reported by Murty (1975) and Fattsh *et. al.*, (1982) for yield and oil content.

Estimates of specific combining ability effects for different characters in Sesamum (Table 3) indicated that seven cross combinations exhibited highly significant and positive sca effects for yield plant^{-1}. The cross TC25 x RT 161 was identified as the best combination on the basis of good general mean for yield plant^{-1} (9.40 g), oil content (53.65%) and number of capsules plant^{-1} (49.33) with high sca effects (2.40) for yield plant^{-1}. AHT 123 x TKG 117 and Col x TKG 105 recorded high mean values and sca effects for seed yield plant^{-1}, high oil content, number of capsule plant^{-1} and also both the parents in these crosses had good sca effects for these characters. Similar results were also reported by Narkhede and Sudhirkumar (1991) and Kadu *et. al.*, (1992). TKG 105 x TKG 117 exhibited high mean performance for oil content (52.26%) and moderate mean performance for yield (7.80 g) involving high x high gca effects for seed yield plant^{-1} and oil content. These results indicated the predominance of both additive and non-additive genetic components.

As regards to weight of seeds capsule^{-1}, seven hybrids expressed positive sca effects. The cross TC 25 x RT 161 manifested the highest positive significant sca effects, followed by Co 1 x TKG 105 and TKG 32 x AHT 123. The hybrid which had high sca effects had also high sca values for number of capsules plant^{-1}, plant height and number of branches plant^{-1} suggesting importance of these characters for weight of seeds capsule^{-1}. Chandraprakash (1987), Narkhede and Sudhir Kumar (1991) and Kadu *et. al.*, (1992) reported similar results in sesamum.

From the 21 crosses, 8 crosses showed significant and high positive sca effect for plant height and number of branches plant^{-1}. The cross AHT 123 x TKG 117 showed the highest positive significant sca effect for plant height whereas the cross Col x TKG 32 had highly significant positive sca effects for number of branches plant^{-1}. Similar results had been reported by Singh *et. al.*, (1983), Khorgade *et. al.*, (1988) and Narkhede and Sudhir Kumar (1991).

Highly significant sca effects were observed in the cross TC 25 x AHT 123 for days to 50 per cent flowering, while twelve cross combinations showed significant negative sca effects for days to maturity. The highest significant negative sca effect was recorded in the cross TC 25 x AHT 123, followed by TKG 117 x RT 161 involving high x high general combiners indicating additive type of gene action. Similar results were also reported by Sharma and Chavan (1984) and Khorgade *et.al.*, (1988).

These crosses may serve as a better source population for developing superior recombinant lines for increasing seed yield and oil content. It is clear from the present study that the genetic amelioration of the characters like seed yield, oil content and other yield components would be possible by exploitation of both additive and non additive components. Therefore, recurrent selection if possible in early generation may be useful for genetic improvement.

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Genetic Components of Variation in Sesame (*Sesamum indicum* L.)

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ABSTRACT

Genetic analysis of components of variation for yield and yield components revealed importance of both additive and non-additive types of gene action in the inheritance of characters in a 7 x 7 diallel study. However, dominance components were relatively larger than the additive components for all the characters. Days to 50 per cent flowering, days to maturity, plant height, oil content and yield per plant were governed by both additive and non additive gene components. The estimates of narrow sense heritability were high for days to maturity, length of capsule, weight of seed per capsule and days to 50 per cent flowering.

Sesame breeding programmes are directed towards exploitation of exotic and local germplasm in improving and stabilizing theyield potential. Hence, proper choice and proper selection of parents that can nick well to produce superior offsprings is essential for rapid success in any conventional hybridization programme. In present investigation, diallel technique which provides genetic information on the inheritance and behaviour of quantitative characters associated with yield and yield components was adopted. The present study of 7 x 7 diallel was, therefore, made to understand the genetic architecture of eleven quantitative characters in sesame.

MATERIAL AND METHODS

All possible crosses were made (excluding reciprocals) using seven genotypes viz. Krishna - 2-4-, Co.1, TKG 32, TC 25, AHT 123, TKG 105, TKG 117 and RT 161. All the 21 F1 hybrids along with their parents were raised in randomized block design with three replications during *Kharif* 1998 at 30 x 15 cm spacing. The recommended cultural practices were followed. Data recorded on ten randomly selected plants from each replication were used for statistical analysis. The genetic components of variance were worked out as per the Hyman's Model (1954, 1,2). The observations were recorded on eleven quantitative traits viz. days to first flowering, days to 50 per cent flowering , days to maturity, numbers of branches plant^{-1}, plant height (cm), 1000 seed weight (g), oil content (%) and yield plant^{-1} (g).

RESULTS AND DISCUSSION

The estimates of genetic components of variation, standard error, the ratio of genetic components and estimates of narrow sense heritability for each of eleven characters were worked out in F1 generation and are presented in Table 1. Components of variance analysis showed that the dominance components were relatively larger than the additive components for all the characters. The value of H_1 and H_2 for all the characters except for days to maturity were higher than those of D and were significant and positive except days to first flowering, weight of seeds capsule^{-1} and length of capsule, which indicated the predominance of non-additive genetic variance in the control of most of the characters under study. The ratio GCA/SCA being the range of 0.01 to 0.89 indicated the predominance of dominance geneaction where as for days to first flowering, additive gene action was observed. Similar results have also been reported earlier by Pathak and Dixit (1988) and Godawat and Gupta (1985).

F-values were mostly positive (except 1000 seed weight) and non-significant, indicating that dominant alleles were more frequent than recessive ones. This was also corroborated by KD/KR ratio for all these morphological characters indicating excess of dominant genes among the parents, which confirmed the predominance of non-additive components. All these characters exhibited dominant effect as indicated by h^2 values. Chavan *et.al.*, (1981) and Sharma and Chavan (1984), also reported similar observations for these traits.

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Table 1. Genetic components of variation for eleven quantitative characters in sesame

Crosses	Days to first flowering	Days to 50% flowering	Days to maturity	No. of branches plant^{-1}	Plant height (cm)	No. of capsules plant^{-1}	Wt. of seeds capsule (g)	Length of capsule (cm)	1000 seed weight (g)	Oil content (%)	Yield plant^{-1} (g)
D	0.78	5.79**	39.93**	0.03	149.74**	36.00	0.001	0.02	0.001	0.08*	1.95*
	± 0.28	± 1.41	± 6.79	± 0.02	± 62.95	± 28.01	± 0.001	± 0.01	± 0.04	± 0.38	± 0.85
F	0.10	2.14	3.49	0.09	85.15	12.78	0.001	0.02	-0.01	0.16	1.86
	± 0.67	± 3.38	± 16.28	± 0.06	± 151.02	± 67.19	± 0.001	± 0.02	± 0.09	± 0.92	± 2.03
H_1	1.23	11.66**	65.68**	0.41**	553.53*	250.58**	0.001	0.04	0.28**	2.80**	8.61**
	± 0.67	± 3.39	± 16.34	± 0.06	± 151.55	± 67.43	± 0.001	± 0.02	± 0.09	± 0.92	± 2.04
H_2	1.20	10.98**	16.77**	0.30**	406.73**	194.97**	0.001	0.04	0.20**	2.55**	6.96**
	± 0.59	± 2.99	± 14.40	± 0.05	± 133.54	± 59.41	± 0.001	± 0.02	± 0.08	± 0.81	± 1.79
H^2	-0.07	-0.26	0.50	0.00	36.03	4.25	0.001	0.01	0.16**	0.43	1.03
	± 0.40	± 2.01	± 9.67	± 0.03	± 89.69	± 39.90	± 0.001	± 0.01	± 0.05	± 0.55	± 1.21
E	0.33**	0.54	0.90	0.01	2.28	0.76	0.001	0.01	0.001	0.04	0.11
	± 0.10	± 0.50	± 2.40	± 0.01	± 22.26	± 9.90	± 0.001	± 0.001	± 0.01	± 0.14	± 0.30
$(H_1/D)^{1/2}$	1.26	1.42	1.28	3.53	1.92	2.64	1.47	1.54	10.26	5.74	2.10
$H_2/4H_1$	0.24	0.24	0.23	0.18	0.18	0.19	0.24	0.22	0.18	0.23	0.20
$(4DH_1)^{1/2}$ ± F	1.11	1.30	1.07	2.18	1.35	1.14	1.24	1.88	0.69	1.38	1.59
h^2/H^2	-0.06	-0.02	0.01	-0.01	0.09	0.02	0.20	-0.02	0.79	0.17	0.15
Heritability (n.s.) %	24.17	33.16	37.76	8.68	23.88	13.00	34.41	36.82	0.89	2.95	21.32
t^2 values	0.93	3.22*	0.05	1.04	2.31	9.63**	1.37	6.76**	46.63**	43.72**	0.45

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

The t^2 estimates to test the uniformity of the Wr, Vr values were non significant for days to first flowering, days to maturity, number of branches per plant, plant height, weight of seed per capsule and yield per plant indicating the fulfillment of diallel assumptions for these traits. For remaining traits the t^2 values were highly significant suggesting the failure of one or a few assumptions for diallel mating design.

The value of $(H_1/D)^{1/2}$ ratio were more than unity for all the characters, indicating the operation of over dominance as reported earlier by Sharma and Chavan (1984), Shivprakash (1986) and Sasikumar and Sardana (1990). The H_2 component was smaller than H_1 except for 1000 seed weight, oil content in percent and yield plant^{-1} indicating the unequal proportion of positive and negative alleles in the loci governing the characters. The asymmetrical distribution of genes in the parents was evidenced by the value of $H_2/4H_1$, which was less than 0.25 in all the cases, this was similar to findings of Dora and Kamala (1986) and Shivprakash (1986). The number of blocks of genes influencing the character was just one for all the characters as revealed by the h^2/H_2 value. Sharma and Chauhan (1984), and Narkhede and Sudhir Kumar (1991) have also obtained similar results for some of these characters.

The estimates of narrow sense habitability were high for days to maturity, length of capsules, weight of seed capsule^{-1} and days to 50 per cent flowering compared to other characters. Sharma and Chavan (1984) also reported similar findings. In the present study, both additive and non-additive genetic components were important in governing the yield and yield components. The breeding progress would therefore depend on the procedures that capitalize on both types of gene effects. Recurrent selection procedure may therefore be practised to concentrate favourable genes to achieve a performance of characters. So also, biparental mating in early generations among the selected lines or diallel selective mating can be adopted in breeding programs for the improvement of characters studied as suggested by Jensen (1970).

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Chemical Control of Sorghum Stem Borer *Chilo partellus* Swinhoe

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ABSTRACT

The experiments conducted for four years with three insecticides at different intervals for the control of sorghum stem borer at Sorghum Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.), revealed that one spray of endosulfan 35 EC at 0.05 per cent on 25th days after germination was found at par with one spray of chlorpyriphos 20 EC at 0.05 per cent in respect of leaf injury, peduncle damage and grain yield obtained. On the basis of CBR one spray of endosulfan 35 EC 0.05 per cent ranked first having 1:13.09 CBR, followed by two sprays of the same insecticide with 1:9.80 CBR. The third effective treatment was one spray of chlorpyriphos 20 EC @ 0.05 per cent concentration having 1:9.63 CBR.

Sorghum stem borer *Chilo partellus* Swinhoe has been recorded as a serious pest not only for the Indian sub continent but also from a number of African countries, Indonesia, Malesia, Taiwan and Srilanka (Young and Teetes, 1977). It is also an important pest of sorghum in Vidarbha region of Maharashtra State. Avoidable grain losses of 55 to 83 per cent on CSH 1 and CSV 1 were recorded by Jotwani *et. al.*, 1971. Therefore an experiment on newer insecticides applied on sorghum crop at different interval was carried out for the control of stem borer.

MATERIAL AND METHODS

The experiments were conducted at the farm of Sorghum Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.), during *kharif* season of 1994, 1995, 1996 and 1997 in a Randomizd Block Design with three replications having plot size of 6.75 m^2 (3.0 x 2.25 m) and sowing was done with the Sorghum Hybrid CSH 9 at the spacing of 45 x 15 cm on dated 28.6.94, 7.7.95, 19.7.96 and 8.7.97 in the respective years. In all ten treatments including three insecticides applied at different interval alongwith untreated control were evaluated. The treatment details are given in the Table 1. The observations on leaf injury caused by stem borer on 40th day, peduncle damage at harvest, and grain yield were recorded in each treatment including untreated control. The data thus collected for four years were pooled and are presented in the Table 1.

RESULTS AND DISCUSSION

A) Leaf injury :

The results of pooled analysis were significant and revealed that all the insecticidal tretments were superior to untreated control in recording leaf injury due to stem borer. The treatment chlorpyriphos 20 EC with three sprays @ 0.05 per cent recorded the lowest (4.94%) leaf injury and this treatment was found at par with chlorpyriphos with two sprays @ 0.05 per cent, quinalphos 25 EC three sprays @ 0.05 per cent and endosulfan 35 EC with three sprays @ .05 per cent.

B) Peduncle damage :

Significant difference were observed due to treatments and maximum damage (43.73%) was recorded in untreated control. Minimum peduncle damage was recorded in the treatment endosulfan 0.05 per cent with two sprays (22.94%) and this treatment was found at par with quinalphos 0.05 per cent two sprays (23.30%), quinalphos 0.05 per cent three sprays (24.35%), endosulfan 0.05 per cent three sprays (24.69%), chlorpyriphos 0.05 per cent three sprays (25.63%), quinalphos 0.05 per cent one spray (25.68%) and chlorpyriphos 0.05 per cent two sprays (25.83%) and significantly superior over chlorpyriphos 0.05 per cent one spray and endosulfan 0.05% one spray.

C) Grain yield :

Yield differences were significant. Maximum grain yield 32.37 q ha^{-1} was recorded due to three sprays of endosulfan 0.05 per cent, followed by two

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Table 1. Average percentage of Stemborer leaf injury, peduncle damage and grain yield (q ha^{-1}) and CB ratio (*kharif* 1994-1997) pooled data

S.N.	Treatments	Pooled average			Cost benefit ratio
		Av. % Leaf injured plants	Av. % peduncle damage	Grain yield q ha^{-1}	
1	Chlorpyriphos 20 EC 0.05% spray on 25th day after emergence	7.33 (15.40)	30.32 (32.56)	28.17	1:9.63
2.	Chlorpyriphos 20 EC 0.05% spray on 25th and 35th day after emergence.	5.64 (12.59)	25.83 (29.51)	29.33	1:5.64
3.	Chlorpyriphos 20 EC 0.05% spray on 20th, 30th and 40th day after emergence	4.94 (11.75)	25.63 (27.71)	30.13	1:4.13
4.	Quinalphos 25 EC 0.05% spray on 25th day after emergence	7.30 (14.21)	25.68 (28.61)	25.89	1:5.83
5.	Quinalphos 25 EC 0.05% spray on 25th and 35th day after emergence	7.14 (14.63)	23.30 (28.61)	30.12	1:5.64
6.	Quinalphos 25 EC 0.05% spray on 20th, 30th and 40th day after emergence	5.99 (12.94)	24.35 (28.63)	29.94	1:3.68
7.	Endosulfan 35 EC 0.05% spray on 25th day after emergence	8.87 (16.23)	30.07 (32.21)	27.53	1:13.09
8.	Endosulfan 35 EC 0.05% spray on 25th and 35th day after emergence	6.37 (15.95)	22.94 (27.88)	30.59	1:9.80
9.	Endosulfan 35 EC 0.05% spray on 20th, 30th and 40th day after emergence	6.27 (13.33)	24.69 (29.03)	32.27	1:7.09
10.	Untreated control	13.38 (19.81)	43.73 (40.86)	21.38	-
	F test	Sig	Sig	Sig	
	SE (m) ±	0.80	0.87	1.80	
	. CD at 5%	2.31	2.56	4.97	

Figures in parenthesis are arc sine values

sprays of endosulfan, three sprays of chlorpyriphos, two and three sprays of quinalphos, and two and one spray of chlorpyriphos and one spray of endosulfan. All these treatments were at par with each other. Lowest grain yield was recorded (21.38 q ha^{-1}) in unteated control and this was at par with one spray of quinalphos 0.05 per cent (25.89 q ha^{-1}).

D) Cost Benefit Ratio : Cost benefit ratio was observed to be very high (1:13.09) with one spray of endosulfan 0.05 per cent, followed by two sprays of endosulan (1:9.80) and one spray of chlorpyriphos 0.05 per cent (1.9.63). The results in case of endosulfan are in agreement with the results of Sukhani, 1986 and Kundu and Sharma, 1974 who reported endosulfan to be effective against stem borer. However, the use of chlorpyriphos for control of stem borer could not be traced inthe published literature.

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small quantity of *Corcyra* eggs, for newly hatched larvae. The larvae after hatching were transferred into separate transparent plastic vials along with fresh sterilised *Corcyra* eggs with the help of a fine hairbrush. The larvae were fed for 3 days and then were subjected to the insecticidal treatments.

For determination of LC_{50} values, serial dilutions of the insecticides were prepared. Three day fed larvae of *C. carnea* were transferred into a petridish. As the larvae are cannibalistic, they were maintained separately. Concentrations of the insecticides were prepred in water, the eggs were treated under Potter's tower and later transferred into separate transparent plastic containers. They were observed everyday for hatching. The eggs which could not hatch upto 8 days after treatment, were considered dead. The data generated on "Ovicidal effect" and "larval mortality" were compiled, averaged and mean data after appropriate transformations were subjected to statistical analysis in completely randomized design (CRD) as per Gomez and Gomez (1984). The data on log dose assay were compiled and subjected to the Probit analysis (Finney, 1971) to determine LC_{50} and residual toxicity values.

RESULTS AND DISCUSSION

Results of bioassay (Table 1) revealed that most toxic insecticide having least value of LC_{50} to *C. carnea* larvae was beta cyfluthrin 2.5 EC (LC_{50}, 0.0034%), followed by cypermethrin 25 EC (LC_{50}, 0.0038 %), Lambda-cyhalothrin 5EC (LC_{50},0.0041%), chlorpyriphos 20EC (0.0042%) quinalphos 25 EC (LC_{50}, 0.005), spinosad 48 SC (LC_{50},0.0118%), indoxacarb 15 EC (0.0173%), thiodicarb 75 WP (0.034%), and endosulfan 35 EC (LC_{50},0.1857%). The highest toxicity of beta cyfluthrin against *C. carnea* larvae was to the extent of 54.62 times as compared to endosulfan 35 EC, followed by cypermethrin 25 EC, lambda-cyhalothrin 5 EC, chlorpyriphos 20 EC, quinalphos, 2.5 EC, spinosad 48 SC, indoxacarb 15, thiodicarb 75 WP which were toxic to the extent of 48.87, 45.29, 44.21, 37.14, 15.74, 10.73 and 5.46 times, respectively as compared to endosulfan.

The data on toxicity of recommended concentrations of insecticides to *C. carnea* eggs (Table 2) revealed that endosulfan 0.07 per cent was the least toxic treatment causing 9.09 per cent egg mortality, followed by spinosad 0.015 per cent (10.28%) and beta-cyfluthrin 0.0035 per cent (13.13%). All these treatments were statistically at par with control (5%). Thiodicarb 0.075 per cent was reported to be the most toxic of all insecticides causing 45.45 per cent egg mortality. Similarly the data on toxicity of recommended concentrations of insecticides to *C. carnea* larvae (Table 2) revealed that endosulfan 0.07 per cent was the least toxic treatment causing 5.00 per cent larval mortality, followed by beta-cyfluthrin 0.0035 per cent (13.13%). Chlorpyriphos 0.05 per cent was reported to be the most toxic of all insecticides causing 100.00 per cent larval mortality.

In the present investigation, synthetic pyrethroids were found to be the most toxic to the *C. carnea* larvae, the order of toxicity being beta-cyfluthrin >cypermethrin > lambda-cyhalothrin. Although bioassays with beta-cyfluthrin against *C. carnea* larvae have not been reported, similar reports of its toxicity could be obtained from the work of Dhawan (2000) who recorded about 70 per cent reduction in population of *C. carnea* with 18.75 g ai ha^{-1} beta cyfluthrin in field. Similarly Vogt (1994) in a field experiment reported cyfluthrin to be most toxic among the neurotoxic insecticides to the *C. carnea* larvae. Rao *et. al.*, (1990) in a field study reported that the pyrethroids were highly detrimental to the predators including *C. carnea*. Further the results of the experiments carried out by El-Maghraby *et.al.*, (1994) state that the *C. carnea* larvae were susceptible to cypermethrin. Also the results of the studies carried out by Toda and Kashio (1997) revealed that high mortality from the pyrethroid group was caused by cypermethrin.

The next most toxic insecticide was chlorpyriphos, followed by quinalphos, both of which are from the organophosphorus group. The studies carried out by Krishnamoorthy (1985) revealed similar results wherein quinalphos (0.05%) and chlorpyriphos (0.05%) caused 100 per cent larval mortality. Singh and Verma (1986) also reported quinalphos to be highly toxic to *C. carnea* larvae.

The reports of Toda and Kashio (1997) also indicated that most of the organophosphate insecticides showed higher toxicity to *C. carnea* larvae causing 76 per cent mortality at 0.04 per cent dose. Spinosad 48 SC, indoxacarb 15EC, and thiodicarb 75 WP followed next in the order of toxicity after quinalphos. These results are in corroboration with the findings of the work of Dhawan (2000)

Table 1. Toxicity of insecticides to *C. carnea* larvae

S.N.	Insecticides	LC_{50}, (%)	Slope	F.L. 50 per cent	X_2	Relative toxicity
1.	Beta-Cyfluthrin	0.003	1.37	0.0026-0.0046	4.225	54.62
2.	Cypermethrin	0.003	1.50	0.0029-0.0051	1.325	48.87
3.	Lambda-cyhalothrin	0.004	1.37	0.0030-0.0055	3.232	45.29
4.	Chlorpyriphos	0.004	1.03	0.0028-0.0064	2.111	44.21
5.	Quinalphos	0.005	1.41	0.0036-0.0068	3.638	37.14
6.	Spinosad	0.111	2.46	0.0100-0.0138	3.630	15.74
7.	Indoxacarb	0.017	1.13	0.0119-0.0250	3.027	10.73
8.	Thiodicarb	0.034	1.02	0.0231-0.0501	4.691	5.46
9.	Endosulfan	0.185	6.4	0.1746-0.1976	0.896	1

Table 2. Toxicity of recommended concentrations of insecticides to *C. carnea*

S.N.	Treatments	Concentration, per cent	Mean per cent egg mortality	Mean per cent larval mortality
1.	Endosulfan 35 EC	0.07	9.09	5.00
			(14.97)	(9.23)
2.	Quinalphos 25 EC	0.05	26.92	92.5
			(30.86)	(83.74)
3.	Chlorpyriphos 20 EC	0.05	21.86	100.00
			(27.68)	(99.98)
4.	Cypermethrin 25 EC	0.075	27.50	67.50
			(30.87)	(55.44)
5.	Lambda-Cyhalothrin 5 EC	0.006	24.31	55.00
			(29.14)	(47.89)
6.	Beta Cyfluthrin 2.8 EC	0.0035	13.33	40.00
			(18.44)	(39.17)
7.	Thiodicarb 75 WP	0.075	45.45	62.50
			(42.31)	(50.83)
8.	Indoxacarb 15 EC	0.015	20.84	50.00
			(26.79)	(45.00)
9.	Spinosad 48 EC	0.015	10.28	57.50
			(18.69)	(49.33)
10.	Control (Water spray)	-	5.00	0.00
			(9.48)	(0.025)
	SE (m) $\pm$		4.07	3.87
	CD at 5%		12.12	11.50

wherein spinosad @ 75 g ai ha^{-1} caused more than 40 per cent larval mortality in *C. carnea*. Indoxacarb @ 80 g ai ha^{-1} and thiodicarb @ 300 g ai ha^{-1} caused more than 60 per cent larval mortality.

No insecticide except thiodicarb was found to be harmful to *C. carnea* eggs at recommended doses. The egg mortality due to thiodicarb was 45.45 per cent. The reason must be that thiodicarb has ovicidal action (Krishnamoorthy, 1985). The eggs were not very much affected by other pesticides.

Endosulfan recorded least LC_{50}, as well as least affected to eggs and larvae of *C. carnea*. Krishnamoorthy (1985) found endosulfan to be the least toxic insecticide which was totally innocuous to the larvae and adults of *Chrysopa scelestes*, wherein no mortality was observed when the larvae were treated with recommended field concentration. Srinivasan and Sundararababu (2000) also reported that

endosulfan at 0.07 per cent caused only 6.66 per cent grub mortality, egg mortality was reported to be only 8.07 per cent.

The endosulfan was found ecofriendly whereas newer insecticides such as indoxacarb and Spinosad were quite safer. The levels of tolerance of different insecticides would help the crop protection specialists to adopt the chemical insecticides along with the tolerant natural enemies.

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Toxicity of New Molecules of Insecticides Against *Earias Vitella* (*Fabricius*)

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ABSTRACT

Larvicidal activity of nine newer insecticides was tested against the third instar larvae of *Earias Vitella* (Lepidoptera : Noctuidae), a serious shoot and fruit borer pest of Okra by fruit dip method. Spinosad 45 SC (0.012 %), indoxacarb 14.5 SC (0.0087 %) and Bt. var. *Kurstaki* (Halt) (0.1%) exhibited cent per cent larval mortality, 3, 5 and 5 days after treatment respectively. Bt. var. Kurstaki (Dipel 8L) and novaluron 10 EC recorded 90.00 per cent and 80.00 per cent mortality 7 days after treatment.

Among the various vegetables grown in India, Okra (bhendi) is one of the largely cultivated fruit vegetables. This crop is attacked by many pests, out of which shoot and fruit borer commonly known as spotted bollworm *Earias vitella* (Fab.) is the most important one. This pest causes heavy damage in all seasons. The larvae attack the shoot initially and later bore into tender fruits, causing 88 to 100 per cent fruit damage (Radke and Undirwade, 1981). Application of broad spectrum pesticides has many serious and self defeating features like development of pesticides resistance in target species, resurgence of pest and residual toxicity. The overcome this, identification of new chemical molecules with better insecticidal properties, lower mammalian toxicity, lower dosage application with selective action fits very well in the IPM concept. Such molecules like spinosad 45 SC, a natural insecticide obtained from the fermentation of a soil Actinomycetes, *Saccharopolyspora spinosa*, similarly abamectin which is naturally derived from the soil microorganism *Streptomyces avermitilis* was used in the present study besides the indoxacarb 14.5 SC belonging to oxadiazine group of insecticide. Therefore, it was felt necessary to find out the toxicity of different novel insecticides as larvicides in suppressing *E. vitella* populations in Okra.

MATERIAL AND METHODS

The laboratory experiment was carried out in Completely Randomised Design (CRD) with ten treatments and three replications in the Department of Entomology, Dr. PDKV, Akola during 2002-2003 season. Bioassay was conducted on laboratory reared uniform third instar larvae of *E. Vitella* maintained on pieces of bhendi by fruit dip method.

The fruits of bhendi were dipped in freshly prepared concerntration of insecticide solution for ten seconds with gentle agitation. The fruits were kept on blotting paper to remove excess of insecticide solution. For each treatment, ten larvae each of third instar having equal size, were kept on the treated fruits in the plastic vials. Simultaneously, a control was maintained by dipping bhendi fruits in distilled water. The treatments were replicated thrice. Mortality of larvae was recorded from one to seven days after treatment. Moribund larvae were treated as dead. The data so obtained were transformed and subjected to statistical analysis (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The data regarding per cent mortality of third instar larvae of *E. vitella* from one to seven day after treatment are presented in Table 1. All the treatments were significantly superior over control. Amongst the treatments, spinosad 45 SC @ 0.012 per cent caused 70.00, 80.00 and 100.00 per cent larval mortality at 1, 2, 3 DAT, respectively. It was followed by indoxacarb 14.5 SC @ 0.0087 per cent causing corresponding per cent mortality of 63.33, 76.66, 86.66, 96.66 and 100.00 at 1 to 5 DAT, respectively. The next effective treatments were Btk (Halt) and Btk (Dipel 8 L) showing corresponding larval mortality ranging from 40.00 to 100.00 per cent at 1 to 5 DAT and 30.00 to 90.00 per cent at1to 7 days after treatment, respectively. Novaluron 10 EC @ 0.002 per cent and

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Table 1. Per cent larval mortality of *E. vitella* due to stomach action by fruit dip method

S.N.	Treatments	% conc.	% *E. vitella* larval mortality						
			1 DAT	2 DAT	3 DAT	4 DAT	5 DAT	6 DAT	7 DAT
1.	Diflubenzuron 25 WP	0.02	0.00	6.66	26.66	43.33	60.00	73.33	73.33
			(2.5)	(13.12)	(30.99)	(40.77)	(51.14)	(59.00)	(59.00)
2.	Novaluron 10 EC	0.002	10.00	23.33	53.33	60.00	70.00	76.66	80.00
			(18.44)	(28.77)	(47.00)	(51.14)	(57.78)	(61.92)	(63.93)
3.	Acetamiprid 20 SP	0.002	0.00	3.33	20.00	30.00	36.66	40.00	46.66
			(2.5)	(7.81)	(26.07)	(33.00)	(37.22)	(39.14)	(43.07)
4.	Imidacloprid 17.8 SL	0.00356	0.00	6.66	23.33	33.33	40.00	43.33	53.33
			(2.5)	(13.96)	(28.77)	(35.21)	(39.23)	(41.15)	(46.92)
5.	Spinosad 45 SC	0.012	70.00	80.00	100.00	*	*	*	*
			(57.00)	(63.93)	(90.00)				
6.	Abamectin 1.8 EC	0.0027	3.33	6.66	26.66	56.66	66.66	73.33	76.66
			(7.81)	(13.96)	(30.99)	(48.93)	(54.99)	(59.70)	(61.71)
7.	Indoxacarb 14.5 SC	0.0087	63.33	76.66	86.66	96.66	100.00	*	*
			(52.77)	(61.22)	(68.85)	(83.85)	(90.00)		
8.	*Bt* var *kurstaki* (Dipel 8L)	0.15	30.00	66.66	83.33	90.00	90.00	90.00	90.00
			(33.00)	(54.78)	(66.14)	(71.56)	(71.56)	(71.56)	(71.56)
9.	*Bt* var *kurstaki* (Halt)	0.1	40.00	73.33	86.66	96.66	100.00	*	*
			(39.14)	(59.00)	(72.29)	(83.85)	(90.00)		
10.	Control (water spray)		0.00	3.33	10.00	10.00	10.00	10.00	10.00
			(2.5)	(7.81)	(15.83)	(15.83)	(15.83)	(15.83)	(15.83)
	'F' test		Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
	SE (m) ±		2.65	4.22	4.50	5.26	4.88	4.54	3.86
	CD at 5%		7.89	12.53	13.36	15.63	14.51	13.51	11.48

N.B. : Figures in parantheses arcsine value, * Larvae did not survive in this treatment,
DAT - Days after treatment

abamectin 1.8 EC @ 0.0027 per cent resulted in mortality of 80.00 per cent and 76.66 per cent at 7 days after treatment.

The findings regarding spinosad 45 SC and indoxacarb 14.5 SC corroborate with the results of Rao *et al.*, (2001), they reported 100.00 per cent mortality of third instar larvae of *H. armigera* with spinosad 45 SC @ 0.4 g lit^{-1} and indoxacarb 14.5 SC @ 1 g lit^{-1}. The findings regarding Btk (Halt) and Btk (Dipel 8 L) are in conformity with the findings of Kharbade *et. al.*, (1998) and Kharbade *et. al.*, (1999) who observed 100.00 per cent mortality of both Btk treated first instar larvae of *E. vitella* with Btk (Dipel 8L) @ 1.5 ml $li1^{-1}$ and Btk (Halt) @ 2 g lit^{-1}.

Hence, it could be concluded that these insecticides with novel mode of action could be incorporated in Integrated Resistance Management Programme against *E. vitella*.

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PKV Res. J. Vol. 27 (1) 2003

Evaluation of Various Integrated Pest Management (IPM) Modules Against Bollworm Complex of Cotton

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ABSTRACT

Various integrated pest management (IPM) modules comprising different components such as bioagents, plant products, mechanical control measure and chemical were evaluated in the present investigation for management of cotton bollworms. The pooled results clearly evidenced the effectiveness of IPM module M_6 - HaNPV 250 LE ha^{-1} +1/2 dose of endosulfan (0.025%) endosulfan (0.05%), NSE 5 per cent + 1/2 dose of endosulfan (0.025%), monocrotophos (0.05%), M_2, NSE 5 per cent + 1/2 dose of endosulfan (0.25%) and M_8 - spray of recommended insecticides (endosulfan 0.05%), chloropyriphos 0.05 per cent, monocrotophos 0.05 per cent, quinalphos 0.05 %) in recording minimum infestation of bollworm complex in green fruiting bodies, open bolls, loculi damage due to pink bollworm and highest seed cotton yield. CBR was also maximum in IPM module M_6 and M_2.

Cotton the 'White gold' is an important commercial crop and play a key role in the economy of the country. India accounts for 29 per cent of world's cotton area and ranks first, however 4th with 15 per cent of world's cotton production (Sarkate and Pawar, 2003). Amongst the various factors responsible for low yields, the losses caused by insect pests are of major importance. In India 162 species of insects are associated with cotton. Amongst these 12 species are of major importance resulting in an annual loss of 50-60 per cent of total production (Anonymous, 1989). The yield losses caused due to cotton bollworms (Spotted, Pink and American bollworms) alone are reported to the extent of 50 per cent by Geeta Bharathan (2000). Area under cotton crop in the country is only 5 per cent of the total cropped area, but the chemical pesticides to the tune of 50 per cent are being used for the control of pests on this crop (Kapadia and Mohla, 1980). This excessive and indiscriminate use of chemicals on cotton have led to development of resistance in pest, resurgence of secondary and minor pests, adverse effects on natural enemies like parasitoids, predators besides pollinators and environmental pollution etc. Continued usage of pesticides not only have lost their efficiency but also have become economically non-acceptable. Keeping in view the above, various IPM modules comprising different components such as bioagents, plant products, mechanical control measures and chemical were evaluated in the present investigation for management of cotton bollworm.

MATERIAL AND METHODS

A field experiment was conducted at Regional Research Centre, Amravati, Maharashtra during *Kharif* season in 1998-99, 2000-2001 and 2001-2002 to evaluate the various IPM modules comprising different components against cotton bollworms. The experiment was laid in randomized block design with three replications Nine treatments including untreated control were evaluated. Rajat variety of cotton was sown at a spacing of 60 x 30 cm in a plot of 5.4 x 5.4 m. Observations were recorded on five randomly selected plants in each net plot (3.6 x 4.2 m). The pretreament observations were recorded 24 hrs before application of treatment and post treatment observations at an interval of 5 days on the following aspects.

1. Infestation of bollworm complex in green fruiting bodies.
2. Infestation of bollworm complex in open bolls at harvest.
3. Loculi damage due to pink bollworm
4. Yield of seed cotton.

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RESULTS AND DISCUSSION

Infestation of bollworm complex in green fruiting bodies

The poolded data of three years (Table 1) revealed that all the treatments were significantly superior over untreated control in recording the minimum infestation of bollworm complex in green fruiting bodies at 7 and 14 days after treatment application. Minimum infestation of bollworm complex in green fruiting bodies i.e. 12.23 per cent and 17.03 per cent was observed in module M_6. (HaNPV 250 LE ha^{-1} + 1/2 dose of endosulfan (0.025 %), endosulfan (0.05%), NSE 5 per cent + 1/2 dose of endosulfan (0.025%), monocrotophos (0.05%) followed by modules M_8, recommended insecticides (endosulfan 0.05%, chlorpyriphos 0.05%, monocrotophos 0.05%, quinalphos 0.05%) i.e.12.66 per cent and 17.29 at 7 and 14 days after application of treatment respectively.

Infestation of bollworm complex in open bolls at harvest

Significantly minimum infestation (48.78 %) in open bolls at harvest was recorded in module M_8, recommended insecticides (endosulfan 0.05%, chlorpyriphos 0.05%, monocrotophos 0.05%, quinalphos 0.05) followed by module M_2, NSE 5% + 1/2 dose of endosulfan (0.025%) and M_6, (HaNPV 250 LE ha^{-1}+ 1/2 dose of endosulfan (0.025%), endosulfan (0.05%), NSE 5 per cent + 1/2 dose of endosulfan (0.025%), monocrotophos (0.05%) i.e. 49.03 per cent and 49.63 per cent respectively. These treatments were at par with each other.

Loculi damage due to pink bollworm

The observations indicated that all treatments except module M_7, mechanical control measures (collection and destruction of grown up larvae) were found significantly superior over untreated control in recording the minimum loculi damage. The module M_6, HaNPV 250 LE ha^{-1} + 1/2 dose of endosulfan (0.025%), endosulfan (0.05%), NSE 5 per cent + 1/2 dose of endosulfan (0.025 %), monocrotophos (0.05%) recorded minimum loculi damage (14.82%) followed by M_8 and M_2 i.e. 14.83 and 15.28 per cent, respectively. All these modules were at par with each other.

Yield of seed cotton and cost benefit ratio

The data revealed significant differences in yield of seed cotton in different modules. Highest seed cotton yield 5.13 q ha^{-1} was recorded in the IPM module M_6, HaNPV 250 LE ha^{-1} + 1/2 dose of endosulfan (0.025%), endosulfan (0.05%), NSE 5 per cent + 1/2 dose of endosulfan (0.025%), monocrotophos (0.05%), followed by M_2, NSE 5 per cent + 1/2 dose of endosulfan (0.025%) and M_8, recommended insecticides i.e. 4.40 and 4.40 q ha^{-1} respectively. Highest CBR was found in IPM module M_6 and M_2 i.e. 1:2.79 and 1:2.76 respectively.

Sarode *et. al.*, (1994) and Rao and Reddy (1999) reported the effectiveness of HaNPV against *Helicoverpa armigera* on cotton eqivalent to that of recommended chemical insecticides. HaNPV in combination with half dose of recommended insecticides enhanced the efficacy and good control of bollworms on cotton was obtained. The HaNPV spray @ 250-500 LE ha^{-1} at weekly interval during peak oviposition period of pest has been recommended for control of *H. armigera* on cotton (Reddy and Krisnamurthy, 1989). Half dose of recommended insecticide with neem seed extract, found to perform better against major pests of cotton was reported by Sarode *et. al.*, (1993). Gupta and Sharma (1996) reported the satisfactory control of bollworm complex as well as increase in cotton yield by using combination of neem and *Bacillus thuringinensis* and 84 per cent reduction in use of synthetic pyrethroids was achieved. Mass releases of *Trichogramma chilonis* and *T. achaeae* during initial stage of formation of fruiting bodies reduced the incidence of all three species of bollworms (Agrawal ad Gupta, 1986). Clipping of spotted bollworm affected terminal shoots along with larvae and its destruction, hand picking larvae of *H. armigera* and their destruction are recommended for the adoption in the IPM programme (Sarode *et.al.*, 2003).

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Table 1. Pooled effect of different IPM modules on bollworm complex infestation, loculi damage and yield of seed cotton

IPM modules	Av. (%) infestation of bollworm complex			Av. (%) loculi damage due to pink bollworm	Yield of seed cotton q ha^{-1}	Cost benefit ratio
	Green fruiting bodies		Open bolls			
	7 days after application of treatment	14 days after application of treatment				
M_1= NaNPV 250 LE ha^{-1} + 1/2 dose of endosulfan 0.025%	16.16 (3.94)*	19.47 (4.33)*	53.07 (46.47)**	18.03 (4.22)*	3.55	1:0.58
M_2 = NSE 5 % + 1/2 dose of endosulfan 0.25%	14.08 (3.68)	17.67 (4.11)	49.03 (44.81)	15.28 (3.88)	4.40	1:2.76
M_3= *Trichogramma chilonis* @ 1 lakh ha^{-1}, HaNPV 250 LE ha^{-1}, NSE 5 per cent, *Bacillus thuringiensis* 1 lit ha^{-1}	15.11 (3.83)	19.65 (4.34)	58.21 (49.77)	17.90 (4.20)	3.60	1:0.82
M_4= HaNPV 250 LE ha^{-1}, endosulfan 0.05%,NSE 5%, monocrotophos 0.05%	14.80 (3.78)	18.67 (4.25)	55.80 (48.38)	17.26 (4.14)	4.12	1:1.75
M_5= HaNPV 250 LE ha^{-1}, collection and destruction of grown up larvae, NSE 5 %, collecion and destruction of grown up larvae, endosulfan 0.05 %	14.73 (3.76)	18.06 (4.18)	54.48 (47.59)	16.86 (4.09)	3.29	1:0.70
M_6 = HaNPV 250 LE ha^{-1} + 1/2 dose of endosulfan, 0.025%, endosulfan 0.05%, NSE 5% + 1/2 dose of endosulfan 0.025%, monocrotophos 0.05%	12.23 (3.44)	17.03 (4.06)	49.63 (44.78)	14.82 (3.82)	5.13	1:2.79
M_7= Mechanical control (collection and destruction of grown up larvae	17.30 (4.08)	21.77 (4.57)	63.30 (52.87)	20.59 (4.51)	3.20	1:1.12
M8 = Recommended insecticides (endosulfan 0.05% chlorpyriphos 0.05% monocrotophos 0.05% quinalphos 0.05%)	12.66 (3.51)	17.29 (4.08)	48.78 (44.30)	14.83 (3.84)	4.40	1:2.01
M_9 = Untreated control	19.44 (4.35)	24.35 (4.86)	71.14 (57.59)	22.49 (4.72)	2.76	
'F' test	Sig	Sig	Sig	Sig	Sig	
SE (m) ±	0.04	0.06	0.73	0.86	0.30	
CD at 5%	0.14	0.18	2.20	0.25	0.91	
CV%	3.76	4.35	4.53	6.22	24.15	

* Figures in the parentheses are square root values, ** Figures in the parantheses are arc sin values

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Efficacy of Synthetic Insecticides Against Stemfly *Melanagromyza sojae* (Zebntner) of Soybean

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ABSTRACT

Efficacy of some synthetic insecticides were evaluated against the stemfly Melanagromyza (Zebntner) a major pest of soybean. The treatment with soil application of phorate 10 G @ 10 kg ha^{-1} recorded significantly minimum infestation of stemfly (4.75%) followed by acephate 0.07 per cent (5.07%) and chlorpyriphos 0.04 per cent (5.89%). Highest yield (19.58 q ha^{-1}) and maximum cost benefit ratio (1:4.90) was recorded due to soil application of phorate 10 G 10 kg ha^{-1}.

In India soybean *Glycine max* (L.) Merill crop was introduced some where between 1870-1880. Appreciating the immense potential of soybean in augmenting the oil and protein supply and encouraged by its excellent performance, cultivation of soybean on large scale was started in selectd state during the year 1971-1972. By overcoming several stumbling factors and convention bound detraction, Soybean cultivation in India has steadily increase from 0.003 million hectares in 1918 to more than 1.3 million hectares i 1985 (Singh *et. al.*, 1989). The soybean production in the world has been showing an ever increasing trend. Soybean presently considered as cash crop having 42-43 per cent protein and 20 per cent good quality oil is used as food, feed and also utilized by the industries. The average yield of soybean is 907.2 kg ha^{-1} which is considered as low (Ventateson, *et. al.*, 1994). Soybean crop was considered to be the safest crop as regard to the insect pest attack. But recently the situation has changed drastically and is recorded to be pest prone crop in India. Among various pests, stemfly *M. sojae* is one of the major pests of soybean.

In India, stemfly is a serious pest of soybean showing about 40 per cet infestation during winter season, above 90 per cent during rainy season in Madya Pradesh and about 90 per cent in Delhi. It also infests soybean in Maharashtra (Singh *et. al.*, 1989). Yield losses in soybean caused by *M. Sojae* ranged from 18.6-40.1 per cent. Owing to the seriousness of the problem of this pest some synthetic insecticides were evaluated.

MATERIAL AND METHODS

A field experiment was conducted for three years at Regional Research Centre, Amravati, Maharasthra during the Kharif season of 1996-1997, 1998-1999 and 1999-2000 to evaluate the efficacy of synthetic insecticides against major pest of soybean. The experiment was laid in randomized block design with three replication. Nine treatments including untreated control were evaluated. JS-335 variety of soybean was sown at a spacing of 45 x 5 cm in a plot of 3.00 x 2.70 m.

The stemfly infested plants were counted in one meter row length basis in three rows in each plot. The observations were recorded 24 hr before and 14 days after application. Phorate 10 G was applied in the soil at the time of sowing. The average per cent of stemfly infested plants per meter row length were worked out. The stemfly infestation data and grain yield data were analyzed statistically.

RESULTS AND DISCUSSION

The data presented in Table 1 revealed that, all the treatments were significantly superior to untreated control in recording minimum infestation of stemfly damage. The treatmet with soil application of phorate 10 @ 10kg ha^{-1} recorded significantly minimum infestation of stemfly (4.75%) followed by acephate 0.07 per cent (5.07%) and chlorpyriphos 0.04 per cent (5.89%) and all these treatments were at par with each other.

Three years Pooled data (Table 1) revealed

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Table 1. Effect of different synthetic insecticides on infestation of stemfly and yield of soybean

S.N.	Treatments	Av. % stemfly infestation	Yield q ha^{-1}	Cost benefit ratio
1.	Quinalphos 0.05 %	7.05 (2.44)*	18.23	1:2.11
2.	Chlorpyriphos 0.04 %	5.89	19.05 (2.21)	1:3.63
3.	Endosulfan 0.05%	7.40 (2.53)	18.20	1:4.22
4.	Monocrotophos 0.05%	6.56 (2.39)	17.70	1:3.30
5.	Triazophos 0.04%	6.21 (2.27)	19.22	1:4.19
6.	Acephate 0.07%	5.07 (2.11)	19.01	1:3.64
7.	Phorate 10 G @ 10 kg ha^{-1}	4.75 (2.01)	19.58	1:4.90
8.	NSE 5%	7.92 (2.61)	16.30	1:2.65
9.	Untreated control	13.63 (3.51)	14.70	
	'F' test	Sig	Sig	
	Se (m) ±	0.08	0.70	
	CD at 5%	0.25	2.10	

* Figures in parentheses are square root transformation

that highest yield due to the treatment with phorate 10 G @ 10 kg ha^{-1} (19.58 q ha^{-1}) followed by triazophos 0.04 per cent (19.22 q ha^{-1}), chlorpyriphos 0.04 per cent (19.05 q ha^{-1}), acephate 0.07 per cent (19.01 q ha^{-1}), quinalphos 0.05 per cent (18.23 q ha^{-1}), endosulfan 0.05 per cent (18.20 q ha^{-1}) and monocrotophos 0.05 per cent (17.70 q ha^{-1}) and all these treatments were at par with each other. The treatment NSE 5 per cent was at par with untreated control in respect of yield. Maximum cost benefit ratio (1:4.90) was recorded in the treatment soil application of phorate 10 G which was closely followed by endosulfan and triazophos.

Bagle and Verma (1990) reported that single application of granular phorate at 1.5 kg a.i. ha^{-1} and 3 applications of Monocrotophos at 0.5 kg a.i. ha^{-1} were effective against *M. sojae*. Quinalphos and mephosfolan besides phorate were also reported to reduce the infestation of *M. sojae* (Kundu and Mishra, 1993). Similarly Kundu and Srivastava (1991) observed that spray of 0.04 per cent monocrotophos significantly reduced the stemfly tunneling of *M. sojae*. Chlorpyriphos 50 EC + cypermethrin 5 EC, quinalphos 20 AF and ethofenprox 10 EC were highly effective against stem fly *M. sojae* (Yadav *et. al.*, 2001).

Taware *et. al.*, (2000) also recorded the highest seed yield of soybean in the treatment chlorpyriphos spray @ 1.5 l ha^{-1} and phorate 10 G @ 10 kg ha^{1} as soil application before sowing. However, Venkatesh and Kundu (1994) obtained maximum yield in plot treated with endosulfan whose cost benefit ratio was also highest (1:6.16). Similarly it was reported that Chlorpyriphos 50 EC + cypermethrin 5 EC gave the maximum yield followed by quinalphos 20 AF and lambda-cyhalothrin 5 EC and these insecticidal treatments gave the net return of Rs. 6212 ha^{1}, Rs. 6090 ha^{1} and Rs. 5878 ha^{1} with cost : benefit ratio of 1 : 4.63, 1:7.00 and 1 : 8.61, respectively (Yadav *et. al.*, 2001).

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Development of Tractor Mounted Cotton Under Root Cutter

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ABSTRACT

Tractor mounted two-row U-shaped under root cutter with depth controlling wheels was developed at Department of Farm Power and Machinery, Dr PDKV, Akola, MS, India. It was tested in different varieties of cotton (i.e. PKV- Rajat and Ankur) and its performance was compared with tractor mounted V-blade. The effective field capacity of under root cutter varied from 0.24 ha h^{-1} to 0.36 ha h^{-1} and the efficiency of root cutting operation of the cutter was 98 to 99% of the plant population. In case of V-blade it was ranged from 0.23 to 0.24 ha h^{-1}. The operational cost was found to be Rs 800 to Rs 1650 ha^{-1} for the under root cutter.

In India, farmers uproot the cotton stalks after harvest using long armed pincer tool, locally called sad chimta. The operation is arduous and time consuming. Among the different methods for cotton stalks removal, tractor operated V-blade is quite common. However, in absence of depth controlling mechanism, penetration of V-blade is uneven which results into formation of channels in the field that disturb general grade of field. Therefore, development of tractor operated equipment provided with a depth control mechanism for cutting roots at 100 to 150 mm depth was undertaken.

MATERIAL AND METHODS

Tractor mounted U-shaped cotton stalk under root cutter was designed and developed to cut the crop root at a depth of 100 -150 mm below the soil surface within a width of about 2000 mm to facilitate easy movement of the tractor implement system. The clearance below the main frame provided was 90 to 100 cm to allow a passage of uprooted cotton stalks with minimum obstruction. Thickness (25 mm) and width (50 mm) of the tyne were designed so that it could be protected against the bending. The operating width of the blade was designed so that it could be operated by commonly used 45-47 hp tractor (Fig1). Two depth-controlling wheels of 450 mm diameter were fabricated from steel flat and rods and fitted with a tool bar by flat plates. The manufacturing cost of the implement was observed to be Rs 10,000/- only.

The cotton under root cutter and V-blade (Table 1) were tested on different fields located in Dr. PDKV, Akola and on farmer's field (Table 2). During trials, the tractor (Mahindra DI 575, 47 hp) was operated in second-low gear. The speed of operation for under root cutter was in the range of 2.60 kmph to 2.74 kmph and that for V-blade it was 2.56 kmph to 2.60 kmph.

RESULTS AND DISCUSSION

Effective Field Capacity

The field capacity of under root cutter varied from 0.24 ha h^{-1} and 0.36 ha h^{-1} respectively for 60 cm and 90 cm row spacing cotton crop. Irrespective of the crop spacing, the work done by the implement in the manipulation of the soil remained same for two rows. The field capacity of V-blade varied from 0.23 to 0.24 ha h^{-1} and the depth of operation under the nose was found to be 26 to 28 cm whereas it was 8 to10 cm under the wing. The channels of about 22 to 25 cm deep developed in the field. The deeper operation under the nose of V-blade also overloads the tractor. The total width of operation was found to be 130 to 140 cm (Table 3).

Field Efficiency

The field efficiency of under root cutter was 71per cent and that of V-blade was 51per cent. The field efficiency was lower in case of V-blade because of the lower effective field capacity obtained in the field. The higher depth of operation and width has reduced the effective field capacity of the V- blade (Table 3).

Fuel Consumption

The fuel consumption of tractor with under root cutter was 11.10 to 16.65 l ha^{-1} while it was 17.40 to 16.67 l ha^{-1} in case of V-blade. The higher fuel consumption for V-blade can be attributed to the higher depth of operation and consequently more soil manipulation.

Root cutting efficiency

The efficiency of under root cutter was found to be 98 to 99 per cent. The efficiency is very much related with maintaining the proper depth of operation

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Table 1. Specification of tractor mounted under root cutter and V-blade

S N	Particulars	Under root cutter	V-blade
1	Manufacturer	Dr. PDKV, Akola.	Commercially available
2	Size, l x b x h, mm	1975 x 900 x 1175	2200 x 1000 x 950
3	Soil working parts	U-shaped bevel edged plane blade	V-shape, bevel edged plane blade
4	Operational depth control	Two depth adjusting gauge wheels	Not provided
5	Implement weight, (kg)	260	200
6	Implement cost, (Rs)	10,000	8,000

Table 2. Characteristics of cotton crop

S N	Particulars	Observation before test*	
1	Field Location	Gudadi block (A)	Farmers field (B)
2	Variety	PKV – Rajat	Ankur
3	Sowing method	Drilling	Dibbling
4	Plant spacing, cm x cm	60 x 60	90 x 60
5	No. of plants ha^{-1}	23,600	17,100
6	Plant height, cm	90 – 100	90 – 110
7	Av. diameter of stalk, mm	13	15
8	Plant moisture content, % (wb)	48	40
9	Root zone depth, cm	24.5	20
10	Soil moisture, % (db)	8.5	10
11	Stalk yield, t ha^{-1} (estimated)	4.50	4.14

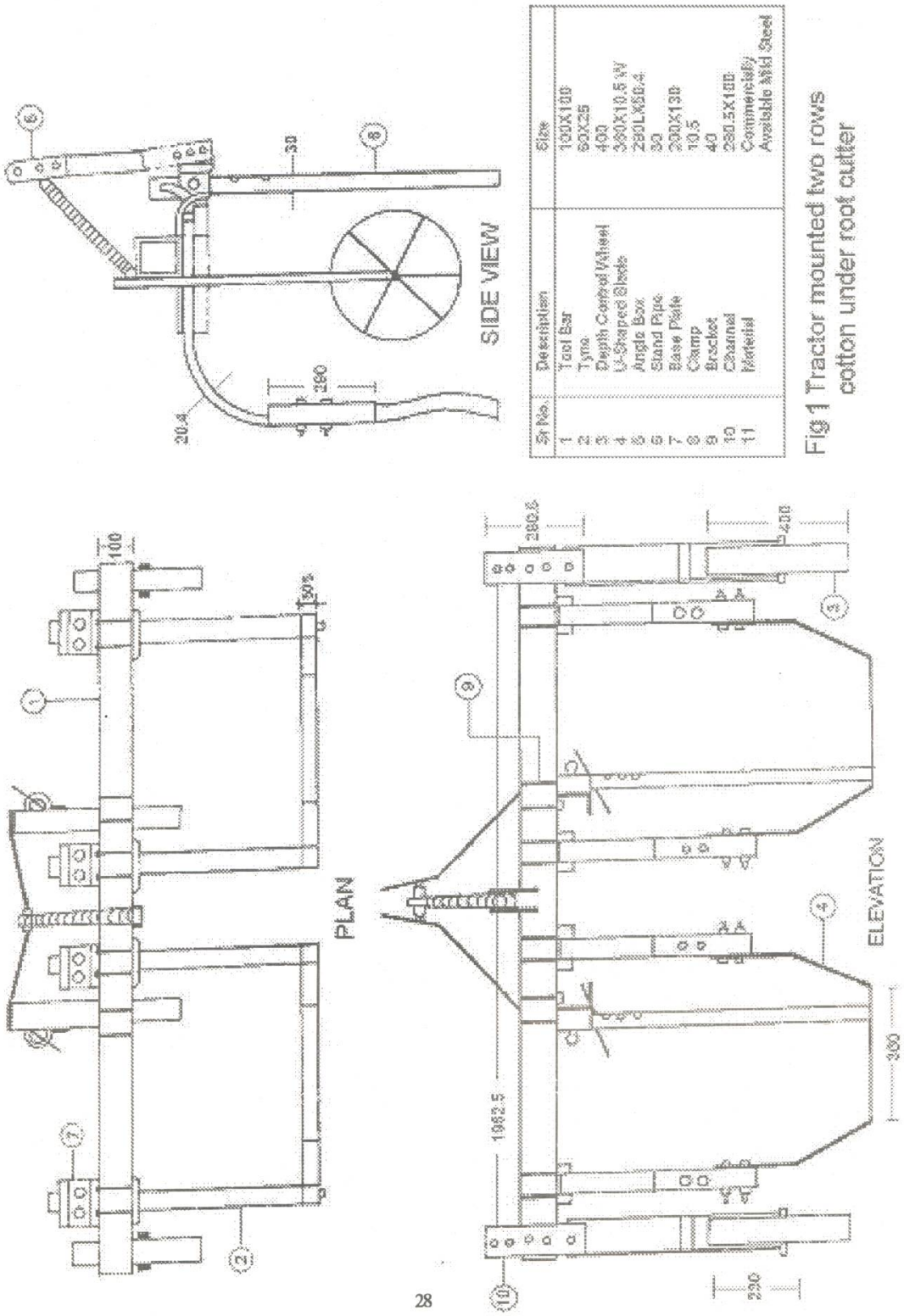
(* Average of three observations)

Table 3. Performance of under root cutter and V-blade in cotton crop*

SN .	Particulars	Under root cutter			V-blade	
1.	Trials	I	II	III	I	II
2	Date of Test	23.2.03	8.3.03	9.3.03	8.3.03	9.3.03
3	Location and area, ha	A, 0.72	A, 0.72	B, 1.0	B, 0.5	B, 0.5
4	Width of cut per row, mm	375	375	375	375	325
5	Actual area covered, ha	0.7	0.7	1.0	0.5	0.5
6	Working width, cm	120	120	180	180	180
7	Av. working depth, cm	15	15	14	26	28
8	Operating speed, kmph	2.65	2.74	2.60	2.56	2.60
9	Actual field capacity, ha h^{-1}	0.24	0.26	0.36	0.23	0.24
10	Theoretical field capacity, ha h^{-1}	0.32	0.33	0.47	0.46	0.47
11	Field efficiency, %	76	79	77	50	52
12	Fuel consumption, l ha^{-1}	16.65	15.30	11.10	17.40	16.67
13	Root cutting efficiency, %	99	98	99	91	94
14	Operational Cost, Rs ha^{-1}.	1150	1100	8000	1200	1150

(*Average of three observations)

all the times, which is possible due to the provision of depth control wheels. In case of V-blade, the efficiency of plant removal was found to be 91 to 94 per cent. Because of the less clearance (about 45 cm) available below the frame of the implement, the operation was to be stopped intermittently because of the implement clogging with uprooted plants.



Sr No.	Description	Size
1	Tool Bar	100X100
2	Tyre	600X25
3	Depth Control Wheel	400
4	U-Shaped Blade	380X10.5 W
5	Angle Box	280LX50.4
6	Stand Pipe	30
7	Base Plate	300X130
8	Clamp	10.5
9	Bracket	40
10	Channel	280.5X100
11	Material	Commercially Available Mild Steel

Fig 1 Tractor mounted two rows cotton under root cutter

Operational cost

The operational cost is related to field capacity. In case of under root cutter the operational cost was found to be Rs 1100 to Rs 1150 ha^{-1} for 60 cm row spacing crop and Rs 800 ha^{-1} for 90 cm row spacing. The operational cost for V-blade operation varied from Rs 1150 to Rs 1200 ha^{-1}. Hence a saving of about 36 per cent in operational cost could be achieved with under root cutter compared to V-blade.

The newly developed under root cutter performed satisfactorily for the removal of cotton stalks from the field.

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Performance of Different Interculture Equipment in Cotton Crop

A. A. Deogirikar[1], N. N. Narkhede[2], K. P. Arulkar[3] and B. B. Landge[4]

ABSTRACT

A study was conducted to evaluate performance of different interculture equipments for their weeding efficiency, field capacity and cost of operation on the University field at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS). The (different interculture) equipment used were bullock drawn hoe, tractor mounted three tines cultivator with two different types of shovel and two types of power tillers. It was found that the field capacity of the tractor operated cultivator varied from 0.74 to 0.80 ha h^{-1} and saving of about 86 per cent in the cost of operation was obtained compared to the conventional method of interculture. It was found economical to use tractor mounted cultivator for interculture operation in cotton crop.

Cotton is the major cash crop of India. But the productivity of cotton in India is very low. The reasons behind this low productivity may be variety of cotton, poor pest control and competition of crop for light, water and nutrients with the weeds growing in between and in the rows. Though chemical methods like weedicides are available for effective control of weeds, it needs highly precision application technique and equipment and hence it is not popular among the farmers. Another method for controlling weeds is by mechanical means in which animal drawn, manual, tractor drawn and self-propelled implements and equipments are available. Manual and animal drawn methods are time and labour consuming but still these are preferred by majority of farmers because of the low cost and ready availability. Biswas *et. al.*, (1999) studied the performance of different types of animal drawn hoe. They found the triangular hoe required more time i.e. 8.23 h to cover one hectare area compared to blade hoe, which required 7.73 h for the same area. Self-propelled equipments like power tillers and tractor operated implements are commercially available in the market and which are mainly used for the seed bed preparation. Power tillers can be the midway between the tractor and bullock power for weed control. The cost of power tillers is lower compared to tractor, which can be afforded by comparatively large number of farmers. Dash et. al. (1993) found power tiller farming superior to bullock farming system considering yield. The higher yield was attained with power tiller due to better availability of plant nutrients by thorough mixing of soil; more levelled and pulverized seedbed, less weed density and optimum plant damage. Pullon and Cowell (1997) reported that the weeding efficiency of 88 per cent and 65 to 89 per cent could be achieved with sweep and duck foot shovels, respectively used with tractor mounted cultivator. The present study was undertaken to evaluate the weeding efficiency, field capacity and cost of operation of the animal drawn, tractor drawn and self propelled interculture equipment in the field of cotton crop.

MATERIAL AND METHODS

The study was conducted on the University fields at Central Research Station, Dr. PDKV, Akola at Shivani and Babhulgaon Block in the rain fed cotton variety AKH-081 and AK-7. A bullock drawn hoe with 0.70 m blade length was used for animal drawn interculture implement. Two different power tillers of 12 hp (Kamco) and 5 hp (Craftsman) were evaluated in the study. Both the power tillers were provided with a lever to adjust the depth of operation. The Kamco power tiller was having three forward and one reverse gear in both low and high speed. In case of Craftsman power tiller, a lever was provided to engage or disengage the rotary tines. The machine had three gears out of which one for reverse direction, one for forward direction and remaining for engaging or disengaging the tines. The direction of rotation of tines in Kamco power tiller was forward or down cut while in case of Craftsman power, the direction of rotation of tines was reverse or up cut.

A three tines tractor mounted cultivator with shovel I (0.22 m), shovel II (0.40 m) and plane blade (0.40 m) were tested in the field of cotton (Fig 1).

The performance of the implements was studied for their width of cut, travel speed, weeding

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efficiency, fuel required and cost of operation. Five trials were conducted and the average of these readings was considered for the comparison of their performance (Table 1 and 2). The procedure prescribed by the RNAM Test code for testing of cultivator was followed throughout the test.

RESULTS AND DISCUSSION

Weeding efficiency

The weeding efficiency varied from 51.82 to 65.56 percent in tractor mounted cultivator using shovels. The depth of operation within the two rows varied from 2 cm on the wing side to 5 to 7 cm in the furrow. Such a wide variation in the depth of operation opens the soil and expose to the atmosphere, which leads to increase in the loss of soil moisture. Therefore plane blades (40 cm size) were prepared and used instead of shovels. Uniform depth of operation (3 cm) with weeding efficiency of 69.24 per cent was obtained with plane blades.

The power tillers, Craftsman and Kamco gave the weeding efficiency of 71.27 and 66.06 per cent, respectively. The Craftsman power tiller showed better weeding efficiency and cutting of weed into pieces and mixing it with soil because of its reverse rotation. The depth of operation obtained with Craftsmans power tiller was 4 cm while with Kamco power tiller it was 5 cm.

The conventional method of bullock drawn plane blade hoe could achieve weeding efficiency of about 55 percent and the depth of operation 3 cm.

Field capacity

The effective field capacity of tractor mounted cultivators varied from 0.74 to 0.80 ha h^{-1} whereas it was 0.043 to 0.089 ha h^{-1} in power tillers and 0.113 ha h^{-1} with the conventional method. The tractor mounted cultivators have a very high field capacity compared to conventional implement and this single parameter justifies its use for interculture on the farmer's field where the interculture has to be completed within the shortest possible time for making the good use of favourable soil moisture (*Wapsa*) condition. The power tillers though have a good weeding efficiency, lag behind in the field capacity even to that of the conventional method.

Cost of operation

The use of power tillers represents the costliest method of interculture in cotton. The cost of operation for Craftsman power tiller was observed

Table 1 Evaluation of tractor mounted cultivator for interculture in cotton crop.

SN	Particulars Date of Test	Shovel I 24.08.2001	Shove II 26.08.2001	Plane blade 28.08.2001
A)	**Test condition**			
	a) Condition of the field			
1.	Location : C.R.S. Akola (Plot No.)	Shivani block (19/20)	Shivani block (34)	Shivani block (34)
2.	Area of field, ha	1.01	2.26	2.26
3.	Soil moisture (d.b.) ,%	29	27	26
4.	Weed population, weeds sq. $m.^{-1}$	467	332	193
	b) Condition of crop variety	AKH-081	AK-7	AK-7
1.	Age in days after sowing	35	41	43
2.	Sowing method & row spacing, cm	Drilling, 70	Drilling, 70	Drilling, 70
	c) Draft power & cultivator			
1.	Make/model		Tractor Mahindra DI 575	
2.	Type of working parts used	Shovel (I)	Shovel (II)	Plane blade
3.	Width of cut, cm	20	40	40
B)	**Field performance**			
1.	Effective working width, cm	210	210	210
2.	Working depth, cm (bed and furrow)	2 and 7	2 and 5	3 and 3
3.	Travel speed, kmph	4.43	4348	4.65
4.	Effective field capacity, ha hr^{-1}	0.74	0.76	0.80
5.	Field efficiency, %	79.95	80.32	80.79
6.	Fuel consumption, lit. ha^{-1}	8.32	9.16	8.73
7.	Weeding efficiency, %	51.82	65.66	69.24
8.	Plant damage, %	7.63	6.88	5.03
9.	Cost of cultivation, Rs. ha^{-1}	333	324	308

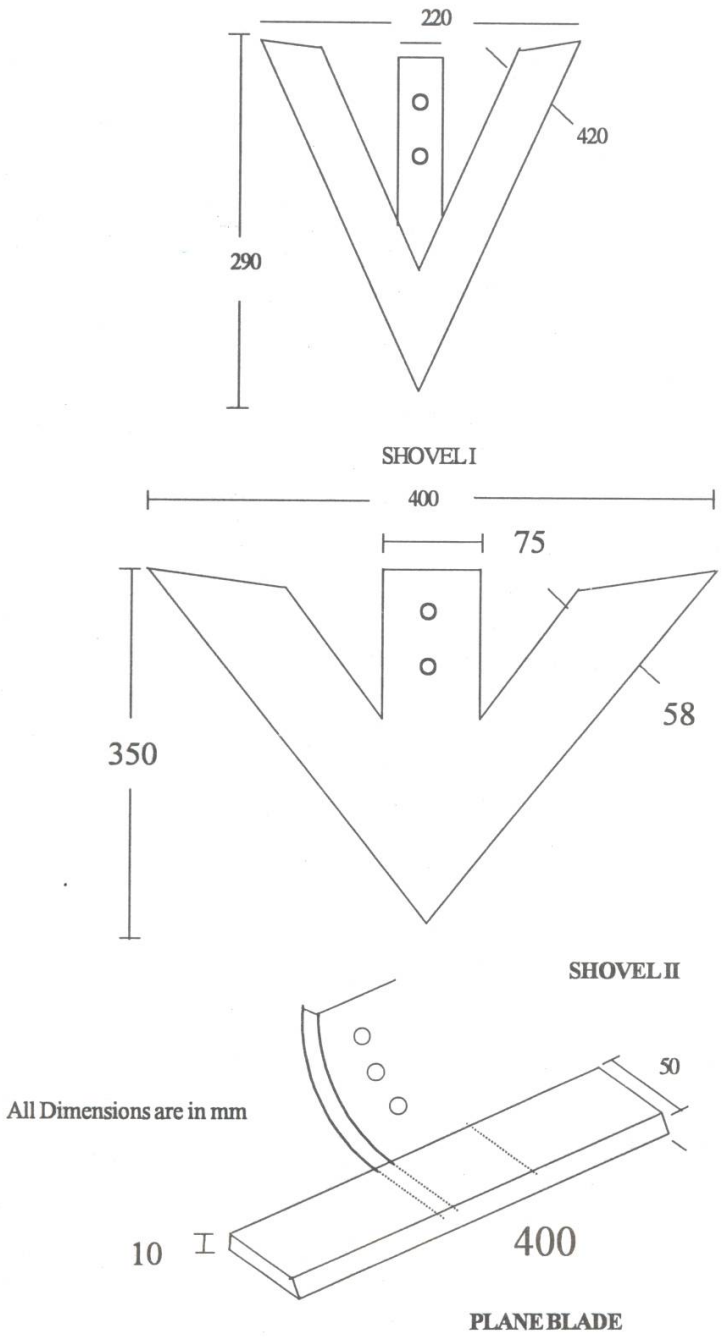

Fig. 1. Shovels and blade used for interculture operation in cotton crop

Table 2 Evaluation of self –propelled interculture equipment

SN	Particulars Date of Test	Mini Powertiller 25.08.2001	Power tiller 27.08.2001	Bullockdrawn hoe 29.08.2001
A)	**Test condition**			
	a) Condition of the field			
1.	Location : C.R.S. Akola		Babhulgaon Block	
2.	Area of field, ha	0.0410	0.1958	0.4876
3.	Soil moisture (d.b.), %	25	28	27
4.	Weed population, weeds sq.m.$^{-1}$	286	302	294
	b) Condition of crop variety	AK-7	AK-7	AK-7
1.	Age in days after sowing	57	69	37
2.	Sowing method and row spacing, cm	Planting, 90	Planting, 120	Drilling, 60
	c) Draft power & cultivator			
1.	Type of working parts used	Reverse rotary tines	Forward rotary tines	-
2.	Width of cut, cm	42	82	20
B)	**Field performance**			
1.	Av. working width and depth, cm	90 and 4	120 and 5	60 and 3
2.	Travel speed, kmph	1.20	1.39	2.99
3.	Effective field capacity, ha hr^{-1}	0.043	0.089	0.113
4.	Field efficiency, %	41.22	53.73	62.66
5.	Fuel consumption, lit ha^{-1}	19.99 (Petrol)	42.23 (Diesel)	-
6.	Weeding efficiency, %	71.27	66.06	54.66
7.	Plant damage as % of total plants	11.84	8.33	14.66
8.	Cost of cultivation, Rs. ha^{-1}	943	338	197

to be Rs. 943 ha^{-1} and that for Kamco power tiller it was Rs. 338 ha^{-1}. As the Craftsman power tiller was petrol operated, the cost of operation was higher compared to diesel operated Kamco power tiller. The cheapest method of interculture was by using tractor mounted cultivator for which the cost of operation varied from Rs. 308 to 333 ha^{-1}. The cost of operation for conventional method was calculated to Rs. 369 ha^{-1}.

Savings obtained over conventional method

The study revealed that there is a great saving in the time, varying from 85 to 86 percent by using tractor mounted cultivator along with 9.75 to 16.50 per cent saving in the cost of operation. The use of power tillers for interculture in cotton is not justified as the negative saving obtained both in time and the cost of operation over the conventional method. This is due to the lower field capacity and higher fuel consumption by these equipments.

The tractor mounted cultivator can be successfully used for the interculture operation in the cotton crop. Considerable saving in time and cost can be obtained by the use of tractor mounted cultivator for interculture. The self-propelled machines like power tillers can undertake the job of interculture in cotton. However, it is not economical, both time wise and cost wise to operate them in cotton crop.

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Energy and Cost Requirement for Construction of Greenhouse

S. D. Golait[1], A. A. Deogirikar[2], P. B. Kale[3], N. L. Raut[4] and A. P. Deshmukh[5]

ABSTRACT

A study was conducted to determine direct energy and cost required for construction of 100m² semi controlled greenhouse at Nagarjuna Medicinal Plant Unit, Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Dr PDKV, Akola). (M.S) India. From unloading of raw material to complete erection of greenhouse human and electrical energy was involved. Human energy required was 852.6 MJ while electrical energy for welding and drilling work was 596.5 MJ. The energy required was 1449.1 MJ i.e. 14.49 MJ/m². This energy requirement can considerably be reduced if skilled worker are appointed and increased working speed. Constructional cost required was Rs 156539.4 excluding transportation charges. The cost can also be reduced up to 25 to 30 per cent if some locally available material is used instead of GI. Material.

Greenhouse technology is one of the emerging technologies to boost up quality agricultural production. But this technology is not getting popularity due to its high dead investment. Very less information is available on constructional cost of greenhouse and also energy requirement for construction of greenhouse. The cost varies according to the location and quality of material used for construction. But a benchmark is necessary to estimate the construction cost of greenhouses of various sizes. This will also to reduce the cost of energy involvement of construction work. Hence study was undertaken at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S) India to work out the energy and cost involvement in the construction of 100m² semi- controlled greenhouse.

MATERIAL AND METHODS

A 100 m² greenhouse having 16 m X 6 m cultivable area and 2 m X 2 m cabin for electrical panels and instruments keeping was constructed on turnkey basis in Indian Council of Agricultural Research and ad hoc scheme "Greenhouse Management For Propagation Of Horticulture and Medicinal Crops" at Nagarjuna Medicinal Plant Unit, Dr. P. D. K. V., Akola (MS) India. It was constructed by M/s. Rajdeep Agriculture product Pvt Ltd, New Delhi. The raw material was procured from New Delhi on 4/11/2003. The actual construction work started on 10/11/2003. One skilled and two unskilled workers were engaged in construction work. As per requirement the number of workers were varied. The working period of worker was 10 a.m. to 6 p.m. i.e. 8 hr but in fact they were working productively for 5 hr of the day. Energy conversion factor was used to convert the man-hour in MJ unit. Daily paid charges and working days of the labour were considered to determine the labour charges in the work. The material cost was evaluated from the actual material required and the material cost in the local market (Table 1).

RESULTS AND DISCUSSION

Energy required for construction of 100 sq m greenhouse

The energy required for the construction of greenhouse was calculated by considering the operation wise energy involvement (Table 3). For conversions, the energy constants were considered (Table 2). Only two types of energy were required one of them was electrical and another was human energy. The electrical energy consumption for welding and drilling at the site was 50 kWh i.e. 596.5 MJ and the human energy required was 441 MJ. In the operation like unloading, bending, welding the human energy involved was 235.2 MJ. As there was no use of any electrical appliances in irrigation, humidity and cooling system fitting there was no electrical energy involved. The human energy required for these operations was 127.4 MJ. The total human and electrical energy required for construction of 100 sq m size greenhouse was calculated to be 1449.1 MJ i.e. 14.491 MJ/m². During construction, it was observed that the labours were wasting their time that directly adds in constructional cost of the greenhouse and wastage of energy.

From the study, it can be concluded that the cost required for the construction of the greenhouse can

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Table 1 Material required for construction of 100 m² greenhouse

S.N.	Items	Details	Qty.	Rate, Rs	Amount, Rs
1	G.I. Sq. Pipe	38 x 38 x 2 mm	350.37 m	78/m	27328.86
2	G.I. Sq. Pipe	32 x 32 x 1.5 mm	113.32 m	68/m	7705.76
3	G.I. Pipe	25mm	12 m	65/m	780.00
4	G.I. Pipe	32mm	18 m	82.5/m	1485.00
5	U.V. Film	200 microns	212 m²	55/m²	11660.00
6	Shed net	50% Black-Green	157 m²	25/m²	395.00
7	Fogger	7 lph	56 No.	120/pc	6720.00
8	Micro-tube	1.2 mm (PVC)	34 m	3.00/m	102.00
9	Lateral	16 mm (PVC)	100 m	5.50/m	550.00
10	Fan 1.5 Hp	48"	1 No.	10000/pc	10000.00
11	Electrical Panel Board	Complete Set	1 No.	300/pc	300.00
12	Generator Set	2 KW	1 No.	38,000/pc	38000.00
13	Monoblock pump	0.5 hp	1 No.	2200/pc	2200.00
14	Monoblock pump	1 hp	1 No.	2700/pc	2700.00
15	Micro sprinkler	40 lph	12 No.	25/pc	300.00
16	Miscellaneous	L.S	L.S		39410.72
	Total, Rs				156549.40

Table 2 Equivalent for direct and indirect source of energy

S. N.	Particulars	Unit	Equivalent energy, MJ
1.	Input energy		
	A) Direct sources		
	1) Human labour		
	a) Man	Man-hr	1.96
	b) Women	Women-hr	1.57
	c) Child	Child-hr	0.98
	2) Electricity	kWh	11.93
	B) Indirect energy		
	a) Seed	kg	18.00
	b) Biomass	kg	10.00
2.	Output energy		
	1) Cereal/pulses crop (grain)	Kg	14.70
	2) Byproduct		
	a) Fodder/stacks	Kg	18.00
	b) Straw	Kg	12.50

Table 3. Operation wise energy involved in construction of greenhouse

S. N.	Construction operation	Manual operation		Electricity required	Human energy, MJ	Electrical energy, MJ
		No. of labour	Hr of operation	Hrs of operation		
1	Cutting, Bending, Welding, Unloading	24	120		235.2	
2	Erection Work, Welding, Drilling	45	225	50 kWh	441	596.5
3	Electric fitting	5	25		49	
4	Irrigation, humidification and cooling system	13	65		127.4	
	Total	87	435		852.6	596.5
	Total energy required, MJ				1449.1	

be reduced to some extent by redesigning the structural components viz. by increasing the horizontal distance between two vertical poles and by replacing the horizontal components of smaller dimensions. Also the direct energy involved can be reduced by properly managing the labours engaged in the work.

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Effect of Pre-Sowing Magnetic Treatment on the Biometric Characteristics and Yield of Isabgol Crop Inside Greenhouse

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ABSTRACT

A study was conducted at Nagarjuna Medicinal Plant Unit, Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS) to evaluate the effect of pre sowing magnetic seed treatment of medicinal crop Isabgol inside greenhouse. Two seed samples were kept separately on South Pole and North Pole of the magnet of 1250 gause for 12 hrs. The results of the North Pole treated seeds found better than South Pole treated seed both in biometric characteristics and yield of the crop. The plant height was increased by 7.55 per cent in North Pole treated plot while it was increased by 3.56 per cent in South Pole treated plot. Also the seed yield in kg/ha was increased by 67.46 and 23.55 per cent in North Pole and South Pole treated plots, respectively.

The magnetic field has shown an effect on plant life. Savostine (1930) conducted studies for the first time and observed 100 per cent elongation of wheat seedlings under the influence of magnetic field. Magnetic treatment has been reported to have a beneficial effect on seed and seedling growth. Pittman (1977), Bhatnagar and Deb (1977), Gusta, Kirkland and Austenson (1978), Gubbles (1982), Kavi (1983), Phirke *et. al.,* (1990), Pietruszewski (1993) and others reported increased seedling growth, seed vigour and crop yield when the dormant seeds of corn, beans, barley and wheat were exposed to a magnetic field. Frydemberg and Nielsen (1965), Moustafa (1973), Gubbels (1982) and others reported effects on growth and yield in field crops. Various types of magnet with different ranges of magnetic fields were used for the seed treatment. The authors conducted an experiment on Isabgol seed and found the encouraging effect of magnetic seed treatment on seed yield and biometric characteristics of the crop. In India, Isabgol is cultivated in Gujarat and adjoining areas of southern Rajasthan, Punjab and UP. It is propagated by seeds. The husk of seed yields colloidal mucilage consists of xylose, arafinose and galacturonic acid. The mucilage is over 30 per cent of the whole seed. It serves as safe bulk laxative; promote regular foul movement for chronic dysenteries of amoebic and bacillary origin. It is used to cure inflammation of the mucus membrane of gastro intestinal and geneto-urinary tracts, duodenal ulcer, gonorrhea and piles. It is also used as cervical dilator for termination of pregnancy. (Kirtikar K.R and Basu B.D, 1975, and Ravindra Sharma, 2003) Though Isabgol is having high medicinal value, its cultivation is not popular in the Vidarbha region of Maharashtra.

MATERIAL AND METHODS

The Isabgol seed (Variety: G. I. – 4) was acquired from AICRP on Medicinal and Aromatic Plant, Nagarjuna Medicinal Plant Unit, Dr PDKV, Akola. The seed samples were placed on static magnets of 1250 gause for 12 hrs. One sample of seeds was kept on the North face of magnet while another was on South face of magnet. The treated and untreated seed samples were sown manually inside the greenhouse on 18th Dec 2003. In first three plots on the left portion inside greenhouse (Plot No. L1, L2 and L3) were sown with South Pole treated seeds while the last four plots (Plot No. L4, L5, L6 and L7) were sown with North Pole treated seeds. Untreated seeds were sown in each of the plots on the right portion in greenhouse (Plot No. R1 to R7). The actual sowing period of Isabgol is 1st to 2nd week of November, but due to delay in the construction of greenhouse late sowing was done. Neither fertilizer nor pesticides were applied to the crop throughout the cropping period. Only regular irrigation water was supplied and weeding operations were done as per requirement.

The environmental parameters like ambient temperature, soil temperature, light intensity and relative humidity and biometric characteristics of the crop were measured regularly to evaluate the effect of greenhouse and magnetic treatment of the seed.

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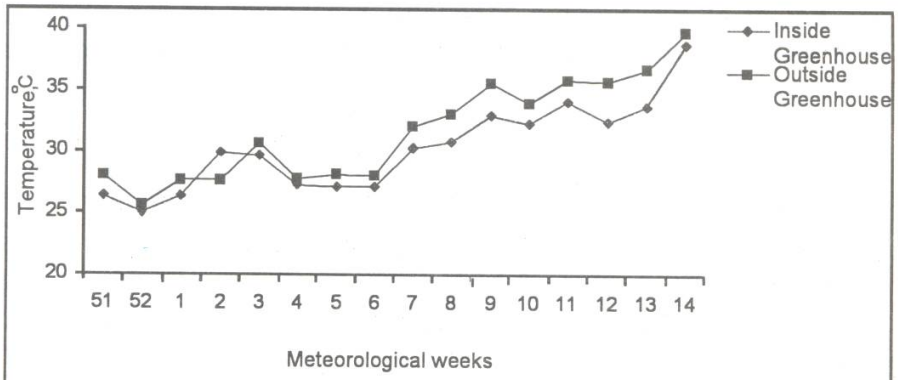

Fig 1 Meteorological weekly temperature variation inside and outside greenhouse

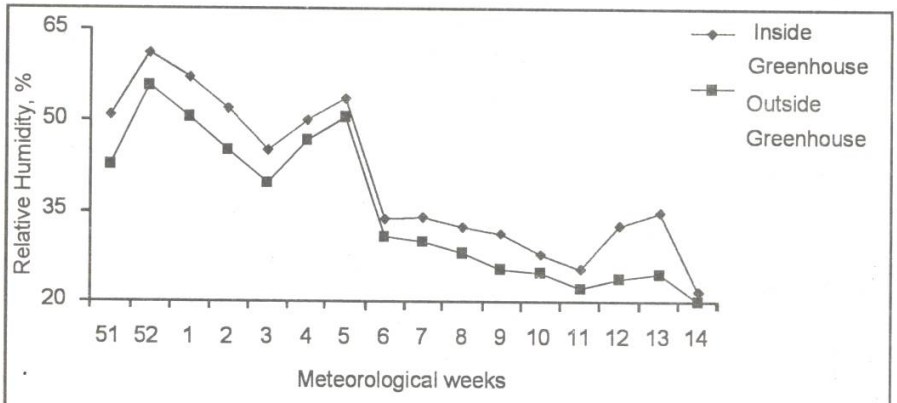

Fig 2 Meteorological weekly relative humidity variation inside and outside greenhouse

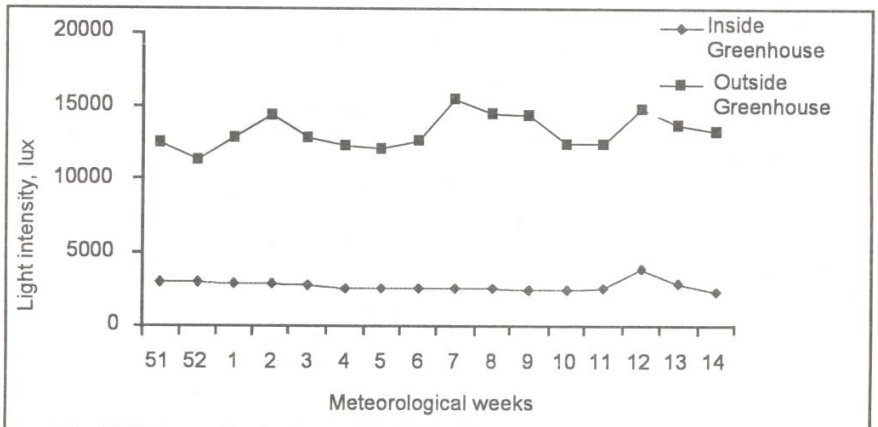

Fig 3 Meteorological weekly light intensity variation inside and outside greenhouse

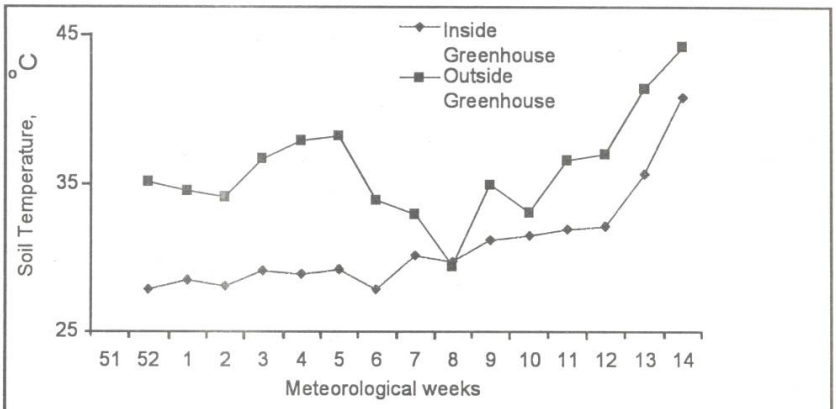

Fig 4 Meteorological weekly soil temperature variation inside and outside greenhouse

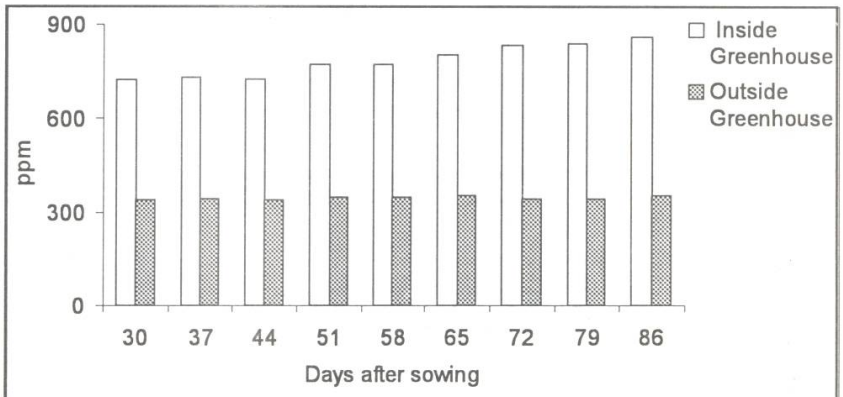

Fig 5 CO_2 concentration with respect to plant growth period

RESULTS AND DISCUSSION

Environmental parameters :

Temperature

Throughout the crop period, outside temperature was always higher than inside temperature except in second metrological week of 2004. The average maximum and minimum temperature inside were 38.6°C and 25°C, whereas in open condition it was recorded to be 39.6°C and 25.7°C, respectively. The average maximum and minimum temperature difference between outside and inside greenhouse throughout the experimentation were recorded to be 3.2° C and –2.2° C. The minus sign indicates the lower temperature outside compared to inside. This was because of cold blow during second week (Fig 1).

Relative Humidity (RH)

The RH inside the greenhouse was always higher than that of outside (Fig 2). The average maximum and minimum relative humidity inside greenhouse was observed to be 60.93 and 21.49 per cent and that for outside, these values were 55.61 and 20.07 per cent. The maximum difference between relative humidity inside and outside greenhouse was 10.24 per cent and minimum 1.42 per cent.

Light Intensity

The light intensity inside and outside greenhouse showed a great difference because of the 50 per cent green shade net used in the greenhouse at ceiling height. The average maximum and minimum values of light intensity outside greenhouse were 15441 and 11330 lux and for inside

Table 1. Effect of magnetic seed treatment on biometric characteristics and yield of Isabgol crop in greenhouse.

Plot No.	Treatments	Plot size	No. of plants (Plants ha^{-1})	Av. plant height, (cm)	No. of panicles	Panicles length (cm)	Dry matter yield (kg ha^{-1})	Seed yield (kg ha^{-1})	Yield $plant^{-1}$, (kg)
L_1	South Pole	2.3 X 1.8	170 (410628)	29.84	10.8	3.4	888.88	120.77	$2.94 X 10^{-4}$
L_2	South Pole	2.3 X 1.8	363 (876812)	36.39	15.4	4.2	2376.81	425.12	$4.84 X 10^{-4}$
L_3	South Pole	2.3 X 1.8	250 (603865)	35.61	14.8	3.8	1710.14	299.51	$4.95 X 10^{-4}$
L_4	North Pole	2.3 X 1.8	216 (521739)	35.30	15.6	3.9	1415.45	270.53	$5.18 X 10^{-4}$
L_5	North Pole	2.3 X 1.8	338 (816425)	35.21	19.9	4.0	1714.97	323.67	$3.96 X 10^{-4}$
L_6	North Pole	2.3 X 1.8	298 (719807)	36.33	19.4	4.0	2135.26	381.64	$5.29 X 10^{-4}$
L_7	North Pole	2.3 X 0.8	157 (853261)	34.17	12.2	3.6	1456.52	552.00	$6.47 X 10^{-4}$
R_1	Untreated	2.3 X 1.8	178 (429952)	30.96	12.7	3.6	647.34	111.11	$2.58 X 10^{-4}$
R_2	Untreated	2.3 X 1.8	360 (869565)	32.71	14.1	4.5	1541.06	275.36	$3.16 X 10^{-4}$
R_3	Untreated	2.3 X 1.8	264 (637681)	33.01	12	3.9	1603.86	217.39	$3.40 X 10^{-4}$
R_4	Untreated	2.3 X 1.8	200 (483092)	33.34	15.7	4.1	2091.78	217.39	$4.49 X 10^{-4}$
R_5	Untreated	2.3 X 1.8	350 (845411)	34.86	13.2	3.6	2845.41	294.68	$3.48 X 10^{-4}$
R_6	Untreated	2.3 X 1.8	310 (748792)	33.26	14	3.7	1487.92	285.02	$3.80 X 10^{-4}$
R_7	Untreated	2.3 X 0.8	160 (869565)	31.30	9.7	3.6	2820.65	195.65	$2.24 X 10^{-4}$

Table 2. Plant height (cm) with respect to date and plot inside greenhouse.

Plot No.	L_1	L_2	L_3	L_4	L_5	L_6	L_7	R_1	R_2	R_3	R_4	R_5	R_6	R_7
17/1/2004	9.49	12.71	10.74	9.87	9.64	9.4	10.93	10.59	12.37	11.64	10.99	12.67	10.73	10.11
25/1/2004	13.99	13.71	15.73	14.29	14.79	16.3	12.54	17.1	16.8	16.33	15.27	16.79	15.16	15.61
1/2/2004	19.71	20.00	20.9	20.26	20.01	21.54	15.74	21.14	20.34	21.33	20.73	19.46	18.57	20.03
8/1/2004	21.56	22.00	23.43	22.2	21.91	23.16	19.19	23.27	22.63	23.14	23.73	21.73	21.64	23.53
15/2/2004	21.86	26.80	25.19	23.8	25.26	26.2	23.54	24.54	26.64	25.36	26.39	26.31	26.31	23.76
23/2/2004	21.89	27.41	26.26	24.9	25.34	27.46	24.67	26.46	28.41	29.39	29.41	29.73	28.77	27.54
1/3/2004	22.21	28.51	26.54	26.8	27.04	27.66	25.69	28.47	30.14	30.66	31.64	30.56	31	28.84
8/3/2004	23.83	28.97	28.67	28.51	30.14	28.37	29.84	29	31.07	31.21	31.83	31.79	31.83	29.06
16/3/2004	29.84	36.39	35.61	35.3	35.21	36.33	34.17	30.96	32.71	33.01	33.34	34.86	33.26	31.3

it was 3896 and 2320 lux. The maximum difference recorded as 12923 lux when it was clear sunshine and minimum difference was 8377 lux when the sky was cloudy (Fig 3).

Soil Temperature

Due to lower light intensity and use of fan – pad system for controlling temperature, the soil temperature inside greenhouse was always lower than that of outside (Fig 4). The average maximum soil temperature outside and inside greenhouse was recorded as 44.2 and 40.8°C, whereas minimum soil temperature in greenhouse observed as 29.4 and 27.8° C, respectively. The maximum and minimum soil temperature difference between outside and inside was 9.0° C and – 0.3° C, respectively. The negative sign indicates lower soil temperature outside greenhouse compared to that inside. It was the cumulative effect of rain, irrigation and cloudy atmosphere in the 8th meteorological week

Co_2 Concentration

The CO_2 concentration was measured weekly inside and outside greenhouse at 8.00 hr. It was observed that the CO_2 concentration was about double inside greenhouse as compared to outside. (Fig 5)

Biometric characteristics

The biometric characteristics of plant, like plant height was measured weekly while the number of panicles and panicle length was measured just before harvesting. The average plant height in South Pole, North Pole treated and an untreated plot was observed to be 33.94, 35.25 and 32.77 cm, respectively. The average number of panicles observed in these plots was 13.66, 16.77 and 13.05 with the panicle length 38, 38.75 and 38.57 mm, respectively. The percentage increase in the plant height in the South Pole and North Pole treated plot was 3.56 and 7.55 per cent, respectively as compared to untreated plot. In the South Pole treated plot the panicle length observed to be lowered by 1.48 per cent while it was increased by 0.46 per cent in North Pole treated plot. (Table 1 and 2)

Yield

The average seed yield in South Pole, North Pole and untreated plots was observed to be 281.80, 381.96 and 228.08 kg ha^{-1} respectively and it was recorded to be 4.24 X 10^{-4}, 5.22 X 10^{-4} and 3.30 X 10^{-4} kg $plant^{-1}$. In other words the percentage increase in the seed yield, kg ha^{-1} compared to untreated plot was 23.55 and 67.46 per cent, respectively in South and North Pole treated plots. Similarly the seed yield, kg $plant^{-1}$ was increased by 28.30 and 57.99 per cent, respectively in these plots. (Table 1)

The North Pole treated seeds showed the better results than South Pole treated seed both in biometric characteristics and yield of the crop.

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Effect of Zinc and Iron Application on Yield and Uptake of *Kharif* Sorghum

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ABSTRACT

Field experiment was conducted at Sorghum Research Unit during 1997-2001 on medium black soil, with 10 treatment combinations of Zn and Fe. Pooled results indicated that if the soils are deficit in Zn (i.e. < 0.6 ppm) and Fe (< 4.5 ppm) then application of 10 kg $ZnSo_4$ + 20 kg Fe So_4 ha^{-1} along with recommended dose of fertilizer (80:40 kg N and P_2O_5 kg ha^{-1}) has been found promising for getting maximum economic returns of hybrid *Kharif* sorghum.

Sorghum most popularly known as *Jawar* is cultivated all over India on varied soil types and climatic conditions however, the consideration for micronutrients is negligible and therefore, the yield gets affected. Soils of Vidarbha region are mostly medium to deep black calcareous having low to medium fertility status. Various workers have reported significant response of sorghum to the micronutrients application in calcareous black soils (Kene and Deshpande, 1980). Hence it was felt necessary to study the response of micronutrients particularly where Zn and Fe in the soil are deficit with an objective to study the effect of Zn and Fe application on yield of Hybrid Sorghum and uptake of nutrients.

MATERIAL AND METHODS

A field experiment was conducted at Sorghum Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) during *Kharif* season of 1997-2000, in a randomized block design with three replications. Treatments comprised of T1 : Absolute control, T2 : Control (With recommended NP dose of 80:40 but without micro nutrient), T3 :T2 + Zn 1 (5.0 kg $ZnSo_4$ ha^{-1}), T4:T2 + Zn2 (10.0 kg $ZnSo_4$ ha^{-1}), T5:T2 + Fel (10.0 kg FeSo4 ha^{-1}), T6 : T2 + Fe2 (20.0 kg $FeSo_4$ ha^{-1}), T7 : T2 + Znl (5.0 kg $ZnSo_4$ ha^{-1}) + Fe 1 (10.0 kg $FeSo_4$ ha^{-1}), T8 : T2 + Znl (5.0 kg $ZnSo_4$ ha^{-1}) + Fe 2 (20.0 kg $FeSo_4$ ha^{-1}), T9 : T2 + Zn 2 (10.0 kg $ZnSo_4$ ha^{-1}) + Fel (10.0 kg $FeSo_4$) ha^{-1}) and T10 : T2 + + Zn2 (10.0 kg $ZnSo_4$ ha^{-1}) + Fe2 (20.0 kg $FeSo_4$ ha^{-1}) Zinc and Iron micronutrients are applied as soil application at the time of sowing. Sowing was undertaken on 04/07/1997, 06/07/1998, 21/07/1999 and 08/07/2000. The genotype used for experimentation was CSH-14 and plot size adopted was Gross : 3.6 x 6.0 m, Net : 2.7 x 5.0 m. The initial status of soil was pH 8.1, E.C. : 0.15 (dSm^{-1}), Org. Carbon : 0.54 (%), Available N : 176.7 (kg ha^{-1}), P_2O_5 : 16.8 (kg ha^{-1}), K_2O : 288.7 (kg ha^{-1}) DTPA Zn : 0.435 ppm and DTPA Fe : 3.468 ppm. Observations on grain and fodder yield were recorded and uptake was estimated and presented in Table 1,2,3 and 4.

RESULTS AND DISCUSSION

Grain and Fodder yield

Application of RDF along with 10 kg Zn + 20 kg Fe ha_{-1} (T10) recorded significantly higher yield (41.99 q ha^{-1}) but was found at par with T9 (i.e. Zn 10 kg + Fe 10 kg ha^{-1}). Alone application of Zn and Fe at various levels could not prove its puperiority over combined application of Zn and Fe. Where as Zn @ 10 kg ha^{-1} along with RDF recorded higher yield (33.27 q ha^{-1}) amongst the individual application. Treatments T3, T5 and T6 were found at par with T2 i.e. RDF.

Amongst the combined applications T10, (i.e. RDF with 10 kg Zn + 20 kg Fe ha^{-1}) recorded significantly higher fodder yield (106.77 q ha^{-1}) followed by T9 (93.93 q ha^{-1}). Among the individual application of Zn and Fe T4, i.e. application of Zn @ 10 kg ha^{-1} recorded significantly higher fodder yield over T2 i.e. RDF. Kene and Deshpande (1980) and Patil *et. al.*, (1989) reported similar results.

Uptake of Zn and Fe

Application of Zn and Fe increased the content and uptake of Zn by grain and fodder. The

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Table 1. Grain and fodder yield (q ha^{-1}) of sorghum as influenced by different treatments

Treatments		Grain and fodder yield (q ha^{-1})				Pooled
		1997-98	1998-99	1999-2000	2000-01	mean
T_1	Absolute control	12.59	14.68	13.11	10.49	12.71
		(30.09)	(30.81)	(25.98)	(25.17)	(28.01)
T_2	Control (With NP but without	34.44	34.38	22.14	25.68	29.16
	Micronutrients)	(75.55)	(76.07)	(39.25)	(61.60)	(63.11)
T_3	T2 + Zn 1 (5.0 kg Zn ha^{-1})	35.06	36.76	24.22	27.90	30.98
		(83.70)	(80.51)	(48.14)	(69.73)	(70.52)
T_4	T2 + Zn 2 (10.0 kg Zn ha^{-1})	36.91	38.59	26.22	31.36	33.27
		(84.44)	(88.59)	(54.07)	(78.36)	(76.36)
T_5	T2 + Fe 1 (10.0 kg Fe ha^{-1})	34.93	35.57	25.11	26.42	30.50
		(80.74)	(80.74)	(51.11)	(66.02)	(69.65)
T_6	T2 + Fe2 (20.0 kg Fe ha^{-1})	35.30	37.08	27.11	27.41	31.72
		(82.96)	(91.85)	(55.55)	(68.49)	(74.71)
T_7	T2 + Zn 1 + Fe1	36.66	42.29	31.11	34.07	35.32
		(89.62)	(100.74)	(57.55)	(85.19)	(83.27)
T_8	T2 +Zn 1 + Fe2	37.15	46.29	31.11	32.59	36.78
		(97.77)	(116.29)	(64.66)	(81.84)	(90.05)
T_9	T2 + Zn 1 + Fe 1	39.25	48.39	32.14	36.05	38.95
		(99.25)	(119.99)	(66.37)	(90.12)	(93.93)
T_{10}	T2 + Zn 2 Fe2	42.34	52.74	34.37	38.52	41.99
		(102.22)	(141.48)	(87.11)	(96.30)	(106.77)
	CD at 5%	9.03	6.79	4.16	2.80	3.62
	(15.11)	(15.50)	(8.87)	(6.97)	(11.69)	

Figures in parentheses indicate Fodder yield (q ha^{-1})

Table 2. Zn Uptake (g ha^{-1}) and content (ppm) in grain as influenced by different treatments

Treatments .		Zn uptake (g ha^{-1}) and content (ppm) in grain				
		1997-98	1998-99	1999-2000	2000-01	Mean
T_1	Absolute control	33.13	29.99	24.09	18.20	26.35
		(26.43)	(20.70)	(18.23)	(17.28)	(20.66)
T_2	Control (With NP but without	93.06	72.47	41.64	45.36	63.13
	Micronutrient)	(26.98)	(20.97)	(18.78)	(17.72)	(21.11)
T_3	T2 + Zn 1 (5.0 kg Zn ha^{-1})	103.70	100.89	59.60	67.56	82.94
		(29.36)	(27.49)	(24.65)	(24.17)	(26.42)
T_4	T2 + Zn 2 (10.0 kg Zn ha^{-1})	115.27	109.00	66.02	96.15	96.61
		(31.07)	(28.07)	(25.35)	(30.38)	(28.72)
T_5	T2 + Fe 1 (10.0 kg Fe ha^{-1})	102.22	96.64	65.37	84.97	87.29
		(29.75)	(27.32)	(25.85)	(32.25)	(28.79)
T_6	T2 + Fe2 (20.0 kg Fe ha^{-1})	106.99	103.45	71.69	71.54	88.42
		(30.28)	(27.89)	(26.35)	(26.09)	(27.65)
T_7	T2 + Zn 1 + Fe1	112.20	121.91	79.92	96.86	102.72
		(30.90)	(28.99)	(28.94)	(28.40)	(29.31)
T_8	T2 +Zn 1 + Fe2	119.99	134.69	90.36	92.37	109.35
		(31.46)	(29.01)	(29.12)	(28.31)	(29.48)
T_9	T2 + Zn 2 + Fe 1	130.18	145.97	90.62	102.41	117.30
		(32.90)	(30.13)	(28.16)	(28.40)	(29.90)
T_{10}	T2 + Zn 2 Fe2	143.20	170.00	104.55	116.12	133.47
		(33.40)	(32.28)	(30.36)	(30.12)	(31.54)
	CD at 5%	47.22	24.81	12.58	23.19	13.26

Figures in parentheses indicate Zinc content in PPM (Grain)

Table 3. Zn Uptake (kg ha^{-1}) and content (ppm) by fodder as influenced by different treatments

Treatments		Zn uptake (kg ha^{-1}) and content (ppm) by fodder				
		1997-98	1998-99	1999-2000	2000-01	Mean
T_1	Absolute control	122.01	109.80	72.84	69.83	93.62
		(40.40)	(35.45)	(35.50)	(27.74)	(34.77)
T_2	Control (With NP but without	318.89	281.16	114.80	187.94	225.70
	Micronutrients)	(42.20)	(36.90)	(36.10)	(30.33)	(36.38)
T_3	T_2 + Zn 1 (5.0 kg Zn ha^{-1})	393.56	346.07	144.32	254.21	284.54
		(47.00)	(43.00)	(39.70)	(36.52)	(41.56)
T_4	T_2 + Zn 2 (10.0 kg Zn ha^{-1})	429.40	372.72	184.23	292.06	319.60
		(52.00)	(49.10)	(41.30)	(37.28)	(44.92)
T_5	T_2 + Fe 1 (10.0 kg Fe ha^{-1})	374.86	470.19	186.51	227.88	314.86
		(42.30)	(42.30)	(36.30)	(34.48)	(38.85)
T_6	T_2 + Fe2 (20.0 kg Fe ha^{-1})	368.16	405.99	217.51	241.18	308.21
		(44.50)	(44.20)	(37.20)	(35.21)	(40.28)
T_7	T_2 + Zn 1 + Fe1	439.71	485.51	248.92	323.50	374.41
		(49.20)	(48.30)	(39.70)	(37.96)	(43.79)
T_8	T_2 +Zn 1 + Fe2	552.08	579.73	291.37	318.48	435.42
		(51.30)	(50.10)	(41.20)	(39.09)	(45.42)
T_9	T_2 + Zn 2 + Fe 1	540.43	626.08	316.23	385.43	467.04
		(54.40)	(52.20)	(46.20)	(42.73)	(48.88)
T_{10}	T_2 + Zn 2 Fe2	563.99	772.64	430.96	431.97	549.89
		(55.30)	(54.60)	(48.60)	(44.91)	(50.85)
	CD at 5%	68.18	174.97	35.11	45.96	73.46

Figures in parentheses indicate zinc content in PPM (Fodder)

Table 4. Fe Uptake (kg ha^{-1}) and content (ppm) by grain as influenced by different treatments

Treatments		Fe uptake (kg ha^{-1}) and content (ppm) by grain				
		1997-98	1998-99	1999-2000	2000-01	Mean
T_1	Absolute control	40.90	44.43	35.56	23.19	36.02
		(32.70)	(29.65)	(27.12)	(22.17)	(27.91)
T_2	Control (With NP but without	119.09	79.87	62.48	65.91	81.84
	Micronutrients)	(34.60)	(31.78)	(28.14)	(25.81)	(30.08)
T_3	T_2 + Zn 1 (5.0 kg Zn ha^{-1})	164.37	142.26	83.90	79.93	76.65
		(46.60)	(38.70)	(34.70)	(28.47)	(37.12)
T_4	T_2 + Zn 2 (10.0 kg Zn ha^{-1})	165.55	155.26	92.46	105.51	129.70
		(45.70)	(39.95)	(35.20)	(33.71)	(38.64)
T_5	T_2 + Fe 1 (10.0 kg Fe ha^{-1})	226.35	208.53	134.80	93.88	165.89
		(65.60)	(58.95)	(53.60)	(35.44)	(53.50)
T_6	T_2 + Fe2 (20.0 kg Fe ha^{-1})	278.63	259.42	166.81	103.79	202.16
		(78.70)	(69.92)	(61.40)	(37.83)	(61.96)
T_7	T_2 + Zn 1 + Fe1	290.80	300.58	178.97	133.32	225.92
	(79.60)	(71.12)	(63.24)	(41.41)	(68.16)	
T_8	T_2 +Zn 1 + Fe2	307.96	366.62	215.37	134.74	256.17
		(82.65)	(79.24)	(69.32)	(41.41)	(68.16)
T_9	T_2 + Zn 2 + Fe 1	325.02	387.64	240.40	180.34	308.79
		(81.45)	(80.13)	(74.72)	(44.36)	(70.17)
T_{10}	T_2 + Zn 2 Fe2	354.24	431.18	269.40	180.34	308.79
		(69.22)	(33.70)	(25.34)	(24.47)	(56.65)
	CD at 5%	69.22	33.70	25.34	24.47	56.65

Figures in parentheses indicate zinc content in PPM (Fodder)

Table 5. Fe Uptake (kg ha^{-1}) and content (ppm) by fodder as influenced by different treatments

Treatments		Fe uptake (kg ha^{-1}) and content (ppm) by fodder				
		1997-98	1998-99	1999-2000	2000-01	Mean
T_1	Absolute control	213.91	167.95	142.90	135.39	165.04
		(70.70)	(54.30)	(61.30)	(53.79)	(60.02)
T_2	Control (With NP but without Micronutrients)	570.24	424.46	224.16	340.21	389.77
		(75.50)	(55.70)	(67.40)	(55.24)	(63.46)
T_3	T_2 + Zn 1 (5.0 kg Zn ha^{-1})	663.02	460.76	280.94	411.58	454.08
		(79.20)	(57.60)	(69.20)	(59.07)	(66.27)
T_4	T_2 + Zn 2 (10.0 kg Zn ha^{-1})	660.85	555.50	296.79	512.68	506.46
		(78.40)	(57.90)	(70.60)	(63.58)	(68.07)
T_5	T_2 + Fe 1 (10.0 kg Fe ha^{-1})	853.40	558.84	359.31	440.25	552.95
		(105.70)	(68.40)	(98.50)	(66.72)	(84.83)
T_6	T_2 + Fe2 (20.0 kg Fe ha^{-1})	897.40	705.73	435.87	507.10	636.53
		(108.10)	(77.20)	(105.40)	(74.01)	(91.18)
T_7	T_2 + Zn 1 + Fe1	1011.65	760.30	440.54	644.86	714.34
		(112.60)	(75.60)	(99.30)	(75.70)	(90.80)
T_8	T_2 +Zn 1 + Fe2	1140.70	1082.66	568.06	650.21	860.41
		(116.50)	(93.30)	(106.30)	(79.81)	(98.98)
T_9	T_2 + Zn 2 + Fe 1	1106.93	1141.98	658.18	735.97	910.77
		(111.30)	(95.10)	(104.70)	(81.68)	(98.20)
T_{10}	T_2 + Zn 2 Fe2	1171.72	1552.35	940.26	807.61	1117.99
		(114.50)	(109.79)	(112.70)	(83.82)	(105.81)
	CD at 5%	179.43	113.83	68.27	55.39	172.62

Figures in parentheses indicate zinc content in PPM (Fodder)

Table 6. Economics of various treatments

Treatmentss		Yield q ha^{-1} over control (q ha^{-1})	Additional yield over yield @ 3.80 kg^{-1}	Value of additional micro nutrient Rs. ha^{-1}	Cost of treatment Rs. ha^{-1}	Additional returns	BC (=F/E)
T_1	Absolute control	12.71	-	-	-	-	-
T_2	Control (With NP but without micronutrients)	29.16	-	-	-	-	-
T_3	T2 + Zn 1 (5.0 kg Zn ha^{-1})	30.98	1.82	691.6	400	291.6	0.73
T_4	T2 + Zn 2 (10.0 kg Zn ha^{-1})	33.27	4.11	1561.8	800	761.8	0.95
T_5	T2 + Fe (10.0 kg Znha^{-1})	30.50	1.34	509.2	320	189.2	0.59
T_6	T2 + Fe2 (20.0 kg Feha^{-1})	31.72	2.56	972.8	640	332.8	0.52
T_7	T2 + Zn 1 + Fe 1	35.32	6.16	2340.8	720	1620.8	2.25
T_8	T2 + Zn 1 + Fe 1	36.78	7.62	2895.6	1040	1855.6	1.78
T_9	T2 + Zn 2 + Fe 1	38.95	9.79	3720.2	1120	2600.2	2.32
T_{10}	T2 + Zn2 + Fe2	41.99	12.83	4875.4	1440	3435.4	2.39
Cost of Chemcials i.e. micronutrients		$ZnSo_4$	80 Rs kg^{-1}		FeSo4	32 Rs kg^{-1}	

Table 7. Total uptake (Grain + Fodder) (g ha^{-1}) by grain of Fe as influenced by different treatments

Treatments		Total uptake (Grain + Fodder) (g ha^{-1})				Pooled
		1997-98	1998-99	1999-00	2000-01	mean
T_1	Absolute control	254.82	212.38	178.47	214.08	214.94
T_2	Control (With NP but withou micronutrients)	689.33	504.33	286.64	548.27	507.14
T_3	Zn 1 (5.0 kg Zn ha^{-1})	827.39	603.02	364.84	663.54	614.70
T_4	Zn2 (10.0 kg Zn ha^{-1})	826.40	710.76	389.25	834.55	690.24
T_5	Fel (10.0 kg Fe ha^{-1})	1079.75	767.37	494.11	721.08	765.58
T_6	Fe 2 (20.0 kg Fe ha^{-1})	1176.13	695.15	602.68	824.70	892.17
T_7	Zn 1 + Fe	1302.45	1060.88	619.51	1050.55	1008.35
T_8	Zn 1 + Fe2	1448.66	1449.88	783.55	1209.22	1260.09
T_9	Zn2 + Fe1	1427.95	1529.62	873.55	1209.22	1260.09
T_{10}	Zn2 + Fe2	1525.96	1983.53	1209.66	1333.73	1513.22

Table 8. Total uptake (Grain + Fodeer) (g ha^{-1}) by grain of Zn as influenced by different treatments

Treatments		uptake (Grain + Fodder) (g ha^{-1})			Pooled	
		1997-88	1998-99	1999-00	2000-01	Mean
T_1	Absolute control	155.41	139.79	96.93	118.84	127.68
T_2	Control (With NP but without micronutrients)	411.95	353.63	156.44	314.95	309.24
T_3	Zn 1 (5.0 kg Zn ha^{-1})	497.26	446.96	203.92	434.39	395.63
T_4	Zn2 (10.0 kg Zn ha^{-1})	544.67	481.72	250.25	524.09	450.53
T_5	Fe 1 (10.0 kg Fe ha^{-1})	477.08	566.83	251.88	422.31	429.53
T_6	Fe2 (20.0 kg Fe ha^{-1})	476.15	509.44	289.20	422.18	424.24
T_7	Zn 1 + Fe 1	551.91	607.42	328.48	567.48	513.91
T_8	Zn1 + Fe2	672.07	714.42	381.73	554.64	580.72
T_9	Zn2 + Fe 1	670.61	772.05	406.85	658.58	627.02
T_{10}	Zn2 + Fe	707.16	942.64	535.51	739.93	731.31

maximum Zn content in sorghum grain and fodder was noticed with the application of Zn 10 kg and Fe 20 kg which resulted in significantly higher uptake of Zn by grain and fodder.

The content and uptake of Fe by grain and fodder was found to increase with the application of Zn and Fe alone or in combinations at various levels. However. no significant differences were noticed inthe uptake with various levels of Zn and Fe except that of uptake of Fe by fodder. The uptake of Fe by fodder was significantly highest with the application of Zn 10 kg and Fe 20 kg ha^{-1}. These results are in accordance with the findings of Krishnasami *et.al.*, (1985) and Shukla, (1987).

B:C Ratio

The economics of various treatments is worked out on the basis of four years pooled results, it is observed that higher BC ratio (1:2.38) was osberved in case of T10 (i.e. 10 kg Zn + 20 kg Fe) followed by T9 (i.e. Zn 10 kg + Fe 10 kg).

If the soils are deficit in Zn (i.e. <0.6 ppm) and (Fe < 4.5 ppm) then application of 10 kg $ZnSo_4$ + 20 kg $FeSo_4$ ha^{-1} along with recommended dose of fertilizer (80:40 kg N and P_2O_5 ha^{-1}) has been recommended for getting maximum economic returns of hybrid *Kharif* sorghum.

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Effect of Integrated Nutrient Management on Yield, Uptake of Nutrient and Quality of Rainfed Sorghum

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ABSTRACT

A field experiment revealed that the split application of nitrogen and biofertilizers recorded maximum grain and fodder yield of sorghum. Among, all the treatment combinations, the treatment of recommended dose of NPK along with 5 tone FYM with 3 split of N at Basal, 30 and 45 DAS was found superior than other treatments in respects of grain yield (40.18 q ha^{-1}), straw yield (102.08 q ha^{-1}), uptake of N (124.40 kg ha^{-1}), P (33.04 kg ha^{-1}), K (132.18 kg ha^{-1}) and fat (9.98%), protein (2.61%) and Starch (68.85%) content of *Kharif* sorghum

Sorghum (*sorghum bicolor* L. Moench) is one of the most important cereal crops of the World. It is fifth most important cereal crop in world production after wheat, maize, rice and barley. It is a major dry land crop. In Maharashtra sorghum is grown on 477 million ha, out of which 2.82 million ha. area in *Rabi* season. The total sorghum grain production in Maharashtra is about 4.48 million tonnes with production of 2.78 and 1.70 million tonnes in *Kharif* and *Rabi* season, respectively.

Sorghum contains 10-12 per cent protein, 70 per cent carbohydrate, 3 per cent fats, vitamins, minerals and salts etc. The protein fraction contains albumin and globulin in the range 17.1 to 17.8 per cent, prolamine 5.2 to 8.4 per cent, cross link prolamine 18.2 to 19.5 per cent glutelin like 3.4 to 4.4 per cent, glutelin 33.7 to 38.3 and residues 10.4 to 10.6 (Agarkar, 1999) which are essential for vigorous growth, health and longevity of human life. Plant nutrient management is one of the key components of Intensive Agriculture. To sustain the crop yield an increase land productivity, combination of organic manures with inorganic fertilizer not only increases the crop yield but also improves the physical and biological properties of soil (Shashidhar *et. al.*, 1995). Keeping in view these the studies were undertaken to elaborate the effect of integrated nutrient management and split application of N on grain/fodder yield and quantity of sorghum.

MATERIAL AND METHODS

A field experiment was conducted during *Kharif* season of 2002 at Sorghum Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola in randomised block design with seven treatments replicated thrice. The total rainfall received during growing season of crop from June 2002 to November 2002 was 651.9 mm as against the normal of 837.8 mm. The experimental soil was montimorillonitic, hyperthermic, clay loam, shallow, typic ustorthent, Kanpur series. The soil samples were analyzed for organic carbon by Walkley and Black's wet oxidation method (Piper, 1966), available nitrogen by Subbiah and Asija (1956), available P by Olsen's method (Jacksen, 1967) and available K by N NH_4OAC method (Jackson, 1967). However, plant samples were analysed for that N (Kjeldhals methods), total P (Vanado molybdate method) and total K (flame photometer method) as per Jackson, 1967. The crude protein was determined by multiplying nitrogen percentage with 6.25, reducing and non reducing sugar (Benedict's methods, Motiramani *et. al.*, 1971), Starch content (Duboils methods, A.O.A.C., 1995) and fat content (Soxhlet entraction method, A.O.A.C., 1955).

RESULTS AND DISCUSSION

Grain and fodder yield

The grain and fodder yield of sorghum revealed that the treatment of recommended dose of NPK + 5 tone FYM + Azotobacter + PSB as 3 splits of N i.e. Basal, 30 and 45 DAS showed highest grain (40.18 q ha^{-1}) and fodder yield (102.08 q ha^{-1}). This treatment was significantly superior to all other

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Table 1. Treatment details

Treatments	Nutrient applied kg ha^{-1}	Method of fertilizer application split application		
		Basal	30 DAS	45 DAS
T_1	80:40:40 (100% recommended dose NPK kg ha^{-1}) control	40 kg N, 40 kg P_2O_5, 40 kg K_2O ha^{-1}	40 kg N ha^{-1}	-
T_2	80:40:40 NPK kg ha^{-1} + 5 tonne FYM + Azo + PSB	40 kg N, 40 kg P_2O_5 40 kg K_2O ha^{-1}	40 kg N ha^{-1}	-
T_3	80:40:40 NPK kg ha^{-1} + 5 tonne FYM + Azo + PSB	40 kg N, 40 kg P_2O_5 40 kg K_2O ha^{-1}	20 kg n ha^{-1}	20 kg N ha-1
T_4	80:40:40 NPK kg ha-1 + 5 tonne FYM + Azo+PSB	40 kg N, 40 kg P2O 40 kg K_2O ha^{-1}	-	40 kg N ha^{-1}
T_5	60:30:30 NPK kg ha^{-1} + 5 tonne FYM + Azo + PSB	30 kg N, 30 kg P_2O_5 30 kg K_2O ha^{-1}	15 kg N ha^{-1}	15 kg N ha^{-1}
T_6	60:30:30 NPK kg ha-1 + 5 tonne FYM + Azo + PSB	30 kg N, 30 kg P_2O_5 30 kg K_2O ha^{-1}	30 kg N ha^{-1}	
T_7	60:30:30 NPK kg ha-1 + 5 tonne FYM+Azo+PSB	30 kg N, 30 kg P2O5 30 K_2O ha^{-1}	-	30 kg N ha^{-1}

treatments but was at par with treatment T_2. The treatment T_5 and T_6 gave 30.17 and 29.03 q ha^{-1} and 78.33 and 75.76 q ha^{-1} grain and fodder yield, respectively and were found at par with each other (Table 2). Similar findings were also reported by Pawar *et. al.*, (1996) and Ravankar and Puranik (1998).

NPK uptake

The data pertaining to the uptake of NPK by sorghum revealed that the highest uptake of N (64.19), P(14.97) and K (15.19) in grain and straw (60.21, 18.07 and 166.99 kg ha^{-1}) was observed with treatment T_3 i.e. RD along with 5 tonne FYM + Azo + PSB as 3 splits of N. This was followed treatment (T_2) RD + 5 time FYM + Azo + PSB as 2 splits of N at Basal and 30 DAS which was significantly superior to all other treatments except control (T_1) and RD + 5 tonne FYM + Azo + PSB (T_4) which were at par with each other. Sharma *et. al.*, (1997) reported that sorghum (CSH-5) with application of 100 kg N + 60 kg P_2O_5 + 60 kg K_2O ha^{-1} as N in two splits i.e. 15 days and 45 days after sowing gave higher grain and fodder yield and increased uptake of N, P and K as compared to other treatments.

Quality of sorghum

The results in Table 2 revealed that the highest protein content (9.98%) was found with treatment T_3 i.e. RD + 5 tonne FYM + Azo + PSB as 3 splits of N at Basal, 30 and 45 DAS which was significantly higher than all other treatments but was at par with control. However, the highest fat content (2.70%) was observed in T_1 treatment (control) and also significantly higher than all other treatments except T_2, T_1 treatment (control) and also significantly higher than all other treatments except T_2, T_3, T_4 and T_5. Whereas, in starch content no significant differences were observed. Singh and Singh (1987) and Pal *et. al.*, (1996) also reported similar results.

Reducing and non-reducing sugar

The highest reducing (0.41%) and non reducing sugar (5.34%) was recorded in the treatment T_3 but was statistically at par with other treatments. Selvi and Palannisamy (1989) recorded that total sugar and green stalk yields were positively and significantly associated with sucrose percentage while reducing sugar was associated negatively.

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Table 2. Effect of integrated nutrient management on yield, nutrient uptake and quality of sorghum

Treatments	Grain yield (q ha^{-1})	Fodder yield (q ha^{-1})	Total uptake of nutrient (kg ha^{-1})			Protein content (%)	Fat content (%)	Starch content (%)	Reducing sugar (%)	Non reducing (%)
			N	P	K					
T_1	34.34	68.87	99.77	26.56	110.51	9.89	69.05	0.38	5.26	
T_2	38.04	96.26	103.88	28.37	122.52	9.27	2.64	68.56	0.36	5.22
T_3	48.18	102.08	124.40	33.04	132.18	9.98	2.61	68.85	0.41	5.34
T_4	36.28	91.11	98.86	27.02	114.42	9.06	2.58	67.92	0.40	5.22
T_5	30.17	78.33	76.93	20.14	96.93	8.65	2.44	70.01	0.37	5.25
T_6	29.03	75.65	70.77	18.28	91.88	8.42	2.35	70.61	0.39	5.14
T_7	27.14	72.50	65.22	16.73	86.82	8.27	2.39	69.93	0.37	5.17
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	NS	NS	NS
SE (m) ±	0.89	2.58	4.71	1.13	2.92	0.137	0.076	0.546	0.044	0.044
CD at 5%	2.53	7.37	14.53	3.50	8.99	0.442	0.23	-	-	-
CV (%)	4.24	4.81	9.03	8.10	4.68	2.61	5.56	-	-	-

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Performance of Some Medicinal Plants on Different Soils in Akola District

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ABSTRACT

The research trial was conducted with six medicinal plants (i.e. Ashwagandha, Korphad, Senna, Kalmegh, Kawachbij and Katur bhendi) planted on medium (25-45 cm) and deep (45-90 cm) soil to study the performance of these medicinal plants on different soils in Akola district. It was observed that Ashwagandha showed highest dry matter yield in medium and deep soil. Nitrogen and phosphorus content was maximum in Kawachbij, however Kalmegh removed maximum potassium and nitrogen from medium and deep soil, respectively. The maximum gross monetary return was recorded by Ashwagandha in medium soil and by Korphad in deep soil but, maximum net monetary return was recorded when Korphad was grown on medium and deep soil. Maximum net profit was recorded by Korphad on medium and deep soil.

Plants have been one of the important sources of medicines even since the down of human civilization. Inspite of tremendous developments in the field of allopathy during the 20th century, plants still remain one of the major sources of drugs in modern as well as in traditional systems of medicine throughout the world. Over 60 per cent of pharmaceuticals are plant based. Chemically depending on their active principles, plants may have alkaloids, glycosides, steroids or other groups of compounds which may have marked pharmaceutical action as anticancerous, antimalarial, antihelminthic or antidysentreic, etc. India has been a traditional exporter of medicinal plants for the past several decades and ranks as one of the foremost supplier of medicinal plants in the world. The annual export of vegetable drugs from India has been on increase and during the year 1995-96 it has gone upto Rs. 189.30 crores, besides the export of Rs. 70.03 crores worth of alkaloids. Among the items Ginseng roots and Senna leaves and pods have been earned a foreign exchange of Rs. 16.27 and 13.91 crores, respectively.

It is well known fact that the productivity of a crop in general and a genotype in particular largely depends on the interaction among soil characteristics, climate and level of crop management. Even though comprehensive research work on these aspect in relation to cultivation of medicinal crop has been carried out in this region, hence, the present investigation was planned to study the yield performance of some medicinal plants on different soils in Akola district.

MATERIAL AND METHODS

Field experiment was conducted during *Kharif* 2002-2003 at Dr. PDKV, Akola (22° 42' N, 77 02' and 307.42 m above mean sea level) on medium (25-45 cm) (AICRP on medicinal plant field) and deep soil (45-90 cm) (AICRP on LIFE field). The treatment consisted of six medicinal plants (Ashwagandha, Korphad, Senna, Kalmegh, Kawachbij and Kastur bhendi) replicated four times with gross plot size of 5.6 x 3.6 m^2, in randomized block design. Ashwagandha, Senna, Kawachbij and Kastur bhendi were planted with seed while Korphad and Kalmegh planted with suckers and seedling, repsectively. The soil and plant samples were collected separately from each plot and were analysed for total N, P and K as per the procedure of Jackson (1967). The Ashwagandha base equivalent yield was calculated on the basis of prevailing market rates and all medicinal crops and quantity of Ashwagandha roots can be purchased for the amount of Korphad, Senna, Kalmegh, Kawachbij and Kastur bhendi.

RESULTS AND DISCUSSION

Yield of medicinal plants

Among the medicinal crops grown on medium and deep soils, it was revealed from Table 2 that the yield performance (Ashwagandha based) of Korphad was significantly higher on both medium (12.08 q ha^{-1}) and deep (14.22 q ha^{-1}) soils than all other crops, followed by Ashwagandha in medium

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(7.96 q ha^{-1}) soils and Kastur bhendi in deep soil (8.693 q ha^{-1}). Senna and Kalmegh yield (3.63 and 6.69 q ha^{-1}) on Ashwagandha based significantly lower yield in medium than Korphad due to high water content in the whole plant. While, comparing the productivity performance of Korphad in deep and medium soil, the data (Table 1) revealed that the Ashwagandha base equivalent yield to Korphad was 17.71 per cent higher in deep soil than in medium soil.

Table 1. Physico-chemical characteristics of soil

S.N.	Chemical properties	Content	
		Medium	Deep
1.	Depth (cm)	25-45	45-90
2.	pH (1:2.5)	7.45	7.69
3.	EC (dSm^{-1})	0.38	0.42
4.	Total N (%)	0.043	0.065
5.	Available N (kg ha^{-1})	193.63	230.16
6.	Available P_2O_5 (kg ha^{-1})	47.31	59.33
7.	Available K_2O (kg ha^{-1})	329.16	387.96
8.	Organic carbon (%)	0.41	0.46
9.	Free $CaCo_3$	2.63	1.80

Dry matter yield

Dry matter yield (Table 2) of medicinal plants was significantly influenced under medium and deep soils. Significantly higher dry matter yield (41.83 and 47.13 q ha^{-1}) was recorded by Ashwagandha on both medium and deep soils, followed by Kalmegh, Kastur bhendi and Korphad gave lowest dry matter yield on medium and deep soils, respectively. Dahatonde *et. al.*, (1983) also recorded maximum root yield of Ashwagandha with 40 kg N and 80 kg P_2O_5 ha^{-1} on medium soil.

Nitrogen uptake

Highest content was registered in the dry matter of Kawachbij both in medium (1.49%) and deep soil (1.60%), which was significantly higher than all other crops, followed by Kastur bhendi. Nitrogen content was lowest in Korphad both in medium (0.08%) and deep soils (0.09%).

As regard the nitrogen uptake, it was revealed that Kalmegh removed significantly higher nitrogen from the deep (23.57 kg ha^{-1}) and medium soil (19.74 kg ha^{-1}) followed by Senna from medium soil (19.25 kg ha^{-1}) and Kawachbij from deep soil (18.22 kg ha^{-1}). Nitrogen removed by Korphad from both medium (0.68 kg ha^{-1}) and deep soils (0.85 kg ha^{-1}) was found to be significant lowest.

Phosphorus uptake

Among the medicinal crops, significantly higher phosphorus content (0.5%) was observed in the dry matter of Kawachbij, followed by Senna in medium (0.50%) as well as deep soil (0.56%). Whereas, phosphorus content was significantly lowest (0.25 and 0.28%) in dry matter of Korphad when grown on medium and deep soil.

Among the different medicinal crops, Ashwagandha utilized significantly highest phosphorus from medium (12.56 kg ha^{-1}) and deep soil (15.18 kg ha^{-1}), whereas Korphad utilized significantly lower phosphorus.

Potassium uptake

Table 2, revealed that highest potassium content was registered in the dry matter of Kastur bhendi both in medium (0.86%) and deep soil (0.98%), which was significantly higher than all other crops, followed by Senna. Potassium content was lowest in Korphad both in medium (0.12%) and deep soils (0.13%).

As regards the potassium uptake, it was inferred that Kalmegh removed significantly higher potassium from the deep (18.88 kg ha^{-1}) and medium soil (14.98 kg ha^{-1}), followed by Ashwagandha from medium soil (12.35 kg ha^{-1}) and Kastur bhendi from deep soil (8.80 kg ha^{-1}). Potassium removed by Korphad from both medium and deep soil was found to be significantly lowest. Mutu Manickam and Bala Krishnamurthy (1999) and Schaik Van *et. al.*, (1997) revealed an increase in N, P and K content and uptake with the application of 40 kg nitrogen to Ashwagandha on deep soil.

Monetary returns/economics

Among the medicinal crops highest monetary return was obtained Rs. 48319.50 ha^{-1} in Korphad, followed by Ashwagandha (Rs. 31410 ha^{-1}) when grown in medium soil. Whereas, lowest gross monetary return (Rs. 16960 ha^{-1}) was observed in case of Senna. In the deep soil also highest gross monetary return (Rs. 56,915.25) was noted in Korphad, followed by Kalmegh. Lowest gross monetary return (Rs. 13,195 ha^{-1}) was noted in case of Senna in deep soil.

Maximum net profit amounting Rs. 39,930 ha^{-1} and Rs. 31,484.50 ha^{-1} was recorded when Korphad grown on deep and medium soil (Table 3) respectively, followed by Kalmegh (Rs. 28,940 ha^{-1})

Table 2. Quality parameters, nutrient content and uptake of different medicinal plants

Crops	Ashwagandha based equivalent yield (q ha^{-1})		Actual yield of medicinal crop (q ha^{-1})		Dry matter yield		N content (%)		N Uptake (kg ha^{-1})		P content (%)		P uptake (kg ha^{-1})		K content (%)		K uptake (kg ha^{-1})	
	Med.	Deep	Med.	Deep	Med.	Deep	Med.	Deep	Med.	Deep	Med.	Deep	Med.	Deep	Med.	Deep	Med.	Deep
Ashwagandha	7.96	6.50	7.85	6.50	41.83	47.13	0.32	0.39	13.57	18.60	0.30	0.32	12.56	15.81	0.29	0.31	12.35	14.62
Korphad	12.08	14.22	161.07	189.71	8.19	9.50	0.08	0.09	0.68	0.85	0.25	0.28	2.06	2.73	0.12	0.13	0.97	1.30
Senna	3.63	7.57	12.10	9.01	16.08	13.73	1.19	1.22	19.25	16.78	0.50	0.56	6.26	5.64	0.83	0.86	10.31	8.74
Kalmegh	6.69	5.81	17.85	25.25	17.85	25.25	0.97	1.05	19.74	23.57	0.38	0.42	7.96	9.31	0.77	0.80	14.98	18.88
Kawachbij	7.08	7.79	12.88	14.16	9.23	11.37	1.49	1.60	13.77	18.22	0.51	0.58	4.71	6.61	0.72	0.78	6.68	8.87
Kastir bhendi	7.09	8.63	6.37	7.60	7.43	9.73	1.22	1.40	9.07	13.65	0.31	0.35	2.30	3.42	0.86	0.98	6.42	8.80
F test	Sig	Sig	-	-	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
S.E. (m)±	0.21	0.33	-	-	0.49	0.47	0.01	0.02	0.55	0.58	0.02	0.02	0.37	0.23	0.01	0.05	0.53	0.74
CD at 5%	0.61	0.94	-	-	1.39	1.33	0.03	0.07	1.58	1.62	0.05	0.05	1.04	0.66	0.03	0.14	1.49	2.08

Table 3. Yield and economics of different medicinal crops

Soil type	Economical part	Yield q ha^{-1}	Unit price Rs. q^{-1}	Gross return Rs. ha^{-1}	Cost of production on Rs ha^{-1}	Net returnratio Rs. ha^{-1}	B:C
Medium soil							
Ashwagandha	Roots	7.85	4000	31410	6815	24595	1:3.60
Korphad	Green leaf	161.07	300	48319.50	16835	31484.50	1:1.87
Senna	Dry leaves	12.10	1200	16960	8295	8665	1:1.04
	Seed	1.22	2000				
Kalmegh	Herbage	17.85	1500	26775	8535	18240	1:2.13
Kawachbij	Seed	12.88	2200	28347	7275	21072	1:2.89
Kastur bhendi	Seed	6.37	4500	28395	7165	21230	1:2.96
Deep soil							
Ashwagandha	Roots	6.50	4000	26020	7215	18805	1:2.60
Korphad	Green leaf	189.71	300	56915.25	16985	39930	1:2.35
Senna	Dry leaf	189.71	300	56915.25	16985	39930	1:2.35
	Seed	1.19	2000				
Kalmegh	Herbage	25.25	1500	37875	8935	28940	1:3.23
Kawachbij	Seed	14.16	2200	31152	7875	23277	1:2.95
Kastur bhendi	Seed	7.60	4500	34548.75	7765	26783.75	1:3.44

in deep soil and Ashwagandha (Rs.24,595 ha^{-1}) in medium soil. Maximum BC ratio was recorded by Ashwagandha (1:3.60) in medium soil and by Kastur bhendi (1:3.45) in deep soil, followed by Kalmegh (1:3.23) and Kawachbij (1:2.95). Senna showed significantly lowest (1:0.4 and 1:0.51) B:C ratio in medium and deep soils respectively.

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Effect of Season on Yield and Yield Components in Groundnut (*Arachis hypogaea* Linn.)

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ABSTRACT

Ten cultivars including two check varieties were grown in two seasons Summer 1998 and *Kharif* 1998 with three fertilizer doses, to observe the effect of season on yield and yield components in groundnut. Planting during Summer (January) prolonged vegetative period with delayed flowering while monsoon sowing showed early flowering. The plant height was not much influenced by sowing seasons. Sowing of groundnut in Summer with fertilization acted a higher value of pods, pod weight and pod yield whereas monsoon sowing without fertilizer acted as unfavourable environmental and adversely affected yield and yield contributing characters.

Ground is the major oilseed crop in India. It is mainly grown as *Kharif* crop, but now a days it is being cultivated in almost all the seasons, *Kharif, Rabi* and Summer. However, there are great fluctuations in its annual production. Groundnut suffers due to various climatic, edaphic or biological stresses. The present study was undertaken to see the effect of season on yield and yield contributing characters in groundnut.

MATERIAL AND METHODS

The experimental material, for the present study comprised of ten cultivars (eight promising lines with two check varieties namely AK-107, AK-135. AK-143, AK-159, Ak-205, AK-237, AK-240, AK-247, TAG-24 and TG-26). The trials were conducted in randomised block design at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The simulated field experiments were conducted in three sets, first with no fertilizer application, second with 50 per cent of recommended dose of fertilizer and third with full dose of recommended dose of fertilizer in two consecutive seasons i.e. Summer 1998 and *Kharif* 1998. There were, thus six trials conducted in three sets sown at two different times with three levels of fertilizes. Six experiments so conducted were treated as six environment. Uniform irrigation, plant protection and cultural operations were followed. Observations were recorded on five randomly selected plants from each genotype in each environment. The data so collected were subjected to statistical analysis as per method suggested by Panse and Sukhatme (1984). The observations so recorded on all ten genotypes for different traits were averaged over six environments (E_1 to E_6) and presented in Table 3.

RESULTS AND DISCUSSION

Characterisation of environments :

The agronomic traits under study provided the information on the influence of ecological factors like sowing time and fertilization on the general behavior of groundnut, although soil fertility must have major contribution to the developmental traits.

Table 1. Details of environments

Environment numbers	Fertilizer (Kg ha^{-1})	Sowing Date
E_1	Without fertilizer	30-01-98
E_2	12.5 kg N + 25.0 kg P_2O_5	
E_3	25 kg N + 50.0 kg P_2O_5	
E_4	Without fertilizer	07-07-98
E_2	12.5 kg N + 25.0 kg P_2O_5	
E_3	25 kg N + 50.0 kg P_2O_5	

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Table 2. Details of seasons, growth phases and mean GDD_s (°C)

Seasons	Growth phase	Mean growing degree days (°C)
Summer	Vegetable phase	18.84
	Reproductive phase	12.88
	Maturity phase	18.35
Kharif	Vegetative phase	18.03
	Reproductive phase	17.98
	Maturity phase	17.39

On the basis of results presented in Table 3 it has been observed that planting during Summer (January) prolonged vegetative growth with delayed flowering, while *Kharif* sowing showed early flowering. The seasons to cause early or late flowering included either treatments of fertilization used for simulation. It was observed that fertilizer dose may not have much influence for deciding flowering time. Further it was also noted that the plant height in groundnut was also not much influenced by sowing seasons. Almost all the environments have shown more or less similar plant growth. However, the fertilizers have definitely influenced the height depending upon the status of soil fertility.

In respect of number of pods per plant environments E_2 and E_3 i.e. Summer sown environments with half and full dose of fertilizers, respectively exhibited significantly more number of pods while in E_4, E_5 and E_6 (*Kharif* sown), the number of pods reduced significantly. This means that summer sowing with fertilizer dose increased the pod number significantly as compared to *Kharif* sowing. Bensal *et. al.*, (1992) also indicated that environment had great influence to increase number of pods.

Highest pod weight and seed weight plant^{-1} was exhibited by environment E_3 (Summer sowing with full dose of fertilizer) i.e. 9.696 g and 6.383 g respectively, whereas the least pod weight and seed weight were produced by *Kharif* sowing with no fertilization (E_4), 4.034 and 2.496 g respectively. Out of six environments E_1, E_2 and E_3 (Summer sown) had significantly higher pod and seed weight, while in the remaining three E_4,E_5 and E_6 (*Kharif* sown) environments the pod weight and seed weight plant^{-1} were significantly lower. It may be generalised that plant^{-1} productivity is better in Summer season while it is lower in *Kharif* season. These findings are in agreement with the results reported by Reddy and Gupta (1994).

As regards the shelling outturn, there was no significant variation in genotypes across the environments. This implies that environments have no role to influence the shelling out turn. Patra *et. al.*, (1995) also found the same result in their studies.

Pod size and seed size are likely to be dependent on the climatic factors including soil moisture, temperature, humidity etc., (Table 2) more particularly reproductive phase upto maturity. The environment of Summer season (E_1, E_2 and E_3) recorded significantly higher pod and seed size compared to environments of *Kharif* season (E_4, E_5 and E_6). Sowing of groundnut in Summer with fertilization increased size of pods and seeds as compared to monsoon sowing (Padma *et. al.*, 1991).

In case of pod yield hactare^{-1}, genotypes performed well in Summer season as compared to monsoon sowing. There was significant increase in pod yield in Summer crop particularly in E_2 and E_3 as compared to *Kharif* crop. This finding was also supported by Veerabadran *et. al.*, (1990).

Oil content is one of the important traits in groundnut crop. In the present study there were no significant differences among the environments. This indicated that the environments have no much influence on the oil content in groundnut crop.

Agronomic traits like number of pods plant^{-1}, pod weight, seed weight plant^{-1} and pod yield plot^{-1} are quantitative in nature. These traits are likely to be highly influenced by soil moisture and nutrients available at critical stage like flowering and pod development, although native soil status may be a major factor of equal importance.

From the present study it can be seen that E_1, E_2 and E_3 Summer sowing irrespective of fertilization acted as favourable environments to produce significantly higher values for each of the characters usually pods plant^{-1}, pod weight plant^{-1}, seed weight plant^{-1}. and 100 seed weight as compared to E_4, E_5 and E_6 (*Kharif* sowing).

It indicates that groundnut crop perform well

Table 3. Characterization of environments

Environments	Days to 50 % flowering	Plant height (cm)	Number of pods plant^{-1}	Pod weight plant^{-1} (g)	Seed weight plant^{-1} (g)	Shelling per cent	100 pod weight (g)	100 pod weight (g)	Pod yield ha^{-1} (kg)	Oil content (%)
E_1	46.125	18.375	9.875	8.778	5.032	58.584	99.582	39.918	1720.0	49.782
E_2	46.225	18.714	10.750	9.030	5.866	65.031	97.440	41.010	1732.0	49.491
E_3	46.000	19.700	11.550	9.696	6.383	65.974	97.228	41.115	1736.0	49.570
E_4	30.625	19.015	6.425	4.034	2.496	60.658	65.595	28.538	1372.0	50.602
E_5	30.925	19.365	6.550	4.370	2.827	64.704	67.180	29.653	1492.0	50.334
E_6	31.075	20.468	6.925	4.464	2.891	64.736	69.733	29.903	1524.0	49.401
S.E. (m)	0.229	1.087	0.468	0.090	0.072	2.499	2.054	0.642	68.0	0.640
CD at 5% level	0.664	3.152	1.356	0.260	0.210	7.245	5.955	1.863	196	1.855

in *Summer* season rather than in *Kharif*. Patra and Mohanty (1987) and Singh and Dabas (1990) also reported such type of differential response.

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Genetic Divergence in Lathyrus (*Lathyrus sativus* L.)

Lathyrus (*Lathyrus sativus* L.) is an important protein rich (28 %) pulse crop. The protein requirement of the predominantly vegetarian Indian population is mostly met by pulses. This crop is hardy and grown on residual moisture. It is relatively disease resistant and tolerant to pest and drought conditions. Lathyrus seed contain neurotoxin 3-ODAP which is reported to be resonsible for human nervo lathyrism a crippling disorder if consumed in large quantities over prolonged period (Dwivedi and Prasad, 1964, and Kulkarni *et. al.*, 1977). Inspite of the presence of toxic compound, lathyrus is highly nutritive, also contain carbohydrates (58%), fat (0.6%), minerals (3%) and vitamins B_1, B_2 and niacin.

The genetic diversity is produced due to inherent genetic differences in plant species and is of major interest to plant breeder. The D^2 statistics has been found to be a powerful tool to estimate genetic divergence among populations and to assess the relative contribution of different yield components to total diversity. The selection of parents for hybridization is generally based on the yield, adaptation and genetic diversity. Present investigation was undertaken in the germplasm collections of the lathyrus containing sixty diverse genotypes from different geographical origion representing the spectrum of variation.

The material was sown in a randomized complete block design with three replications during *Rabi* 1999-2000. Each entry represented in two rows of 3.00 m length. The inter-row and inter plant spacing were 45 and 20 cm, respectively. Five plants selected randomly from each plot for recording observations on nine characters viz. days to 50% flowering, plant height (cm), number of seeds pod^{-1}, 100 seed weight (g), seed yield $plant^{-1}$ (g), seed protein content (%) and ODAP content (%) in dry seed. Divergence was studied by multivariate analysis using Mahalnobis D^2 as described by Rao (1952). The genotypes were grouped into different clusters by employing Tocher's method (Rao, 1952).

The multivariate analysis based on D^2 statistic indicated considerable amount of genetic diversity among the genotypes. The D^2 values (corresponding to the pairs of comparisons) between sixty genotypes ranged from 1.05 to 132.20. The maximum D^2 value of 132.20 was observed between the genotypes EC-209026 and NLK-37, while the lowest D^2 a value of 1.05 was observed between the genotypes ALK-19 and NLK-62. On the basis of D^2 values, sixty genotypes were grouped into fifteen clusters (Table 1). Fifty-nine genotypes were grouped into fourteen clusters. There was a single genotype viz. NLK-58 in cluster X. The cluster X1 was the largest possessing eight genotype followed by the cluster XIII having seven genotypes. The clustering pattern showed that some genotypes, coming from the same source were grouped into different geographical areas were included into the same clusters suggesting that geographical diversity does not necessarily represent the genetic diversity. These results are in line with earlier reports of Waghmare (1996) and Namboodiri (1997).

Table 1. Distribution of 60 genotypes of lathyrus into fifteen clusters

Clusters	Total No. of genotypes	Genotypes
I	2	NLK-6, NLK-8
II	4	IC-120469, IC-120472, NLK-3, NLK-94
III	4	LSD-3, ALK-7, ALK-19, NLK-48
IV	2	BIOR-208, EC-209026
V	6	PUSA-28, ALK-12, NIC-18773, NLK-54, NLK-56, NLK-63
VI	2	RLK-602, NLK-1
VII	4	PUSA-24, RLK-1203, BIOR-222, BIOR-231
VIII	2	EC-209071, EC-209072
IX	6	NLK-36, NLK-37, NLK-39, NLK-42, NLK-50, NLK-73
X	1	NLK-58
XI	8	RLK-281, RLK-1045, RLK-1093, KH-1, RLS-2, JRL-16, JRL-115, PUSA-90-2
XII	3	BIOR-212, PS-6, EC-209081
XIII	7	IC-120491, NLK-5, NLK-62, NLK-68, NLK-70, NLK-74, NLK-102
XIV	4	NLK-38, NLK-44, NLK-49, NLK-55
XV	5	RLK-579, NLK-47, NLK-51, NLK-53, NLK-67.

Table 2. Average intra and inter cluster distance (D values)

Clusters	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
I	1.18	2.80	2.84	5.26	3.21	2.95	3.90	6.17	2.42	5.00	3.59	2.69	3.85	3.18	4.04
II		1.26	3.38	4.27	2.82	3.20	3.30	4.86	2.66	3.52	2.66	2.52	2.00	2.84	2.95
III			1.87	4.51	3.08	2.98	4.33	6.16	3.55	5.93	3.76	3.18	4.12	3.98	4.97
IV				1.63	4.28	4.15	4.43	3.07	4.82	5.77	4.12	4.13	4.00	5.22	4.48
V					1.64	4.31	2.69	5.13	3.31	5.30	3.23	3.23	2.91	4.16	3.36
VI						1.33	4.02	5.15	3.60	5.29	3.30	3.41	3.87	3.20	4.15
VII							1.61	4.17	4.43	4.85	3.00	4.05	3.42	3.94	2.64
VIII								1.86	5.43	5.35	3.56	4.67	4.20	5.23	3.50
IX									1.41	4.78	2.90	2.53	2.56	2.60	3.16
X										0.00	4.26	4.08	4.02	3.78	4.24
XI											1.53	2.42	2.49	2.61	2.04
XII												1.34	3.36	3.43	3.62
XIII													1.56	2.70	2.05
XIV														1.54	2.92
XV															1.67

Table 3. Cluster mean of nine characters in lathyrus collection

Clusters	Days to 50% flowering	Plant height (cm)	No. of fruting branches plant^{-1}	No. of pods plant^{-1}	No. of seeds pod^{-1}	100-seed weight (g)	Seed yield plant^{-1} (g)	Protein content (%)	ODAP content (%)
I	61.00	56.42	26.33	74.30	2.95	7.10	17.53	20.39	0.385
II	63.17	58.27	26.88	87.47	2.89	7.10	23.07	24.71	0.345
III	61.33	65.43	23.00	77.75	3.18	6.38	15.02	24.75	0.360
IV	66.17	73.67	27.20	104.67	3.03	8.86	16.09	27.92	0.283
V	59.00	64.47	26.17	80.63	2.75	7.64	18.08	26.85	0.394
VI	65.33	67.55	28.43	83.43	3.21	6.71	17.13	21.94	0.431
VII	61.24	72.65	30.27	98.43	2.54	7.02	17.13	25.37	0.268
VIII	65.50	87.78	30.43	126.97	2.79	8.74	21.35	25.95	0.328
IX	59.78	57.99	27.13	92.83	3.17	7.85	22.26	21.09	0.325
X	65.33	54.85	25.20	140.87	2.57	7.10	26.07	21.73	0.364
XI	61.46	78.66	27.62	106.48	2.95	7.29	22.64	23.07	0.364
XII	62.56	69.19	23.36	88.67	2.93	7.82	21.76	20.95	0.340
XIII	61.24	60.78	29.02	109.69	2.99	7.62	23.67	26.64	0.337
XIV	61.33	60.94	28.52	126.32	3.10	6.65	21.59	21.03	0.342
XV	60.73	70.73	31.64	112.27	2.80	7.67	23.24	23.68	0.416
Variance	9.00	78.32	4.66	384.9	0.04	0.45	10.30	6.67	0.024

The inter and intra cluster distances between and within the clusters arepresented in Table 2. The divergence was maximum between cluster I and VIII (D=6.17), followed by between clusters III and VIII (D=6.16). It indicates that genotypes in cluster VIII had direct genetic constitution from the genotypes in the clusters I and III. The divergence was minimum (D=2.00) between clusters II and XIII. The intra cluster distances ranged between D=0 (cluster X) to 1.87 (cluster III), followed by cluster VIII (D=1.86) in these cluster.

The relative importance of the individual character towards genetic diversity can be known on the basis of the coefficient of the canonical vectors (Rao, 1952). The canonical analysis suggests that the number ofpods per plant, seed yield per plant, plant height, 100 seed weight, number of fruiting branches per plant and protein content were important characters in determining genetic diversity in lathyrus. Waghmare (1996) reported that days to 50 per cent flowering, days to maturity, plant height and number of pods plant^{-1} were important sources of variation in addition to number of seeds pod^{-1}. According to Namboodiri (1997), days to 50 per cent flowering, days to maturity, plant height and 100 seed weight had marked influence on the genetic diversity in lathyrus in addition to number of branches plant^{-1}.

The *per se* performance (mean) of genotypes in each cluster was presented for nine characters in Table 3. Days to 50 per cent flowering ranged between 59 (in genotypes of cluster V) and 66.17 days (cluster IV). The plant height varied from 54.85 (cluser X) to 87.78 cm (cluster VIII). Number of fruiting branches per plant recorded maximum (31.64) in cluster XV and minimum (23.0) in cluster III. Number of pods per plant observed highest (140.87) in genotypes of cluster X and lowest (74.3) in cluster I. Number of seeds per pod varied from 2.54 (cluster VII) to 3.21 (cluster VI) in the population under study. the bold seeded genotypes observed in cluster IV (8.86) and VIII (8.74g/100 seed). The seed yield ranged between 15.02 (cluster III) and 26.07 g/plant (cluster X) within the clusters. The protein content of seed was highest (27.92%) in genotypes of cluster IV and cluster V (26.85%) while ODAP content of seed was lowest in genotypes of clusters IV (0.283%) and VII (0.268%). It reveals that the genotype NLK-58 (cluster X) had distinct characteristics like highest seed yield plant^{-1}., Pods plant^{-1} and dwarf in stature. While, the genotype EC-209026 (cluster IV) had bold seeded, higher protein content and lower ODAP (β-N-oxalyl-1-α, β -Diamono Propionicacid) value and late in duration. These genotypes may be used in recombination breeding programme for simultaneous improvement of required characteristics in this crop.

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Indoor Rearing of Tasar Silkworm *Antheraea mylitta* Dury on *Terminalia arjuna* and *Casurina equisetifolia*

Tasar silkworms are generally reared outdoor since many years. Efforts are being made to domesticate them for indoor rearing but it is very difficult to rear these worms indoor. Mira Madan *et. al.*, (1991) undertook indoor rearing of tasar silkworm on Jamun. Aherkar *et.al.*, (1996) also reported the indoor rearing of tasar silkworm on five different hosts. In the present study, indoor performance of larvae on a secondary host casuarina and on primary host arjuna has been evaluated.

In the study, rearing of tasar larvae was undertaken in the month of September and November, the Dfl's required for the study were procured from Basic Seed Multiplication Center, Chandrapur. All due care was taken while transporting the eggs. When the yellow colour of eggs started turning blackish they were black box. After emergence of the larvae they were released on the leaves of casuarina and arjuna. Rearing of 1st and 2nd instar was undertaken as suggested by Jolly *et. al.*, (1979) and the old age worms were reared in the iron cage covered by polybag. Larvae were fed once in the mroning with fresh foliage. The old, unfed leaves and excreta was also removed same time. Observations were recorded on different parameters indicated in Table 1and 2.

The pooled data of two rearing presented in Table 1 indicated that tasar larvae reared indoor on host casuarina underwent an additional moult and instar i.e. five moults and six instars. Larvae took less duration to complete first, second, third, fourth, fifth instar i.e 156, 132, 168, 180 and 360 on casuarina, whereas on host arjuna it took 180, 156, 228, 282 and 366 h to complete first, second, third, fourth, fifth instar, respectively. Highest duration of 564 h (i.e. 23.5 days) was required by the larvae fed on casuarina to complete their sixth instar. Due to addtional instar maximum duration of 1560 h (65 days) was required by the larvae reared on casuarina as against on arjuna 1211.6 h (50.48 days) were required to complete larval period.

Table 1. Effect of hosts on larval duration weight and length of *A. mylitta*

Treatments		Instars						
		1st	2nd	3rd	4th	5th	6th	Cumulative
	1st rearing	156	132	168	180	336	540	1512
Casuarina	2nd rearing	156	132	168	180	384	588	1608
	Pooled	156	132	168	180	360	564	1560
	1st rearing	180	156	204	252	324	-	1116
Arjuna	2nd rearing	180	156	250	312	408	-	1308
	Pooled	180	156	228	282	366	-	1212
		Weight of larvae						
	1st rearing	0.036	0.168	0.374	1.561	4.382	15.326	15.326
Casuarina	2nd rearing	0.040	0.192	0.442	1.537	4.043	15.672	15.672
	Pooled	0.039	0.180	0.408	1.549	4.212	15.499	15.499
	1st rearing	0.069	0.350	1.279	4.293	15.553	-	15.553
Arjuna	2nd rearing	0.072	0.420	1.160	4.919	18.924	-	18.924
	Pooled	0.071	0.385	1.220	4.606	17.238	-	17.328
		Length of larvae						
	1st rearing	1.1	1.4	2.4	3.6	4.4	6.9	6.9
Casuarina	2nd rearing	1.4	1.9	2.5	3.5	4.6	7.0	7.0
	Pooled	1.3	1.7	2.5	3.6	4.5	7.0	7.0
	1st rearing	1.3	2.2	3.0	4.7	7.8	-	7.8
Arjuna	2nd rearing	1.5	2.8	3.4	4.6	8.2	-	8.2
	Pooled	1.4	2.5	3.2	4.7	8.0	-	8.0

Table 2. Effect on hosts on cocoon yield, cocoon pupa shell weight, disease incidence, cocoon length and breadth of *A. mylitta*

Characters	Arjuna			Casuarina		
	1st	2nd	Pooled	1st	2nd	Pooled
Cocoon yield dfl^{-1}	113.65 (114)	60.12 (60)	86.88 (87)	43.19 (43)	22.73 (23)	32.96 (33)
Cocoon wt. (g)	8.313	8.381	8.347	4.630	6.142	5.386
Pupal wt. (g.)	7.340	7.397	7.369	4.137	5.088	4.613
Shell wt. (g.)	0.904	0.918	0.911	0.554	0.493	0.534
Disease incidence	43.17%	69.30%	56.20%	77.64%	92.03%	84.83%
Cocoon length (cm)	3.95	4.28	4.12	3.06	4.06	3.56
Cocoon breadth (cm)	2.37	2.62	2.49	2.06	2.21	2.14

Though the tasar larvae reared on casuarina completed first five instars in short duration than that of arjuna, there was less weight and length gain by the larvae on casuarina (i.e. 0.039, 0.192, 0.442, 1.537, 4.043, 15.499 g and 1.3, 1.7, 2.5, 3.6, 4.5 and 6.9 cm) during 1st to 6th instar, respectively. On arjuna there was maximum weight and length gain by the larvae i.e. 0.071, 0.385, 1.220, 4.606 and 17.238 g and 1.4, 2.5, 3.2, 4.7 and 8.0 cm from 1st to 5th instar, respectively (Table 1).

There was 56.20 per cent disease incidence observed in the larvae reared on arjuna and on casuarina it was 84.83 per cent (Table 2). Most of the larvae on host casuarina died due to anal lip and chain excreta caused due to bacterial infection. Highest cocoon recovery of 86.88 cocoons per dfl was on the host arjuna whereas it was only 32.96 cocoon per dfl on host casuarina. Highest cocoon, pupa and shell weight was recorded on host arjuna, besides this there was highest fecundity, length and breadth of cocoon on host arjuna (Table 2).

Due to feeding on host casuarina tasar larvae underwet six instars which is the first record and hence it could not be compared with other findings. Kole *et. al.*, (1990) reared tasar silkworm larvae on casuarina, rose and arjuna and recorded the larval span of 32 to 53 days on casuarina whereas in present findings it was 65 days. On arjuna it was recorded tobe 31 to 51 days which is quite consistence with present findings.

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Microplate Assay For Detection of Esterase Mediated Cypermethrin Resistance in Cotton Bollworm, *Helicoverpa armigera* (Hubner)

American bollworm is most dreaded pest of many agricultural crops worldwide. Various insecticides belonging to different classes are being in use for management of this pest all over the world. Over past decade, management of *H. armigera* has become increasingly difficult due to development of resistance to the most commonly used insecticides particularly pyrethroids. Various detoxifying mechanisms have been involved in development of resistance in *H. armigera* against pyrethroids. Amongst it, increased level of esterase is the major one (Goh, 1995).

Reliable detection of insecticide resistance is a key element of Insecticide Resistance Management. However, rapid and sensitive biochemical techniques have been adopted to monitor the resistance amongst field populations of certain insect species. (ffrench-constant and Roush, 1991, Zhou *et. al.*, 2002). The objective of the present study was to develop a simple and reliable microplate assay, based on increased esterase activity to detect cypermethrin resistance in *H. armigera*.

The field-collected population of *H. armigera* was maintained in the laboratory without selection pressure of insecticide for 10 generations to get the susceptible strain. To carry out the resistance studies, this strain was compared with the field-collected population of *H. armigera*. The Log Dose Probit assay (LDP) were carried out with laboratory-reared population of third instar larvae (35-45 mg body weight) of *H. armigera* collected from different locations in Maharashtra.

For conducting enzyme assay, randomly twenty larvae of resistant and susceptible fifth instar *H. armigera* weighing 300-350 mg approximately were dissected and the dissected midguts were homogenized at 1500 rpm in the Teflon tissue homogenizer in ice-cold condition. The homogenate thus obtained was centrifuged at 15,000 rpm for 15 minutes at 0° C in high speed refrigerated centrifuge. Solid debris and cellular material was discarded. The resultant post mitochondrial supernatant obtained was stored at -20°C and used as enzyme source. Protein concentration of insect homogenate was determined by following Bradford method (1976) using Bovine Serum Albumin as a standard on UV-Spectrophotometer (Hitachi-2001).

Ninety six well microplate was used in this assay. Fifty microliter of α naphthol (5-50 nM, in triplicate) per well were loaded, followed by 100 µl phosphate buffer (100 mM, pH 6.5) [PB]. After gentle manual shaking, 100 µl of staining solution (0.8 mg Fast Brilliant Blue per ml of PB with 0.5 % SDS) was added in each well. The plate was incubated in dark at 20°C for 30 min. and was read in microplate reader (Metertech, USA) equipped with a 600 nM filter. Standard graph was drawn by plotting concentration verses optical density values. For calculating the esterase levels in field-collected population, aforesaid protocol was repeated with 5 µl of enzyme extract.

The Log Dose Probit assay (LDP) indicated LD_{50} for cypermethrin to be 2.51, 1.24, 1.23 and 1.91 µg per larva for Akola, Amravati, Buldhana and Yavatmal population, respectively. Data on the toxicity of cypermethrin from different locations showed that the fold increase in LD^{50} of cypermethrin was 4.35, 2.15, 2.13 and 3.31 for respective locations. Various workers reported the same trend from Akola region earlier as Kranthi *et. al.*, (2001) observed the LD_{50} of cypermethrin to be 2.55 µg during 1997, 7.25 µg during 1998 from Akola and adjoining areas, while it was 0.213 µg during January 2000 by Undirwade (2002).

Esterase activity in Akola, Amravati, Buldhana and Yavatmal population of *H. armigera* was found to be 54.66, 39.66, 51.66 and 40.33 nM. min^{-1} mg $protein^{-1}$ and 30 nM min^{-1} mg $protein^{-1}$ in laboratory reared susceptible population.

Thus, *H. armigera* population from Akola, Amravati, Buldhana and Yavatmal district was found to have 1.82, 1.31, 1.72 and 1.34 fold higher esterase activity as compared to the laboratory reared susceptible population. This indicated that relative resistance of field collected *H. armigera* population against cypermethrin was quantitatively correlated with the over expressed esterase activity. Though, magnitude of increase in LD_{50} is not exactly correlated with magnitude of increase in esterase activity, increased level of esterase was ubiquitous in all cypermethrin resistant field collected strains. Tikar

(2001) studied esterase mediated cypermethrin resistance in *H. armigera* from Vidarbha region by using synergist bioassay method. Similarly, Gunning *et. al.*, (1996) quantitatively and qualitatively correlated the relative resistance of field collected strains of *H.armigera* with the abundance and activities of an over expressed carboxylesterase, which is in agreement with the present findings.

This technique is found to be simple and accurate as noted earlier by Dary (1990), who has adopted the Gomori's assay on microplate for quantitative determination of general esterase activity in *Culex spp*. Similarly, Zhou *et. al.*, 2002, diagnosed esterase-mediated resistance mechanism in Western Corn Rootworm with the help of microtitre plate assay. Most importantly, it reduces the time factor very effectively required to measure esterase mediated resistance levels in prevailing pest population and ultimately provide more time to curtail its devastating effect with proper IPM module.

Table 1. Fold increase in LD_{50} values against cypermethrin and esterase activity in *H. armigera* collected from different locations.

S.N.	*H. armigera* strain	LD50 for cypermethrin µg larvae^{-1}	Fold increase in LD_{50}	Esterase activity (nM. min^{-1}. mg protein)	Fold increasein esterase activity
1.	Susceptible	0.57	-	30	-
2.	Akola	2.51	4.35	54.66	1.82
3.	Amravati	1.24	2.15	39.66	1.31
4.	Buldhana	1.23	2.13	51.66	1.72
5.	Yavatmal	1.91	3.31	20.16	1.34

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Development of Power Weeder Cutter Wheels With Various Helix Angles

Cotton grown as monsoon crop in one of the major commercial crops of India. Among the many problems faced by the cotton growers, the most troublesome one is the control of weeds, which rob crop plants for nutrients and water, often serve as hosts to insects and other pests that prey on crop plants and create equipment problems, interfere with agriculture operations, increase labourers and reduce yield of crops. Removal of weeds therefore is of paramount importance and is one of the major objectives of interculturing the cultivated crops.

In India, weeding is traditionally carried out with indigenous hand tools. It is costly and due to urbanization, availability of the required number of labourers during peak season of the year is a problem. Animal drawn cultivators are used but their maintenance cost strains the economic condition of the farmers. For small Indian farms the tractor-operated implements are not suitable. In view of above facts and considering the strain of work involved in cotton cultivation, low cost self-propelled power weeder intercultural equipment was modified and tested.

The self-propelled power weeder consisted of lightweight Shriram Honda G.K.-200 (4 hp) petrol start, kerosene run engine as a prime mover (Anonymous, 1997). The performance of power weeder along with straight serrated inclined blade cutter wheels was evaluated with different helix angles and compared in three different field conditions. The field trials were conducted as per RNAM test code (Anonymous, 1983).

The clods as well as pulverized soil both were collected from top surface and mixed. Composite sample was selected from it and after air drying, sieve analysis was performed for mean weight diameter of soil aggregates (MWD) using 10 sieves of 10, 4.75, 3.35, 2.8, 2, 1.4, 1, 0.5, 0.25 and 0.125 mm size (Van Bavel, 1949). It was noticed that, T_4 attachment gave the highest reduction in the value of MWD (3.56) than other attachment than other attachments and difference in value of MWD before and after operation was highest in case of T_4 attachment (2.78 mm) than T_1 (1.43), T_2 (1.96 mm), T_3 (2.43 mm) and T_5 (1.88 mm) attachments (Table 1). The lower variation in case of T_1 attachment was due to lower penetration, high

Table 1. Average performance of power weeder with different cutter wheels attachments.

S.N.	Particulars	Attachments				
		T_1	T_2	T_3	T_4	T_5
1.	MWD before operation, mm	6.70	6.71	6.70	6.34	6.04
2.	MWD after operation, mm	5.27	4.75	4.27	3.56	4.16
3.	Soil strength before operation, kgf/cm^2	1.72	1.66	1.62	1.60	1.58
4.	Soil strength after operation kfg/cm^2	1.30	1.14	0.98	0.93	1.25
5.	Working depth, cm	5.40	6.30	7.04	7.14	6.11
6.	Traveling speed, km h^{-1}	1.68	1.57	1.59	1.55	1.52
7.	Theoretical field capacity, ha h^{-1}	0.151	0.144	0.143	0.138	0.147
8.	Effective field capacity, ha h^{-1}	0.135	0.132	0.136	0.133	0.135
9.	Field efficiency, %	88.80	91.75	94.67	95.88	91.10
10.	Weeding efficiency, %	84.81	88.44	95.31	95.99	90.21
11.	Plant damage, %	10.47	9.05	5.97	4.96	5.94
12.	Cost of operation, (Rs ha^{-1})	487.77	499.09	465.98	474.35	499.74

T_1 - Power weeder with straight edge blade cutter wheel (0^0 helix angle)
T_2 - Power weeder with serrated edge blade cutter wheel (0^0 helix angle)
T_3 - Power weeder with straight edge blade cutter wheel with 45^0 helix angle.
T_4 - Power weeder with serrated edge blade cutter wheel with 45^0 helix angle.
T_5 - Power weeder with straight edge blade cutter wheel having 60^0 helix angle.

slippage and because of straight cutting. The highest reduction, in case of T_4 was due to highest penetration, inclined pointwise cutting and better gripping. After weeding operation the average maximum reduction in soil strength of 0.93 kgf/cm^2 was observed by T_4 attachment. From Table 1, it was revealed that the maximum difference in soil strength before and after operation was found in T_4 attachment (0.67 kgf/cm^2), it may be because of serrated inclined blades, which deeply cut the soil pointwise without slippage and well pulverization effect. The higher depth of 7.14 cm was found in case of T_4 attachment. The traveling speed varies from 1.52 to 1.68 kmph. The highest speed was in case of T_1 attachment (1.68 kmph); highest speed was due to lower depth of penetration. The average field efficiency in case of T_1 attachment was 88.80 per cent and highest field efficiency of 95.88 per cent was observed with respect to T_4 attachment. The lower field efficiency in case of T_1 may be due to poor self-cleaning ability of weed and difficulty in turning. The highest weeding efficiency of 95.99 per cent was noticed for T_4 attachment, followed by T_3 (95.31%), T_5 (90.21%), T_2 (88.44%) and T_1 (84.81%) attachments (Table 1). The average plant damage was in the range of 4.96 to 10.47 per cent. The lowest plant damage was observed in case of T_4 attachment (4.96%), it might be due to better stability and grip of serrated inclined blades. The cost of interculture operation with different attachments ranged from Rs. 465.98 to Rs. 499.74 ha^{-1}.

The performance of power weeder with serrated blade cutter wheel with 45° helix angle was superior as compared to straight blade cutter wheel having 0°, 45°, and 60° helix angle and serrated blade cutter wheel having 0° helix angle. It was easy to operate and involved fewer efforts compared to other attachments.

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Status of Greenhouse Technology in Amravati District

Greenhouse technology is one of the promising technologies to improve the quality and productivity of the crop. But due to high investment, it is not gaining popularity. Few enthusiastic persons are using this technology. Considering the present status of greenhouse technology in India, action should be taken to increase area under greenhouse at faster rate. The greenhouse technology has potential to meet the growing demand of crops.

A survey was conducted in Amravati District (MS) in the year 2003-2004 to know the awareness and status of greenhouse technology and to estimate the existing material and suggest modification in designs of poly-net house.

Only ten greenhouses were observed in this region in which seven were low to medium cost greenhouses and nethouse type and only three were high cost polyhouses, two of them were under Department of Botany and Department of Biotech, Amravati University and third one was under Taluka Beej Gunan Kshetra, Anjangaon Surji. It is observed that cultivators are not getting the expected output from greenhouse, as they have not constructed greenhouse as per proposed design, location and orientation. Also management of this greenhouse was found very poor. The farmers were aware about this technology but they need guidance about subsidy plans and for proper management of greenhouse. It was therefore felt necessary to survey this district to know status of greenhouse technology to know the problems of farmers having greenhouse and give them proper suggestion for operating greenhouse for better and maximum output.

A questionnaire was prepared for collecting information like name of farmer, address, types of greenhouse, crops under cultivation, problems that farmer has to face in this technology etc. Information was collected from District level office regarding location of greenhouses erected in Amravati District. Farmers were contacted personally and information regarding greenhouse was collected (Table 1).

In the surveyed area of Amravati District, only ten greenhouses were observed. Out of these, three were poly houses and seven were net houses. The total area under poly houses was 309.15 m^2 and area under net houses was 1714 m^2. The KVK, Mandal, institutions or farmers had constructed these greenhouses.

Most of the greenhouses that surveyed were low to medium cost type having cost range between Rs. 195 to 512 m^2. Only three greenhouses were observed

Table 1: Details of Poly / Net houses Surveyed

S.N.	Location (Year of construction)	Dimension (m) L x W x H	Cost (Rs sq m^{-1})	Type
1	T.S.F., Anjangaon Surji (2000-2001)	18 x 6 x 3.6 (108)	1006.5	Modified Quonset type Polyhouse
2	Deptt. Of Botany, Amravati University (2000-2001)	15.3 x 10.5 x 3.5 (160.65)	1244.91	Quonset type Polyhouse
3	Deptt. of Biotech, Amravati University (2003-2004)	9 x 4.5 x 3.57 (40.5)	14510	Quonset Type Polyhouse
4	T.S.F., Tiwasa (1995-1996)	30 x 4.5 x 2.7 (135)	333.50	Quonset Type Nethouse
5	T.S.F., Chandur railway (2000)	9 x 15 x 2.7 (135)	512	Even Span Type Nethouse
6	Mr. Vinay Shirrao, Pohra (2003-2004)	15 x 9.2 x 3 (138)	289.95	Even Span Type Nethouse
7	Shivaji Agriculture College, Amravati (2000)	24 x 6 x 2.7 (144)	381.94	Quonset Type Nethouse
8	Shivaji Agriculture College, Amravati (2001)	30 x 9 x 5.4 (270)	362.96	Quonset Type Nethouse
9	K.V.K., Durgapur (1998)	18 x 24 x 2.4 (432)	226.85	Ridge and furrow Type Nethouse
10	K.V.K., Ghatkheda (1998)	25 x 18.4 x 3.25 (460)	195.65	Ridge and Furrow Type Nethouse

under high cost category. The semi controlled greenhouse under Department of Botany, University Of Amravati was having constructional cost of Rs. 1244.91/ m². Polyethylene sheet of 200 micron has used for cladding. The instruments like sunshine recorder, thermometers, hygrometer etc were installed in it. The greenhouse was in use for experiment purpose only. Another semi controlled type greenhouse was constructed under Department of Biotech, University Of Amravati. Its construction cost was Rs. 14510/ m². Fiber Rigid panel sheet was used for cladding it. This was in use for experimentation on medicinal plants and nursery propagation. The polyhouse constructed under Taluka Beej Gunan Kshetra, Anjangaon Surji was of semicontrolled type having constructional cost of Rs. 1006.5/ m². It was equipped with 200 micron, polyethylene sheet for cladding, fan and pad system and misters. It was being used for seed propagation. The net house in this area was under use for nursery and floriculture. Only Mr. Vinay Shirrao, Chairman of "Shri Biyane" Fertilizer Company in Pohra was using his net house for cottonseed testing. No one was using the net houses for medicinal or high value crop like safed musli, etc. Two of the greenhouses were left abandoned because of shortage of electricity and water supply. It was observed that greenhouses were not maintained property according to need of crop. Also location and orientation of some greenhouses was not proper. Few of them were under shade of tree. Hence cultivators are not getting expected output from them.

The survey revealed that the farmers are having awareness of greenhouses technology but they are not adopting it due to the poor result obtained by other farmers who have used it. Farmers need guidance for proper management of greenhouse for its maximum output. More area can be brought under greenhouse cultivation if the advantages of technology are explained to farmers. The modification in existing structure should be made to have better results in future.

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Performance of Maize and Sorghum Varieties to Different Levels of Nitrogen

In India, maize is mainly grown as rainfed crop. In rainfed farming, since water is not under control, fertilizer management become very inportant. Secondly, Sorghum is a staple food of rural masses in Maharashtra. The application of N fertilizers is known to increase sorghum yield (Turkhede and Prasad, 1978). Hybrids are particularly more responsive to fertilizers (Rao and House, 1967). The sorghum CSH-9 is a popular hybrid in Maharashtra. It was threrfore, felt essential to study response of maize and sorghum varieties to different levels of nitrogen in rainfed conditions.

The experiment was arranged in factorial RBD with two cultivars each of maize (AMC -1 and Q-5) and sorghum (CSH-9 and SPH-388) in main plots and four levels of nitrogen (0,40, 80 and 120 kg ha^{-1}) sub-plot with three replications in *Kharif* seasons during 1995-96, 1996-97 and 1998-99 at National Agricultural Research Project, Yavatmal. The experimental plot soil was shallow, low in available N (240 kg N ha^{-1}) and available P_2O_5 (33.13 kg ha^{-1} and high in potash (437 kg ha^{-1}). Fertilizer N was applied as per the treatments whereas P and K were aplied @ 60:30 kg PK ha^{-1} for maize and @ 40:40 kg PK ha^{-1} for sorghum.

Among maize varieties tested, varity 'AMC-1' recorded significantly highest grain yield over variety Q-5. As regards to sorghum varieties tested, sorghum variety SPH-388 recorded significantly higher grain yield over CSH-9.Grain yield was significantly influenced by Nitrogen levels (Table 1). Grain yield incresed by 31.64, 48.65 and 59.29 per cent in pooled by N_2, N_3 and N_4 treatments over control. Increasing the level of N from 40 to 80 and 80 to 120 kg ha^{-1} raised grain yield by 5.37 and 5.64 q ha^{-1}. The applicaation of N @ 120 kg ha^{-1} was found to give maximum and significant higher yield (27.22 q ha^{-1}). Response of nitrogen level was linear up to highest level of N applied. This increases in grain yield due to nitrogen might have come through increased grains/ear and grain weight $plant^{-1}$ and probably the result of efficiency moisture use by the plants caused by nitrogen nutrition as reported by Viets (1962).

Highest GMR was recorded by maize variety AMC-1, followed by variety Q-5 (Table 2). In case of sorghum variety SPH-388 recorded significantly higher GMR over CSH-9. Highest GMR was recorded when crop was fertilized with 120 kg N ha^{-1}. Similar results were also reported bySutaria *et.al.*, (1999) and Sharma *et. al.*, (2000). In general, it was concluded that for getting higher GMR, maize crop should be perferred over sorghum due to more response of maize crop to the nitrogen and phosphorus as

Table 1. Grain yield (q ha^{-1}) of Maize and Sorghum varieties as influenced by different levels of Nitrogen.

Treatments		Grain yield (q ha^{-1})			
		1994-95	1995-96	1996-97	Pooled Mean
A)	Crop and variety				
	V1-Maize (AMC-1)	11.69	27.30	28.29	22.42
	V2 - Maize (Q-5)	11.44	22.59	24.98	19.67
	V3 - Sorghum (CSH-9)	9.31	16.95	18.80	15.01
	V4 - Sorghum (SPH-388)	10.45	22.67	23.97	19.02
	SE±	0.26	0.42	0.58	0.38
	CD at 5%	0.75	1.21	1.70	1.06
B)	Nitrogen levels Kg ha^{-1}				
	N1 - 0 Kg N ha^{-1}	5.94	12.74	14.56	11.08
	N2 - 40 kg N ha^{-1}	9.33	18.94	20.36	16.21
	N3 - 50 kg N ha^{-1}	11.71	25.49	27.56	21.58
	N4 - 120 kg N ha^{-1}	15.90	32.33	33.43	27.22
	SE±	0.26	0.42	0.58	0.43
	CD at 5%	0.75	1.21	1.70	1.18
C)	Interaction (A x B)				
	SE±	0.52	0.84	1.17	0.52
	CD at 5%	1.51	2.42	3.40	–

Table 2. Gross monetary return (Rs ha^{-1}) of maize and sorghum varieties as influenced by different levels of nitrogen

	Treatments	GMR (Rs. ha^{-1})			
		1994-95	1995-96	1996-97	Pooled mean
A)	Crop and variety				
	V1-Maize (AMC-1)	8,056	17,809	19,691	15,185
	V2 - Maize (Q-5)	7,131	15,620	17,456	13,402
	V3 - Sorghum (CSH-9)	5,630	11,973	15,819	11,140
	V4 - Sorghum (SPH-388)	6,109	14,430	18,049	12,862
	SE±	176	378	435	227
	CD at 5%	508	1092	1258	628
B)	Nitrogen levels Kg ha^{-1}				
	N1 - 0 Kg N ha^{-1}	4,114	9,488	10,717	8,106
	N2 - 40 kg N ha^{-1}	6,138	13,156	15,485	11,593
	N3 - 50 kg N ha^{-1}	7,324	16,526	20,087	1,645
	N4 - 120 kg N ha^{-1}	9,349	20,626	24,725	18,233
	SE±	176	378	435	227
	CD at 5%	508	1092	1258	628
C)	Interaction (A x B)				
	SE±	352	756	871	409
	CD at 5%	–	2,185	2,516	–
Prices of the Produce Rs. ha^{-1}					
Maize	Grain	274	337	395	
	By-product	60	100	100	
Sorghum	Grain	214	365	359	
	By-product	60	100	100	

comapred to sorghum and it should be fertilized at 120 kg N + 60 kg P_2O_5 + 30 kg K2O ha^{-1} and sorghum should be fertilized at 120 kg N + 40 kg P_2O_5 + 40 kg K_2O ha^{-1}.

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Effect of Zinc Application on Yield of Maize (*Zea mays* L.)

In India, maize is mainly grown as rainfed crop. In rainfed farming, since water is not under control, fertilizer management become very important. Zinc is one of the micro-nutrients essential for crop growth. Among the several factors causing zinc deficiency in maize, high native soil phosphorus and applied fertilizer phosphorus have been noted to cause detrimental effects on zinc nutrition on corn (Sharma *et. al.*, 1968). The agro-climatic conditions of Central Vidarbha Zone of Maharashtra coincide to be conditions under which detrimental effects of phosphorus on zinc nutrition have been noticed by several workers. The present investigation was undertaken to study the effect of zinc fertilization on growth and yield of maize in Central Vidarbha zone of Maharashtra.

The experiment was conducted during *Kharif* 1999, 2000 and 2001 at Zonal Agril. Research Station, Yavatmal. Two varieties of maize (V1 - Q - 5 composite) and V2 - Pioneer 30R26 Hybrid) and three levels of zinc. (Zn_1 - control, Zn_2 - 5 kg Znha^{-1} through $ZnSO_4$, $7H_2O$, Zn_3-10 kg Znha^{-1} through $ZnSO_4$ $7H_2O$) was laid out in RBD with four replications. The soil of the experimental site was shallow, low in available N (240 kg ha^{-1}, low available P_2O_5 (39.77 kg ha^{-1}) high in Potash (412 kg ha^{-1}) and low in zinc (<0.6 ppm). The gross plot size was 6.00 x 5.4 m^2 and net plot size was 5.40 x 4.20 m^2 and spacing used for maize sowing was 60 cm x 15 cm and fertilizer application was @ 120 : 60 : 30 kg NPK ha^{-1}.

Data presented in Table 1 revealed that, in general the grainyield in 2000-2001 was higher than 1999-2000 and 2001-2002. This was due to better crop growth and development as compared to latter two years. Hybrid variety Pioneer 30 R 26 recorded highest grain yield than Q-5 (composite) variety during three years of experimentation. Pooled data of three years revealed that the hybrid maize (Pioneer 30R26) recorded signficantly highest grain yield (56.67 q ha^{-1}) was over maize variety Q-5 (35.76 q ha^{-1}). The results are in agreement with findings of Paradkar and Sharma (1993) and Sahoo *et.al.*, (2002).

An application of zinc increased the grain yield significantly over control. Higher dose of 10 kg Znha^{-1} recorded significantly more grain yield than its lower level i.e. 5 kg Zn ha^{-1} during all years of experimentation.

From pooled results it was revealed that, an appliationof 120:60:30 NPK kg ha^{-1} with zinc @ 10 kg ha^{-1} recorded highest yield of maize (52.21 q ha^{-1}) and it was significantly superior to 5 kg Zn ha^{-1}. This might have been the result of significantly higher shelling percentage under higher rate of zinc application. Similar results were also obtained by Singh and Shrma (1976) and Dwivedi *et. al.*, (2002). The interaction effect was to be non-significant.

From three years pooled data, it can be concluded that, for getting highest grain yield, hybrid maize crop should be fertilized @ 120 kg N + 60 kg P_2O_5 + 30 kg K_2O ha^{-1} along with basal application of 10 kg Zn ha^{-1} (50 kg ha^{-1} $ZnSO_4$) for central Vidarbha Zone of Maharashtra under rainfed condition.

Table 1. Grain yield (q ha^{-1}) as influenced by varieties and zinc levels during 1999-2000, 2000-2001 and 2001-2002

	Treatments	Grain yield (q ha^{-1})			
		1999-2000	2000-2001	2001-2002	Pooled Mean
A)	**Crop and Variety**				
	V1 - Q-5 (Composite)	17.77	46.33	43.20	35.76
	V2 - Pioneer 30R26 (Hybrid)	36.26	70.37	63.69	56.67
	SE±	0.79	0.97	1.25	0.62
	CD at 5%	2.37	2.91	3.76	1.73
B)	**Zinc levels**				
	Zn-1 - Control	22.20	53.29	46.86	40.78
	Zn 2 - 5 kg Zn ha^{-1}	26.78	57.49	52.71	45.66
	Zn - 3 - 10 kg Zn ha^{-1}	32.07	64.27	60.31	52.21
	SE±	0.97	1.19	1.53	0.71
	CD at 5%	2.90	3.58	4.62	1.96
C)	**Interaction (A x B)**				
	SE±	1.36	1.68	2.16	4.93
	CD at 5%	NS	NS	NS	NS

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Response of Safflower to Irrigation Levels, Land Configuration and Wheat Straw Mulch

Safflower is the important *Rabi* oilseed crop of Maharashtra state mostly grown on residual moisture. It's production is quite (4.74 q ha^{-1}) mainly due to the fact that safflower is grown on receding soil moisture coupled with minimum use of inputs. This crop is rarely irrigated. Therefore, in order to study the effect of irrigation, land configuration and mulching on yield and water use of safflower, the present investigation was conducted at Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Rabi* 1994-95.

Field experiment was conducted in split plot design allotting 12 combinations of three land configuration (Conventional i.e. sara, furrow after every row and after two rows) and four irrigation schedules (Control, irrigation at rosette, flowering and at rosette plus flowering) to main plots and no mulch and mulching to sub plots, replicated thrice. The soil of the experimental site was sandy clay with 0.035 per cent total N, 18.63 kg ha^{-1}, of available P_2O_5, 308.0 kg ha^{-1} of total K_2O with pH of 7.8. Field capacity, permanent wilting point and bulk density of 0 to 60 cm soil profile were 32.38 per cent, 15.98 per cent and 1.22 g cm^3 respectively.

After presowing irrigation of 6 cm, variety Bhima was sown on 29/10/94 at 45 cm spacing. The crop was thinned 10 days after sowing keeping one seedling at 20 cm intrarow distance. The crop was fertilized with 50:25:25 kg N, P_2O and K_2O ha^{-1}. Land configuation treatments were superimposed 20 DAS. At the same time wheat straw mulch was spread @ 5 t ha^{-1} as per the treatments. One weeding and one endosulfan spray were given to protect the crop from weeds and aphids infestation, respectively. Irrigations of 6 cm depth measured through 90° V notch were given as per the treatments. Soil samples from 0 to 30 and 30 to 60 cm soil profile were taken prior to and 48 hr after irrigation to estimate the

Table 1. Seed yield and yield attributes as influenced by irrigation, land configuration and straw mulch treatments

Treatments	Seed yield (kg ha^{-1})	Number of branches $plant^{-1}$	Number of capsules $Plant^{-1}$	Grain weight $plant^{-1}$ (g)	Test weight (g)	Consumptive use (mm)	Water use efficiency mm^{-1}
I Irrigation scheduling							
I_0 No irrigation	1292	5.1	11.7	11.10	56.33	131.4	9.80
I_1 Irrigation at rosette	1594	5.6	13.2	14.32	60.44	195.9	8.13
I_2 Irrigation at flowering	1395	5.3	14.1	11.29	57.55	218.4	6.38
I_3 Irrigtion at rosette and flowering	1810	6.1	15.7	15.17	61.00	279.7	6.47
SE(m)±	19	0.18	1.1	-	-	-	-
CD at 5%	55	0.55	3.4	-	-	-	-
II. Land configuration							
L_1 Conventional	1424	5.5	12.5	11.59	58.00	209.8	6.78
L_2 Furrow after every row	1571	5.4	14.2	12.76	59.06	202.9	7.74
L_3 Furrow after every row	1574	5.6	14.3	12.60	59.31	206.2	7.63
SE (m)±	17	0.21	1.0	-	-	-	-
CD at 5%	48	NS	NS	-	-	-	-
III. Wheat straw mulch							
M_0 No mulch	1445	5.4	13.1	12.90	58.81	215.5	6.70
M_1 Mulching	1601	5.6	14.3	13.05	59.76	197.2	8.11
SE (m)±	15	0.11	0.4	-	-	-	-
CD at 5%	43	NS	1.2	-	-	-	-

consumptive use. During crop growth period 55.6 mm of rainfall was received. Crop was harvested on 15/03/1995.

Table 2. Seed yield (kg ha^{-1}) as affected by interaction between irrigation regimes and land configuration treatments.

Treatments	L_1	L_2	L_3
I_0	1224	1326	1302
I_1	1444	1598	1741
I_2	1290	1463	1430
I_3	1716	1894	1821
SE (M) $\pm$	33		
CD at 5%	96		

Two irrigation at rosette and flowering stages has recorded significantly highest seed yield (Table 1) over rest of the irrigation treatments. Irrigation at rosette outyielded irrigation at flowering and no irrigation. Likewise one irrigation at flowering yielded significantly more than no irrigation. Pawar *et.al.* (1987), also reported highest yield with two irrigations at branching and flowering in addition to presowing irrigation. Number of branches, capsules and grain yield per plant and test weight were increased with irrigations and they were highest with two irrigations at rosette and flowering. Comsumption of water by the crop was increased with increase in frequency of irrigation. However, water use efficiency was decreased.

Furrow after every row or every two rows being at par had outyielded conventional method. Number of branches, capsules and grain weight per plant and test weight were enhanced with land configuration although not significantly. Consumptive use was more orless equal in all the treatments but water use efficiency was improved under furrow openings.

Mulching of wheat straw had significantly increased the seed yield over no mulching. Number of capsules and grain weight per plant and test weight were enhanced due to mulching. This conforms the findings of Mazal *et.al.*, (1990).

Interaction between irrigation regimes and land configuration treatments (Table 2) indicated that the two irrigations at rosette and flowering in furrow after every row had recorded significantly highest seed yield although it was at par with two irrigation coupled with furrow after two rows.

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Effect on Sorghum Grain Germination in Various Storage Structures

The study on sorghum grain germination was conducted in various types of storage structure in the laboratory of Sorghum Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.). The produce of sorghum grain samples of each genotype was collected from the eight farmer's field trials of two villages of Akola district. The grain samples of each genotype was stored in four types of storage structures, viz. tin container, gunny bag, fibre bag and plastic container. One kg. sorghum grain was stored in each type of storage structure. After harvest of field trials, the experiment was carried out from January 2001 and continued upto September 2001, at each month interval, the observation on germination of grain was recorded in each genotypes from various storage structure. The germination test was conducted by Paper Towel Method (ISTA, 1966), in the laboratory. The initial and final percentage recorded on germination are illustrated in Table 1.

The data in Table 1 indicated that, the germination percentage in tin container is decreased in the range of 10.67 to 49 per cent. The lowest decrease was observed in the genotype PVK-400, followed by CSH-9 and highest decrease in CSH-17.

In case of gunny bags, the germination in the grain was decresed to the range of 20.34 to 66.67 per cent in various genotypes. The lowest decrease in germination was observed in the genotype CSV-15 (20.34) and the highest percent decrease was noted in the genotype CSH-17 (66.67). The germination per cent in fiber bags storage structure was decreased in the range of 16.0 to 37.34 per cent in various genotypes. The lowest decrease was observed in the genotype CSH-17 (16.0) and highest decrease in the genotype PVK-400 (37.34). The last observation on germination could not be recorded due to fungus development in the plastic container storage structure. The results of the present study are more or less in agreement with Delouche *et. al.*, 1973.

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Table 1. Germination percentage in sorghum grain

S.N.	Genotypes	Tin container			Gunny bags			Fiber bags			Plastic container		
		Initial	Final	% decrease	Initial	Final	% decrease	Initial	Final	% decrease	Initial	Final	% decrease
1.	CSH-14	88.75	69.99	19.25	89.75	50.16	39.09	87.25	57.99	29.26	90.50		
2.	CSH - 16	93.75	63.66	30.08	89.25	57.33	31.92	90.75	55.99	34.76	90.75		
3.	CSH - 9	91.66	74.66	17.00	89.00	57.33	31.67	92.33	65.32	27.01	92.33	Fungus	
4.	CSH - 13	97.00	77.99	19.01	95.00	39.99	55.50	96.50	68.66	27.84	95.50	Development	
5.	CSV-15	84.00	62.66	21.34	95.00	74.66	20.34	93.00	62.66	30.34	98.00		
6.	PVK-400	88.00	77.33	10.67	81.00	38.66	52.34	96.00	58.66	37.34	88.00		
7.	CSH - 17	97.00	48.00	49.00	98.00	37.33	66.67	96.00	80.00	16.00	85.00		

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Effect of Dates of Sowing and Spacing on Grain Yield of Maize

Among the several maize varieties extra early composite, 'AMC-1' has been found suitable for Central Vidarbha Zone due to its extra early maturity that facilitates double cropping after maize. Realization of the yield potential of this variety warrants planting at the optimum time and spacing. Maize ears are generally reduced in size as the crop is grown more thickly by row to row distance (Zimmerman, 1966). There appears to be an optimum combination of planting date and spacing (Nandpuri, 1960 and Rao *et. al.*, 1961). Hence present investigation was undertaken to find out the optimum sowing date and spacing for exrtra earlymiaze cultivar - AMC-1.

The experiment was conducted in F.R.B.D. with three replications during *Kharif* seasons of 1996-97, 1997-98 and 1998-99 at Zonal Agril. Research Station, Yavatmal. The treatments comprised of four sowing dates D_1-24th M.W (15th June), D_2-26th M.W. (25th June), D_3-27th M.W. (5th July). D_4-28th M.W. (15th July) and two spacings S_1 - 60 cm x 15 cm, S_2 - 45 cm x 20 cm. The soil of the experimental site was shallow, low in available N (240 Kg ha^{-1}), low available P_2O_5 (39.77 kg ha^{-1}) and high in available potash (420 kg ha^{-1}). The gross plot size was 5.0 M x 3.6 M. Fertilizer applied to maize crop @ 120 : 60 : 30 NPK kg ha^{-1}. Seed was dibbled as per spacing treatments.

The highest grain yield (31.27 q ha^{-1}) was obtained with the 26th M.W. Sowing date (25th June) which was significantly superior over other sowing dates. Sowing of maize in 27th M.W. also recorded significantly higher grain yield (29.09 q ha^{-1}) over other two sowing dates.

Before onset of monsoon sowing (24th M.W.) and late Monsoon sowing (28th M.W.) were found to produce average crop yields. Rao *et. al.*, (1961) also reported similar results.

Grain yield increased by 3.23 q ha^{-1} (Table 1) when the crop was spaced at 60 cm x 15 cm as compared to crop sown at 45 cm x 20cm. Yield increased per ha was not commensurate with the plant population. It might be due to the fact that more availability of growth factors viz. Space, light, moisture and nutrients per plant under wider row spacing as compared to the closure row to row spacing. For getting higher yields from maize crop, plant population ha^{-1} should be 78000 to 65000 have been reported as optimum by Nandpuri (1960) and Pandey *et. al.*, (1999).

From three years pooled data it was concluded that, for getting highest maize grain yield crop should be sown in the 26th M.W. (last week of June) at the spacing of 60 cm x 15 cm.

Table 1. Grain yield (q ha^{-1}) as influenced by different dates of sowing and spacings during 1996-97, 1997-98 and 1998-99

Treatments		Grain yield (q ha^{-1})			
		1996-97	1997-98	1998-99	Pooled Mean
A)	Sowing dates				
	D1 - 24th M.W.	30.29	19.81	23.61	24.57
	D2 - 26th M.W.	39.09	26.82	29.41	31.27
	D3 - 27th M.W.	37.24	23.42	26.63	29.09
	D4 - 28th M.W.	20.45	11.10	15.83	15.79
	SE±	0.36	0.56	0.65	0.39
	CD at 5%	1.09	1.71	1.94	1.08
B)	Spacing				
	S1 - 60 cm x 15 cm	30.05	22.15	25.59	26.92
	S2 - 45 cm x 20 cm	30.51	18.42	22.14	23.69
	SE±	0.26	0.40	0.46	0.23
	CDat 5%	0.77	1.21	1.39	0.63
C)	Interaction				
	SE±	0.52	0.80	0.92	0.48
	CD at 5%	1.56	NS	2.79	NS

Table 2. Rainfall data recorded at National Agricultural Research Project, Yavatmal during 1996-1997, 1997-98 ad 1998-1999.

Met. Week	Dates	1996-97		1997-98		1998-99	
		Rainfall	R.D.	Rainfall	R.D.	Rainfall	R.D.
22	28-30 June	--	--	--	--	--	--
23	4-10	--	--	23.3	2	10.2	1
24	11-17	9.6	1	40.3	2	76.0	4
25	18-24	22.4	1	36.5	4	21.8	2
26	25-1 July	--	--	10.9	1	13.9	2
27	2-8	56.3	3	28.7	3	99.9	7
28	9-15	69.0	4	13.2	2	222.4	3
29	16-22	38.7	2	45.4	4	38.6	4
30	23-29	121.2	6	81.2	3	115.4	3
31	30-5 Aug.	116.6	5	34.8	4	63.5	6
32	6-12	50.6	2	--	--	50.6	5
33	13-19	26.2	1	2.3	--	17.0	1
34	20-29	31.7	3	80.8	4	18.7	2
35	27-2 Sept.	58.8	3	26.8	3	13.2	2
36	3-9	41.1	3	6.6	1	54.7	4
37	10-16	87.0	4	70.0	5	44.6	4
38	17-23	37.6	2	128.4	5	53.9	3
39	24-30	1.1	--	16.6	2	32.2	2
40	1-7 Oct.	46.1	4	--	--	--	--
41	8-14	--	--	--	--	1.8	--
42	15-21	--	--	2.7	1	5.2	1
43	22-28	42.7	3	14.0	2	--	--
44.	29-4 Nov.	--	--	7.3	1	3.4	--
45.	5-11	--	--	0.3	--	61.2	2
46.	12-18	--	--	30.9	2	--	--
47	19-25	--	--	3.9	1	--	--
48	26-2 Dec.	--	--	50.0	2	--	--
49	3-9	--	--	8.6	1	--	--
50	10-16	--	--	7.5	1	--	--
51	17-23	--	--	13.0	1	--	--
52	24-31	--	--	35.0	2	--	--
	Total	856.7	47	821.00	60	818.2	58

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Information Sources Used by Anganwadi Workers

The scheme of Integrated Child Development (ICDS) was launched in the country from 2nd October, 1975. The package of services comprising pre school education, immunization and supplementary nutrition are provided to children. Health care and education to the pregnant and lactating mothers are provided under this scheme. The Anganwadi worker is the key and trained functionary working at field level in this scheme and provides these services to the children and pregnant and lactating mothers. The Anganwadi worker is therefore required to acquire information about integrated child development practices from various sources for efficient implementation of ICDS activities and effective job performance. An attempt was therefore made to ascertain the sources of information used by Anganwadi workers for seeking information about integrated child development practices.

The study was undertaken in Akola Panchayat Samiti of Akola district. The functional Anganwandi Centres were identified and the population of 180 anganwadi workers working at these centres was selected as respondents for the study.

1. Information sources used

The use of various sources for obtaining information about integrated child development practices and activities revealed that (Table 1) from among personal sources, cent per cent Anganwadi workers used to contact the Circle Officer, Project Officer and the Cowokers for information about

Table 1. Distribution of Anganwadi workers according to use of different sources for information about ICDS

S.N.	Sources of information	Frequency	Percentage
I	**Personal sources**		
1.	Contact with officers at circle head quarter	180	100.00
2.	Contact with officer at project head quarter	180	100.00
3.	Contact with co-workers	180	100.00
4.	Contact with Mukhyasevika	179	99.44
5.	Contaot with PHC staff	178	98.89
6.	Contact with school teacher	178	98.89
7.	Contact with gramsevika	174	96.67
8.	Contact with locl leaders	091	50.56
9.	Letters to Mukhyasevika	061	33.89
10.	Letters to Gramesevika	020	11.11
11.	Contact with village level worker	004	02.22
12.	Contact with Grampanchayat members	015	08.33
II.	**Group sources**		
1.	Meeting with Mukyasevika	180	100.00
2.	Group discussion with Mukhyasevika	180	100.00
3.	Meeting at circle head quarter	180	100.00
4.	Meeting at project office	180	100.00
5.	Training programmes	175	097.22
6.	Seminars	050	027-78
7.	Visit to exhibition	035	019.44
8.	Graphs and charts	150	083.34
III	**Mass media and other sources**		
1.	Posters	180	100.00
2.	News papers	168	93.33
3.	Television	164	91.11
4.	Radio programmes for women	101	56.11
5.	Films on nutrition and health	002	01.11

integrated child development practices. A great majority of the Anganwadi workers used to contact Mukhasevika (99.44%), Gramsevika (96.67%) Primary Health Center Staff (98.89%) and School Teacher (98.89%) for information about practices and activities of ICDS. About fifty per cent Anganwadi workers (50.56%) also contacted local leaders for information on ICDS. Nearly one-third of the Anganwadi workers (33.87%) wrote letters to Mukyasevika. A negligible percentage of the Anganwadi workers wrote letters to Gramsevika, contacted Grampanchayat members and village level workers, for seeking information about ICDS related activities.

Regarding group contact, information sources, cent per cent Anganwadi workers attended meetings both at circle and project head quarter and had a meeting and group discussion with Mukhyasevika. An overwhelming majority of the Anganwadi workers (97.22%) reported that they have undergone trainings for detail information about ICDS and related aspects and tried to obtain graphs and charts related to ICDS practices (83.34%).A relatively small percentage of Anganwadi workers attended seminars and visited exhibitions for information on ICDS.

The use of mass media sources further shows that cent per cent Anganwadi workers tried to acquire posters for information on ICDS. The majority of the Anganwadi workers stated that for getting information about ICDS, they used to read news papers (91.11%), watch television information (91.11%), and listen radio programmes(56.11%). A meagre percentage of the Anganwadi workers watched movie films on nutrition and health practices. Vijaylaxmi (1993) also noted that newspapers and radio programmes were the important sources of information to Anganwadi Workers.

2. Determinants of information source use

The correlational analysis between socio-personal and psychological characteristics of Anganwadi workers with information source used indicated that the experience of an Anganwadi workers was negatively (r = -0.147) and job satisfaction positively (r = 0.211) and significantly related with information source use. No other characteristic was observed to be significant in relation with information source use. Shridhar and Reddy (1980) have also reported similar results. This shows that lesser the experience and more the job satisfaction higher was the information source and use on the part of Anganwadi workers to seek information about ICDS. With a view to promote information source use and improve information seeking about ICD. With a view to promote information source use and improve information seeking about ICD practices on the part of Anganwadi workers, there is a need for enhancing their job satisfaction by providing needed facilities and opportunity to use various information sources for obtaining information about ICDS activities.

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Constraints in Adoption of University Recommended Rice Production Technology

Agriculture is the back bone of Indian economy,nearly 65 to 70 per cent of population is engged in agriculture and its allied activities. Whatever the technology is generated in the laboratory is not generally accepted by farmers fully in all respects so that there is a gap between what is the recommendation and its adoption at farmer's level.

The Sakoli Panchayat Samiti of Bhandara district has more area under irrigated rice than any Panchayat Samiti of the district. In this region rice is taken as the monocrop year after year. The farmers are facing the problem of adopting recommended rice production technology. The present investigation aims to ascertain constraints faced by the farmers while adopting the recommended rice production technology.

The study was undertaken in Sakoli Panchayat Samiti of Bhandara district of Maharashta state. Out of 96 villages in Sakoli Panchayat Samiti 10 villages were selected having larger area under irrigated rice crop. Total 150 farmers were selected from 10 villages by random sampling method.

An interview schedule relevant to study objective was developed and pre tested. The data were collected through face to face contact method by contacting the selected farmers personallly. The constraints were received with respect to various recommended package of practices of rice production

Table 1. Distribution of respondents according to constraints encountered by them in adoption of rice production technology

S.N.	Constraints	Frequency (n = 150)	Percentage*
A)	Land preparation		
1.	Lack of labour/skill labours	67	44.66
2.	Lack of moisture in soil	28	18.66
B)	Composting and manuring		
1.	Seeds are not available at time	23	15.33
2.	Unavailability of FYM	55	36.66
3.	High cost of seed sunhemp	26	17.33
4.	Lack of knowledge about sunhemp	22	14.66
C)	Raised bed		
1.	Lack of knowledge about size of bed	36	24.00
2.	Unavailability of labour	16	10.66
D)	Variety		
1.	High cost of improved variety seed	71	47.33
2.	Not available at time (Shop/farm)	7	4.66
E)	Seed rate		
1.	Seed rate is not known	58	33.66
F)	Seed treatment		
1.	Procedure not known	30	20.00
2.	Benefit not known	42	28.00
G)	Transplanting		
1.	High wages	95	63.33
2.	Unavailability of tractor	46	30.66
3.	Unavailability of labour/skill labour	69	46.60
4.	Per acre seedlings are not known	82	54.66
5.	Unavailability of seedlings at the time of transplanting	17	11.33
H)	Fertilizer application		
1.	High cost of fertilizer	78	52.00
2.	Problem of money	82	54.66
3.	Doses are not known	5	3.33
4.	Unavailability of fertilizer (Shop/society)	26	17.33

Cont.....

I)	Water management		
1.	Problem due to heavy rainfall	42	2800
2.	Water not available at last/need	59	39.33
3.	Water level is not known	23	16.66
4.	Delay in getting water (from various sources)	15	10.00
J)	Interculture		
1.	Unavailability of labour (skill) for weeding/spraying	44	29.33
2.	Lack of knowledge about weedicide	65	43.33
K)	Insect pests and disease management		
1.	Unavailability of equipment (spraying)	61	40.66
2.	High cost of pesticide	83	55.33
3.	Delay in getting insecticide from Panchayat Samiti	35	23.33
4.	Lack of guidance about IPDM/DM	59	39.33
5.	Lack of knowledge about IPDM/DM	32	21.33
L)	Harvesting and Threshing		
1.	Unavailability of threshing machine	61	40.66
2.	Delay in harvesting due to labour	13	8.66
M)	Other		
1.	Natural calamity	59	39.33
2.	Low-market rate	102	68.00
3.	Problem in getting loan	45	30.00
4.	Delay in getting money from merchants	53	35.33
5.	Delay in selling of paddy in society or market	32	21.33

* The sum of percentage is more than 100 due to mutiple responses

technology. The data were analyzed with the help of frequency and percentage.

From Table 1 it is observed that most important constraints emerged as low market rate of crop (68.00%), followed by high wages during transplanting of crop (63.00%) and high cost of pesticide (55.33%) and problem of money during purchase of fertilizer (52.00%) were the major constraints.

The practice wise constraints are discussed in the following lines -

As regards the land preparation 44.66 per cent of farmers experienced the constraints of lack of labour or skilled labours, followed by lack of moisture in soil (18.66%). The supplementary fertilizers, unavailability of FYM was the major problem (36.66%), followed by high cost of seed (17.33%).Whereas the lack of knowledge about sunhemp (9.33%) were the minor constraints faced by rice growers. As regards the raise bed, lack ofknowledge about size of bed was found to be major constraint (14.66%), followed by unavailability of labour (10.66%). High cost of improved variety seed was found to be major (47.33%) constraint in adoption of recommended rice production technology, followed by non availability of seed at a time. About 1/3 of the respondents had no knowledge of the exact seedrate to be used for rice production.

As regards seed treatments 28 per cent respondents expressed that the benefit of seed not known, followed by 20 per cent of them expressing that the procedure of application was not known to them. Majority of respondents expressed constraints as high wages during transplanting (63.33%), followed by unavailability of labour or skill labour (46.00%), unavailability of tractor (30.66%). Only 11.33 per cent respondents expressed unavailability of seedling at the time of transplanting. More than fifty per cent of respondents (54.00%) money problem for purchase of fertilizer, followed by high cost of fertilizers (52.00%) and unavailability of fertilizers in shop or society (17.33%). Majority of respondents expressed that water was not available at the time of need (39.33%). The problem due to heavy rainfall was also constraint for 28.00 per cent of respondents. Lack of labour or skilled labour for weeding and spraying (29.33%) were the major constraints regarding interculture. Only 8 per cent respondents expressed lack of knowledge about weedicide.

As regards the practices of insect pest and disease management, the high cost of pesticide was fund to be major (55.33%) constraint, followed by unavailability of spraying equipments (40.66%), lack of guidance about IPDM/DM (39.33%) and lack of knowledge about IPPM/DM (24.66%). Unvailability of threshing machine was found the major constraint (40.66%) for harvesting and threshing practices. Only 8.66 per cent respondents expressed as a constraint

of delay in harvesting due to labours. Low market rate was found to be the major constraint (68.00%) regarding the adoption of recommended rice production technology, followed by natural calamity (39.33%), delay in getting money from merchants (35.33%) and problem of getting loan (30.00%). In order to increase the adoption of rice technology it is necessary to pay attention to these constraints. This will help in adoption of the technology and increasing production.

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Evaluation of Different Wheat Strains Against Alternaria Leaf Blight Disease

Different 120 wheat strains were screened under artificial epiphytotic conditions at Wheat Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Rabi* season of 1998-99 against Alternaria leaf blight disease.

Alternaria leaf blight is the major disease in irrigated wheat in Vidarbha. It was first reported by Kulkarni (1924) and Mc. Rae (1924). The losses of grain yield upto 25 to 40 per cent were recorded when infection of alternaria leaf blight occurs at tillering and boot stage.

The wheat strains were inoculated with spraying conidial suspension of *Alternaria triticina* at boot stage (40-45 DAS) and the plot was heavily irrigated in the evening to ensure high humidity. Sufficient himidity was maintained by giving frequent

Table 1. Reaction of different wheat strains against Alternaria leaf blight disease

S.N.	Disease intensity (%) (PDI)	Reaction	Total no. of strains	Name of wheat strains
1.	0	Free from disease (F)	9	KAAW 3717, AKAW 2875-2, AKDW 3422, AKAW 3133-4, AKAW 2982, AKAW 3442, AKAW 3469, AKAW 3339, AKAW 2646,
2.	1 to 10	Resistant (R)	48	NKAW34, AKAW 2884-1, AKAW 1041-1, AKAW 2862-2, AKAW 2883, AKAW 1041-2, AKDW-3114, AKDW 2841- 3, AKAW 2745-1, AKDW2835-1, AKAW 2646, AKDW 284-2, AKAW2984-3, AKAW 3491, AKDW2835-5, AKAW3259-1,AKAW2344, AKAW3192, AKAW3297, AKAW3469, AKDW4312, AKAW 3452, AKAW2835-7, AKAW 2800, AKAW 2860-1, AKAW 2899, AKAW 1071,AKDW 2985-1, AKAW2994-2, AKAW 2866-1, AKAW 3260, AKAW 3463, AKDW 3416, AKAW 3457, AKAW 3459, AKAW 3719, AKAW 3294, AKAW 3060, AKAW 2846-3-3, AKAW 3725, AKAW 2984-10-10, AKAW 2264, AKAW 3131-3, AKAW 2978-2.
3.	11 to 25	Moderately resistant (MR)	40	HD 2610, DWR 162, HD 2189, DWR 195, HI 977, AKAW 2984-4, AKAW 2784-1, AKAW 2862, AKAW 2946 AKAW 3169, AKAW 2878, AKAW 2972, AKDW 2835-4, AKAW 2956, AKAW 2520, AKAW 3244, AKAW 534-21-1, AKDW 2982-1, AKDW 3244, AKAW 534-21-1, AKDW 2982-1, AKDW 3258-3, AKAW 2697, AKAW 3244-1, AKAW 2665, AKAW 3252-1, AKAW 2988-4, HD 1553, AKAW 2839-4, AKAW 2892, AKAW 3072, AKAW 2248, AKAW 2839-5, AKAW 1949, AKAW 1811, AKAW 3403, BARC-PKV-83-7, AKDW 2997-6, AKAW 2981-21-1-6, AKAW 2989-8-1-4, AKAW 2847-7-3, AKAW 3125-4.
4.	26 to 50	Moderately susceptible (MS)	18	MACS 2496, AKW 381, AKAW 3158-4, AKAW 499-1, AKAW 2747, AKAW 2984-2, AKAW 3259-2, AKAW 374-3-2-1, AKAW 2860-2, AKAW

				3294, AKAW 2984-1, AKAW 2860-2, AKAW 3294, AKAW 2984-1, AKAW 3508, AKAW 3260, AKDW 2841-4, AKAW 3464, AKAW 2979-4, AKAW 3724, AKAW 2978-12.
5.	51 to 75	Susceptible (S)	3	AKAW 2602, AKAW 2848-3-9, AKDW 2839-6
6.	Above 75	Highly susceptible (HS)	2	AKAW 3139, AKAW 2980-2 Check Vijay

irrigation to the plot. The observations regarding leaf blight incidence was recorded as per modified scale (Nayar, 1997) and the per cent disease index (PDI) were calculated as per formula suggested by Kotasthane and Agrawal, 1976.

$$PDI = \frac{\text{Sum of all numerical values}}{\text{Total Plants/ Leaves observed x maximum rating}} \times 100$$

As per PDI values, wheat strains were grouped in six different categories.

In the present investigation, 120 wheat strains were screened against Alternaria leaf blight under artificial inoculation conditions. The results (Table 1) revealed that only 9 strains were found free from the disease, while 48 strains showed resistant reaction, 40 moderately resistant, 18 moderately susceptible, 3 strains viz. AKAW 2602, AKAW 2848-3-9 and AKDW 2839-6 susceptible and two strains viz. AKAW 3139 and 2980-2 were found highly susceptible to leaf blight disease of wheat. Patil (1976), Ahmad and Singh (1993), Singh *et. al.*, (1990) and Shivankar and Lokhande (1993) also reported the results and tested different set of wheat entries. Disease free and resistant wheat cultivar observed against Alternaria leaf blight can be used as a source of resistant material in breeding programme.

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Phytochemical Analysis of Aqueous Extracts of Few Medicinal Plants

The Indian flora offers a variety of plants having medicinal properties, these plants can be exploited to find out effective alternatives to synthetic drugs. It is well known that the pharmacologically active principles in plants vary from species to species and/or genus to genus. It may also be due to variation in the water solubility of the active principles in different plants. The present qualitative phytochemical analysis of the aqueous extracts was carried out to know the broad chemical nature of the active principles.

The present investigation involves quantitative phytochemical analysis of seven medicinal plants. The various plant materials used were seeds of *Artemisia maritima, Butea frondosa, Nigella sativa*, barks of *Azadirachta indica, Ocimum sanctum* and fruits of *Embelia ribes* and *Piper longum*. The above plant materials were collected from Nagarjuna Vanaushadhi Udyan, Dr. PDKV, Akola and M/s Amarsing Thakur, Akola, shade dried at room temperature, powdered and sieved. The aqueous extract was presented by adding 100 g powder of each of the seven plant materials in one litre of distilled water in different flasks and boiled on a hot plate till the contents of the flasks reduced to half. The contents were then cooled and filtered through muslin cloth, so as to remove the insoluble material. The filtrate thus obtained was again filtered through ordinary filter paper and evaporated completely on a hot plate in a clean dry petridish. Care was taken to avoid charring.

Qualitative phytochemical analysis of the extracts was carried out for presence of active principles, namely alkaloids, amino acids, anthraquinones, flavonoids, glycosides, proteins, resins, saponins, sterols and tannins using various chemical tests described by Rosenthaler (1930).

The results of various qualitative phytochemical tests carried out using the aqueous extracts of all the seven plant materials are summarized in Table 1.

The seeds of *A. maritima* indicated presence of alkaloids, flavonoids, saponins, sterols and tannins. The neem bark extract showed presence of saponins and tannins. Alkaloids, resins, sterols and tannins were detected in the extract of *B. frondosa* seeds. The fruits of *E. ribes* were positive for glycosides, saponins and tannins. The seed of *N. sativa* revealed presence of resins, sterols and tannins. The *Ocimum sanctum* bark extract showed presence of anthraquinones and tannins. Whereas *P. longum* fruit extract showed presence of tannins only.

Earlier reports confirm the presence of flavonoids in *A. maritima* (Hazmi and Basha, 1991), glycosides (Nadkarni, 1954) and sterols (Pund, 2000) in *N. sativa* as observed in the present study. Contrary to the present observations alkaloids were detected in *A. indica, E. ribes* and *P. longum* (Nadkarni, 1954).

Table 1. Results of qualitative phytochemical analysis of aqueous extracts of medicinal plants

S.N.	Active principle	Medicinal plant species						
		A. maritima	*A. indica*	*B. frondosa*	*E. ribes*	*N. sativa*	*O. sanctum*	*P. longum*
1.	Alkaloids	✓		✓				
2.	Amino acids							
3.	Anthraquinones						✓	
4.	Flavonoids	✓						
5.	Glycosides				✓			
6.	Proteins							
7.	Resins			✓		✓		
8.	Saponins	✓	✓		✓			
9.	Sterols	✓		✓		✓		
10.	Tannins	✓	✓	✓	✓	✓	✓	√

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Taley, Y.M., B.S. Rajurkar and K.R. Thakare, 1981. Bionomics of *Atherigona soccata* Rondani (Diptera : Anthomyidae) PKV Res. J. 5(1) : 62-68.

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